Natura Impact Statement

Coolglass Windfarm NIS

Prepared by:

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Making Sustainability Happen

Revision Record

Revision	Date	Prepared By	Checked By	Authorised By
1.0	10 February 2023	Michelle Robertson	Richard Arnold and Jonathon Dunn	N/A
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1.0 Introduction

1.1 Project Overview

The proposed Coolglass Wind Farm Project consists of the following elements, described in summary here and in more detail at stage 2 in section 4.1:

- Turbines and associated infrastructure;
- Turbine Delivery Route;
- Cable Routes; and
- Recreational Amenity trail.

The proposed wind farm is located approximately 11km southeast of Portlaoise, 14km northwest of Carlow and 11km east of Abbeyleix. The Project site includes lands contained within the following townlands: Fossy Upper, Aghoney, Gorreelagh, Knocklead, Scotland, Brennanshill, Monamantry, Coolglass, Crissard, Kylenabehy, County Laois (refer to Appendix 1 for location of the Project).

For the NIS, the Project is everything except the recreational Amenity trail described above, and due to the legislative context the 'Proposed Development' is referred to as the 'Project' for this report only. Further detail of the Project is provided in stage 2, refer to section 4.1.

The planning application for the wind farm will be submitted with a supporting Environmental Impact Assessment Report, based on, *inter alia*, ecology survey work undertaken in 2021 and 2022. Full detail of ecological survey is provided in Stage 2, refer to section 4.4.1

1.2 Relevant Legislation

The Habitats Directive (Council Directive 92/43/EEC on the Conservation of Natural Habitats and of Wild Fauna and Flora) requires all Member States to establish a strict protection regime for species listed in Annex IV, both inside and outside European sites and forms the basis for the designation of Special Areas of Conservation (SACs) and a precursor designation Sites of Community Interest (SCI). Similarly, Special Protection Areas (SPAs) are classified under the Birds Directive (Council Directive 2009/147/EEC on the Conservation of Wild Birds). Collectively, SACs, SCIs and SPAs are referred to as European Sites. The European Sites Network is the minimum required to conserve certain habitats and species which are listed in the Directives.

Under Article 6(3) of the Habitats Directive, an Appropriate Assessment (AA) must be undertaken for any plan or project that is not directly connected with or necessary to the management of a Natura 2000 site but is likely to have a significant effect thereon, either individually or in combination with other plans or projects. An AA is an evaluation of the potential adverse effect of a plan or project alone or in combination with any other plan or project on the conservation objectives and therefore integrity of a European site, and the identification, where necessary, of mitigation or avoidance measures to preclude adverse effects on the integrity of the site.

Article 6, paragraph 3 of the European Commission Habitats Directive 92/43/EEC ("the Habitats Directive") as defined above states that:-

"Any plan or project not directly connected with or necessary to the management of the site but likely to have a significant effect thereon, either individually or in combination with other plans or projects, shall be subject to appropriate assessment of its implications for the site in view of the site's conservation objectives. In the light of the conclusions of the assessment of the implications for the site and subject to the provisions of paragraph 4, the competent national authorities shall agree to the plan or project only after having ascertained that it will not adversely affect the integrity of the site concerned and, if appropriate, after having obtained the opinion of the general public".

1.2.1 Planning and Development Act 2000 (as amended)

These processes have been further enshrined in the Planning and Development Act 2000 (as amended), in sections 177T, 177U and 177V, which are as follows:

- s177T(1)(b) A Natura impact statement means a statement, for the purposes of Article 6 of the Habitats Directive, of the implications of a proposed development, on its own or in combination with other plans or projects, for one or more than one European site, in view of the conservation objectives of the site or sites.
- (2) Without prejudice to the generality of subsection (1), a Natura impact report or a Natura impact statement, as the case may be, shall include a report of a scientific examination of evidence and data, carried out by competent persons to identify and classify any implications for one or more than one European site in view of the conservation objectives of the site or sites.
- 177U. — (1) A screening for appropriate assessment of a draft Land use plan or application for consent for proposed development shall be carried out by the competent authority to assess, in view of best scientific knowledge, if that Land use plan or proposed development, individually or in combination with another plan or project is likely to have a significant effect on the European site.
- (4) The competent authority shall determine that an appropriate assessment of a draft Land use plan or a proposed development, as the case may be, is required if it cannot be excluded, on the basis of objective information, that the draft Land use plan or proposed development, individually or in combination with other plans or projects, will have a significant effect on a European site.
- s177U(5): The competent authority shall determine that an appropriate assessment of a draft Land use plan or a proposed development, as the case may be, is not required if it can be excluded, on the basis of objective information, that the draft Land use plan or proposed development, individually or in combination with other plans or projects, will have a significant effect on a European site
- 177V. — (1) An appropriate assessment carried out under this Part shall include a determination by the competent authority under Article 6.3 of the Habitats Directive as to whether or not a draft Land use plan or proposed development would adversely affect the integrity of a European site and an appropriate assessment shall be carried out by the competent authority, in each case where it has made a determination under section 177U(4) that an appropriate assessment is required, before — … (b) consent is given for the proposed development.
- 177V. – (2) In carrying out an appropriate assessment under *subsection (1)* the competent authority shall take into account each of the following matters: (*a*) the Natura impact report or Natura impact statement, as appropriate; (*b*) any

supplemental information furnished in relation to any such report or statement; (*c*) if appropriate, any additional information sought by the authority and furnished by the applicant in relation to a Natura impact statement; (*d*) any additional information furnished to the competent authority at its request in relation to a Natura impact report; (*e*) any information or advice obtained by the competent authority; (*f*) if appropriate, any written submissions or observations made to the competent authority in relation to the application for consent for proposed development; (*g*) any other relevant information.

1.3 Purpose of Report

The purpose of this Natura Impact Statement (NIS) is to provide the information for the competent authority, in this case An Bord Pleanála, to carry out a screening assessment and, if applicable, an Appropriate Assessment (AA) of the Project, in accordance with and fulfilment of the requirements of Article 6 of the Habitats Directive.

1.4 Statement of Authority

Richard Arnold

This NIS has been reviewed by Richard Arnold BSc MRes MCIEEM CEnv. Richard has over 24 years of experience as a professional ecological consultant. This experience includes work on some of the largest development projects in the UK and Ireland, as well as some work in the Middle East. Richard has worked on projects in most development sectors, including pipelines, cable routes, railways, roads, urban regeneration, ports, power stations and renewable energy projects, such as wind farms, and at all stages of the development process, from design to completed development.

Jonathon Dunn

This NIS has been reviewed by Jonathon Dunn MA (Cantab.) MSc PhD MCIEEM. Jonathon also undertook habitat surveys, mammal surveys, bat surveys and co-ordinate the bird surveys. Jonathon has worked in the environmental sector since 2014 and joined SLR Consulting in 2021. Prior to working in environmental consultancy, he used to undertake research at Newcastle University on avian ecology and conservation. He holds a PhD in avian ecology from Newcastle University, a MSc in Ecology, Evolution and Conservation from Imperial College London and a MA (Cantab.) in Natural Sciences from the University of Cambridge. Jonathon has extensive experience managing bird surveys. Jonathon has worked on a wide variety of projects with a focus on wind farms.

Michelle Robertson

This NIS has been written by Michelle Robertson BSc Hons Dunelm, MSc MCIEEM. Michelle is an associate ecologist at SLR Consulting Ltd and has 14 years of ecological experience with a specialism in ornithology, which includes preparing and overseeing assessments under the Habitats Regulations/Directive for multiple projects, including small and large infrastructure projects.

Sinéad Clifford

Habitat surveys, mammal surveys and the bat surveys (including call analysis) were undertaken by Sinéad Clifford BSc (Hons). Sinéad has worked in the environmental sector since 2015 and joined SLR Consulting in 2021. She holds a BSc. in Wildlife Biology from Institute of Technology Tralee, and a Certificate (Distinction) in Ecological Consultancy from Ecology Training UK (formerly Acorn Ecology). Sinéad has strong field skills, and regularly carries out bat, ornithological, botanical and mammalian surveys. In addition, she has extensive experience managing bat surveys for large scale projects, including wind energy developments.

Michael Austin

The collision risk modelling report was written by Michael Austin. Mike is a Senior Consultant (in Ecology) with SLR. He has over 30 years' experience within ecology and ornithology, both in conservation and consultancy. He has experience of ECoW work at a number of sites (predominantly at wind farms but also in other sectors). He holds a CSCS card for working on construction sites. Mike has managed a wide range of major Environmental Impact Assessment projects for infrastructure developments throughout the UK, in particular within the renewables industry. Since 2007 Mike has project managed a range of major Environmental Impact Assessments for wind farms and other developments. In addition to this he is proficient in data management systems and GIS. Prior to joining SLR, he held a number of positions as a consultant within RPS Planning and Development and Ecology UK. Before joining the consultancy industry Mike worked within conservation on species recovery projects and habitat management, for RSPB and local wildlife trusts.

Ross Macklin

The aquatic ecology and fisheries reports (**Appendix 3**) were written by Ross Macklin PhD (in preparation) B.Sc. (Hons) MCIEEM., MIFM, HDip GIS, PDip IPM (Principal ecologist with Triturus Environmental Ltd). Ross is an ecologist with over 16 years' professional experience in Ireland. He specialises in freshwater fisheries ecology, biology and water quality. He has considerable experience in a wide range of ecological and environmental projects including EIAR, EcIA, AA/NIS, CEMP reporting, as well as biodiversity, water quality monitoring, invasive species and fisheries management. He also has expert identification skills in macrophytes, freshwater invertebrates, protected aquatic habitats and protected aquatic species including freshwater pearl mussel.

2.0 Methodology

2.1 General Approach

The methodology used in this report is based on and in accordance with guidance provided by the National Parks and Wildlife Service (NPWS 2010), the Office of the Planning Regulator (OPR 2021) and EC Guidance (EC 2018) (EC 2020) (EC 2021) on the application of Article 6 of the Habitats Directive. The 2021 EC guidance describes a series of stages and steps which should be completed when carrying out the assessment and these are followed here with the addition of sub-headings for further clarity. The assessment applies only to European Sites. More specifically, it only applies to the qualifying interest features of such sites i.e., the features which are the reason that the site was designated.

2.2 Stage One: Screening

The purpose of the screening stage is to determine, on the basis of a preliminary assessment and objective criteria, whether a plan or project, alone and in-combination with other plans or projects, could have significant effects on a Natura 2000 site in view of the site's conservation objectives.

There is no necessity to establish such an effect; it is merely necessary for the competent authority to determine that there may be such an effect. The need to apply the precautionary principle in making any key decisions in relation to the tests of Appropriate Assessment (AA) has been confirmed by the case law of the Court of Justice of the European Union (CJEU). Plans or projects that have no appreciable effect on a European site may be excluded. The threshold at this first stage is a very low one and operates as a trigger in order to determine whether a Stage Two AA must be undertaken by the competent authority on the implications of the proposed development for the conservation objectives of a European site. Therefore, where significant effects are likely, uncertain or unknown at screening stage, a second stage AA will be required.

2.3 Stage Two: Appropriate Assessment

A Stage Two AA is a focused and detailed examination, analysis and evaluation carried out by the competent authority of the implications of the plan or project, alone and in-combination with other plans and projects, on the integrity of a European site in view of that site's conservation objectives. Case law has established that such an Appropriate Assessment, to be lawfully conducted, in summary:

(i) must identify, in the light of the best scientific knowledge in the field, all aspects of the proposed development which can, by itself or in-combination with other plans or projects, affect the conservation objectives of the European site;

(ii) must contain complete, precise and definitive findings and conclusions and may not have lacunae or gaps; and

(iii) may only include a determination that the proposed development will not adversely affect the integrity of any relevant European site where the competent authority decides (on the basis of complete, precise and definitive findings and conclusions) that no reasonable scientific doubt remains as to the absence of the identified potential effects. If adverse impacts can be satisfactorily avoided or successfully mitigated at this stage, so that no reasonable doubt remains as to the absence of the identified potential effects, then the process is complete. If the assessment is negative, i.e. adverse effects on the integrity of a site cannot be excluded, then the process must proceed to stage three and, if necessary, stage four.

2.3.1 Sources of Information

Sources of information for the assessment of the Project 'alone' include:

- Coolglass Wind Farm Ltd (2023) Coolglass Wind Farm Environmental Impact Assessment, especially Chapters 3, 9 and 15 (this includes all desktop study information);
- SLR (2022) Coolglass wind farm breeding and non-breeding season bird reports 2021- 2022 (**Appendix 2**);
- SLR (2022) Coolglass wind farm breeding bird report 2022 (**Appendix 2**);
- SLR (2022) Coolglass wind farm Collision Risk Model (**Appendix 2**);
- Non-breeding season 2017/18 bird survey data collected by Fehily Timoney and Company (**Appendix 2**);
- Triturus (2022). Aquatic baseline report for Coolglass wind farm, Co. Laois. Report prepared by Triturus Environmental Ltd. for SLR Consulting. December

2022.Triturus (2022). Fisheries assessment of Coolglass wind farm, Co. Laois. Report prepared by Triturus Environmental Ltd. for SLR Consulting. December 2022 (**Appendix 3**); and

- Site Synopses, Conservation Objectives and Standard Data Forms for European Sites[1].

Sources of information for the plans and projects for the "in combination" assessment were as above and also include:

- Cullenagh Wind Farm (2013), Environmental Impact Statement[2]
- Pinewoods wind farm (2017) Natura Impact Statement[3];
- Farranrory Wind Farm Natura Impact Statement[4]
- Bilboa Wind Farm (2011) Natura Impact Statement[5]
- Gortahile Wind Farm Environmental Impact Statement[6]
- Lisdowney Wind Farm (2012)Environmental Impact Statement[7]
- White Hill Wind Farm (2023) Galtech Energy Services, Natura Impact Statement[8]
- Spink quarry (2022) Appropriate assessment screening[9];
- Bord Na Móna Powergen Ltd.(2020) Natura Impact statement[10]
- Michael Johnson (2020) Planning report [11]
- Laois County Development Plan 2021 - 2027[12];
- Kilkenny City and County Development Plan 2021 - 2027[13];
- National Biodiversity Action Plan[14]; and

[1] https://www.npws.ie/protected-sites Accessed 28/07/2023

[2] Collite (2013) Cullenagh wind farm Environmental Impact Statement Accessed 28/07/2023

[3] EcoFact Environmental Consultants (2017) Pinewoods Wind Farm Natura Impact Statement Accessed 28/07/2023

[4] Doherty Environmental (2021) Natural Impact Statement Farranrory Wind Farm Electrical Cable Route Accessed 28/07/2023

[5] Conservation Services (2011) NIS for proposed wind farm at Bilboa, County Carlow. Accessed 28/07/2023

[6] EcoPower Development ltd. (2004) Gortahile Wind Farm Proposal Environmental Impact Assessment. Accessed 28/07/2023

[7] Lisdowney wind farm (2012) Environmental Impact Assessment Accessed 28/07/2023

[8] Galtech Energy Services (2023) Natura Impact Statement White Hill Wind Farm Accessed 28/07/2023

[9] Lagan (2022) Appropriate Assessment Screening Accessed 28/07/2023

[10] Boar na Mona (2019) Natura Impact Statement for the proposed Renewable Gas facility at Cuil na Mona, Portlaoise, Co. Laois. Accessed 28/07/2023

[11] Laois County Council (2002) Michael Johnson planning report http://plandocs.laois.ie/iDocsWeb/ViewFiles.aspx?docid=331201&format=djvu Accessed 28/07/2023

[12] https://laois.ie/departments/planning/review-of-laois-county-development-plan-2017-2023-2/ Accessed 28/07/2023

[13] https://www.kilkennycoco.ie/eng/services/planning/development-plans/city-and-county-development-plan/ Accessed 28/07/2023

[14] https://www.npws.ie/sites/default/files/publications/pdf/National%20Biodiversity%20Action%20Plan%20English.pdf Accessed 28/07/2023

- Regional Spatial and Economic Strategy 2020-2032 (RSES)[15].

2.4 Consultation

A consultation response of relevance to biodiversity was received from the Department of Housing, Local Government and Heritage and this was fully considered in the formation of this statement. The consultation response and how it has been addressed is provided in **Table 2-1**.

Table 2-1 Response to consultation comments

Consultee	Date of first consultation	Consultee's Comments	Response
An Tasice	06/7/2022	No response	None required
BirdWatch Ireland	06/7/2022	No response	None required
Department of Agriculture, Food and the Marine	06/7/2022	No response	None required
Department of Arts, Heritage, Regional and Rural and Gaeltacht Affairs – Development Applications Unit (Nature Conservation)	06/7/2022	No response	None required; sent follow-up email on 17/06/2022 but no response provided.
EPA	06/7/2022	No response	None required
Inland Fisheries Ireland	06/7/2022	Required the following of surveys: • Must demonstrate how Proposed Development will cause no deterioration to named waterbodies; and • Baseline ecological assessments of watercourses potentially affected by Proposed Development including physico-chemical surveys. Required the following reporting: • Must demonstrate how Proposed Development will cause no deterioration to named waterbodies; • Map of all aquatic habitats potentially affected by project;	EIAR Chapter 9 'Water' demonstrates that the Proposed Development will cause no deterioration to named waterbodies. Undertook baseline ecological and hydrological surveys following IFI guidance for wind farm developments including physico-chemical surveys. All aquatic habitats potentially affected by the Proposed Development are mapped in the current Chapter, which is accompanied by a detailed aquatic ecology and fisheries report (**Appendix 3**) that shows the locations of Annex 1 freshwater habitat. An assessment of all potential adverse effects on relevant

15 https://www.nwra.ie/rses/#:~:text=Regional%20Spatial%20and%20Economic%20Strategy%202020%2D2032%20(RSES)&text=The%20RSES%20introduces%20the%20concept,we%20need%20effective%20regional%20planning. Accessed 28/07/2023

Consultee	Date of first consultation	Consultee's Comments	Response
		• Assessment of all potential adverse effects on all relevant aquatic receptors including River Barrow and River Nore SAC; and • Impact assessment should also include all other existing/approved Projects cumulatively. Required the following mitigation/monitoring: • Field testing and laboratory analysis of parameters to be undertake at agreed sites according to specific criteria during construction; • Records of monitoring before, during and after works; • Adherence to 'Guidelines on Protection of Fisheries during Construction Works in an advance to Waters 2016'; • Restrictions on timing of instream works and no interference with watercourses without IFI agreement and method statement; • Minimisation of new water crossings. Alteration of existing crossings should improve habitats and biodiversity net gain with IFI consultation; • Inclusion of CEMP, SWMP, EMP for EIAR and NIS, including EM and ECoW for works; and • SuDS principles for SWMP and installation of drainage in dry conditions.	aquatic receptors is included in the EIAR chapter, which is accompanied by the current NIS which includes an assessment of all potential effects on relevant aquatic receptors for Natura 2000 sites (including the River Barrow and River Nore SAC). Both this chapter and the NIS consider cumulative effects from other existing/approved projects. The mitigation/monitoring regime for the Project as pertains to aquatic ecology is described in the EIAR biodiversity chapter 15. The Construction and Environmental Plan (CEMP), Surface Water Monitoring Plan (SWMP, which includes SuDS principles) and Ecological Monitoring Plan (EMP) are shown in **Appendix 5**. All monitoring and mitigation measures adhere to the IFI requirements and will be implemented in full.
Irish Peatland Conservation Council	06/7/2022	No response	None required
Irish Raptor Group	06/7/2022	No response	None required
Irish Red Grouse Association	06/7/2022	No response	None required
Irish Wildlife Trust	06/7/2022	No response	None required
Kilkenny County Council	06/7/2022	The River Barrow and River Nore SAC, which is designated Natura 2000 site, is located close to the	Impacts on the River Barrow and Rive Nore SAC were assessed in the NIS. This concluded that with

Consultee	Date of first consultation	Consultee's Comments	Response
		proposed wind farm and the associated NIS should ensure that there shall be no significant impact on the conservation objectives of the Natura 2000 site [sic]. The EIAR shall also address potential impacts pertaining to County Kilkenny in addition to County Laois.	mitigation the conservation objectives of this Natura 2000 site would not be undermined and there were no likely significant effects on this Natura 2000 site from the Proposed Development, alone or in combination with any other plan or project. The current chapter examines potential impacts on County Kilkenny as well as County Laois.
Laois County Council	06/7/2022	With respect to AA, refer to DOEHLG AA of Plans and Projects in Ireland Guidance for Planning Authorities (2009) and Court Ruling (case C-323/17 People Over Wind and Peter Sweetman v Coillte) whereby CJEU ruled that mitigation measures could not be taken into account at screening stage of an AA	Mitigation measures are not included in the AA screening stage.
South Eastern River Basin Districtiion	06/7/2022	No response	None required
Waterways Ireland	06/7/2022	No response	None required

3.0 Stage 1: Screening

The Appropriate Assessment screening assessment must not take into account any mitigation measures (People Over Wind and Peter Sweetman v Coillte Teoranta [2017] IEHC 171) and specific wording should be used: "Measures intended to avoid or reduce the harmful effects of the proposed development on European sites" (i.e. "mitigation measures") or best practice measures have not been taken into account in the screening stage appraisal.

3.1 Step 1: Management of European sites

The Project is the construction, operation and decommission of a proposed wind farm. Therefore, it is not connected with, or necessary for, the management of a European site.

3.2 Step 2, Part 1: Brief Project Description

3.2.1.1 Turbines and associated infrastructure

The turbines and their associated infrastructure will consist of:

- 13 no turbines across two clusters – the northern cluster consists of 7 no turbines while the southern cluster consists of 6 no. turbines,
- 110kV on site substation,
- two no. construction compounds to assist in the construction process of the project
- 15.5 km of access tracks connecting the turbines to all associated and ancillary infrastructure
- 1 no. borrow pit to assist in the construction process of the project.

The townlands for this element of the project include: Fossy Upper, Aghoney, Gorreelagh, Fallowbeg Upper, Brennanshill, Scotland, Coolglass, Crissard, Kylenabehy, Co. Laois.

This element of the Project comprises part of the development consent currently sought for this planning application. The general layout of the site is shown in **Appendix 1**.

3.2.1.2 Turbine delivery route

Temporary accommodation works to facilitate turbine delivery is proposed within the following townlands: Monamanry, Brennanshill, Aghoney, Baunogemeely, Knocklead, Timahoe, Carrigeen, Ballygormill South, Money Upper, Derrytrasna, Derry, Rathleague, Ballymooney, Rathbrennan, Ballydavis, County Laois.

The Turbine Delivery Route element of the project forms part of the development consent Project currently sought for this planning application . The turbine delivery route assessed as part of this project is found in **Appendix 1**.

3.2.1.3 Cable Routes

Two 110 kV cable routes are to be assessed as part of this EIAR. The preferred underground cable route connecting the proposed wind farm to the national grid will be part of a separate planning application. The two cable routes to be assessed in this EIAR traverse the following townlands:

- Option 1: Under this option, the cable route will exit the proposed onside on-site substation heading south before entering the L3851 (Knocklead Road). From there, the cable will cross the R426 and head south and west along two minor unnamed roads before crossing forestry tracks to the south and joining Pinewoods substation from the north. The length of this cable route is c. 9.9km and crosses the following townlands: Knocklead, Baunogemeely, Knockacrin, Cleanagh, Knockbawn, Garrintaggart, Graiguenahown, Boleybeg and Knockardagur, Co. Laois.
- Option 2: The cable route will exit the proposed onsite substation heading south, before entering the L3851. From there, the route will head north along the R426 for approximately 10km before entering private fields to the Coolnabacky substation. The length of this cable route is c. 10.1km and crosses the following townlands: Aghoney, Fossy Upper, Ballintlea Lower, Fossy Lower, Timahoe, Coolnabacky, Esker, Cremorgan, Carrigeen, County Laois.

The proposed cable routes to be assessed is shown in **Appendix 1**, but do not form part of the planning application.

3.2.1.4 Recreational Amenity Trail

A recreational amenity trail is proposed within the northern cluster of the Project. This trail will utilise an existing trail around and across Fossy Mountain and connect to other existing trails in the vicinity while also linking the town of Timahoe to Fossy Mountain. The proposed recreational amenity trail will traverse the townlands of Fallowbeg Upper, Fossy Upper, Fossy Lower, Clashboy and Timahoe.

Works proposed for this element of the Project comprise

- Minor surface enhancements where required to the existing trails on Fossy Mountain so that the trails are suitable for walking
- The provision of signage throughout the trail
- Minor works from Timahoe town to Fossy Mountain to facilitate safe pedestrian access to the site.

The recreational amenity trail does not form part of the development consent of the Project currently sought for this planning application.

3.2.1.5 Meteorological Mast

The Project will involve the erection of a permanent 102.5m meteorological mast located at ITM coordinates X 656149, Y 687904 and is part of this planning application.

3.2.1.6 Habitats

The dominant habitats within the boundaries of the Project Site are conifer plantation and improved agricultural grassland. There are also numerous eroding/upland rivers including the Fallowbeg Upper, Owveg [Nore], Clogh 15 and Brennanshill. The north of the Project Site is focused on Fossy Mountain, which is a hill, 323m above sea level in height.

Habitats (Annex I)

There are no Annex 1 habitats within the Project Site, identified via walkover survey, refer to **Table 4-5** for methodology.

3.2.1.7 Species (Annes I birds and Annex II others)

Hen harrier (*Circus cyaneus*)

Hen Harrier flight activity was at a very low level throughout the study period (September 2017- March 2018, April 2021 to August 2022, refer to **Appendix 2** for further details). All flights were recorded in winter, suggesting a few birds moving through the wider area while foraging (there was no evidence to suggesting roosting occurred within 2km of the Project Site).

European golden plover (*Pluvialis apricaria*)

During a flight activity survey in the winter of 2021/2022, a peak count of 2,000 golden plover in one flock was recorded. No breeding European golden plover were recorded at or nearby Project Site during breeding wader surveys and the habitat is not suitable breeding habitat for this species. While the winter peak count was indeed large, most of the flight activity was distant from the proposed turbine locations.

Little egret (Egretta garzetta)

There are desktop records for little egrets only, refer to **Appendix 2**, i.e., none were observed during extensive bird surveys undertaken at the Project site.

Merlin (Falco columbarius)

Merlin flight activity was at a low level throughout the study period and were focused in an area that has been dropped from the current Project layout. No breeding merlin were observed during breeding raptor surveys. All flights were recorded in winter, suggesting a few birds moving through the wider area while foraging (there was no evidence to suggesting roosting occurred within 2km of the Project Site).

Peregrine falcon (*Falco peregrinus*)

Four flight activity surveys were carried out with 10 peregrine flights recorded in the 2021 breeding season, six flights in the 2022 breeding season, three flights in the winter of 2017/2018 and seven flights in the winter of 2021/2022. One breeding female was observed at a quarry 3.3km from Project Site, which is greater than the 750m minimum distance required to avoid disturbance.

Red kite (Milvus milvus)

There are desktop records for red kites only.

Marsh fritillary (*Euphydryas aurinia*)

There are desktop records for marsh fritillary only. However, the habitats present were unsuitable for marsh fritillary and so it is likely the desktop record is outside the Project site.

White-clawed crayfish (Austropotamobuis pallipes)

White-clawed crayfish were recorded in small populations in Owveg River (aquatic sampling sites B7 and B8, see **Appendix 3** for site locations) and eDNA confirmed presence at Owveg River (site B10) and Clogh River (site C7). This species is a QI for the River Barrow and River Nore SAC. While small populations were recorded, those along the Owveg and Clogh rivers are near the SAC, so are almost certainly part of SAC populations.

Atlantic salmon (*Salmo salar*)

Atlantic salmon were recorded in low densities at Stradbally River (aquatic sampling site A15; see **Appendix 3** for site locations), and Owveg River (Sites B3 and B10 see **Appendix 3** for site locations). This species is a QI for the River Barrow and River Nore SAC. The only sites where this species was present were within the SAC, so they are part of the SAC population.

Brook lamprey (*Lampetra planeri*)

Brook lamprey were recorded in low densities at Crooked River (site A6; see **Appendix 3** for site locations), Stradbally River (A11 and A15; see **Appendix 3** for site locations), Owveg River (B10; see **Appendix 3** for site locations), and Clogh River (C7; see Appendix 3 for site locations). This species is a QI for the River Barrow and River Nore SAC. The survey sites with the highest densities of ammoecetes (juvenile lampreys) were in the Clogh River, with site C7 near the SAC, so they are highly likely to be part of the SAC population.

River lamprey (Lampetra fluviatilis)

River lamprey were also recorded in low densities at Crooked River (site A6; see **Appendix 3** for site locations), Stradbally River (A11 and A15; see **Appendix 3** for site locations), Owveg River (B10; see **Appendix 3** for site locations), and Clogh River (C7; see **Appendix 3** for site locations). This species is a QI for the River Barrow and River Nore SAC. The survey sites with the highest densities of ammoecetes were in the Clogh River, with site C7 near the SAC, so they are highly likely to be part of the SAC population.

Otter (Lutra lutra)

Despite some good habitat suitability at numerous survey locations, otter signs were only recorded at a total of four sites (see **Appendix 3** for site locations): A12 on the Cremorgan Stream, A14 and A15 on the Stradbally River and site C7 on the Clogh River. A latrine and couch (resting) area were also identified under Stradbally Bridge at site A15. Of these locations, only site A12 is adjacent to the Project (GCR option 2). Sites A14, A15 and C7 are all at least 4km instream distance from the Project.

3.2.1.8 Ecological Connections

Any species using the site that is a QI for a designated site, potentially, hen harrier, white clawed crayfish, otter, lamprey species and Atlantic salmon could use habitat within the Project site and these species would be connected to the relevant designated sites.

3.2.1.9 Hydrology connections

There is hydrological connectivity, via surface and ground water, between the Project site and the River Barrow and River Nore SAC, as both SACs are located downstream of the project, refer to **Drawing 3** for hydrological connectivity and **Table 3-1** for further detail.

3.3 Step 2, Part 2: Potential Impacts

The potential impacts associated with the construction and decommissioning phases of the Project are:

- Damage of habitats and flora during the construction/removal of infrastructure;
- Loss of habitats and reduction in home ranges of qualifying interest species;

- Displacement of qualifying interest species;
- Spread of non- native invasive species to European Sites;
- Disturbance of Annex 1 bird species and their food sources by noise, visual, human disturbance during construction and decommissioning;
- Changes in hydrology (water quality/ quantity); and
- Changes in air quality due to construction and site traffic.

The potential impacts associated with the operational phase of the Project are:

- Mortality of bats and birds through collisions with wind turbines for the period of operation;
- Disturbance and displacement of birds from the area around the wind turbines for the period of operation;
- Reduction of prey availability for some raptors due to displacement of small birds by turbines for the period of operation;
- Disturbance and displacement of birds during routine maintenance operations; and
- Barrier effect, disruption of migratory or other routes used by birds due to avoidance of wind turbines for the period of operation.

3.4 Step 3: Identification of European Sites

DoEHLG (2009)[16] guidelines suggest that a 15 km study area is adopted, but a case-by-case basis is undertaken when assessing the potential for source-receptor connectivity between a project and European Sites.

In this instance, an objective approach was undertaken using birds to establish an initial search area. Birds typically are the most mobile taxonomic group. Therefore, it is likely that ecologically connected sites at greatest remove from a project are those designated for birds i.e. SPAs.

In the absence of any specific European or Irish guidance in relation to establishing ecological connectivity to SPAs, NatureScot guidance (SNH, 2016)[17] was consulted. This document provides guidance in relation to the identification of ecological connectivity between development sites and SPAs. The guidance takes into consideration the distances species may travel beyond the boundary of relevant SPAs and provides information on dispersal and foraging ranges of bird species which are frequently encountered when considering plans and projects. It goes on to state that "in most cases the core range should be used when determining whether there is connectivity between the proposal and the qualifying Interests". Where SPAs and developments are separated by a greater distance than the core foraging ranges for the SPAs listed Special Conservation Interest (SCI) species, there is no likely ecological connectivity to the development.

[16] Department of Environment, Heritage and Local Government (2009) Appropriate Assessment of Plans and Projects in Ireland: Guidance for Planning Authorities https://www.npws.ie/sites/default/files/publications/pdf/NPWS_2009_AA_Guidance.pdf

[17] NatureScot. (2016). Assessing Connectivity with Special Protection Areas (SPAs)

According to NatureScot guidance (SNH, 2016), the core foraging distances of wintering grey geese (greylag goose *Anser anser* and pink-footed goose *Anser brachyrhunchus*) from SPAs is 15-20km. This represents the largest foraging range of all the species listed in this guidance document recorded in Ireland. It is acknowledged that information on core foraging ranges is not available for all Irish SCI species. In such cases, the 15-20km core foraging range for grey geese has been adopted as a precautionary approach.

It also stands to reason that a 20km search distance should be used as an initial starting point when assessing the potential for source-receptor connectivity between a project and European Sites.

Thus, all Natura sites within 20km from the Project were considered for source-receptor connectivity, as recommended by the Office of the Planning Regulator's Practice Note PN01. In some cases i.e. where birds travel long distances, this has been extended. Similarly, hydrological connectivity beyond 20km was also searched for using GIS to identify any European Sites downstream of the Project connected via watercourses.

The Zone of Influence (ZoI) was therefore categorised as 20km, although may be smaller for some pathways and receptors, refer to **Table 3-1**.

The proposed Project site is located within 20km of the following designated sites detailed in **Table 3-1**; the closest is the River Barrow and River Nore SAC which the site would drain into via downstream connectivity. The location of these site is shown in **Drawing 2**.

Table 3-1: Designed Sites within 20km

Site Name and Code	Qualifying Interest Features	Brief Description	Conservation objectives in summary	Direct line distance to site (min- max)	Connections (Source -Pathway – Receptor)
River Barrow and River Nore SAC 002162	Estuaries [1130] Mudflats and sandflats not covered by seawater at low tide [1140] Reefs [1170] *Salicornia* and other annuals colonising mud and sand [1310] Atlantic salt meadows (*Glauco-Puccinellietalia maritimae*) [1330] Mediterranean salt meadows (*Juncetalia maritimi*) [1410] Water courses of plain to montane levels with the *Ranunculion fluitantis* and *Callitricho-Batrachion* vegetation [3260] European dry heaths [4030] Hydrophilous tall herb fringe communities of plains and of the montane to alpine levels [6430] Petrifying springs with tufa formation (Cratoneurion) [7220] Old sessile oak woods with *Ilex* and *Blechnum* in the British Isles [91A0]	The SAC site includes freshwater stretches of the Barrow and Nore River catchments as far upstream as the Slieve Bloom Mountains, and it also includes the tidal elements and estuary of both rivers, as far downstream as Creadun Head in Co. Waterford. It is designated as an SAC for a variety of riparian, coastal, woodland and ground-water-dependent habitats. These habitats support a variety of riparian and wetland species.	To maintain the favourable conservation condition within the River Barrow and River Nore SAC of: • Desmoulin's whorl snail, • white-clawed crayfish, • estuaries, mudflats and sandflats not covered by seawater at low tide, • Salicornia and other annuals colonizing mud and sand, • Killarney fern, • Water courses of plain to montane levels with the *Ranunculion fluitantis* and *Callitricho-Batrachion* vegetation, • European dry heaths,	2.4-3.2km	**Hydrological** Construction/ decommissioning of windfarm - release of suspended solid (and other) pollution – (Water courses of plain to montane levels with the *Ranunculion fluitantis* and *Callitricho-Batrachion* vegetation, Hydrophilous tall herb fringe communities of plains and of the montane to alpine levels, all lamprey and fish species, all mussel species and otter). **Hydrogeological** Construction/ decommissioning of windfarm - release of pollution into soil - aquatic interest features (Water courses of plain to montane levels with the *Ranunculion fluitantis* and *Callitricho-Batrachion* vegetation, Hydrophilous tall herb fringe communities of plains and of the montane to alpine levels,, all lamprey and fish species, all mussel species and otter). **Ecological** Construction/ decommissioning of windfarm - physical injury, physical damage to breeding/ resting / foraging sites, disturbance/ displacement or reduction in foraging opportunities, e.g. if otter detained in excavation or crayfish injured during installation of a watercourse crossing - mobile qualifying interest species (white-clawed crayfish, lamprey spp, twaite shad, salmon and otter) could move outside of the SAC along hydrological connections.

Site Name and Code	Qualifying Interest Features	Brief Description	Conservation objectives in summary	Direct line distance to site (min- max)	Connections (Source -Pathway – Receptor)
	Alluvial forests with *Alnus glutinosa* and *Fraxinus excelsior* (*Alno-Padion, Alnion incanae, Salicion albae*) [91E0] *Vertigo moulinsiana* (Desmoulin's whorl snail) [1016] *Margaritifera margaritifera* (Freshwater pearl mussel) [1029] *Austropotamobius pallipes* (White-clawed crayfish) [1092] *Petromyzon marinus* (Sea lamprey) [1095] *Lampetra planeri* (Brook lamprey) [1096] *Lampetra fluviatilis* (River lamprey) [1099] *Alosa fallax fallax* (Twaite shad) [1103] *Salmo salar* (Salmon) [1106] *Lutra lutra* (Otter) [1355] *Trichomanes speciosum* (Killarney fern) [1421] *Margaritifera durrovensis* (Nore pearl mussel) [1990]		• Hydrophilous tall herb fringe communities of plains and of the montane to alpine levels, • Petrifying springs with tufa formation To restore the favourable conservation condition within the River Barrow and River Nore SAC of: • Sea lamprey, • Brook lamprey, • River lamprey, • Twaite shad, • Atlantic salmon, • Atlantic salt meadows, • Otter, • Mediterranean salt meadows, • Nore freshwater pearl mussel, • Old sessile oak woods with Ilex and Blechnum in the British Isles		

Site Name and Code	Qualifying Interest Features	Brief Description	Conservation objectives in summary	Direct line distance to site (min- max)	Connections (Source -Pathway – Receptor)
			• Alluvial forests with *Alnus glutinosa* and Fraxinus excelsior (*Alno-Padion, Alnion incanae, Salicion albae*) Freshwater pearl mussel status is currently under review for the River Barrow and River Nore SAC		
Lisbigney Bog SAC 000869	Calcareous fens with *Cladium mariscus* and species of the *Caricion davallianae* [7210] *Vertigo moulinsiana* (Desmoulin's whorl snail) [1016]	This a SAC is a wetland dominated by fen vegetation, for which it is designated. It is a former lake basin and is now criss-crossed by streams. It supports a population of Desmoulin's whorl snail.	To restore favourable conservation condition of Calcareous fens with *Cladium mariscus* and species of the *Caricion davallianae**and Desmolin's whorl snail in Lisbigney Bog SAC.	6.1-12.2km	No hydrological or hydrogeological as Lisbigney Bog is situated upstream of the nearest potentially connected water course and a considerable distance from the site for any hydrogeological links. Lisbigney Bog SAC is within Water Framework Directive (WFD) Catchment 15 Nore and the Project is within WFD Catchment 14 Barrow[18]. No ecological connectivity as the designates features are specifically habitats and invertebrates which have a localised distribution and will not travel between the Project and the Lisbigney Bog SAC, therefore, no Pathway.
Ballyprior Grassland SAC 002256	Semi-natural dry grasslands and scrubland facies on calcareous substrates (*Festuco-Brometalia*) (*important orchid sites) [6210]	This SAC comprises of orchid rich calcareous grasslands located at the north end of the Castlecomer Plateau on largely limestone bedrock.	To restore the favourable conservation condition of Semi-natural dry grasslands and scrubland facies on calcareous substrates (*Festuco-Brometalia*)	3.8-5.9km	Although the Bally Prior Grasslands SAC is within the same catchment as the Project (WFD Catchment 14 Barrow), study of water courses reveal no hydrological or hydrogeological connectivity as the SAC is located north of the Project, and distant from any hydrological connection. Habitat is likely rainwater fed. No

[18] https://gis.epa.ie/EPAMaps/Water

Site Name and Code	Qualifying Interest Features	Brief Description	Conservation objectives in summary	Direct line distance to site (min- max)	Connections (Source -Pathway – Receptor)
			(*important orchid sites) in Ballyprior Grassland SAC.		ecological connectivity, due to the designated feature being habitats and sedentary, therefore, no Pathway.
River Nore SPA 004233	Kingfisher (*Alcedo atthis*) [A229] (resident)	This is SPA is a long linear river site, supporting 22 pairs of kingfisher (NPWS 2010)	To maintain or restore the favourable conservation condition of the kingfisher population; given recent population declines nationally, it is assumed that the objective is to restore the population,	5.9-11.8km	**Hydrological** Construction/ decommissioning of windfarm - release of suspended solid (and other pollutants) into waterway - impacting prey for kingfisher and/or turbidity of watercourse, impacting hunting efficiency of kingfisher. **Hydrogeological** Construction/ decommissioning of windfarm - release of pollution into soil and eventually watercourse - impacting prey for kingfisher. **Ecological** Kingfisher could use water courses within the Project site, however no observations of kingfisher were made during the surveys, and kingfisher are believed to be absent from the Project area, therefore there is no ecological connection.
Slieve Bloom Mountains SPA 004160	Hen harrier (Circus cyaneus) [A082] (p)	The site has a near continuous ridge of mountain blanket bog, with wet and dry heaths	To restore the favourable conservation condition of hen harrier in Slieve Bloom Mountains SPA.	16-20km	**Ecological** Windfarm operation – collision risk – commuting hen harrier. Hen harrier have been observed during bird surveys for the project and although not identified as using the habitat for foraging, this species could commute over the Project. This could lead to a collision risk. There is a hydrological/ hydrogeological connection to Slieve Bloom Mountains SPA, however, the Slieve Bloom Mountain SPA is upstream of the Project and therefore there is no risk of contamination travelling to the SPA.

3.5 Step 4: Likely Significant Effects

European sites which may be subject to Likely Significant Effects (LSE) from the Project are identified using the 'source-pathway-receptor' (S-P-R) conceptual model. The S-P-R model is a standard tool in environmental assessment to determine links between sensitive features and sources of impacts. In order for an effect to occur, all three elements of this mechanism must be in place. The absence of one of the elements of the mechanism means there is no likelihood for the effect to occur e.g. if there is no ecological pathway or functional link between the proposed development and the European site, there is no potential for impact and as such no potential for significant effects.

An impact may occur without having a significant effect. An impact is essentially the 'source' in the S-P-R assessment. It is the biophysical change caused to the environment by the project e.g. increase in sediment runoff due to ground disturbance. For the effect to be significant, the Qualifying Interests / Special Conservation Interests of the European site must be sensitive to the biophysical change, and this would undermine the conservation objectives for that QI/SCI.

The LSEs of the proposed project are described below. The European sites considered are generally those with an SPR link, as outlined in **Table 3-1**, however other pathways are also investigated.

3.5.1 For the project 'Alone'

None of the SACs within 20km have bats as a qualifying interest feature. The nearest such site is East Burren Complex SAC (site code 1926) which is designated for its lesser horseshoe bat *Rhinolophus hipposideros* population. It is over 100km distant while lesser horseshoe bat typically forages within 2.5km of its roost (NPWS 2018)[19]. Moreover, no lesser horseshoe bats were recorded foraging at the Project site and it is outside the core range of this species in Ireland. Lesser horseshoe bat is the only Annex II bat species for which SACs are designated in Ireland (BCI 2012)[20]. Therefore, Likely Significant Effects on this SAC and all other SACs which only have Lesser horseshoe bat as a qualifying interest feature can be excluded.

Lisbigney Bog SAC is located 12.2km SW of the main wind farm site, 6.1km SW of cable route option 1 and 11.5km SW of cable route option 2 and Ballyprior Grassland SAC is located 5.1km NE of the main wind farm site, 5.9 Km NE of cable route option 1 and 3.8km E of cable route option 2. For both these SACs, there is no hydrogeological or hydrological connectivity between each SAC and the Project, via the Nore_SC_060 sub-catchment or surface water flows. Therefore, there is no potential for pollutants nutrients or suspended solids generated during construction or decommissioning to reach either SAC, due to the location of the Project and the lack of hydrological/ hydrogeological connectivity, and Likely Significant Effects on qualifying interest features of these SACs can be excluded at this stage without further assessment or mitigation.

The nearest European site is the River Barrow and River Nore SAC to which there is downstream connectivity from the proposed wind farm site via onsite drainage ditches,

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[19] NPWS (2018) Conservation objectives supporting document – lesser horseshoe bat (*Rhinolophus hipposideros*) Version 1. Conservation Objectives Supporting Document Series. National Parks and Wildlife Service, Department of Culture, Heritage and the Gaeltacht, Dublin, Ireland.

[20] Carden, R., Aughney, T., Kelleher, C. and Roche, N. (2010) Irish bat monitoring Schemes, BATLAS Republic of Ireland report for 2008-2009

which flow into surface watercourses and on to the SAC and from both cable route options via off-site watercourses crossed by the cable routes.

Potential routes include:

- From the northern cluster via Falllowbeg (Upper), Crooked River, Timogue River, Stradbally River, and finally the River Barrow, with the Stadbally River and River Barrow included in the SAC;
- From the northern cluster via Honey stream, and onto the Crooked River, with the remainder of the route as described above;
- From the northern cluster via Fossy Lower and Stradbally streams, Timahoe, Bauteogue and Stradbally Rivers, and finally the River Barrow, with the Stadbally River and River Barrow included in the SAC;
- From construction compounds and substation compounds etc via the Scotland 15 stream and Owveg/Owenbeg which flows onto the River Nore, with parts of the Owveg/Owenbeg and all of the River Nore included in the SAC;
- From the southern cluster via the Brennanshill (Coolglass), Clogh 15 and Moyadd streams which join together to form the Clogh stream, a tributary of the Dinin River, which is in turn a tributary of the River Nore, with part of the Clogh, and all of the Dinin and all of the Nore included in the SAC.
- From the points where the cable routes cross stream via Grainguenahown stream (one location), Owveg (Nore) (3 locations), Garrintaggart (2), Cleanah (1), Aghoney (1), Fossy Lower (1), Stradbally (Laois) (1), Cremorgan (1) and Scotland (1), with option 1 primarily in the River Nore catchment and option 2 primarily in the River Barrow catchment.

At the shortest, the southern cluster is 3.3km is upstream of SAC and the northern cluster 8.1km is upstream of SAC. See **Drawing 3** which illustrates the hydrological connectivity between the Project site and the SAC; essentially all water draining from the Project site reaches the SAC by one of the routes described above.

Therefore, without mitigation, suspended solids, nutrients and other pollution generated during the construction and/or decommissioning stage could be transported from the proposed Project site to the River Barrow and River Nore SAC via surface water. For terrestrial/ marine/ coastal habitats or species/ habitats located at least 70km downstream, this could not undermine the conservation objectives and therefore there will be no Likely Significant Effect on the following qualifying interest features:

- Estuaries [1130],
- Mudflats and sandflats not covered by seawater at low tide [1140],
- Reefs [1170],
- Salicornia and other annuals colonising mud and sand [1310],
- Atlantic salt meadows (Glauco-Puccinellietalia maritimae) [1330],
- Mediterranean salt meadows (Juncetalia maritimi) [1410]),
- Old sessile oak woods with *Ilex* and *Blechnum* in the British Isles [91A0],
- Alluvial forests with *Alnus glutinosa* and *Fraxinus excelsior* (Alno-Padion, Alnion incanae, Salicion albae) [91E0]) or

- *Trichomanes speciosum* (Killarney fern) [1421]

This is because they are either terrestrial and therefore not hydrologically connected to the proposed Project site or are located beyond the distance where effects could be perceptible due to dilution of any suspended solids, nutrients or pollution.

Equally, European dry heaths occur on freely-draining soils[21] therefore are reliant on rainwater, rather than ground or surface water. The nearest dry heath is greater than 65km to the south of the Project. There is no pathway to undermine to conservation objectives of dry heaths qualifying interest feature for the project alone and therefore there will be no Likely Significant Effect on this habitat. This habitat is therefore also excluded from further discussion regarding water quality, or any other impacts related to the Project.

Petrifying springs could also be negatively affected by declines in groundwater quality, specifically as run off from the project site has the potential to be acidic, due to the coniferous forestry, and petrified springs rely on a calcareous environment. However, the only petrified spring that is part of the River Barrow and River Nore SAC is located near the River Nore, approximately 45km to the south west. This is sufficiently far for dilution of any acidic pollution from the Project site to not undermine the conservation objectives of the petrified spring and therefore there will be no Likely Significant Effect on petrified springs as an interest feature.

As set out above, the Project site is hydrologically connected to the River Barrow and River Nore SAC via several routes which link it to both the River Nore and the River Barrow via designated tributaries. Suspended solids/nutrients/pollutants in surface water could significantly affect riparian ecosystems that are sensitive to water quality changes (in this case Water courses of plain to montane levels with the *Ranunculion fluitantis* and *Callitricho-Batrachion* vegetation and Hydrophilous tall herb fringe communities of plains and montane to alpine levels) by reducing water quality. This could then significantly affect freshwater aquatic species reliant on such habitats (such as white clawed crayfish), and also by reducing water quality and the quality of fish spawning grounds could decline impacting fish species (Atlantic salmon, Twaite Shad, lamprey species). Furthermore, poor fish spawning could impact species that rely on fish as prey or hosts (otter, freshwater pearl mussel respectively).

One of the qualifying populations of Desmoulin's whorl snail is located on a tributary of the River Nore which is not hydrologically connected to the project site. The other is located 55km downstream from the Project site on the River Barrow. Moreover, this species is not aquatic (Killeen 2003) and therefore not sensitive to water quality like the other qualifying interest features. Therefore, Likely Significant Effects can be excluded for this species.

The proposed Project is also hydrogeologically connected (i.e. via groundwater) to the River Barrow and River Nore SAC, as the Project is within the same sub-catchments as the SAC (Dinin [North]_SC_010, Barrow_SC_050 and Nore_SC_060). Both grid connection options are also in the same sub-catchment as the SAC (cable route option 1- Nore_SC_060 and Barrow_SC_050 and cable route option 2 Nore_SC_060). Ground water quantity will not change in relation to the project, as ground water will not be diverted away from springs etc and no suspended solid pollutants would reach ground water, due to the filtration effect of soil and rock. Other pollutants remain a risk however, and so water quality could potentially be affected. Therefore, Likely Significant Effects on the freshwater

[21] https://sac.jncc.gov.uk/habitat/H4030/ and https://eunis.eea.europa.eu/habitats/10084 accessed 5/5/23

qualifying interest features, via surface or ground water of this SAC cannot be excluded at this stage without further assessment or mitigation.

There is ecological connectivity between the SAC and the Project, as mobile qualifying interest features, specifically white-clawed crayfish, lampreys , twaite shad, salmon and otter, could move outside the SAC along watercourses and could utilise watercourses in the vicinity of the project. These mobile species could be affected by pollution if physical habitat structure and water quality is altered. Disturbance or displacement via construction/decommissioning activities could also have a negative effect on species such as otter. Therefore, without mitigation, actions with the project site, most likely during construction and/or decommissioning stage could impact these qualifying interest features from the River Barrow and River Nore SAC.

The River Nore SPA qualifying interest feature is kingfisher. The ecological connectivity is discounted as kingfisher were not observed on any of the bird or aquatic ecology surveys and the watercourses within the project area were not considered appropriate for foraging kingfisher. There is a hydrological and hydrogeological connection between this SPA and the Project, meaning that pollutants, nutrients or suspended solids, generated during construction or decommissioning, could enter SPA watercourses. This could affect prey kingfisher depend upon or could cloud the waters, so that foraging would not be possible for kingfisher. Therefore, Likely Significant Effects on qualifying interest features of the SPA cannot be excluded at this stage without further assessment or mitigation.

None of the SPAs within 20km had waterfowl as qualifying interest features. The Slieve Bloom Mountains SPA was located 20km from the main wind farm site, 20.3km from cable route option 1 and 16km from cable route option 2. Hen harrier is the qualifying interest feature. Despite the distance from the Project, hen harrier can travel over 20km, especially in the winter (even in the breeding season males have been reported to travel at maximum of 9 km[22] or 11.5km[23] from a nest). Hen harrier were recorded within the winter bird surveys in 2017/18 only (**Table 3-1**; refer to **Appendix 2** for full survey details, limitations, guidance followed etc.) , on three occasions in January 2018 and overall twice within the windfarm polygon (WP) – defined by a 500 m buffer around the proposed outermost turbine locations. No evidence was recorded of hen harriers using the Project site and surrounding area as a habitual winter roost. Collision Risk Modelling (CRM) (refer to **Appendix 2** for parameters used) did not predict any mortality and hen harrier were observed commuting over forestry beneath collision risk height, rather than utilising habitat for foraging. The habitat within the Project is predominately commercial conifer plantation forestry. This forestry habitat at its climax is unsuitable for hen harrier, but at the pre-thicket stage, specifically of the second rotation plantation is classified as the main nesting habitat of hen harrier in Ireland[24]. Although unsuitable currently, there is potential for the habitat to support breeding hen harrier in the future if forestry regenerates within the construction compound areas. However, these areas will be very small and the surrounding habitat would be unlikely to supply enough prey (e.g. skylarks *Alauda arvensis*, meadow pipits *Anthus pratensis*) to support a nesting pair of hen harrier. Equally, the core foraging range

[22] Arroyo, B, Leckie, F, Amar, A, McCluskie and Redpath, S (2014) Ranging behaviour of hen harrier breeding in Special Protected Areas in Scotland. Bird Study 1-8

[23] Irwin S, Wilson M, O'Donoghue B, O'Mahony B, Kelly T and O'Halloran J (2012) Optimum scenarios for Hen harrier conservation in Ireland Department of Agriculture, Food and the Marine.

[24] Caravaggi A, Irwin S, Lushby J, McCarthy A, Mee A, Nagle T and O'halloran J (2020) Forest management and Hen Harrier *Circus cyaneus* conservation in Ireland Irish Birds 42:1-12

for a breeding hen harrier is 2km, with a maximum of 10km[25], so any breeding hen harrier in the vicinity of the Project would not be part of the Slieve Bloom SPA population. Due to the infrequent records of hen harrier within the Project, no identification of a hen harrier winter roost site, no predicted mortality of hen harrier by CRM, the lack of suitable breeding habitat (the only regenerating woodland post- construction is limited to the construction compounds) there will be no Likely Significant Effects on hen harrier and therefore the Slieve Bloom Mountains SPA.

The potential impact factors during operation (section 3.3) cannot be related to the QI/SCI or the conservation objectives of the Slieve Bloom mountains SPA, as collision risk modelling for hen harrier did not predict any collision. Operational effects for other hydrologically linked European sites cannot be ruled out due to ongoing maintenance of the wind turbines. .

3.5.2 For the Project 'In Combination'

Pathways for potential in-combination effects have been identified for:

- River Barrow and River Nore SAC; and
- River Nore SPA.

There is the potential for other plans and projects, specifically any other land use changes, to also result in suspended solids (and other pollution) in the River Barrow and River Nore SAC, River Nore SPA, potentially leading to greater quantities of suspended solid / pollution than could result from the Project alone. Therefore, Likely Significant Effects cannot be excluded for the River Barrow and River Nore SAC and River Nore SPA, when the Project is considered in combination with other plans and projects.

As set out in **Table 3-1** above there are no pathways for impacts between the proposed Project site and any other European Sites. Likely Significant Effects can be excluded for all other European Sites for the Project in combination with other Plans and Projects.

3.6 Conclusions

There is a risk of suspended solid, nutrients (and other) pollution reaching the River Barrow and River Nore SAC and the River Nore SPA, as these sites are hydrologically linked to the Project. Pollution could affect the following qualifying interest features of the River Barrow and River Nore SAC:

- water courses of plain to montane levels with the *Ranunculion fluitantis* and *Callitricho-Batrachion* vegetation [3260],
- Hydrophilous tall herb fringe communities of plains and of the montane to alpine levels [6430],
- freshwater pearl mussel [1029],
- white-clawed crayfish [1092],
- sea lamprey [1095],
- brook lamprey [1096],

[25] Scottish Natural Heritage (now Nature Scot) 2016 Assessing connectivity with Special Protected Areas (SPAs)

- river lamprey [1099],
- twaite shad [1103],
- salmon [1106],
- otter [1355] and
- Nore pearl mussel [1990].

The same is also true for the River Nore SPA and kingfisher [A229] (SPA).

This AA Screening concludes that it cannot be excluded on the basis of objective evidence and in view of best scientific knowledge, that there will not be any likely significant effects from the construction operation or decommissioning activities from the Proposed Development alone, and in combination with other plans or projects, on:

- River Barrow and River Nore SAC (riparian and groundwater-dependent habitats or species only, detailed above) ; and
- River Nore SPA.

This AA Screening also concludes that it can be excluded on the basis of objective evidence and in view of best scientific knowledge, that there will not be any likely significant effects from the Proposed Development alone, and in combination with other plans or projects, on Lisbigney Bog SAC, Ballyprior Grasslands SAC or Slieve Bloom SPA or any other European sites.

4.0 Stage 2: Appropriate Assessment

4.1 Step 1, Part 1: Information on the Project

4.1.1 Summary Description

The proposed Coolglass Wind Farm Project is located approximately 11km southeast of Portlaoise, 14km northwest of Carlow and 11km east of Abbeyleix. The Site Location is shown in **Drawing 1**.

In summary, the proposed Coolglass Wind Farm Project consists of the following elements:

- Turbines and associated infrastructure;
- Turbine Delivery Route;
- Cable Routes; and
- Recreational Amenity trail.

4.1.2 Statutory Development Description

The Project which consists of a 13 no turbine wind farm development and associated works on land within the townlands of Fossy Upper, Aghoney, Gorreelagh, Knocklead, Scotland, Brennanshill, Monamantry, Coolglass, Crissard, Kylenabehy, Monamanry, Brennanshill, Knocklead, Aghoney, Timahoe, Carrigeen, Ballygormill South, Money Upper, Hophall, Rathleague, Ballymooney, Rathbrennan, County Laois. The site is approximately 731ha in size. The development will consist of:

- Construction of 13 No. wind turbines within two clusters with an overall ground to blade tip height of 180m. The wind turbines will have a rotor diameter ranging from 155m to 162m inclusive and a hub height ranging from 99 to 102.5m inclusive.
- Construction of permanent turbine hardstands and turbine foundations.
- Construction of 1 no. permanent 110 kV electrical substation including 2 no. control buildings with welfare facilities, all associated electrical plant and equipment, security fencing and gates, all associated underground cabling, wastewater holding tank, and all ancillary structures and works.
- Construction of a 33kV collector cable circuit connecting the wind farm two clusters along the L3851/Knocklead Road
- Construction of two temporary construction compounds with associated temporary site offices, parking areas and security fencing.
- Development of one on-site borrow pits.
- Construction of new permanent internal site access roads, upgrade of existing internal site access roads, including passing bays and all associated drainage infrastructure.
- Development of an internal site drainage network and sediment control systems.
- All associated underground electrical and communications cabling connecting the wind turbines to the wind farm substation.
- Ancillary forestry felling to facilitate construction of the development.

- All associated site development works including berms, landscaping, and soil excavation.
- Improvement of a site entrance to an existing access off the L3851/Knocklead local road to include localised widening of the road and creation of a splayed entrance to facilitate the delivery of abnormal loads and turbine component deliveries. Improvements include removal of existing vegetation for visibility splays to facilitate the use of the access for the delivery of construction materials to the site.
- A new site entrance slip road from the L3851/Knocklead local road to facilitate the delivery of abnormal loads and turbine component deliveries. Works at this location require the removal of existing forestry to facilitate the use of the access for the delivery of construction materials to the site and for use during the operational phase.
- Construction related temporary upgrade works on the turbine delivery route to facilitate the delivery of turbine components to include the use of temporary road surfaces at a roundabout at the southern exit of Junction 16 of the M7, the R425/N80 roundabout and the R426 – L3851 junction.
- The erection of a permanent meteorological mast 102.5m in height
- This planning application seeks a 10-year construction period and a 35-year operational period.

A cable route will be sought as part of a separate planning process under the provisions of s. 182(A) and does not form part of this planning application. Similarly, a recreational amenity trail will be provided and is not part of this planning application. However, both are considered part of the Project for this NIS.

4.1.3 Existing Environment

The proposed Project is located south-east of Portlaoise. The main towns and villages within the vicinity of the proposed development include: Timahoe, Swan, Wolfhill, Newtown, Ballinakill, Stradbally, Athy, Carlow, Portlaoise, and Abbeyleix.

The Project Site spans Fossy Mountain and Wolfhill, northeast of Swan and southeast of Timahoe. These hills are the most prominent landscape features within the central study area and its wider surrounds with Fossy Hill reaching a height of approximately 325m AOD.

The Project Site is located in a predominantly forestry plantation and agricultural area, with elevations within the site ranging from 196 m to 325 m above sea level. The land cover is classified in Corine Landcover 2018 as predominately Coniferous and Mixed Forest and Transitional Areas interspersed with Agricultural Areas. This is illustrated in **Appendix 1**.

The proposed development is divided into two distinct areas identified as Fossy Mountain and Wolfhill. These areas are identified clearly in **Appendix 1**.

The northern portion of the Project Site (Fossy Mountain) is characterised by elevated lands with elevations between 285 – 325m with moderate to steep slopes to the west and north of the site boundary. Slopes within the Project Site and proposed infrastructure locations generally comprises gentle to moderate slopes.

The southern portion of the Project Site (Wolfhill) is characterised by elevated lands with elevations between 196 – 300m with moderate to gentle slopes down to the north and west throughout the site boundary. Slopes within the Project Site and at proposed infrastructure locations generally comprises gentle to moderate slopes.

The Project is located within two Hydrometric Areas: the northern turbine cluster is located in the Barrow catchment, while the southern turbine cluster is located in the Nore catchment. The Project Site is situated in the South Eastern River Basin District. The main hydrology features are the tributaries of the Stradbally River and Crooked River, which drain the area of the proposed northern turbine cluster, and tributaries of the River Clough and Owveg River which drain the area of the southern turbine cluster.

The geology present within the Project Site and wider study area comprise of carboniferous shales, siltstones and thin coals, with clay beds. The majority of the proposed cable routes is underlain by carboniferous shales, siltstones and thin coals, with clay beds along the proposed route. There are 56 residential properties located within 1 kilometre of the Project. There are 105 residences within 500m of the cable routes. The nearest residential receptors property is located 72202 metres from a wind turbine.

The Project is accessible from both the north and the south via the R526 Regional Road which runs the M7 Motorway and the N 78 National Road. The layout of the Project has been designed to minimise the potential environmental impacts of the wind farm, while at the same time maximising the energy yields of the wind resources passing over the Project Site. Available wind speed is a key factor in determining the economic viability of potential wind energy locations. The Sustainable Energy Authority of Ireland (SEAI) Wind Mapping System identifies the site as having an average wind speed of between 6.1 and 7.8 metres per second at 20m above ground level

4.1.4 Detailed Project Description

Candidate turbines

The exact make and model of the turbine will be dictated by competitive tender process but will remain within the range listed below. The candidate turbines and the dimensions assessed for the purposes of this NIS are set out in **Table 4-1**.

Table 4-1 Design Parameters to be Assessed

Turbine Type	Tip Height (m)	Hub Height (m)	Rotor Diameter (m)	Foundation Size	Hardstand dimensions
Siemens Gamesa SG155	180	102.5	155	25m diameter	50m x 20m
Vestas V162	180	99	162	25m diameter	80m x 30m

The proposed turbines will be within the following specifications, further detail provided in **Appendix 4**:

- The turbines will be three bladed, horizontal access type;
- The turbines will have a height of 180m from top of foundation (at ground level) to blade tip height
- The rotor diameter of the proposed turbines will be within the range of 155 – 162m (inclusive)
- The hub height will be between within the range of 99m-102.5m (inclusive)

Turbine Layout

The turbine layout consists of 13 no turbine layout among two clusters within Fossy Hill and Wolfhill, Co Laois.

The northern cluster (Fossy Hill) consists of seven turbines (no's 1-7) broadly arrayed in mostly commercial forestry plantation with varying stages of maturity. Turbine 4 is to be located within an existing agricultural field.

The southern cluster will comprise 6 no. turbines (no's 8-13), all arrayed within commercial plantation at varying stages of maturity.

The layout of the Project has been designed to minimise the potential environmental effects of the wind turbines on the surrounding area, while at the same time maximising the energy yield of the wind resource which passes over the site. The Proposed Development layout is shown in **Appendix 1**. This layout reflects the outcome of an iterative design process.

The turbines referenced from T1-T13 and coordinates in Irish Transverse Mercator [ITM] are detailed in **Table 4-2**. **Error! Reference source not found.**

Table 4-2 Proposed Coolglass Wind Farm Turbine Coordinates

Turbine ID	X (ITM)	Y (ITM)
1	655032	687985
2	655375	688632
3	655675	688369
4	656166	688288
5	656858	688320
6	656569	687959
7	657151	687733
8	657545	684471
9	657418	684888
10	656562	684216
11	656660	683654
12	656978	684062
13	657286	683895

Turbine Blades

The blades of a modern turbine are comprised of glass fibre reinforced polyester. The blades of a turbine rotate between five and 15 revolutions per minute, dependent on wind speed and turbine make. A turbine begins generating electricity at a wind speed of approximately 3 to 4 m/s depending on the turbine type, with rated power generation at wind speeds of approximately 12 to 14 m/s.

Turbines are usually shut down at wind speeds greater than 25 m/s, although some machines are designed to operate up to 30 m/s. The yaw mechanism, controlled by a wind vane, turns the nacelle and blades into and out of the wind. Blades are pitched to match the wind conditions.

Turbine Tower and Foundation

The tower of a turbine is a conical steel tube, with multiple painted finishes. It is generally transported to the site in 4 to 5 sections. The first section is bolted to the steel base which is cast into a concrete foundation. The shape and size of the foundation may vary depending on the turbine manufacturer specifications; however, the foundations will be approximately 2530m diameter and 2m in depth and are typically gravity-based foundations composed of reinforced concrete. All foundations will be located below ground level.

The upper sections of the tower are bolted to the lower ones in sequence. The base of the tower is around 4.5m to 5m in diameter, tapering to approximately between 3 and 4 metres, where it is attached to the nacelle. It is accessed by a galvanised steel staircase and a steel hatch door which will be kept locked except during maintenance.

Turbine transformer

The turbine will have a transformer located within the tower. The turbine transformer steps up the voltage of the electricity generated by the turbine to approximately 33 kV to reduce the electrical loss on the cabling connector circuits that connect to the site substation.

Power output

The Project will have an estimated installation capacity of approximately 85.8 MW (SG 155) to 93.6 MW (V162) depending on the final turbine technology installed. Turbines of the exact same make, model and dimensions can have different power outputs depending on the capacity of the electrical generator installed in the turbine may sell. Rated capacity of 85.8 MW has been used below to calculate the power output of the proposed windfarm. Assuming installed capacity of 85.8 to 93.6 MW, the proposed windfarm has the potential to produce approximately 248,030 (SG155) to 270,579 (V162) MWh (megawatt hours) of electricity per year, based on the following calculation:

A x B x C = megawatt hours of electricity produced per year

Where:

- A = the number of hours in a year: 8,760 hours
- B = the capacity factor, which takes into account the intermittent nature of wind, the availability of wind turbines and array losses. The capacity factor of 33% is applied here
- C = rated capacity of the wind farm: 85.8 MW (SG 155) or 93.6 MW (V162)

The 248,030 – 270,579 MWh of electricity produced by the Project would be sufficient to supply approximately 59,000 to 64,000 Irish households with electricity per year, based on the average Irish households using 4.2 MWh of electricity

According to the 2016 Census of Ireland, there are a total of 29,107 private households within County Laois. Based on a capacity factor of 33%, the Project would therefore produce enough electricity for the equivalent of 100% of all households in County Laois as per the Housing stock of the 2016 Census, as well as the projected increase of 6,019 households by 2027, leaving capacity to power an additional 23,974 to 28,974 households based on the installation capacity calculated above. Effectively, the Project would have the capacity to power approximately two times the number of households in County Laois with renewable energy, including the additional required housing stock, based on the forecast requirement.

Turbine colour

Turbines have multiple painted coatings which protect against corrosion. They are coloured flies were light grey to blend into the sky background. The colour of the turbine minimises visual impact, as recommended by the following guidelines on wind energy developments:

- Draft Wind Energy Development – Planning Guidelines (2019)[26]
- Wind Energy Developments – Planning Guidelines (2006)[27]
- The Influence of Colour on The Statics of Wind Turbine Generators" – ETSU W/14/00533/00/00[28]
- Pan45, The Scottish Office Environment Department[29]
- PPG 22, Department Of The Environment – Welsh Office[30]
- Technical Advice Note 8, Welsh Assembly, 2005[31]

4.1.5 Turbine Delivery Route, Access Tracks and Hardstandings

4.1.5.1 Turbine Delivery Route

The proposed turbine delivery route is presented in **Appendix 1**. A turbine delivery route selection and assessment were carried out to identify the optimum delivery route to the sites.

Turbine delivery will be from Dublin port and delivered along one distinctive route. The turbine delivery route will leave Dublin port and join with the M 50 motorway via the Dublin Port Tunnel. The roots will continue along the 50, exiting the N7 National Road / M7 Motorway heading west before exiting at Junction 16. The route then exits the motorway and travel south on the R445 Regional Road before descending further south towards

[26] Department of Housing, Local Government and Heritage (2019) Draft Wind Energy Development guidelines Accessed 28/07/2023

[27] Department of Housing, Local Government and Heritage (2006) Wind Energy Development guidelines https://www.gov.ie/pdf/?file=https://assets.gov.ie/111145/93cd5b8e-e0d5-4369-8d41-45b9738a7b4d.pdf#page=null Accessed 28/07/2023

[28] Department of Trade and Industry – ETSU W/14/00533/00/00: The Influence of Colour on the Aesthetics of Wind Turbine Generators Accessed 28/07/2023

[29] The Scottish Office Environment Department Pan 45 Renewable Energy Technologies Accessed 28/07/2023

[30] Planning Policy Guidelines (PPG) 22 Department of the Environment – Welsh Office Accessed 28/07/2023

[31] Welsh Assembly (2005) Technical Advice Note 8 Accessed 28/07/2023

Rathleague. Once the turbine delivery route crosses the M7 motorway, the route will continue in a southern and easterly direction on Portlaoise Road/R426 Regional Road, through the town of Timahoe. The group will continue along the R426 Regional Road before heading east on Knocklead Road before accessing either the southern or northern clusters via existing forestry tracks.

4.1.6 Internal Access Tracks

The Project will require 15.5 kilometres of internal access tracks to be upgraded. Of this, 5 kilometres of old internal access tracks will be utilised.

The proposed internal site track layout will permit access for vehicles during the construction phase, for maintenance during the operational phase, and for vehicles to decommission the turbines at the end of the life of the development.

An extensive network of forestry access tracks exist within the site. These existing access tracks have been utilised wherever possible to facilitate the Project. All access tracks will be approximately 5m wide along straight sections and wider at bends. The tracks will be finished with a well graded aggregate. Existing drainage infrastructure will be maintained and upgraded where necessary.

It is anticipated that the stone required for the construction of all new internal access roads will be sourced from quarries in the vicinity of the site.

Access track formation will consist of a 500m hard core on a geotextile membrane. The construction methodology for newly constructed tracks will be as follows:

- the formation will be prepared to receive the geotextile membrane
- stone will be placed and compacted in layers to 500 mm depth
- drainage will be provided along the sides of the track
- surplus excavated material will be placed along the side of sections of the tracks and dressed to blend in with surroundings landscaping.

4.1.7 Borrow Pit

The Proposed Development will include a singular borrow pit at the access point of the southern cluster as demonstrated in **Appendix 1**.

4.1.8 Cable routes

Two associated cable routes from the Site to the selected offsite substation will be assessed in this EIAR as part of the Project; however, the cable routes do not comprise part of this planning application and will be submitted under a separate planning process in the future. For the purposes of this assessment, two cable routes will be assessed and the most suitable will be taken forward into a separate planning application.

- Option 1 comprises a cable route between the proposed onsite substation and the Pinewoods substation. This route is 9.9km in length.
- Option 2 comprises a cable route between the proposed onsite substation and Coolnabacky substation. This route is 10.1km in length.

These works are expected to be conducted over a 12-month period of time.

4.1.9 Recreational Amenity Trail

A 9km trail loop originating from Timahoe town to and through the northern cluster of the Proposed Development will form a separate planning consent process but will be assessed as part of this EIAR. This trail loop will utilise existing forestry tracks around the Fossy Mountain Loop and local public roads.

Beginning in Timahoe town, the recreational amenity trail will head east on an unnamed local road at the Tower Inn heading towards Stradbally from the town square. It will follow this public road for c. 1.2km before joining a local access road, heading south for c. 1km before joining existing forestry tracks at the bottom of Fossy Hill. This recreational amenity trail is shown in **Appendix 1**. These works could be conducted over a 6-month period of time (ca 26 weeks).

4.1.10 Watercourse Crossings

4.1.10.1 Internal Access Track Watercourse Crossings

The proposed wind turbine layout will utilize in total four crossings as shown in **Appendix 1.** There will be one new crossing over the Fallowbeg Upper stream.

New crossings are designed to convey 1% AEP MRFS (Annual exceedance probability Mid-range future scenario) storm event with minimum 300mm freeboard level. This is in line with the OPW requirements. A Section 50 application will be required to obtain the consent of the OPW for the construction of the crossings.

4.1.10.2 Watercourse Crossings Along the Cable Route

The proposed cable routes will cross twelve watercourses in total. Seven crossings are along Option 1's route while there are five watercourses along Option 2's route. Should a watercourse be required to be crossed for the purposes of the cable route, the most relevant of the following methodologies will apply, to be assessed on a case-by-case basis:

- **Piped culvert crossings** – where sufficient cover is available, the cable ducts will be laid above the culvert with a minimum separation distance, to 300mm unless otherwise required by the local authority and Eirgrid. Where sufficient cover is not available, cable ducts will be laid under the culverts with a minimum separation distance, 300mm unless otherwise required by with the local authority and Eirgrid.
- **Flatbed formation over culvert** – where the cable duct is to be installed over an existing culvert where sufficient cover is not available, the ducts will be laid in a much shallower trench the depth of which will be determined by the location of the top of the culvert. The ducts will be laid in this trench in a flatbed formation over the existing culvert and it will be encased in 6mm thick steel galvanised pleat with the concrete surround as per EirGrid specification.

4.1.10.3 Watercourse Crossings Along the Turbine Delivery Route

There are five watercourses are along Option 2's route and the turbine delivery route which run in parallel along the entire cable corridor. There will be no construction works required on the crossing structures to facilitate the turbine delivery. Only minor works (tree removing, placement of temporary load bearing surface, street furniture removal, vegetation trimming) will be required along the TDR to accommodate the delivery.

4.1.11 Onsite Electricity Substation

It is proposed to construct one on-site electricity substation within the Proposed Development site as shown in **Appendix 1**. This substation will provide a connection point between the Project and the proposed cable route point at either the Option 1 or Option 2 substations. A 33kV collector cable will route electricity from the southern cluster to the proposed on-site substation.

The dimensions of the proposed substation compound will be 65 metres by 127 metres and will include 2 no. substation control buildings and electrical components necessary to export electricity generated from the wind farm to the National Grid. The substation compound will be surrounded by a 2.6 metres high steel palisade fence and internal fences will also be provided to segregate different areas within the main substation compound.

Lighting will be required on site, and this will be provided by lighting poles located around the substation and exterior wall mounted lights on the control buildings.

The proposed substation will contain 2 no. control buildings; one of which, the Customer Switchgear Room (the IPP Building), will be operated and maintained by the Applicant while the Transmission System Operator (TSO) 'Control Building' (the Eirgrid Building) will be operated and maintained by EirGrid. The IPP Building will measure 17.83 metres by 7.5 metres and will have an overall height of 6.28 metres. It will house switchgear, associated electrical equipment and apparatus, storage and welfare facilities.

The EirGrid Building will measure 25 metres by 18 metres and will have an overall height of 8.5m. It will contain a control room, associated electrical equipment and apparatus and will also include storage and welfare facilities.

Staff welfare facilities will be provided in the control building and there will be a small water requirement for occasional toilet flushing and hand washing. It is proposed to install a rainwater harvesting system as the source of water for toilet facilities and this rainwater harvesting tank will be installed adjacent to the control buildings. Waste facilities will include portable toilets which will be serviced by a contractor.

4.1.12 Electrical Cabling

The electricity generated from wind turbines between the northern and southern clusters will be collected at a medium voltage 33 KV cable circuits of buried cables which will follow on site access tracks. A 33kV collector circuit cable will be embedded within the public roadway between the clusters, between Turbine 10 and the proposed onsite substation in the northern cluster. The electricity from the northern and southern clusters will be exported from the on-site substation to the existing grid via a 110 KV buried cable to either the Option 1 or Option 2 substations. Internal collector circuit cable routes are shown in the planning application drawings.

4.1.12.1 Cable Installation

The specifications for cables and cable installation will be in accordance with EirGrid requirements. A description of cable installation works is found within the CEMP in **Appendix 5**.

4.1.12.2 Joint Bays

A joint bay will be constructed in pits. Each joint bay will be approximately 4.5 m x 1.8 m x 1.2 m deep. A reinforced concrete slab will be constructed in the bay to accommodate the jointing enclosure.

Communication chambers, which are similar to small manholes, will also be installed at the joint bay locations to facilitate connection of fibre-optic communication cables.

Wind Farm

Joint bays will be required for the 33kV collector cable which connects the northern and southern clusters of the Proposed Development and will form part of this planning application. Locations of joint bays are specified by Eirgrid at detailed design stage. The locations of joint bays are assumed to be required at each 90 degree bend and approximately every 750m. Using this assumption, approximately 12 no. joint bays are required for the 6km collector cable running from turbine 10 to the on-site substation.

Cable Routes

Joint bays are precast concrete chamber buildings where cables are joined to form one continuous cable. Locations of joint bays are specified by Eirgrid at detailed design stage. The cable routes assessed in this EIAR do not form part of this planning application. Therefore, joint bay drawings for the two cable routes will not be included as part of this planning application, but it is assumed that a joint bay will be required at each 90 degree bend and approximately every 750m. For the purposes of this assessment, approximately 9 no. joint bays will be located in public roads with 5 no. joint bays located on private lands (Option 1) or approximately 12 no. joint bays will be located in public roads with 3 no. joint bays located on private lands (Option 2).

4.1.13 Traffic Management

4.1.13.1 Wind Farm

Access to this element of the Proposed Development will be facilitated via the R426 with the L7791 and the L3851. Entry to Access Point 1 (AP1) is located 1.5km east along the L3851, with the entry to Access Point 2 (AP2) a further 2.1km along the L3851.

4.1.13.2 Turbine Delivery Route

The port of entry for AILs has been identified as Dublin Port, with a route via the M50 and M7 to Portlaoise.

Turbine deliveries would exit the M7 at Junction 16, heading southwest along the R445 for a short distance before turning south onto the R425. The R425 would be followed to the R426, where they will continue for approximately 12.8km. At the junction of the R426 with the L7791 and the L3851, deliveries will head east towards Luggacurren. Access to the northern cluster will be facilitated via Access Point 1 (AP1) which is located 1.5km east along the L3851, with access to the southern cluster via Access Point 2 (AP2) which is located a further 2.1km along the L3851.

4.1.13.3 Cable routes

Two cable routes which leave the Site and connect to external substations are to be assessed as part of the Proposed Development:

- Option 1: Under this option, the cable route will exit the proposed onsite substation heading south before entering the L3851 (Knocklead Road). From there, the cable will cross the R426 and head south and west along two minor unnamed roads before crossing forestry tracks to the south and joining Pinewoods substation from the north.
- Option 2: The cable route will exit the proposed onsite substation heading south, before entering the L3851. From there, the route will head north along the R426 for approximately 10km before entering private fields to the Coolnabacky substation.

A careful approach will be taken to planning the works to ensure minimal impacts on road users and the general public. Cable trenching will be carried out with the aid of either a lane closure or road closure, which will ensure that the trenching works are completed as expeditiously as possible. Due to the length of cabling within the road corridor (ca 10 km), it is expected that these works would be conducted over a 6-month period of time (ca 26 weeks).

4.1.14 Peat management

No peat has been observed within the Project area following an assessment and walkover of the existing environment.

4.1.15 Drainage

The proposed drainage system will be based on two key methods. The first method will involve keeping clean water clean by avoiding disturbance to natural drainage features, minimising any works in or around drainage features, and diverting clean surface runoff around excavations and construction areas. The second method will involve collecting any drainage water from works area that might carry silts or sediments, and to route them towards settlement ponds prior to controlled diffuse release over vegetated natural surfaces.

4.1.15.1 Tree Felling and Replant Lands

Much of the Project site comprises commercial coniferous forestry. There are 11no. turbines located within forestry and consequently tree felling will be required as part of the Project. Felling of 54.36 ha (52.78 ha permanent; 1.58 ha temporary) of largely coniferous forestry is required within and around the wind farm infrastructure to accommodate the construction of some turbines, hardstanding's, crane pads, access tracks, construction compounds and the proposed onsite substation. The Felling area proposed is the minimum necessary to construct the Proposed Development and will provide necessary mitigation where required.

Tree felling will be subject to a felling licence application to the Forest Service prior to construction in accordance with the Forest Service's policy on granting felling licences for wind farm developments.

The Forest Service policy requires that a copy of the planning permission for a wind farm is submitted with a felling licence application, therefore, the felling licence cannot be applied for until planning permission is received for the Project. The licence will include the provision of relevant replant lands to be planted in view of the proposed tree felling on the site.

The construction methodology for tree clearance will follow the specifications set out in the Forest Service Forestry Standards and Procedures Manual (2015[32]) and Felling and Reforestation Policy (2017[33]).

Before harvesting works commence on site, all personnel, particularly machine operators, will be made aware of the following and will have copies of the relevant documentation including:

- The felling plan, surface water management, construction management, emergency plans and any contingency plans;
- Environmental issues relating to the site;
- The outer perimeter of all buffer and exclusion zones;
- All health and safety issues relating to the site.
- The proposed method of tree felling near infrastructure will be limited to:
- A 20m wide buffer for new and upgraded access tracks;
- A 10m buffers surrounding hard standings and compounds;
- A 6m corridor for buried cables on private lands;
- A 50m separation distance from turbine blade tip to vegetation feature height as per the requirements of NatureScot Guidance.

Replacement replanting of forestry in Ireland is subject to licence in compliance with the Forestry Act 2014 (as amended). The consent for such replanting is covered by the Forestry Regulations 2017 (S.I. no. 191 of 2017).

It is proposed to fell 54.36 hectares of coniferous forest for the Project. Replant lands are required. The replacement replanting of forestry can occur anywhere in the state, subject to licence. Potential replanting sites will be subject to a separate application.

It is worth noting that practical difficulties exist in the identification and environmental assessment of replant lands at the planning application stage. Such practical difficulties include the following:

- Felling can only occur after the grant of a felling licence by the Department of Agriculture, Food and the Marine (DAFM), however the extent of felling is determined by the grant of planning permission, thereby necessitating that the scope of the licence required can only be determined after the grant of planning permission.
- The details of the area, size and location of the replant lands will not be capable of being determined until after planning permission is granted.

[32] Department of Agriculture, Food and the Marine: Forestry Standards and Procedures Manual. Available at: https://www.forestryservices.ie/wp-content/uploads/2019/05/Forestry_Standards_and_Procedures_Manual_2015.pdf

[33] Department of Agriculture, Food and the Marine. Felling and Reforestation Policy (2017). Available at: https://www.teagasc.ie/media/website/crops/forestry/advice/Felling-and-Reforestation-Policy.pdf

- It is prudent to note that if a felling licence is obtained at the planning application stage, it is probable that the licence would expire before the planning process is complete and before planning delivery preparations could be completed.
- It is therefore considered that the identification and licencing of replant lands after the grant of planning permission has the benefit of ensuring that the licence is compliant with up to date legislation and environmental information. It would also ensure that cumulative environmental assessment considers the wider enviro9mental impacts at that point in time
- Key environmental issues related to afforestation (i.e water, soils, biodiversity, archaeology, landscape and climate) are subject to regular updates in terms of best practice, guidelines, standards and national policies

It is therefore considered that the delay in the identification of replant lands until such time as they are required enables identification of optimum lands available from an environmental perspective.

4.1.16 Meteorological Mast

There will be a permanent meteorological mast erected on site as part of this planning application. The type of meteorological mast is a lattice design and is 102.5m in height.

4.2 Project Construction

4.2.1 CEMP

A Construction and Environmental Management Report (CEMP) is contained in **Appendix 5**.

The CEMP sets out the key environmental management measures associated with the construction, operation, and decommissioning of the Proposed Project, to ensure that during these phases of the development, the environment is protected, and any potential impacts are minimised. In the event that An Bord Pleanála (ABP) decides to grant approval for the Proposed Project, the CEMP will be updated as required to address the requirements of any relevant planning conditions, including any additional mitigation measures which are conditioned by ABP. The CEMP will be a key construction contract document which will ensure that the contractor will implement the prescribed measures to protect the environment

4.2.2 Construction Activities

4.2.2.1 Wind Farm

For the wind farm element of the Proposed Project, the construction sequence will be as follows:

- tree felling,
- upgrading of existing site tracks and the provision of new site tracks,
- drainage infrastructure to be constructed in parallel with access track construction,
- construction of the turbine foundations and
- the provision of the hardstanding areas

4.2.2.2 Electrical Works and Cable route

Construction of the substation and internal cable network in conjunction with off-site connection works to the National Grid will be carried out in tandem to the wind farm element of the Proposed Project in sequenced activities. A description of construction techniques is contained within the CEMP in **Appendix 5**.

Site Access Tracks and Drainage

4.2.2.3 Access Tracks

In order to provide access to each of the turbines within the Project, access tracks are required. Drainage infrastructure therefore will be constructed in parallel with access track construction.

The Project will incorporate the upgrading of 5 kilometres of existing forest tracks. In addition, the Project will also require the construction of 10.55 kilometres of new site access tracks and associated drainage infrastructure. Existing drainage infrastructure will be retained where possible and improved as necessary While new drainage infrastructure will be required on all new access tracks.

- Access tracks would be formed on suitable underlying material (superficial soil or rock with sufficient bearing capacity) in the following manner:
- stripping of surface vegetation (turves) and careful stockpiling of this material;
- excavating the remaining superficial soil materials and stockpiling this material;
- where different superficial materials are present these would be stored according to type. This material would be monitored and watered (as appropriate) to be retained for reinstatement purposes;
- the exposed suitable track formation would have rock fill material tipped from dumper trucks directly onto the proposed access track alignment; and
- this material would then be either spread by a dozer or placed by a hydraulic excavator and compacted in layers, typically using vibratory rollers.

Access tracks would be formed from a sub-base of general fill and finished off with a cap-stone / wearing course of graded crushed rock to provide a nominal Type-B (Series 800) finish. Wearing course stone would be of a suitable material that is not susceptible to breaking down / weathering to a high fines content material.

Maintenance of the running surface would be carried out on a regular basis, as required, to prevent undue deterioration. Loose track material generated during the use of access tracks would be prevented from reaching watercourses by maintaining an adequate cross fall on the tracks. Periodic maintenance of tracks by way of brushing or scraping would be carried out to minimise the generation of wheel ruts, which could lead to some track material being washed away. In dry weather, dust suppression methods may be required for track and hardstanding areas. The site access tracks, hardstandings and trackside drains would be inspected on a regular basis by the Contractor.

4.2.2.4 Drainage

The construction of the site drainage comprises:

- The excavation of in channel rock check drainage channels 2m in width and 275mm in depth from the edge of the site access track.
- Silt fence textile will be laid within the channel. The silt fence textile will be Hy-tex Terrastop premium or similar and will be fixed to the upslope side of the supporting slope within the main drainage channel.
- Support posts for silt fence support and for channel supports will be inserted at the edge of the drainage channel at 1500mm intervals
- Silt fence textile will be anchored using clean drainage stone

The area behind silt fence will be maintained regularly and silt will be removed and buried. Further detail is shown in the planning drawings refer to **Appendix 1**.

Cable Trenches

4.2.2.5 Wind Farm

Cable-ducts within the site access tracks will be laid when the track is being constructed and will follow the edge of the site access tracks. Cable ducts within the public roadway will be laid within the verge of the roadway where possible. A separation distance of 600mm from existing services will be preserved. The trenches within these locations will be backfilled using the excavated material. The contractor will excavate cable trenches and then lay high density polyethylene (HDPE) ducting in the trench in a surround of cement bound material (CBM). A rope will be inserted into the ducts to facilitate cable-pulling later. The as-constructed detail of the cable duct locations will be carefully recorded. Cable marker strips will be placed above the ducts and the two communication ducts will also be laid. An additional layer of cable marker strips will be laid above the communication ducts and the trench back-filled. Back-filling and reinstatement in public roads will be to a specification to be agreed with the road authority and at least as good as the existing.

4.2.2.6 Cable routes (Collector Cable, Options 1 and 2)

The proposed cable routes are shown in **Appendix 1.** During the consultation and scoping processes for the Proposed Development, searches of existing utility services were carried out to identify areas where existing major assets exist such as high-voltage electricity cables and gas mains are. Private utilities and telecommunications companies were also consulted during this period to inform the proposed design. It should be noted that no responses from utilities were provided to the applicant during the scoping period.

During the construction stage of the Proposed Development, records of services such as water mains, sewers, gas mains and other power cables will be obtained from the relevant service providers ahead of construction works to ensure that all new developments between the period of assessment and pre-– construction is captured.

Where required, cable detection tools, ground penetrating radar, and slit trenches will be used as appropriate to find the exact locations of existing services. The final locations of the cable routes within the public roads and on the verge along the public road will be selected following these investigatory works to minimise conflicts with other services.

A minimum separation distance of 300mm will be maintained with existing services.

4.2.2.7 General Construction Sequence for All Cable Trenches

The detailed construction sequence for the installation of cabling is detailed in the CEMP in **Appendix 5** and in **Plate 4-1**. However, a general overview of the construction sequence is detailed below:

- All relevant bodies i.e. ESBN, Gas Networks Ireland, Eir, Laois County Council, Irish Water etc. will be contacted and all drawings for all existing services will be sought to confirm the conditions predicted in the EIAR.
- Immediately prior to construction taking place the area where excavations are planned will be surveyed and all existing services will be identified, and temporary warning signs erected where necessary.
- For cable works in the public road, the traffic management plan will be implemented. Clear and visible temporary safety signage will be erected all around the perimeter of the live work area to visibly warn members of the public of the hazards of ongoing construction works.
- An excavator will be used to excavate the trench to the dimensions of 600mm wide by 1.2m deep.
- A silt filtration system will be installed on all existing drainage channels for the duration of the cable construction to prevent contamination of any watercourse.
- Any ingress of ground water will be removed from the trench using submersible pumps and pumped to the nearest available existing drainage channel.
- Once the trench has been excavated, a bedding layer of sand or 15 Newton concrete will be installed and compacted. All concrete will be offloaded directly from the concrete truck into the trench.
- PVC ducts will be installed on top of the compacted base layer material in the trench.
- Once the ducts have been installed, couplers will be fitted and capped to prevent any dirt etc. entering the unjointed open end of the duct.
- In poor ground conditions, the open end of the duct will be shimmed up off the bed of the trench to prevent any possible ingress of water and dirt into the duct. The shims will be removed once the next length of duct has been joined to the duct system.
- The as-built location of the installed ducts will be surveyed and recorded using a total station/GPS before the trench is backfilled to ensure recording of exact location of the ducts, and hence the operational electricity cable. These co-ordinates will be plotted on as-built record drawings for the cable route cable operational phase.
- When ducts have been installed in the correct position on the trench base layer, sand (in road trench) or Lean-mix CBM4 (CL1093) (off road trench) will be carefully installed in the trench around the ducts so as not to displace the duct and compacted.
- Spacer templates will be used during installation to ensure that the correct cover of duct surround material is achieved above, below and at the sides of the duct in the trench.

- A red cable protection strip will be installed above duct surround layer of material and for the full length of the cable route.
- A layer of Lean-mix CBM4 (CL1093) (in road) or excavated material (off road) will be installed on top of the duct surround material to a level 300mm below the finished surface level.
- Yellow marker warning tape will be installed for the full width of the trench, and for the full length of the cable route, 300mm from the finished surface level.
- The finished surface of the road, road verge, or agricultural land will be reinstated as per its original condition or to the requirements of the Laois Area Engineer.
- Precast concrete cable joint bays will be installed within excavations in line with the trench. The cable joint bays are backfilled and the finished surface above the joint bay reinstated as per its original condition. The cable joint bays are re-excavated a second time during cable pulling and jointing, after which the finished surface above the joint bays is reinstated again to its original condition.
- When trenching and ducting is complete, the installation of the cable route cable will commence between the onsite sub-stations to the chosen 110kV substation (subject to a separate planning application).
- Construction work areas and traffic management measures will be setup at 2 no. consecutive cable joint bays simultaneously. The underground cable will be pulled through the installed ducts from a cable drum set up at one joint bay and using a winch system which is set up at the next joint bay, the cable is pulled through.
- The cables are jointed within the precast concrete cable joint bays.
- The finished surface above each cable joint bay is reinstated to its original condition, and the construction work area removed.

Plate 4-1: Example of 110kV Cross Section Trefoil Configuration along a roadway

4.2.3 Watercourse Crossings

Watercourse crossings can be classified as follows:

- Existing structures (bridges or culverts) that need to be crossed by infrastructure (access tracks or cables) associated with the Project, without a need to modify the existing structure;
- Installation of new structures to facilitate the crossing of existing watercourses by infrastructure associated with the Project;
- Existing structures that need to be either replaced or upgraded to facilitate the crossing of existing watercourses by infrastructure associated with the Project;

There is only 1 no. new watercourse crossing for new access tracks within the Project site. Proposed methods for crossing existing watercourses along the cable routes are set out in **Table 4-3**.

Table 4-3 Watercourse Crossings

Crossing Point	Existing / Proposed	X coordinate (ITM)	Y coordinate (ITM)	Crossing type	Watercourse
WF-HF1	Existing	656795	688332	Culvert	Unnamed
WF-HF2	Existing	656707	687931	Culvert	Unnamed
WF-HF3	Existing	656548	688049	Culvert	Unnamed
WF-HF4	Proposed	656531	688072	Culvert	Unnamed
WF-HF5	Existing	656810	688357	Culvert	Brennanshill
GCR-1	Existing	651288	683688	Culvert	Grainguenahown
GCR-2	Existing	651826	683756		Owveg (Nore)
GCR-3	Existing	652531	683670		Owveg (Nore)
GCR-4	Existing	652727	683607	Culvert	Garrintaggart
GCR-5	Existing	653089	683731	Culvert	Garrintaggart
GCR-6	Existing	653020	684530	Culvert	Cleanah
GCR-7	Existing	653308	685552		Owveg (Nore)
GCR-8	Existing	654047	687545	Culvert	Aghoney
GCR-9	Existing	653875	689103		Fossy Lower
GCR-10	Existing	653547	690511		Stradbally (Laois)
GCR-11	Existing	653156	691140		Cremorgan
GCR-12	Existing	655421	687083		Scotland

4.2.4 Turbine Hardstands

Each turbine will have a turbine hardstanding area constructed at the base of them to provide solid area for the main installation crane that will be used to back the turbine and for the assembly of the turbine. The dimensions of these hardstandings are 80m by 30m in size for the V162 turbine, while the SG155 turbine the hardstandings will be 50m by 20m in size.

The Proposed Development will use material on site in the first instance, and will utilise local quarries if required for the importation of required materials on the site. These quarries will be sourced once planning consent for the Proposed Development is secured.

Turbine crane hardstands will consist of a 500mm hardcore placed on top of a geotextile separator membrane. The construction methodology for newly constructed tracks will be as follows:

- The formation will be prepared to receive the geotextile membrane.
- Stone will be placed and compacted in layers to 500mm depth.
- A drainage ditch will be formed, within the excavated width and along the sides of the hard standing.
- Surplus topsoil will be placed along the side of the hard standing and dressed to blend in with surrounding landscaping.
- Surplus excavated subsoil will be used to reinstate the borrow pit.

4.2.5 Turbine Foundations

The bases of the foundations are excavated to a competent bearing strata. The proposed foundations will be gravity-based foundations consisting of a reinforced concrete base 25m in diameter. Based on site investigations carried out to date, it is proposed that all turbine foundations will be shallow gravity bases types and founded on either rock or glacial till. This will be confirmed with confirmatory site investigations prior to construction.

Excavated soil will be placed in the temporary storage areas adjacent to the turbines. Formwork and reinforcement are placed, and the concrete poured. Once the concrete is set the earthing system is put in place and the foundation is backfilled with suitable material.

4.2.6 Turbine Erection

The turbine components will be delivered on site where they will be placed on hardstand and laydown areas prior to assembly. The components include the turbine towers which hare delivered in sections, and the turbine blades which will be delivered one by one. Once all components are available and there is suitable weather each turbine will be assembled.

Each turbine will take approximately 3-4 days to erect, weather dependent and will require two cranes in the assembly process. The turbines will then be commissioned and tested. Any waste that is generated during the development's construction phase will be collected, separated and stored in dedicated receptacles at the temporary construction compounds during construction works. the contractor for the main construction works will nominate a suitable site representative such as a Project Manager, Site Manager or Site Engineer as the Waste Manager who will have overall responsibility for the management of waste. The Waste Manager will have overall responsibility to instruct all site personnel including subcontractors to comply with on-site requirements. This will ensure that at an operational level, each crew foreman is assigned direct responsibility.

4.2.6.1 Waste Generated

The following categories of waste will most likely be generated during the construction phase of the Proposed Development:

- construction and demolition waste,
- waste oil and hydrocarbons,
- paper and cardboard,
- timber and steel,
- municipal solid waste generated from the office and canteen.

Sanitary waste will be removed from site by a licensed waste disposal contractor. All portaloo units located on the site during the construction phase will be operated and maintained in accordance with the manufacturer's instructions and will be serviced under contract with the supplier. All such units will be removed off site following the completion of the construction phase.

A fully authorised waste management contractor will be appointed prior to the commencement of construction works. This contractor will provide the appropriate receptacles for the collection of the various waste streams able ensure regular emptying and/or collection of these receptacles.

Table 4-4 lists the licensed waste facilities in the surrounding area:

Table 4-4 Licenced Waste Facilities

Facility	Type of Waste Accepted	Location
Oil Go and Recycle Environmental	Oil	Mountmellick, Co. Laois
Agnail Recycling	Fiber, polymer, Building Materials	Portlaoise, Co. Laois
ROC Recycling	Plastic, Cardboard, Commercial	Portlaoise, Co. Laois
Kyletalesha Landfill	Paper, cardboard, metal, green waste, plastic, waste oil, glass, timber	Kyletalesha, Co. Laois

4.2.6.2 Waste Reduction Practices

All efforts will be made by site management to minimise the creation of waste throughout the lifetime of the Project. Such measures will include the following:

- Material storage areas will be of a suitable design and construction to adequately protect which would generate additional waste
- Material ordering will be optimised to ensure only the necessary quantities of materials are delivered to the site
- All plants will be serviced before arriving to the sites which will reduce the risk of breakdown and the possible generation of waste oil or hydrocarbons on site
- Where material such as concrete are to be ordered, great care will be practice in the calculation of quantities to reduce wastage
- All operators and foreman will be instructed in measures to cut back on the amount of wastage and will only order the materials necessary to complete each construction task as required
- Prefabrication of design elements will be used where appropriate to eliminate waste generation on sites

4.2.6.3 Waste Reuse

When possible, materials will be re used onsite for other suitable purposes as follows:

- Re-use of shuttering etc. Where it is safe to do so;
- Re-use of rebar cut-offs where suitable;
- Re-use of excavated materials for screening, berms etc.;
- Re-use of excavated material etc. – where possible will be used as suitable fill elsewhere on site for site tracks, the hardstanding areas and embankments where possible;
- Excess subsoils from excavations shall be used to reinstate borrow pits on site.

Any excess excavated material that will be used for fill, re-instatement, or similar activities, within the development site boundary is not categorised as a waste material under relevant waste legislation, rather this material is exempt from waste classification.

Article 2 (1) (c) of Directive 2008/98/EC on waste, transposed through Article 26 (1) (c) of the European Communities (Waste Directive) Regulations (S.I. 126 of 2011) identifies the following as being an exemption from waste regulation:

> *"uncontaminated soil and other naturally occurring material excavated in the course of construction activities where it is certain that the material will be used for the purposes of construction in its natural state on the site from which it was excavated".*

Surplus material will be re-instated in its natural condition on the site from which it was excavated, this material is not considered as waste.

4.2.7 Meteorological Mast

The proposed met mast will be comprised of a 102.5m lattice structure. The works involved with the erection of the mast will comprise:

- Private access through existing forestry tracks for the delivery of the mast via a flatbed truck to the base of the proposed mast location.
- Existing forestry tracks are approximately 3 to 4.5 m wide. In areas where tree growth has reduced the track with, trimming of the side branches on the conifer trees will be undertaken with filled branches used for brushing. Sections of the track may require levelling by an excavator to remove deep ruts.
- The mast sections and all other equipment shall be manually lifted from the truck. A 4x4 vehicle, or a tractor and trailer will be used to transport equipment to the mast location.
- Lifting of the tower is achieved using a lifting probe attached to the top of a gin pole and directed via a block at the tower base to the winch position.
- A reinforced concrete foundation will be provided for the 102.5 m lattice structure- the dimensions of the foundation are 10m diameter and 2m in depth
- Once the mast is lifted into position and secured, all materials and machinery will be removed from site. It is anticipated that an area of surface vegetation and subsoil at the base of the met mast and the provision of a hardstand (25m x 25m x 2m in depth) to erect will be provided.
- Anemometers and wind vanes are to be placed at 62.5mm, 82.5m and 102.5 m above ground height on the meteorological mast.
- Delivery of the meteorological mast, erection and decommissioning works will avoid periods of high rainfall, and ideally beats undertaken during the drier summer autumn months as per standard good practice.
- In total it is anticipated that the Met mast will take approximately five days to erect, remaining in situ for the duration of the operation of the Project, whereupon the mast will be removed using the same machinery as proposed in the installation process during the same period. Installation and removal will only be undertaken in dry weather conditions as per good construction standards.

4.2.8 Waste Management

A wastewater holding tank will be provided outside the substation compound fence line but within the red line boundary so that it can be maintained where required without requiring access to the substation compound. The wastewater holding tank will be a sealed storage tank with all wastewater tinkered off-site as required by an authorised waste collector to a wastewater treatment plant. Only waste collectors holding valid waste collection permits under the Waste Management (Collection Permit) Regulations, 2007, will be employed to transport wastewater away from the site). The proposed wastewater storage tank will be fitted with an automated alarm system that will provide sufficient notice that the tank requires emptying. The wastewater storage tank alarm will be part of a continuous stream of data from the site's turbines, wind measurement devices and electricity substation that will be monitored 24 hours a day seven days per week. This approach for managing wastewater on site has become a standard practice in wind farm sites, which are often proposed, and areas were residual waste.

Receptacles will be clearly labelled, signposted and stored in dedicated areas.

The following sources aggregated material containers. The provision of receptacles for the separation and collection of dry recyclables such as paper, cardboard, plastics will be provided and removed to a licenced facility by a suitable contractor.

The developer and the appointed contractor will seek to prevent, reduce, reuse and recover as much of the waste generated on the site as possible and to ensure the appropriate transport and disposal of residual waste is undertaken off site in accordance with the Waste Management Act 1996 (as amended) and in alignment with the National Waste Management Guidelines and the European Waste Management hierarchy.

4.2.8.1 Waste Recycling, Recovery and Disposal

National waste policy requires the separation of recyclable material at source. During the construction phase of the Proposed Development, receptacles will be provided for the separation and collection of dry recyclables (paper, cardboard, plastics), biological waste (canteen waste).

- All receptacles will be clearly labelled, signposted and stored in dedicated areas.

Receptacles for the following sources aggregated materials will be made available on site at a suitable location:

- food waste
- packaging waste
- dry mixed recyclables
- aluminium
- ferrous materials
- timber

These materials will be transported off site by an authorised contractor to a permitted recovery centre. These materials will then be processed through the various recovery operations.

Residual waste generated on site may require disposal. This waste will be deposited within dedicated receptacles and collected by the permitted waste management contractor who will then transport this waste to an appropriate facility. All waste movements will be recorded, and the waste manager on site will hold these records.

4.2.9 Construction Timeline

The construction phase of the Proposed Development, which includes civil, electrical, grid works, and turbine assembly is anticipated to take 18-24 months once the proposed turbines are acquired via a competitive tender process.

4.3 Project Operation and Lifespan

During the construction phase of the Proposed Development, turbines will operate automatically on a day-to-day basis. The turbines will respond to changes in wind speed and direction by means of anemometry-equipment and control systems.

Twice a year each turbine will undergo a schedule service. The operation of the wind turbines will be monitored remotely, and a caretaker will oversee the day-to-day running of the Project.

The expected physical lifetime of the turbine is 35 years, and permission is sought for a 35-year operation period commencing from full operational commissioning of the wind farm. However, it should be noted that following the end of their useful life, wind turbines may, subject to planning permission, be replaced with a new set of turbines or the site may be decommissioned.

4.4 Project Decommissioning

During the decommissioning phase of the Proposed Development, cranes will disassemble the above grounds turbine components which will be removed off site for recycling.

The foundations will be covered over and allowed to re-vegetate naturally. Leaving turbine foundations in situ is considered a more environmentally sensible option as to remove the reinforced concrete associated with each turbine would result in environmental nuisances such as noise and vibration and dust. It is proposed that the internal site access tracks will be left in situ, subject to agreement with Laois County Council and the relevant landowners.

The proposed onsite substation will be taken in charge by ESBN /EirGrid upon completion and should be left in place forming part of the national electricity network

Underground cabling will be cut back and left in situ.

A detailed decommissioning plan will be agreed in advance of construction with Laois County Council if required. A decommissioning plan is contained within the CEMP in **Appendix 5** and will contain the same mitigation measures as the CEMP unless otherwise agreed with the Laois County Council.

4.4.1 Ecology Baseline

Ecology Surveys

Table 4-5 details all the surveys undertaken at the Project site.

Table 4-5 Summary of Ecological Surveys

Survey	Description	Timing	Guidance Applied
Habitats and flora	Walkover survey at Project.	July 2022	(Fossitt, 2000)[34] (Smith, O'Donoghue, O'Hora, & Delaney, 2011)[35]
Birds Full details are contained within **Appendix 2**	Vantage point (VP) surveys covering each turbine location plus a 500 m radius around the same- refer to as the Site . Seven VPs x 36 hours/VP/season over 1.5 years[36] Five VPs x 36/hours/VP/season over 0.5 years[37] (Site reduced in size)	Non-breeding season 2017/18: 7 September 2017 to 29 March 2018	(NatureScot, 2017)[38]
		Breeding season 2021: 27 April to 20 September 2021	
		Non-breeding season 2021/22: 12 October 2021 to 2 April 2022	
		Breeding season 2022: 13 May to 30 August 2022	
	Breeding raptor surveys within the Site plus a 2 km buffer zone	Breeding season 2021: 19 May to 31 July 2021	
		Breeding season 2022: 6 May to 25 July 2022	
	Breeding wader surveys (lowland) within the Site	Breeding season 2022: 6 May to 23 June 2022	
	Feeding distribution surveys within the Site plus a 500 m buffer zone	Non-breeding season 2021/22: 22 October 2021 to 15 March 2022	
	Winter transect surveys within the Site	Non-breeding season 2017/18: 20 November 2017 to 27 March 2018	(Marchant, 1983)[39]
Terrestrial mammals (excluding bats)	Searches within 150 m of Project infrastructure	Winter 2021: 7 to 10 February 2022 and summer 2022: 4 to 6 July 2022	(Cresswell, et al., 2012)[40]

[34] Fossitt, J.A. 2000. A guide to habitats in Ireland. The Heritage Council

[35] Smith, G.F., P. O'Donoghue, K O'Hora, and E Delaney. 2011. Best practice guidance for habitat survey and mapping. Kilkenny: The Heritage Council.

[36] Except for winter 2017/19 where VP1 had 51 hours/season, VP2 had 43.5 hours/season, VP3 had 40 hours/season, VP4 had 32.5 hours/season and VP5 had 30 hours/season. Years referred to include the winter of 2017/18, summer of 2021 and winter of 2021/22.

[37] Years referred to include the summer of 2022

[38] NatureScot. 2017. Recommended bird survey methods to inform impact assessment of onshore wind farms. Version 2. SNH

[39] Marchant, J.H. 1983. Common Birds Census Instructions. Tring: BTO.

[40] Cresswell, W.J., J.D.S. Birks, M. Dean, M. Pacheco, W.J. Trewhella, D. Wells, and S. Wray. 2012. UK BAP Mammals: Interim guidance for Survey Methodologies, Impact Assessment and Mitigation. Southampton: The Mammal Society.

Survey	Description	Timing	Guidance Applied
	Trail cameras within the Site	Summer 2022: 7 to 20 July 2022	
Bats	Preliminary ecological appraisal and winter roost assessment: within Site	Winter 2021: 7 to 10 February 2022	(Collins, 2016)[41] (NatureScot, 2021)[42]
	Summer roost assessment: within Site	Summer 2021: 4 to 6 July 2022	
	Ground-level static detectors: at 16 turbines for summer and autumn 2021 rounds and 11 turbines for spring 2022 round (five less detectors were deployed in spring 2022 due to a reduction in the proposed number of turbines)	Summer: 12 July to 4 August 2021 Autumn: 7 September to 23 September 2021 Spring: 26 May to 7 June 2022	(NatureScot, 2021)
	Transects: two locations (one in Northern Cluster and one in Southern Cluster)	Spring: 26 May 2022 Summer: 16 August 2022 Autumn: 28 September 2022	(Collins, 2016) (NatureScot, 2021)
	Emergence survey: derelict building near quarry	15 August 2022	(Collins, 2016)
	Survey of trees/structures along cable routes and TDR	13 - 14 August, and 20 – 21 August 2022	(Collins, 2016)
Other protected fauna	Invertebrates, amphibians and reptiles within Site	4 to 6 July 2022	N/A
Fisheries and aquatic ecology Full details are contained **Appendix 3**	Undertaken on a catchment-wide scale, the baseline surveys focused on aquatic habitats in relation to fisheries potential (including both salmonid and lamprey habitat), white-clawed crayfish *Austropotamobious pallipes*, freshwater/Nore pearl mussel *Margaritifera margaritifera* and *Magaritifera durrovensis* (eDNA only), macro-invertebrates (biological water quality), macrophytes and aquatic bryophytes, aquatic invasive species, and species of conservation value which may use the watercourses in the catchment in which the the Project is located.	31 August to 3 September 2022	(Environment Agency, 2003)[43]

[41]Collins, J. 2016. Bat Surveys for Professional Ecologists: Good Pratice Guidelines (3rd edn). London: The Bat Conservation Trust.

[42]NatureScot. 2021. Bats and onshore wind turbines - survey, assessment and mitigation. SNH

[43]Environment Agency. 2003. River Habitat Survey in Britain and Ireland Field Survey Guidance Manual.

Habitats (Annex I)

No potential Annex 1 habitats are present at the Project Site.

Species (Annex I birds and Annex II others)

Likely Significant Effects on Annex I birds other than kingfisher were excluded at Stage 1. There is no habitat suitable for kingfisher within the Project site although streams which drain the Project site become suitable for this species further downstream.

Aquatic surveys were undertaken on watercourses within the Project area and within the surrounding catchment (Triturus 2022[44]) provided in **Appendix 3**. White clawed crayfish were recorded at four locations (B7, B8, B10, C7), otter signs were identified at A12, A14, A15, C4, C5 and C7 (refer to **Appendix 3** for locations). Fresh water pearl mussel was not identified in eDNA or other site observations.

Fisheries assessment (Triturus 2022[45]) recorded Atlantic salmon in three (A15, B3 and B10) of 33 water course survey sites and lamprey sp in seven (A6, A11, A15, B10, C4, C6 and C7) of 33.

Despite some good habitat suitability at numerous survey locations, otter signs were only recorded at a total of four sites. Regular otter spraint sites were recorded at sites A12 on the Cremorgan Stream (3 no. spraint sites), A14 and A15 on the Stradbally River (total of 7 no. sites) and site C7 on the Clogh River (2 no. sites). A latrine and couch (resting) area were also identified under Stradbally Bridge at site A15. Of these locations, only site A12 is adjacent to the Project (cable route option 2). Sites A14, A15 and C7 are all at least 4km instream distance from the Project. No breeding (holts) areas were identified in the 150m vicinity of the survey sites.

Ecological Connections

Any species using the site that is a QI for a designated site, potentially, white clawed crayfish, otter, lamprey species and Atlantic salmon, could use habitat within the Project and these species would be connected to the relevant designated sites.

The freshwater survey recorded the closest white clawed crayfish to the main Project site at C7, which is 3.6km along hydrological links to the closest water course within the Project. White clawed crayfish were also identified at B7 and B8 along option 1 for the cable route. However, the cable route will use existing culverts, apart from one location, away from existing white clawed crayfish populations and therefore there is no ecological pathway for the cable rout to effect white clawed crayfish populations within the River Barrow and Nore SAC. In terms of the main Project site, white clawed crayfish disperse relatively slowly, only covering sort distances (no movements greater than 70m in two days) compared to non-native signal crayfish (*Pacifastacus leniusculus*) (maximum two-day movement is 341m)[46]. This suggests that white clawed crayfish would only colonise

[44]Triturus (2022) Aquatic baseline report for Coolglass wind farm, Co.Laois. Report prepared by Triturus Environmental Ltd. for SLR Consulting. December 2022.

[45]Triturus (2022). Fisheries assessment of Coolglass wind farm, Co. Laois. Report prepared by Triturus Environmental Ltd. for SLR Consulting. December 2022.

[46]Bubb, D., Thom, T.J. and Lucas, M.C (2006) Movement, dispersal and refuge use of co-occurring introduced and native crayfish *Freshwater Biology* 51 1359-1368

further upstream, if there is a significant increase in populations further downstream. With the presence of crayfish plague (*Aphanomyces astaci*) within the watercourses (C7 tested positive) populations are likely to be under pressure to maintain current populations, rather than be expanding their range. Therefore, it would be unlikely that the white clawed crayfish populations identified further downstream will reach the stage of expanding into watercourses within the main project site. Expansion of white clawed crayfish into watercourses within the Project at the time of construction (if consented 18-24 months after turbines are acquired) is even more unlikely. The construction phase would pose the highest risk to white clawed crayfish, when crossings are being installed there is the potential for physical damage to individual crayfish, damage to refuges and other habitat. Once water crossings are installed and are in use (i.e during operation) the risks to white clawed crayfish are greatly reduced.

Otters have large home ranges, 32km for males and 20 km for females in freshwater habitats in Scotland[47] and 7.5 km for females in Ireland[48] as otter signs were identified at A12, A14, A15, C4, C5 and C7 there is a high potential that otter would utilise parts of the watercourses within the Project for their territory. Although, no holts were found within the Project or as part of the aquatic surveys, Otter could be present within the project at all stages (construction, operation and decommissioning); therefore, there is a risk of injury to otters during construction, in terms of physical injury e.g. an otter becoming trapped in excavation or through disturbance e.g. displacing otters from foraging habitat.

Atlantic salmon were identified in three locations:

- A15- 5.4km downstream from the main Project and 4km downstream from cable route option 2;
- B3 -2.7km downstream from the main Project and adjacent to cable route option 1; and
- B10- 7.8km downstream from the main Project and 600m from cable route option 1.

Atlantic salmon spawn in upstream rivers that are cool, have well oxygenated water and clean gravels, alevins, fry and par (juvenile Atlantic salmon) require rivers with good water quality, cool temperatures, stony river beds, invertebrate prey sources and aquatic vegetation to provide cover.[49] Disruption of the water course bed has the potential to effect Atlantic salmon, if the stream is used by breeding adults, all other aspects are looked at in more detail in association with water quality. This could occur when water crossings are installed during construction or removed during decommissioning, although once operational such crossings will prevent disturbance to watercourse sediments.

Lamprey species were identified at seven locations,

- A6 5.4km downstream from the main project site and 3.5km form cable route option 2.

[47] Kruuk, H. (2006). Otters – ecology, behaviour and conservation. Oxford University Press, Oxford.

[48] Ó Néill, L., Veldhuizen, T., de Jongh, A., Rochford, J. (2009). Ranging behaviour and socio-biology of Eurasian otters (Lutra lutra) on lowland mesotrophic river systems. European Journal of Wildlife Research: 55: 363-370.

[49] Inland fisheries Ireland https://www.fisheriesireland.ie/species/atlantic-salmon-salmo-salar#:~:text=The%20Atlantic%20salmon%20is%20native,in%20most%20of%20our%20rivers.

- A11 1.9km downstream from the main project site and adjacent to cable route option 2
- A15 9km downstream from the main project and 7.2km from cable rout option 2.
- B10 1.6km downstream from the main project and 2,6 km from cable route option 2
- C4 adjacent to the main project and not downstream of any cable route options.
- C6 600m downstream from the main project and not downstream of any cable route options.
- C7 3.6km downstream from the main project.

Hydrology connections

There is hydrological connectivity, via surface and ground water, between the River Barrow and River Nore SAC. The Project is upstream of the River Barrow and River Nore SAC. The River Barrow part of the SAC is approximately 8.1km downstream of the northern cluster and approximately 3.3km downstream of the southern cluster .The River Nore SPA is 15.4km downstream from the northern cluster of the main project, due to the proximity and connectivity of water course within the Project and beyond.

4.5 Step 1, Part 2 Information on European Sites

4.5.1 River Barrow and River Nore SAC

The River Barrow and River Nore SAC has site specific conservation objectives (NPWS 2011)[50]. These provide clarity of the definition of favourable conservation condition for the qualifying interest of the SAC, and state whether the qualifying interest is favourable or unfavourable, plus the relevant conservation objective, and is summarised in Table 4-6. This information is for some freshwater qualifying interest features only, since Likely Significant Effects have been excluded for Desmoulins's whorl snail, petrifying springs, terrestrial habitats and marine habitats and species (see section 3.5).

Table 4-6 Conservation objectives for the qualifying interest features of the River Barrow and River Nore SAC (F=favourable, U=unfavourable, M=maintain, R=restore)

Qualifying Interest Feature	Occurrence in River Barrow and River Nore SAC	Attributes defining Conservation Condition	Conservation condition and objective
Hydrophilous tall herb fringe communities of plains and of the montane to alpine levels	Present	Habitat distribution Habitat area Hydrological regime: Flooding depth/ height of water table Vegetation structure: sward height	F/M

[50]NPWS (2011) River Barrow and River Nore SAC Conservation objectives. Available from: https://www.npws.ie/sites/default/files/protected-sites/conservation_objectives/CO002162.pdf accessed 24/01/23

Qualifying Interest Feature	Occurrence in River Barrow and River Nore SAC	Attributes defining Conservation Condition	Conservation condition and objective
		Vegetation composition: broad leaf herb / grass ratio, typical species and negative indicator species.	
Water courses of plain to montane levels with the *Ranunculion fluitantis* and *Callitricho-Batrachion* vegetation	Present	Habitat distribution Habitat area Hydrological regie: river flow Hydrological regime: ground water discharge Substratum Composition : Partical size range Water chemistry: minerals Water Quality:: suspended sediment Water quality: nutrients Vegetation composition: typical species Floodplain connectivity	F/M
White-clawed crayfish	Present	Distribution Population structure Negative indicator species Disease Water quality Habitat quality	F/M
Sea lamprey	Present - although artificial barriers have blocked upstream migrations.	Distribution Population structure of juveniles Juvenile density in fine sediment Extent and distribution of spawning habitat Availability of juvenile habitat	U/R
Brook lamprey	Present - although artificial barriers have blocked upstream migrations.	Distribution Population structure of juveniles Juvenile density in fine sediment	U/R

Qualifying Interest Feature	Occurrence in River Barrow and River Nore SAC	Attributes defining Conservation Condition	Conservation condition and objective
		Extent and distribution of spawning habitat Availability of juvenile habitat	
River lamprey	Present - although artificial barriers have blocked upstream migrations.	Distribution Population structure of juveniles Juvenile density in fine sediment Extent and distribution of spawning habitat Availability of juvenile habitat	U/R
Twaite shad	Present - although artificial barriers have blocked upstream migrations.	Distribution Population structure Extent and distribution of spawning habitat Water quality Spawning habitat quality	U/R
Atlantic salmon	Present - although artificial barriers have blocked upstream migrations.	Distribution Adult spawning fish Salmon fry abundance Out-migrating smolt abundance Number and distribution of redds Water quality	U/R
Otter	Present.	Distribution Extent of terrestrial habitat Extent of marine habitat Extent of freshwater habitat (river & lake) Couching sites and holts Fish biomass available	U/R
Nore freshwater pearl mussel	The population stretches from Poorman's Bridge to Lismaine Bridge, in River Nore, part of which is downstream from the project site, via the Owveg/OwenBeg River.	Distribution Population size: adult mussels Population structure: recruitment & adult mortality Habitat extent	U/R

Qualifying Interest Feature	Occurrence in River Barrow and River Nore SAC	Attributes defining Conservation Condition	Conservation condition and objective
		Water quality Substratum quality: sediment, oxygen & filamentous algae Hydrological regime: flow Host fish	
Freshwater pearl mussel	Status is currently under review as a qualifying annex II species for the River Barrow and River Nore SAC.	The outcome of this review will determine whether a site-specific conservation objective is set for this species.	Overall, in Ireland this species is in an unfavourable state[51] and therefore a U/R status is assumed for this NIS U/R

4.5.2 River Nore SPA

Qualifying interest features and conservation objectives

The conservation objectives for the River Nore SPA were generic:

To maintain or restore the favourable conservation condition of the bird species listed as Special Conservation Interests for this SPA.

In the case of the River Nore SPA, this is the resident kingfisher population.

The favourable conservation status of a species is achieved when:

- population dynamics data on the species concerned indicate that it is maintaining itself on a long-term basis as a viable component of its natural habitats; and
- the natural range of the species is neither being reduced nor is likely to be reduced for the foreseeable future; and
- there is, and will probably continue to be, a sufficiently large habitat to maintain its populations on a long-term basis.

Conservation condition

The kingfisher population was 22 pairs in 2010[52]. There are no more recent accessible data for this species within the SPA, therefore it is not possible to establish the most recent population in terms of population dynamic data. However, the most recent BoCCI[53] kingfisher is amber-listed with a moderate decline in the breeding population of 45% and 44% over short and long time periods respectively. Therefore, under the precautionary principle, the assumption is the population is unfavourable and the conservation objective

[51]NPWS (2013)The Status of EU protected habitats and species in Ireland

[52]NPWS site synopsis for River Nore SPA https://www.npws.ie/sites/default/files/protected-sites/synopsis/SY004233.pdf accessed 25/1/23

[53]Gilbert G, Stanbury A and Lewis L (2021), "Birds of Conservation Concern in Ireland 2020 –2026". Irish Birds 9: 523—544

is to restore (U/R). Kingfisher were not recorded on any of the bird surveys undertaken at the Coolglass Project

4.6 Step 2, Part 2: Effects on the Integrity of European 'Alone'

4.6.1 River Barrow and River Nore SAC

Hydrological connectivity

The Project is upstream of the River Barrow and River Nore SAC. The River Barrow part of the SAC is approximately 8.1km downstream of the northern cluster and approximately 3.3km downstream of the southern cluster. The River Barrow and River Nore SAC is also in the same sub-catchment as the Project. During construction, decommissioning and to a lesser extent, during operation (in the form of routine maintenance) of the Project there is potential for release of:

- suspended solids (soils likely acidified due to the coniferous plantation woodland),
- other pollution, (such as release of hydrocarbons, contamination from wastewater disposal, release of cement-based products),
- release of nutrients; and
- dispersal of non- native invasive species and/ or disease.

All identified pollution pathways have the potential to impact aquatic habitat interest features within the River Barrow and River Nore SAC (Water courses of plain to montane levels with the *Ranunculion fluitantis* and *Callitricho-Batrachion* vegetation and Hydrophilous tall herb fringe communities of plains and of the montane to alpine levels). Suspended solids could cover the leaves, reducing the plants ability to photosynthesise, leading to die back, this is likely be exasperated if the pH changes as well due to any acidity associated with the coniferous plantation. Additional nutrients can lead to algal blooms (eutrophication) out competing the existing vegetation. Hydrocarbon pollution affects leaf biochemistry[54], leading to decline in productivity and die back of vegetation. Non-native botanical species could outcompete and shade those species key to creating the habitats specified as qualifying features, reducing ecosystem functionality[55].

Release of suspended solids could occur when soil is disturbed during construction and/or decommissioning works, especially during periods of heavy rainfall. In the worst case, suspended solid pollution could reduce water quality and smother spawning beds of fish species, leading to effects on fish, freshwater pearl mussel (salmon are host species for freshwater pearl mussel), and therefore otter populations (as fish prey sources are affected). As the soils are likely to be acidified, due to the coniferous forestry there are further risks; as a decrease in pH can lead to poor development of the salmon eggs[56] and impoverished aquatic invertebrate fauna[57], this would include white-clawed crayfish populations. In addition, a reduction in invertebrates would reduce food resource for other

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[54]Arellano, P, Tansey, K, Balzter, H and Boyd, D.S (2015) Detecting the effects of hydrocarbon pollution in the Amazon forest using hyperspectral satellite images. Environmental Pollution 205 225-239

[55]Santos, M. J., Anderson, L.W and Ustin, S.L (2011) Effects of invasive species on plant communities an example using submersed aquativ plant at the regional scale. Biological Invasions 13 443-457

[56]Carrick, T.A (2006) The effect of acid water on the hatching of salmon eggs. Journal of Fish Biology 14 (2): 165-172

[57]Fridberg, N, Radsdrof, A and Larsen, S.E. (1998) Effects of afforestation on acidity and invertebrates in Danish streams and implications for freshwater communities in Denmark. Water, Air and Soil pollution 101 235-256.

QI species such as fish, freshwater pearl mussel and otter. Hydrocarbon pollution has a negative effect on fish, at low levels bio-accumulation can occur, leading to suppressed immune systems, reduced metabolism and damage to gills[58]. Declines in fish would impact fish qualifying interest features and those that forage upon them (otter) or reliant on fish for a part of the life cycle (freshwater pearl mussel). Nutrients and associated algal blooms have the potential to affect invertebrates, fish and mammals that feed on them. In worse cases, water oxygen level can become depleted, negatively impacting all aquatic life and anything that forages or relies on another species for dispersal. Fish can die during algal blooms due to inflammation, mucus production and haemorrhaging gillls[59], impacting those species that forage upon them or reply on them for dispersal.

However, the quantities of suspended solids that could be released at the Project site would be very small and subject to high levels of dilution in the river system. Moreover, the release of suspended solids could only occur for short period of time during the construction and/or decommissioning works.

Dispersal of non-native species, such as signal crayfish, or contaminated soil or water could pass disease such as crayfish plague (*Aphanomyces astaci*) to native species, i.e. white clawed crayfish. Although, no signal crayfish were identified in the watercourses surrounding the Project (refer to **Appendix 3**) the Stradbally River site A15 and Clogh River site C7 did test positive via eDNA for crayfish plague. This could suggest that the white clawed crayfish population near to C7 and A15 are vulnerable to infection with crayfish plague and construction could increase this risk if crayfish are under additional stress or contaminated soils or water, also containing crayfish plague, are used within the Project.

Seeds of non- native plant species could also be transferred via watercourses from the Project. Japanese Knotweed *Reynoutria japonica* was found to be present within the quarries, for example. This could be washed down stream and become established on the riparian margin, out shading native species. Of specific concern is the QI: Water courses of plain to montane levels with the Ranunculion fluitantis and Callitricho-Batrachion vegetation and Hydrophilous tall herb fringe communities of plains and of the montane to alpine levels.

Ecological connectivity

Mobile qualifying interest features of the River Barrow and River Nore SAC, specifically white-clawed crayfish, lamprey species, twaite shad, salmon and otter, could move outside the SAC along hydrological connections into the vicinity of the project. Further information on distribution of twaite shad and sea lamprey indicates that they are not present within the Project area or surrounding water courses, and only located considerable distance further south[60]. Any water pollution would be substantially diluted before reaching the areas where these species are distributed within the SAC, as for coastal QI features, twaite shad and sea lamprey are not discussed further as there will be the Project could not undermine the conservation objectives for these qualifying interest features.

The aquatic surveys did not identify white clawed crayfish, salmon or twaite shad within the Project area (refer to **Appendix 3**). Lamprey (brook or river) were identified in the red line boundary (A6 and C4) and otter signs were identified within the red line boundary at

[58]Austin, B (2010) The effects of pollution on fish health. Journal of Applied Microbiology 85 S1 p234-242
[59]Hallegraeff, G.M (1992) Harmful algal blooms in the Australian region Marine Pollution Bulletin 25 5-8 186-190
[60]National Parks and Wildlife Service (2011) River Barrow and River Nore SAC 002162 Conservation objectives

C4 and C5, refer to **Appendix 3**. During construction, a total of 17 streams will be crossed either via new bridges (one crossing) or reinforcing existing bridges (16 crossings). Construction could directly cause mortality to these species with work undertaken within the channel or the need to enter the channel during bridge installation or reinforcement.

Any of the effects of pollution mentioned previously could be magnified if species are in closer proximity to the Project and at the immediate source of pollution dispersal.

Otters could utilise streams and terrestrial habitat within the Project and there is a risk an otter could become trapped in excavations on land if no appropriate exit is provided. If present within or nearby to the Project, human activity could affect otter by disturbing and/or displacing individuals, preventing foraging and leading to a loss of condition.

4.6.2 River Nore SPA

Hydrological and hydrogeological connectivity

The River Nore SPA qualifying interest feature is kingfisher. There is a hydrological and hydrogeological connection to the Project, meaning that pollutants or suspended solids, generated during construction or decommissioning, could enter the watercourse designated as an SPA. This could affect prey kingfisher depend upon, as described for the Rive Barrow and River Nore SAC or could cloud the waters so that foraging would not be possible or the success reduced for kingfisher, leading to a decline in condition. The ecological connectivity is discounted, refer to section 3.5.1.

4.7 Step 2, Part 2: Effects on the integrity of European sites 'In Combination'

4.7.1 Projects

A monthly desktop-based planning search spanning 10 years within a radius of 20km was undertaken. Sources consulted included the EIA portal, An Bord Pleanála, Laois County Council and Carlow County Council planning lists. The list was refined be eliminating all single homes from 2km outside the red line boundary of the Project and focused on planning applications of over 50 houses and planning applications which contained an EIAR or an NIS. This formed our cumulative long list of developments.

Further refinement was undertaken to ascertain developments within this list. These refinements included:

- All wind farms and cable route planning applications within 20km where the planning status is to be determined, or where the construction period would likely coincide with the construction period of the Project;
- All infrastructural projects which are operational and utilising the same road networks that are proposed by the Project;
- All quarries within 2km of the Project red line boundary;
- All Strategic Infrastructure and Strategic Housing Developments within 20km where the same road network would be utilised; and
- All Strategic Housing Development and Large-Scale Residential Developments within 5km.

There are no constructed wind farms in the immediate vicinity (5km) of the Project. There are eight wind farms within 20km. **Appendix 6** illustrates the wind farms within 20 km of the site. A 10-year search was used. Data sources included planning portals. A further four projects are also considered, mostly quarries and a renewable gas facility, **Table 4-7** gives further details.

Table 4-7 Other projects considered for 'In Combination' effects

Applicant / Development Name	Development Type	Reg. Ref.	Distance to Development
Michael Johnson	Restoration of existing quarry to agricultural grassland and to include the importation of inert soil and stones (EWC class 17 05 04) at a rate of 15,000 tonnes per year to facilitate same development and associated site works.	20247 (Laois) Granted 19/11/2020	4km
Bilboa Wind Farm	Installation of approximately 4.6 ('km') of underground cables within Carlow County Council ('CCC') boundary and approximately 2.0km within Laois County Council ('LCC') boundary with a voltage of up to 38 kilovolts and associated works, including a new substation with LCC, for the connection of the consented Bilboa Wind Farm (Planning Register References: Carlow County Council 11/154; An Bord Pleanala PL 01.240245) to the national electricity grid; upgrading of an existing forestry track within CCC; construction of two new onsite access track within CCC; re-orientation and increasing in size of a crane hardstanding area within CCC; and road strengthening and widening along an updated turbine delivery route, within LCC, pursuant to the consented Bilboa Wind Farm (Planning Register References: Carlow County Council 11/154; An Bord Pleanala PL 01.240245).	Date Granted: 12.07.2021 (Laois Co. Co.) / 13.07.2021 (Carlow Co. Co.) Grant Date: 19/11/2020	17km
Bilboa Wind Farm	Installation of approximately 4.6 kilometers ('km') of underground cables within Carlow County Council ('CCC') boundary and approximately 2.0km within Laois County Council ('LCC') boundary with a voltage of up to 38 kilovolts and associated works, including a new substation with LCC, for the connection of the consented Bilboa Wind Farm (Planning Register References: Carlow County Council 11/154; An Bord Pleanala PL 01.240245) to the national electricity grid; upgrading of an existing forestry track within CCC; construction of two new onsite access track within CCC; re-orientation and increasing in size of a crane hardstanding area within CCC; and road strengthening and widening along an updated turbine delivery route, within LCC, pursuant to the consented Bilboa Wind Farm (Planning Register References: Carlow County Council 11/154; An Bord Pleanala PL 01.240245).	Laois (20281) / Carlow (20282) Date Granted: 15/02/2022	17km
Bord Na Móna Powergen Ltd.	Develop a Renewable Gas Facility, associated peat deposition area and external and internal road upgrades at Cúil Na Móna Bog within the townland of Clonboyne and Clonkeen, Portlaoise, Co. Laois. The total area of the proposed development is 17.34 Ha and consists of the following elements: 1. Renewable Gas Facility (6.85 Ha) including the following: Weighbridge and Weighbridge Office - 21m2 in area 4.45m high, Administration Building 228m2 in area 5.1m high, Reception Building 2,700m2 in area 11.75m high, Odour Abatement unit 400m2 in area stack height 18m, Tank Farm - 2 no. primary digestion tanks (6,500m3) 22m high; 2 no. secondary digestion tanks (5,650m3) 17.2m high; 2 no. buffer storage (450m3) 6m high; 4 no. liquid feed intake tanks (100m3) 12m high; 2 no. process water tanks (30m3) 7.5m high; 4 no. pasteurisation tanks (30m3) 7.5m high, Gas Upgrade and Injection Plant 1,278m2, Covered Digestate lagoon 55,100m3 capacity, Surface Water Attenuation pond 20m x 30m, Wastewater below ground	ABP-309293-21 / 19530 (Laois) 3rd Party appealed on 06/10/2022	14km

Applicant / Development Name	Development Type	Reg. Ref.	Distance to Development
	holding tank 10m3 capacity, Palisade site fencing 2.4m high, 1,420m in length, On-site electrical sub-station up to 22m2, Circulation yard area 3,500m2 incl. 28 no. car parking spaces. 2. Peat deposition and surrounding area (9.13Ha) 3. External road upgrades including proposed new roundabout, upgrade of R445 and local access road to existing site entrance - 660m in length (0.91Ha) 4. Internal upgrade of site access road - 443m in length (0.45Ha). Permission is sought for a period of 10 years and is a development that is for the purpose of an activity requiring an Industrial Emission Licence from the EPA		
Lagan Materials Limited (Spink Quarry)	Develop as follows: the continued use and operation of the existing quarry including deepening of the quarry. Extraction will be confined to the existing permitted quarry area (P.A. Ref. 10/383) comprising an extraction area of c. 14.5 ha within an overall application area of c. 19.6 ha. The development will include provision of new site infrastructure, including portacabin site office / canteen, toilets, concrete batching plant and truck washdown facility, hydrocarbon interceptors, mobile crushing and screening plant, upgrading of the water management system, provision of holding tank for wastewater, and other ancillaries. The proposed development will utilise/upgrade the existing in-situ quarry infrastructure, including site access, internal roads, storeroom, wheel wash, weighbridge, aggregate storage bays, refuelling hard stand, water settlement pond system, and other ancillaries.	21700 (Laois)	3km
Pinewood Wind Limited	11 wind turbines, electricity substation, switch room, equipment compound, site access tracks, 7 site entrances, meteorological mast, upgrade of road junction. Townlands: Knockardugar, Boleybawn, Garrintaggart, Ironmills, Co. Laois	PL11.248518 (ABP) / 16/260 (Laois) Granted 03/09/2021	4km
Pinewood Wind Limited	A 110kv 'loop in/loop-out' Air-Insulated Switchgear substation, electricity lines, on-site access tracks and all associated site development works. Townlands: Knockardagur, Ballinakill, County Laois	ABP-308448-20 Granted 22/11/2021	4km
Pinewood Wind Limited	2 kilometres of site access tracks, underground electricity and communications cabling and site drainage works. Townlands: Lands at Crutt, County Kilkenny.	PL10.248392 (ABP) /17/62 (Laois) Granted 03/09/2019	4km
Cullenagh Wind Farm	Develop 18 no. wind turbines each with a hub height of up to 85m and a rotor diameter of up to 93m with an overall tip height of up to 131.5m (including associated transformers and hardstands at each turbine). Permission is also being sought for the provision of internal access roads and strengthening and widening of existing internal forestry access roads; 1 no. permanent meteorological mast of approx. 86m in height; a	PL11.232626 (ABP) / 13268 (Laois(	3.5km

Applicant / Development Name	Development Type	Reg. Ref.	Distance to Development
	38KV single storey substation compound (including switchrooms, control room and ancillary areas) with sanitary facilities and holding tank & 6 no. associated car parking spaces; underground electrical and communication cables linking the turbines with the substation compound; widening of 2 no. existing entrances on the L3777 for temporary construction access, temporary construction compound, and all associated site development and drainage works.	Granted 14/6/2014	
Gortahile Wind Farm	A ten-year planning permission for a renewable energy development with a 40-year operational life (from the date of commissioning of the renewable energy development). The entirety of the development constitutes the provision of a 9-turbine wind farm and all associated works on lands in both Counties Tipperary and Kilkenny.	04935 (Laois) Granted 27/10/2024	11km
Farranrory Wind Farm and Cable route	Erect 7 no. wind turbines, up to 80m hub height & up to 45m blade length, access roads, control building & ancillary site works / a ten-year appropriate period planning permission for development of this site: the proposed development will constitute the provision of the following: the installation of 2.25 km of 38kV underground cable route comprising cable ducting and associated electrical cabling and all other ancillary works including joint bays, culverts, maker posts and all associated developments. Advisory Note: The full extent of the cable route is 33.8 km	Wind Farm- 211620 Tipperary (granted 30/32021 Cable route 20972 Tipperary Granted 14/11/2022	17km
Lisdowney Wind Farm (Kilkenny)	For a modification for the redesign of a previously approved development at site address Lisdowney, Ballyragget, Co. Kilkenny planning reference no 08/1511. The previously approved development consisted of a wind farm with 4 turbines, a meteorological mast, electrical control transformer building, burrow pit and associated site roads. The proposed revision is to optimise the layout of the 4 turbines and associated road infrastructure and associated ancillary works and increase the hub height from 64m up to a hub height of 80m and increase the maximum blade tip height from 99.5m to 121.5m.	08/1500, modified under 12/172 (Kilkenny) Granted 23/7/2012	11km

4.7.2 Plans

The following development plans have been reviewed and taken into consideration:

- Laois County Development Plan 2021 - 2027;
- Kilkenny City and County Development Plan 2021 - 2027;
- National Biodiversity Action Plan; and
- Regional Spatial and Economic Strategy 2020-2032 (RSES).

The review examined policies and objectives relating to designated sites for nature conservation, biodiversity, protected species, conservation of peatlands, sustainable land use and preservation of surface water quality.

Key policies and development allocations are summarised in **Table 4-8**.

Table 4-8: Assessment of relevant local plans

Plan	Policies for the Protection of European Sites	Development Allocations with Potential for in combination effects
Laois County Development Plan 2021-2027	**BNH2** Conserve and protect habitats and species listed in the Annexes of the EU Habitats Directive (92/43/EEC) (as amended) and the Birds Directive (2009/147/EC), **BNH3** Support and co-operate with statutory authorities and others in support of measures taken to manage proposed or designated sites in order to achieve their conservation objectives. **BNH5** Projects giving rise to significant cumulative, direct, indirect or secondary impacts on European Sites arising from their size or scale, land take, proximity, resource requirements, emissions (disposal to land, water or air), transportation requirements, duration of construction, operation, decommissioning or from other effects shall not be permitted on the basis of this Plan (either individually or in combination with other plans or projects)[16]. Screening for AAs and AAs undertaken shall take into account invasive species as relevant. **BNH9** Engage with the National Parks and Wildlife Service to ensure Integrated Management Plans are prepared for all Natura sites (or parts thereof) and ensure that plans are fully integrated with the County Development Plan and other plans and programmes, with the intention that such plans are practical, achievable and sustainable and have regard to all relevant ecological, cultural, social and economic considerations and with special regard to local communities. **BNH15** Encourage, pursuant to Article 10 of the Habitats Directive, the management of features of the landscape, such as traditional field boundaries and laneways, important for the ecological coherence of the European site network and essential for the migration, dispersal and genetic exchange of wild species.	No development allocations identified within the development plan were found to occur within the wider area surrounding the Project Site. However, the Plan provides a framework for land use developments and activities with potential for construction and operation source effects throughout the County.

Plan	Policies for the Protection of European Sites	Development Allocations with Potential for in combination effects
	BNH29 Protect the Nore Pearl Mussel through the measures set out in the Freshwater Pearl Mussel Nore Sub-Basin Management Plan (2009). **BNH30** Protect the migration of fish in the River Barrow Nore SAC from high-risk barriers such weirs and bridge sills.	
Kilkenny City and County Development Plan 2021-2027	**9.2.2** a) To ensure that development proposals, where relevant, improve the ecological coherence of the European network and encourage the retention and management of landscape features that are of major importance for wild fauna and flora as per Article 10 of the Habitats Directive; **9.2.10** a) To require relevant development proposals to address the presence or absence of invasive alien species on proposed development sites and (if necessary) require applicants to prepare and submit an Invasive Species Management Plan where such a species exists to comply with the provisions of the European Communities (Birds and Natural Habitats) Regulations 2011-2015; and b) For proposals connected to surface water systems, risks associated with the spread of crayfish plague shall be considered and applicants should submit a crayfish plague management strategy where appropriate. **9.2.11** The Council will promote the use of native plants and seeds from indigenous seed sources in all landscape projects.	No development allocations identified within the development plan were found to occur within the wider area surrounding the Project Site. However, the Plan provides a framework for land use developments and activities with potential for construction and operation source effects throughout the County.
Carlow County Development Plan 2022-2028	**NS. P1** Support the conservation and enhancement of Natura 2000 Sites, and to protect the Natura 2000 network from any plans and projects that are likely to have a significant effect on the coherence or integrity of a Natura 2000 Site, in accordance with relevant EU Environmental Directives and applicable National Legislation, Policies, Plans and Guidelines.	Not applicable

Plan	Policies for the Protection of European Sites	Development Allocations with Potential for in combination effects
	NS. P2 Screening for Appropriate Assessment and if required Appropriate Assessment is undertaken for all plans to be adopted and projects to be granted permission/authorised by the Council. Where likely significant effects have been identified in respect of any plan or project not directly connected with or necessary to the management of a Natura 2000 site, either individually or in combination with other plans or projects, ensure appropriate assessment, in accordance with Article 6(3) of the Habitats Directive. The Council shall only agree to the plan or project after having ascertained that it will not adversely affect the integrity of the site concerned, unless the plan or project is subject to the provisions of Article 6(4) of the Habitats Directive. **NS. P3** Consider impacts within a plan or project's zone of influence, which may include Natura 2000 sites outside the County, when assessing whether a plan or project is likely to have significant effects on Natura 2000 sites. **NS. P4** Maintain or restore the favourable conservation status of County's Natura 2000 sites qualifying interests	
Waterford City and County Development Plan 2022 - 2028	**BD 01** We will protect and conserve all sites designated or proposed for designation as sites of nature conservation value (Natura 2000 Network, Ramsar Sites, NHAs, pNHAs, Sites of Local Biodiversity Interest, Geological Heritage Sites, TPOs) and protect ecological corridors and networks that connect areas of high conservation value such as woodlands, hedgerows, earth banks and wetlands. **BD04** Appropriate Assessment All projects and plans arising from this Plan[2] will be screened for the need to undertake Appropriate Assessment under Article 6 of the Habitats Directive. A plan or project will only be authorised after the competent authority has ascertained, based on scientific evidence, Screening for Appropriate Assessment, and subsequent Appropriate Assessment where necessary, that: 1.The plan or project will not give rise to significant direct, indirect or secondary effects on the conservation objectives of any	Not applicable

Plan	Policies for the Protection of European Sites	Development Allocations with Potential for in combination effects
	European site (either individually or in combination with other plans or projects); or 2.The plan or project will have significant adverse effects on the integrity of any European site (that does not host a priority natural habitat type/and or a priority species) but there are no alternative solutions and the plan or project must nevertheless be carried out for imperative reasons of overriding public interest, including those of a social or economic nature. In this case, it will be a requirement to follow procedures set out in legislation and agree and undertake all compensatory measures necessary to ensure the protection of the overall coherence of Natura 2000; or 3.The plan or project will have an adverse effect on the integrity of any European site (that hosts a natural habitat type and/or a priority species) but there are no alternative solutions and the plan or project must nevertheless be carried out for imperative reasons for overriding public interest, restricted to reasons of human health or public safety, to beneficial consequences of primary importance for the environment or, further to an opinion from the Commission, to other imperative reasons of overriding public interest. In this case, it will be a requirement to follow procedures set out in legislation and agree and undertake all compensatory measures necessary to ensure the protection of the overall coherence of Natura 2000. **BD05** Protection of European Sites Projects giving rise to adverse effects on the integrity of European sites (cumulatively, directly or indirectly) arising from their size or scale, land take, proximity, resource requirements, emissions (disposal to land, water or air), transportation requirements, duration of construction, operation, decommissioning or from any other effects shall not be permitted except as provided for in Article 6(4) of the Habitats Directive, viz. There must be a) no alternative solution available, b) imperative reasons of overriding public interest for the project to proceed; and c) Adequate compensatory measures in place. **BD07** We will protect plant and animal species and habitats which have been identified by the EU Habitats Directive (1997), EU Bird Directive (1979), Wildlife Act (1976) and Wildlife (Amendment) Act	

Plan	Policies for the Protection of European Sites	Development Allocations with Potential for in combination effects
	2000 and the Flora Protection Order (2015) and ensure development does not impact adversely on wildlife species or the integrity and habitat value of the site. **BD08** We will assess all proposed developments at each level of the Development Planning process from City & County Development Plan, Local Area Plan to project level to determine potential for significant effects on the conservation objectives and /or adverse impact on the integrity of the Natura 2000 network and ensure that the requirements of Articles 6(3) and 6(4) of the Habitats Directive are fully satisfied.	
Tipperary County Development Plan 2022-2028	**11- 1 I**n assessing proposals for new development to balance the need for new development with the protection and enhancement of the natural environment and human health. In line with the provisions of Article 6(3) and Article 6 (4) of the Habitats Directive, no plans, programmes, etc. or projects giving rise to significant cumulative, direct, indirect or secondary impacts on European sites arising from their size or scale, land take, proximity, resource requirements, emissions (disposal to land, water or air), transportation requirements, duration of construction, operation, decommissioning or from any other effects shall be permitted on the basis of this Plan (either individually or in combination with other plans, programmes, etc. or projects **11-2** Ensure the protection, integrity and conservation of European Sites and Annex I and II species listed in EU Directives. Where it is determined that a development may individually, or cumulatively, impact on the integrity of European sites, the Council will require planning applications to be accompanied by a NIS in accordance with the Habitats Directive and transposing Regulations, ‘Appropriate Assessment of Plans and Projects, Guidelines for Planning Authorities’, (DEHLG 2009) or any amendment thereof and relevant Environmental Protection Agency (EPA) and European Commission guidance documents**.**	Not applicable

Plan	Policies for the Protection of European Sites	Development Allocations with Potential for in combination effects
Wexford County Development Plan 2022-2028	**NH01** To ensure the protection of all designated ecological sites (as detailed in section 13.2.1 to 13.2.11) in relevant Local Area Plans and in the assessment of planning applications and promote the restoration of sites where required. **NH03** To promote biodiversity protection, restoration and habitat connectivity both within protected areas and in the landscape through promoting the integration of green infrastructure and ecosystem services, including landscape, heritage and biodiversity and management of invasive and alien species in the plan making and development management processes. **NH04** To protect the integrity of sites designated for their habitat and species importance and prohibit development which would damage or threaten the integrity of these sites. Such sites include Special Areas of Conservation (SACs) and candidate SACs, Special Protection Areas (SPAs), Natural Heritage Areas(NHAs) and proposed NHAs, Nature Reserves, Refuges for Fauna and RAMSAR sites. To protect protected species wherever they occur. **NH05** In assessing planning applications located in and/or in proximity to Natura 2000 sites, whether hydraulically linked or otherwise linked or dependent (such as feeding, roosting or nesting grounds) to a designated site, regard shall be had to the detailed conservation management plans and data reports prepared by NPWS, where available, to the identified features of interest of the site, the identified conservation objectives to ensure the maintenance or restoration of the features of interests to favourable conservation status, the NPWS Article 17 current conservation status reports, the underlying site specific conditions, and the known threats to achieving the conservation objectives of the site. **NH08** To ensure that any plan/project and any associated works, individually or in combination with other plans or projects, are subject to Screening for Appropriate Assessment to ensure there are no likely significant effects on any Natura 2000 site(s) and that the requirements of Article 6(3) and 6(4) of the EU Habitats	Not applicable

Plan	Policies for the Protection of European Sites	Development Allocations with Potential for in combination effects
	Directive are fully satisfied. Where a plan/project is likely to have a significant effect on a Natura 2000 site or there is uncertainty with regard to effects, it shall be subject to Appropriate Assessment. The plan/project will proceed only after it has been ascertained that it will not adversely affect the integrity of the site or where, in the absence of alternative solutions, the plan/project is deemed by the competent authority imperative for reasons of overriding public interest. **NH10** To ensure that traditional field boundaries, ponds or small woods which provide important ecological corridors, stepping stones or networks are protected. Where such features exist on land which is to be developed the applicant should demonstrate that the design of the development has resulted in the retention of these features insofar as is possible and that the existing biodiversity value of the site has been protected and enhanced. **NH27** To carefully consider and implement the management of invasive species where there is a corridor, such as hydrological connections to European Sites in order to prevent the spread of invasive species to sensitive sites.	
Regional Spatial and Economic Strategy 2020-2031	**RPO 5.4** Encourage the prioritisation of Site-Specific Conservation Objectives (SSCO) for all sites of Conservation Value, designated in EU Directive (i.e. SACs, SPAs) to integrate with the development objectives of this Strategy. **RPO 5.5** Conserve and protect European sites and their integrity. **RPO 5.7** Ensure that all plans, projects and activities requiring consent arising from the RSES are subject to the relevant environmental assessment requirements including SEA, EIA and AA as appropriate.	Not applicable.

4.7.3 River Barrow and River Nore SAC

The primary identified pathway that could affect the River Barrow and River Nore SAC is through a reduction in water quality, due to the number of features associated with aquatic habitat. Any construction projects that are located within the same catchment as the SAC have the potential to have an in-combination effect with the Project. This could occur if other Projects are timed to be constructed or decommissioned while this Project is constructed and/or decommissioned, producing a decline in water quality, or in series, with an ongoing reduction in water quality.

However, it can be expected that all such projects and plans will be subject to an NIS assessment under the Habitats Directive. These have been looked up where possible for the projects identified and a summary of the conclusions and mitigation are presented in **Table 4-9**. Moreover, water quality in the catchment is primarily determined by farming activity rather than the effects of construction.

Table 4-9: Summary of NIS conclusions and mitigation for the other projects identified

Project	NIS conclusion	Mitigation measures summary	Source
Bilboa wind farm access track:	*It is possible that pollutants (suspended sediments, concrete/cement and hydrocarbons) generated during construction works could cause indirect effects on aquatic habitats and fauna in the River Barrow & River Nore Special Area of Conservation (SAC). In response, a range of mitigation measures will be implemented during the construction of the project in order to avoid or minimise the risk that any pollutants could reach nearby watercourses. Subject to the successful implementation of these measures, we conclude that the Development will not have significant effects on any European Sites.*	The following measures are considered to be of particular importance, and must be included in the method statements of any contractors employed to carry out cable-laying or maintenance works: • Works should only take place in mild weather conditions. They will be suspended if high-intensity local rainfall events are forecast (e.g. >10 mm/hr, >25 mm in a 24 hour period or high winds); • When excavating a trench for the cable ducts, excavated material will be placed immediately adjacent to the trench, and not on the road verge. When the cable has been laid, this material will be used to back-fill excavations, and the remainder will be moved to a licensed land fill; • Silt fences will be placed along both sides of the road within 50 m of all watercourses, including the section of the Cable Route and Upgraded Access Track that are within 10 m of the River Dinin. Within this zone the following activities will not be permitted: ○ Temporary storage of excavated material or working materials; ○ Re-fuelling of vehicles; ○ Storage or mixing of road-surfacing materials; and ○ Storage or mixing of concrete. • All maintenance and will take offsite where possible. If onsite, refuelling will be undertaken by an appointed refuelling personnel who will be trained in the correct methods of refuelling on site to ensure that pollution incidents are prevented and a quick response plan is implemented, should a spill occur, to minimise the impact of spills. Vehicles will be checked for leaks on a regular basis; • A spill-kit will be available on site, in order to allow rapid containment of any accidental spills; • All cement-based materials and road-surfacing materials will be controlled by: ordering ready-mixed materials (thereby avoiding wet-mixing on site), working in dry conditions, and cleaning machinery at a distance of at least 50 m from watercourses. All material storage and machinery cleaning will be within the wind farm construction compound;	Arcus (2020) Bilboa Wind Farm Grid Connection and Access Natura Impact Statement

Project	NIS conclusion	Mitigation measures summary	Source
		• If the trench or any excavations need to be dewatered, the pumped water will be collected and pumped into a settlement tank / pond (or similar feature), left undisturbed until sediments have settled, and then discharged via a buffered outflow to a soakaway. Water will not be pumped into any watercourses along the route; • Dust suppression measures will be implemented, as outlined in Section 8 of the IFI guidelines. Water will not be abstracted from the River Dinin for dust suppression purposes; and • Temporary toilet facilities will be provided for construction workers within the wind farm construction compound, and all foul water will be removed from site for disposal at a suitable off-site treatment facility.	
Bilboa Wind Farm Date Granted: 12.07.2021 (Laois Co. Co.) / 13.07.2021 (Carlow Co. Co.) Grant Date: 19/11/2020	*If all recommend mitigation measures are implemented in full, the construction and operation of the proposed wind farm will not have a significant impact on the ecological integrity or conservation objectives of any Natura 2000 site*	• Schedule development close to watercourses to minimise risk of potential erosion by, where possible planning construction activities in dryer months, halting construction during periods of heavy precipitation and run-off to minimise soil disturbance and restrict vehicular and equipment access ot provide working surfaces/ pads. • Works with high risk of suspended solid pollution to streams will not be carried out between end of September and the end of April. • Retain existing vegetation where possible and physically mark boundaries at the construction site. • Revegetate denuded areas particularly cut and fill slopes and disturbed slopes as soon as possible. Use mulches and other organic stabilisers to minimise erosion until vegetation is established on sensitive soils. However, it should be noted that re-sodding is essential on upland and lowland peatlands and all other upland sites. • Divert run off away from denuded areas • Minimise length and steepness of slopes where possible. • Minimise runoff velocities and erosion energy by maximising length of flow paths for precipitation run off, construction interceptor ditches and channels with low gradients to minimise secondary erosion and transport and lining unavoidable steep interceptors or conveyance ditches with filter fabric, rock or polyethylene lining to prevent channel erosion.	

Project	NIS conclusion	Mitigation measures summary	Source
		• Retain eroded sediments on site with erosion and sediment control structures such as sediment traps, silt fences and sediment control ponds • Access roads will be constructed or topped with a suitable coarse granular material/non-woven geotextile, and if possible organic topsoil will be stripped prior to access road construction. • No stream diversions are proposed; however, in the case of temporary watercourse diversions (such as to facilitate culvert installation), the diversion will be excavated in isolation of stream flow, starting from the bottom end of the diversion channel and working upstream to minimise sediment production. The temporary channel will be constructed in such a way as to minimise suspended solids released when the river is re-routed. Upon completion the bank will be stabilised around the temporary diversion. • If permanent watercourse diversions are unavoidable, the new channel should be completed as far in advance as possible. The channel will be constructed in such a way as to minimise suspended solids released when the watercourse is re-routed. Use of loose fine grained materials in the new channel construction will be strictly limited. • Other than single span temporary bridges with no instream structures, strictly no temporary stream crossings or temporary culverting will take place without the prior agreement of Inland Fisheries Ireland. • Machinery will never cross a watercourse by entering it (e.g. at fords) Mitigation Measures for Construction of Turbine Pads, Laying of Site Cables and Upgrade of Roads/Tracks • The drainage system with settlement ponds and/or soak-aways, and/or interceptor drains will be installed prior to any excavation work along access roads to be constructed. • Settlement ponds/ silt traps will be installed towards the end of drainage channels, however, where practicable these will not be closer than 100m to the receiving watercourse. • Machinery and vehicles used in track construction will be operated from the track as it is constructed. Excavation machinery will be operated from access	

Project	NIS conclusion	Mitigation measures summary	Source
		roads and trench digging machinery will be operated from bog mats where appropriate. • Surface vegetation turves will be laid out, stored and watered for restoration use after construction, in suitably designated areas. The stored turves will be used to reinstate turbine foundations etc following construction • If, during excavation, spoil is to be stored or is likely to fall onto the adjacent bog surface, the bog surface will be protected with shuttering boards or geotextile. • At locations where excavated materials are stored, French drains will surround and intercept surface runoff from materials mounds and distribute this water to the controlled drainage system in place. • All electrical and communications cabling will run underground in PVC ducts alongside the site tracks. The cable trench will be dug to a width of approximately 0.5m. The excavated material will be laid alongside the trench for use in reinstatement following the laying of the cables. Silt runoff from excavated material to surface waters will be prevented using methods outlines above, and any water pumped from trenches will be passed through a suitable silt removal facility before discharge to surface waters. Mitigation Measures for Forestry Clear-Felling • Vegetated riparian buffer zones where they exist will be maintained and where possible left undisturbed to prevent or reduce the input of nutrients. • Drainage channels will never form a direct connection between the clearfell area and the stream (i.e. bypassing of buffer strips will not occur in any way). If it is not possible to get machines on to a clearfell site to block all drainage channels which empty directly into a stream, straw bales placed in these drains to act as filters may be an option to reduce the input of sediment. However, care must be taken to prevent the release of trapped sediment when the bales are removed. • Care will be taken to prevent bank collapses ad slippages. Any risk of bank collapse and slippage will be identified and eliminated prior to commencement of clearfelling operations. • Silt traps will be constructed at locations that will intercept run-off to streams	

Project	NIS conclusion	Mitigation measures summary	Source
		• Where sediment traps have been put in place, a regime of checking and emptying them will accompany the felling schedule, to prevent them from overflowing. • Machinery roads/tracks will be kept away from watercourses to avoid them becoming a direct route of sediment input. Where tracks have been created on slopes, small offlets will be dug at intervals to prevent water running directly down the slope. • Skidding on all but the least erodible sites must be ruled out • Minimise the potential of soil and sediment movement towards watercourses by avoiding long ground extraction routes on steep slopes • If erosion and soil inputs to streams/rovers occur, be prepared to modify operating procedures immediately (including cessation of the operation if necessary) and construct silt traps as appropriate. However, it is strongly recommended that construction of silt traps always occurs prior to commencement of clearfelling operation. Mitigation Measures to Prevent Peat Failure • Best practice measures to prevent peat erosion which are presented in the AGEC report will be implemented. Mitigation of Pollution of Watercourses with Nutrients due to Decaying Brash • Whole tree harvesting (either one stage or two stage) will be carried out from all proposed clearfell areas where it is possible to do so without causing a significant increase in suspended solids to streams and rivers. If necessary and practicable artificial substrates will be used support the movement of machinery • If brash removal without serious additional risk of suspended solids generation is not possible using conventional methods (including artificial substrates), brash will be left of site but will be removed as far back from watercourses as possible as has been recommended in the Lough Melvin Catchment Management Plan (Campbell & Foy 2008). Brash must be moved a minimum of 20m back from all watercourses including drains.	

Project	NIS conclusion	Mitigation measures summary	Source
		• Stacking and loading of timber will not be carried out in proximity to a watercourse, and ideally should be located on dry ground • Any brash removed during clearfelling must be removed from the site and managed in such a way as to avoid negative impacts on the aquatic environment. Reduction or Elimination of Pollution of the Streams with other Substances Associated with the Construction Process • Raw or uncured waste concrete will be disposed of by removal from the site • Only ready-mixed concrete will be used during the construction phase, with all ready-mixed concrete being delivered form batching plants in sealed concrete delivery trucks • Only the chute of the concrete delivery truck will be cleaned on site, using the smallest volume of water necessary. Concrete trucks will be direct back to their batching plant for washout • So as to avoid spillage, concrete will not be transported around the site in open trailers or dumpsters. All concrete used in the construction of turbine bases will be pumped directly into the shuttered framework from the delivery truck. • The arrangement for concrete deliveries to the site will be discussed with suppliers before commencement of work, agreeing routes, prohibiting on-site washout and discussing emergency procedures. • Clearly visible signs will be placed in prominent locations close to the concrete pour areas, stating that washout of concrete lorries is not permitted on the site. • Large concrete pours will be avoided where prolonged periods of heavy rain are forecast and covers will be available for freshly placed concrete to avoid the surface washing away in heavy rain • Wash down water from exposed aggregate surfaces and cast in place concrete will be trapped on-site to allow sediment to settle out and reach neutral pH before clarified water is released to the stream or drain system to allow to percolate into the ground	

Project	NIS conclusion	Mitigation measures summary	Source
		• Fuels, lubricant and hydraulic fluids for equipment used on the construction site will be carefully handled to avoid spillage, properly secured against unauthorised access or vandalism, and provided with spill containment according to the best codes of practice. (Enterprise Ireland BPGCS005) • Fuelling and lubrication of equipment will be carried out in a specially bunded area • Any spillage of fuels, lubricant or hydraulic oils will be immediately contained and the contaminated soil removed form the site and properly disposed of • Waste oils and hydraulic fluids will be collected in leak proof containers and removed form the site for disposal or recycling • Hardstandings or crane platforms will be required in the vicinity of each turbine position to allow two cranes to work in the vicinity of a turbine. During turbine foundation construction, the crane platform also serves as a storage area for material (e.g. reinforced steel) and machinery. Runoff from the platforms will be to a drainage system which includes silt removal. • Prior to any work close to water courses it will be ensured that all construction equipment is mechanically sound to avoid leaks of oil, fuel, hydraulic fluids and grease. • All pumps using fuel or containing oil will be locally and securely bunded when situated within 25m of waters or when sited such that taking account of gradient and ground conditions there is possibility of discharge to waters • Where site works involve the discharge of drainage water to receiving surface waters, temporary oil interceptor facilities will be installed and maintained • Appropriate spill control equipment, such as oil soakage pads, will be kept within the construction site to deal with any accidental spillage and emergency procedures will be put in place • Foul drainage from site offices etc. will be removed to a suitable treatment facility Location of Sites for use as Storage Areas, Machinery Depots, Site Offices, Temporary Access Roads or the Disposal of Spoil • In general such sites will be located as far as is practicable from watercourses. In general any site which is at least 100m form the nearest watercourse may	

Project	NIS conclusion	Mitigation measures summary	Source
		be chosen. Disposal od spoil will not be carried out in any location where runoff can occur into watercourses Procedure for Contractors • Contractors will establish contact with Inland Fisheries Ireland before works commence, and there will be ongoing liaison with the Board throughout the construction process. Contractors will be in possession o, and familiar with the contents of "Control of water pollution from construction sites – Guidance for consultants and contractors" published by the Construction Industry Research and Information Association (CIRIA 2001) Monitoring • A biological and chemical system will be put in place on potentially affected streams including as a minimum at Sites A-F. As a minimum the monitoring system will measure Q0value, suspended solids, molybdate reactive phosphorus and pH. As the proposed development is located close to a watershed, sampling upstream and downstream of potential impact locations is not a practical possibility at most locations. It will therefore be necessary to establish a statistically meaningful baseline of conditions for a full calendar year immediately prior to the commencement of construction works. It is recommended that the details of the monitoring system, including frequency of sampling, monitoring locations, and parameters to be monitored will be agreed in advance with both Inland Fisheries Ireland and National parks & Wildlife Service. It is also recommended that the option of continuous automated online monitoring of suspended solids should be considered on the tributaries flowing from the proposed wind farm site to Dinin River. Mitigation of Pollution of Watercourses with Contaminated Water Draining from the Proposed Wind Farm • Kerbs will be incorporated into the design of the bridges/crossings to prevent roadway run-off directly into streams • A sustainable drainage system will be installed on the new road, which will prevent significant pollution to surface receiving waters. The system installed	

Project	NIS conclusion	Mitigation measures summary	Source
		will have a proven capability of achieving and sustaining at least an 85% reduction of suspended solids in runoff • As virtually all treatment options require proper maintenance in order to function properly, and as some can become a source of pollution if not properly maintained, a program of regular cleaning, maintenance and inspection of the road runoff treatment system will be adopted to ensure it functions correctly Mitigation of Hydrological Impacts • Flow attenuation will be included in the road drainage design if necessary to ensure that no significant increase in peak stream/river flows is caused by the proposed development • Natural drainage patterns will be restored after the completion of road construction by allowing surface drainage to pass under or over the proposed new road at closely placed intervals, corresponding with existing natural drainage lines • If necessary to avoid bank erosion and significant changes to watercourse flow patterns, energy breaks will be installed to reduce the velocity of the outfalls from drains to receiving waters • Water abstraction form watercourses for any purpose will only take place at locations, in a manner and during a time period agreed with Inland Fisheries Ireland Mitigation of Habitat Loss • One of the most effective methods of minimising loss of stream and riparian habitat during developments such as forestry clearance for construction, new road construction, etc is the establishment of Leave Strips. Leave trips are the areas of land and vegetation adjacent to watercourses that are to remain in an undisturbed state, throughout and after the development process. Leave strips are valuable not only because of riparian vegetation is a vital component of a healthy stream ecosystem, but because this vegetation acts as an effective screen/barrier between the stream and the development area, intercepting runoff and acting as an effective filter for sediment and pollutants from the development area. Where development is to take place	

Project	NIS conclusion	Mitigation measures summary	Source
		close to rivers/streams, a riparian leave strip will be clearly marked and its significance to machinery operators. Mitigation of Obstruction to Upstream Movement of Aquatic Fauna due to Construction of Culverts/Culvert Replacement • Roads will be designed and constructed in such a way as to ensure that watercourses remain passable for aquatic fauna • The proposed development will involve the culverting or replacement of culverts on sections of drain at proposed/existing road crossings, however no streams will be crossed by proposed new roads • Ideally, a culvert should not change the hydrological conditions that existed prior to that installation. This means that the cross-sectional area should not be restricted by the culvert, the slope should not change, and the roughness coefficients should remain the same. Any change in these conditions will result in a velocity change which could alter the sediment transportation capacity of the watercourse • Aquatic fauna passage problems can usually be avoided if culverts are constructed without a bottom or are installed well below stream grade • If concrete bottoms are used, they should be at least 3ocm below the streamgrade with cross walls not less than 8cm to collect natural streambed material • Culverts should be installed at the stream gradient otherwise they may result in a change in water velocities which may create a drop below the culvert or may create a hydraulic jump at the end of the culvert • Culverts should not be aligned so that culverts outflows are directed into a watercourse bank • The culvert should be installed so that it has a constant slope through its length except for the appropriate camber allowance where settlement is anticipated • If pipe culverts are used, the culvert diameter will be at least 1.2 times the bankfull width of the stream + 0.5m and culverts will be embedded to a depth of at least 25% of the pipe diameter	

Project	NIS conclusion	Mitigation measures summary	Source
		• If box culverts are used they will be embedded at least 30cm below the existing stream bed with cross walls not less than 8cm to collect natural streambed material Mitigation of Potential Impacts on Otters • As the only possible impact on otters would be via pollution impacts on their fish prey species, the full implementation of the mitigation measures specified above would prevent any potential negative impacts on this species	
Bord Na Móna Powergen Ltd. ABP-309293-21 / 19530 (Laois) 3rd Party appealed on 06/10/2022	The Stage 1 Screening for Appropriate Assessment found that there was a remote risk to the River Barrow and River Nore SAC and River Nore SPA as a result of indirect effects via hydrological links from the proposed development, in the absence of mitigation measures. This report has assessed: • all aspects of the proposed development project which, in the light of the best scientific knowledge in the field, can by themselves or in combination with other plans or projects, affect the European Sites in light of their conservation objectives; • the potential effects on the integrity of the River Barrow and River Nore SAC and River Nore SPA in light of the sites' conservation objectives and mitigation measures have been developed to prevent such	Measures for Spills • Drip trays and spill kits will be kept available on site, to ensure that any spills from vehicles are contained and removed off site. Any diesel or fuel oils stored at the temporary site compounds will be bunded. The bund capacity will be sufficient to contain 110% of the tank's maximum capacity. Emergency Spill Response Procedures are contained within the CEMP. • Concrete pours will be a minimum of 50m from drainage ditches where possible and appropriate controls implemented to ensure no concrete enters any drain within the site. Invasive Species No high-risk invasive species were identified within the site such as Japanese Knotweed or Giant Hogweed. Montbretia (low impact species) was found along the gas corridor pipeline. Prior to construction in this area, the stand of Montbretia will be cordoned off to prevent vehicles from spreading this species. Biosecurity measures will be implemented for any works near watercourses. Monitoring of Water Quality Mitigation Measures -Daily visual inspections of drains and outfalls will be performed during the construction period to ensure suspended solids are not entering the streams and rivers of the site, to identify any obstructions to channels, and to allow for appropriate maintenance of the drainage regime. If excessive suspended solids are noted, construction work will be stopped and remediation measures will be put in place immediately.	Bord Na Mona Powergen Ltd. (2019) Natura Impact Statement for the Proposed Renewable Gas Facility at Cuil Na Mona, Portlaoise, Co. Loais

Project	NIS conclusion	Mitigation measures summary	Source
	potential effects occurring. This assessment has concluded, on the basis of objective scientific information, the proposed development will not, either alone or in combination with other plans or projects, adversely affect any of the qualifying interests of the River Barrow and River Nore SAC or the special conservation interests of the River Nore SPA in light of each of the sites' conservation objectives. It is concluded beyond reasonable scientific doubt, that with the implementation of the detailed mitigation measures identified in this NIS, the proposed development, either alone or in combination with other plans or projects, is not likely to result in significant effects to any European Site.	- A detailed water quality monitoring programme will be undertaken during the construction phase of the proposed development, in addition to the visual inspections outlined above, to ensure the effective implementation of the proposed mitigation measures. Field measurements and grab samples will be taken at suitable locations, which will be decided prior to the construction phase commencing but would likely be prior to the existing drainage discharge at SW-9. The field measurements will be recorded at the site and will include measurement of the following parameters, electrical conductivity (µs/cm), pH, temperature (°C) and dissolved oxygen (mg/l). The field measurements will be taken on a weekly basis during the preparatory earthworks stage of the construction period. - A suitably qualified person will be appointed by the developer to ensure the effective management and maintenance of mitigation measures during the construction process. Operational Phase -Silt fencing will be maintained around the peat deposition area, to prevent silt run off into adjacent drains until such a time as the area has revegetated. - The tank farm will be bunded to prevent the escape of liquids. The bunded area will be capable of retaining 110% of the largest tank volume or 25% of the installed tank volume (whichever is the greatest). At the liquid reception area, the area immediately surrounding the manifold collection apron will be designed with appropriate drainage to collect any minor liquid waste spillages that may occur during the decoupling and pumping process. The area will drain to a small collection sump where it can be pumped directly to the liquid reception tank	
Michael Johnson Quarry restoration 20247 (Laois) Granted 19/11/2020	*No available NIS information on the National Planning Application Database*		

Project	NIS conclusion	Mitigation measures summary	Source
Lagan Materials Limited (Spink Quarry) 21700 (Laois)	Given the inclusion of strict Best Practice Measures to be included and enforced through a Water Management Plan, the proposed development will have no predicted impacts on local ecology and biodiversity or on hydrologically linked European sites, therefore in-combination impacts can be ruled out. The Laois County Development Plan in complying with the requirements of the Habitats Directive requires that all Projects and Plans that could affect the European Sites in the same zone of impact of the Project site would be initially screened for Appropriate Assessment and if requiring Stage 2 AA, that appropriate employable mitigation measures would be put in place to avoid, reduce or ameliorate negative impacts. In this way any, in-combination impacts with Plans or Projects for the development area and surrounding townlands in which the development site is located, would be avoided. The listed developments have been granted permission in most cases with conditions relating to sustainable development by the consenting authority in compliance with the relevant Local Authority Development Plan and in compliance with the Local Authority requirement for regard to the Habitats Directive. The	-There will be a designated area for refuelling vehicles in the centre of the site. It will be used for refuelling of mobile on-site machinery, e.g. loading shovels, dump trucks. - All runoff landing on the designated refuelling area shall be captured in perimeter ACO-type drains and passed to a new hydrocarbon interceptor. Details of the new hydrocarbon interceptor are included in RFI Appendix 4.10. - Refuelling of semi-mobile plant and machinery such as crushing and screening units will take place at their on-site location using a double-skinned, mobile bowser as it is not practical to bring these units back to the refuelling area on a regular basis. Spill kits will be stored on site and site operatives will be trained in their appropriate usage. The operator will put in place an emergency response procedure for hydrocarbon spills and appropriate training of site staff in its implementation - Lagan will also provide staff with emergency and event–based instructions. Management will also ensure that if an employee is absent from work that his or her roles in an emergency event is reassigned to another adequately trained employee - Capital Water Systems Ltd. have proposed an appropriate warning system to alert the site operator in the event that suspended solids surpass the Emission Limit Value. A Partech Turbitech Turbidity sonde or similar sensor will be installed at the site for this purpose. - There are further mitigation measures, not included in the NIS, which are unrelated to water, found in 9.1 Summary of Mitigation Measures	J Sheils Planning & Environmental Ltd (2022) RESPONSE TO REQUEST FOR FURTHER INFORMATION In Relation to Planning Ref. No. 21/700: Appendix 9.1 Summary of Mitigation Measures J Sheils Planning & Environmental Ltd (2022) RESPONSE TO REQUEST FOR FURTHER INFORMATION In Relation to Planning Ref. No. 21/700 Appendix 10.1 Appropriate Assessment Screening J Sheils Planning & Environmental Ltd (2022) RESPONSE TO REQUEST FOR FURTHER INFORMATION In Relaθon to Planning Ref. No. 21/700 Appendix 11.4 Water Management Mitigation

Project	NIS conclusion	Mitigation measures summary	Source
	development cannot have received planning permission without having met the consenting authority requirement in this regard. There are no predicted in-combination effects given the reasons discussed in the 'Comments' column of Table 5 above and given that the Proposed Development is unlikely to have any adverse effects on the River Nore European sites subject to the implementation of mitigation measures. Any new applications for the Project area will be assessed on a case by case basis initially by Laois County Council which will determine the requirement for AA Screening as per the requirements of Article 6(3) of the Habitats Directive. The potential for in-combination effects will need to be assessed further in Stage 2 Appropriate Assessment.		
Pinewood Wind Limited PL11.248518 (ABP) / 16/260 (Laois) Granted 03/09/2021	As Lisbigney Bog SAC and Ballyprior Grassland SAC are not connected to the development site via potential vector pathways they are not at risk of impact from the proposed Pinewoods Wind Farm development. The River Nore SPA is designated for presence of Annex 1 listed Kingfisher. The SPA is located 13km donstream of the development. A catastrophic impact on the SPA such as fish kill be required in order to impact the Kingfisher. Therefore,t he proposed development does not present a	The below will be employed during the construction phase when working near watercourses to avoid deleterious impacts on the River Barrow and River Nore SAC: -Release suspended solids to all surface waters will be controlled by interception (eg. silt traps) and management of site run off. Any surface water must be treated to ensure that it is free from suspended solids, oils, or other polluting materials - Silty water will be treated using silt trays/settlement ponds and temporary interceptors. Traps will be installed until permanent facilities are constructed - Straw bales/silt fences will be appropriately placed near watercourses to prevent untreated surface water run-off - All fuels, lubricants, and hydraulic fluids will be collected and stored in appropriate containers and disposed offsite	

Project	NIS conclusion	Mitigation measures summary	Source
	potential threat given the nature of the development, and therefore does not have the potential to affect the River Nore SPA. From the examination of the available information, it is considered that the proposed development has the potential to result in significant impacts on the River Barrow and River Nore SAC, specifically related to indirect water quality impacts affecting the aquatic conservation interested of the River Barrow and River Nore SAC. The proposed development must progress to Stage 2with regard to River Barrow and River Nore SAC.	- Containers will be properly secured to prevent misuse/unauthorised access -Any waste oils/hydraulic fluids will be kept in secure bunded areas away from watercourses -No fuelling or lubrication will occur within 50m of watercourses Storage areas, machinery depots, and site offices will be located at least 50 m from the nearest watercourse -Foul drainage from site offices/facilities will be treated and removed to treatment facility -Spill kits will be available near streams and all staff will be trained to use them -Disposal of raw or uncured waste concreate will be controlled to ensure watercourses or other sensitive areas won't be impacted -Attenuation ponds and wetland will be designed, allowing 24h settlement before discharge into surrounding watercourse -Works adjacent to/over watercourses will be carried out outside the salmonid spawning seasons and when early stage salmon will be present -No instream work during October to April	
Pinewood Wind Limited ABP-308448-20 Granted 22/11/2021	The NIS for this project highlighted that in the absence of mitigation effects on water quality may effect the River Barrow and Nore SAC. Subject to the successful implementation of these measures, we conclude that the Development will not have significant effects on any European Sites.	Mitigation measures proposed include: All storage containers will be labelled appropriately, including hazardous markings; • All holding tanks will be constructed of material appropriate for fuel/chemical storage and will be bunded to at least 110% of the maximum tank volume or 25% of the total capacity of all the tanks within the bund, whichever is greatest; • Bunds will be to standard specified in CIRIA Report 163 'Construction of bunds for oil storage tanks' and CIRIA Report C535 'Above-ground proprietary prefabricated oil storage tank systems'; • Barrels and bunded containers will be stored upright and internally where appropriate and always on drip trays or sump pallets; • Appropriate spill kits will be available at all storage locations;	SLR(2020), APPROPRIATE ASSESSMENT SCREENING REPORT AND NATURA IMPACT STATEMENT Pinewoods Wind Farm Substation & Grid Connection

Project	NIS conclusion	Mitigation measures summary	Source
Pinewood Wind Limited PL10.248392 (ABP) /17/62 (Laois) Granted 03/09/2019	The NIS for this project was assessed. In the report it was highlighted that significant effects on water quality could affect the River Barrow and Nore SAC due to an increase in siltation. Subject to the successful implementation of these measures, we conclude that the Development will not have significant effects on any European Sites.	Proposed mitigation measures include: • Installation of interception drains. • Installation of silt traps. • Blocking of any drains which currently collect discharge from roadside swales and discharge directly in existing water courses. • Perimeter swales to collect dirty surface water runoff from crane hardstanding areas./ turbine bases. • Settlement ponds to facilitate the treatment of potential silt laden water. Such features to be assigned a unique reference number to facilitate inspections. • Spill kits available close to streams Attenuation ponds and a constructed wetland shall be designed, allowing a 24hr settlement period before discharging into the surrounding watercourses.	Ecofact Environmental Consultants (2017), Pinewoods Windfarm Natura Impact Statement
Cullenagh Wind Farm PL11.232626 (ABP) / 13268 (Laois) granted 14/6/2014	In the absence of adequate mitigation measures it is considered probable that the proposed wind farm development has the potential for significant impacts on the watercourses draining the proposed development site and ultimately the section of River Nore which is designated under the River Barrow and River Nore SAC. Subject to the successful implementation of these measures, we conclude that the Development will not have significant effects on any European Sites.	Mitigation measures include: • All turbines to be situated at minimum 50m from any water course. • Planning construction during drier months • Retaining vegetation where possible. • Re vegetate bare areas. • Cover temporary storage piles to avoid run off during rain. • Divert run off from bare areas. • Minimise the length and steepness of slopes where possible. • Construct interceptor ditches and channels. • Retain eroded sediments on site by using erosion and sediment control structures. Sediment control ponds should be designed for a minimum retention time of 15 hours.	Coillte (2013), Cullenagh Windfarm Environmental Impact Statement.
Gortahile Wind Farm 04935 (Laois)	An Environmental Impact assessment was written for this project. In the report it states that no designated	Proposed mitigation measures include:	Ecopower Developments Ltd. Gortahile Wind Farm

Project	NIS conclusion	Mitigation measures summary	Source
Granted 27/10/2024	areas will be affected by the project when mitigation measures are put in place. In the absence of this effects could occur on water quality.	• All construction sites including new roadways will be drained into settlement ditches, either existing or newly dug. • The construction site of turbine 2 will be fenced off as to prevent access by vehicles onto intact bogland areas. • The access route for turbine 3 will be sited as to avoid the small valley and field banks present. • Local rock will be used as fill in areas to maintain the ecological integrity of the site.	Proposal Environmental Impact Assessment.
Farranrory Wind Farm and Cable route Wind Farm-211620 Tipperary (granted 30/32021 Cable route 20972 Tipperary Granted 14/11/2022	The NIS concluded that significant effects may occur during the construction phase of the project. This is due to the potential for the discharge contaminated surface water from the project site and effects on water quality during Horizontal directional drilling under the River Nore. In the absence of mitigation likely significant effects are expected to effect qualifying interests of the River Barrow and River Nore SAC. Subject to the successful implementation of these measures, we conclude that the Development will not have significant effects on any European Sites.	All construction phase mitigation measures outlined in this NIS will be required to be included in the Contractor's contract of works. All site personnel will be made aware of their environmental responsibilities at the site. • Requirements for contractors will include contingency plans to deal with spillages, should they occur. • Land disturbance will be kept to minimum and disturbed areas will be stabilised as soon as possible. • Soil excavation should be undertaken during dry periods whenever possible. • Site visits by a Design Engineer will be agreed in advance and will be undertaken at various stages of the construction process to ensure that the proposed SuDS scheme is being constructed in line with the design. • An Environmental Manager will also be appointed who will have responsibility for ensuring attenuation measures are appropriately maintained. • Where the cable trench / access road / works are running adjacent and parallel to a field drain, a minimum 5m buffer will be maintained between the works area and the drain edge. • Silt fencing will be placed down-gradient of the works during construction at all locations within the 50m buffer. No construction activities or side casting of excavated material will be permitted outside of the fenced area. • Silt fencing will be embedded into the local soils to ensure all site water is captured and filtered.	Doherty Environmental (2021), Natura Impact Statement Farranrory Wind Farm Electrical Cable Route.

Project	NIS conclusion	Mitigation measures summary	Source
		• In a case where only a 5-10m buffer is being maintained, double silt fencing will be put in place on the downslope side. • Additional silt fencing or temporary straw bales (rectangular bales, pinned down firmly with stakes) will be placed across any natural surface depressions/91hannel that slope towards a local watercourse or field drain. • Where the cable trench/ access road route slopes down perpendicular towards a watercourse regularly spaced, temporary bunds or shallow swales will also be put in perpendicular across the route corridor to dissipate surface water run-off from the works area and onto adjacent vegetated ground. • Additional silt fencing will be put at the outfall location of the bunds/swales. • Temporary check dams / silt fencing arrangements will be placed in any local artificial watercourses/drains within 30m of the works corridor (this will also include existing road drains). • The check dams / silt fencing arrangements will be placed every 10m • Avoid construction near streams/flowing drains in wet weather whenever possible • Stone will be of a local geochemistry i.e. be sourced from one of the nearby quarries • No concrete will be used in watercourses • Runoff from excavations will not be pumped directly to watercourses. Where dewatering of excavations is required, water shall be pumped to the head of a treatment train (swale or sump) in order to receive full treatment prior to re-entry to the natural drainage system	
Lisdowney Wind Farm (Kilkenny) 08/1500, modified under 12/172 (Kilkenny) Granted 23/7/2012	No NIS was found for this project, however an Environmental Impact Statement was assessed. In this statement it highlighted the possible effects of increased site water drainage resulting from construction works which may indirectly affect habitats not directly affected by the construction works without adequate mitigation. The closest designated	Mitigation measures for water quality include: • On site access tracks and heavy machinery will avoid areas of wetter soils. • Rock and over burden spoil from turbine excavations will be utilised and consumed in on site access track construction. Topsoil excavated during turbine foundation construction will be stored in temporary bunded areas and fully consumed in the post construction rehabilitation of the turbine bases. Where excavation or construction works occur within 20m of any watercourses, direct measures will be taken to ensure that any potential run-off does not enter	Lisdowney Windfarm (2008), Environmental Impact Statement

Project	NIS conclusion	Mitigation measures summary	Source
	conservation sites are Cullahill Mountain and Spa Hill& Clonmantagh Hill. No ecological corridors exist between these sites and the proposed windfarm sites. Subject to the successful implementation of these measures, we conclude that the Development will not have significant effects on any European Sites.	such water courses. If necessary temporary silt traps will be installed during the construction phase and left in place until the surrounding vegetation stabilises.	

For all the identified projects where an NIS/ environmental reporting was available, the projects incorporated significant mitigation to prevent suspended solids/ pollution from reaching the River Barrow and River Nore SAC and the River Nore SPA. Gortahile, Farranrony, Bilboa, Lisdowney, White Hill and Seskin Wind Farms have hydrological connectivity, but not hydrogeological connectivity with the SAC.

The renewable gas facility development have no connectivity and all other projects have hydrological and hydrogeological connections. The quarry projects identified are for the continuation of use or restoration. There are no connections to the quarry restoration and the Kilbride quarry forms part of the Coolglass project (it will form the borrow pit). The Lagan quarry's lifespan will be continued and therefore, Laggan and the Kilbride quarries have the potential to increase sediment deposition.

4.7.4 River Nore SPA

The situation for River Nore SPA is similar as for the River Barrow and the River Nore SAC, as both are hydrologically connected to the Project.

4.8 Step 2, Part 3: Implications for the Conservation Objectives

4.8.1 River Barrow and River Nore SAC

The unmitigated risks for the Project to undermine the draft conservation objective for the River Barrow and River Nore SAC are set out below in **Table 4-10**.

Table 4-10 Unmitigated risk of undermining the Conservation Objectives of the River Barrow and River Nore SAC

Conservation objective (summary)	Maintain or Restore	For the Project Alone	For the Project inCombination with other plans and projects
No decrease in the distribution, change in population structure of **white clawed crayfish**. No increase in disease or increase in non-native cray fish species.	M	Low risk- crayfish plague was recorded at some aquatic survey sites (A15 and C7) – possible that in absence of proper hygiene measures that this could be spread during works at watercourses. Although no plague was detected at aquatic survey sites, refer to Figure 3.3 in **Appendix 3** near (e.g. 100 m) the Project, it could be spread in the interim period between planning submission and construction. A clear plague management strategy is required and set out in section 4.10.5.	Elevated, but low risk, as other projects also have the potential to spread crayfish plague
No decrease in water quality or negative change in habitat quality for **white clawed crayfish**.	M	Low risk - hydrological pathway release of pollutants risk impacting water course water	Elevated but low risk, of other construction and/or decommissioning works at other project sites adding to

Conservation objective (summary)	Maintain or Restore	For the Project Alone	For the Project inCombination with other plans and projects
		quality. Minor risk to population outside SAC that could be present in aquatic habitat within the project.	the risk for the Project alone.
Positive change in distribution, population structure of juveniles, juvenile density in fine sediment, extent and distribution of spawning habitat or availability of juvenile habitat for **sea lamprey.**	R	Low risk, due to sea lamprey being located a considerable distance from the Project. Breeding grounds could be nearer and therefore based on the precautionary principle, suspended solids from the Project unmitigated could impact or hinder the restoration of spawning sites.	Elevated but low risk, of other construction and/or decommissioning works at other project sites adding to the risk for the Project alone.
Positive change in distribution, population structure of juveniles, juvenile density in fine sediment, extent and distribution of spawning habitat or availability of juvenile habitat for **brook lamprey**	R	Low risk, suspended solids from the Project could cover breeding grounds and impact upon breeding productivity or hinder the restoration of breeding grounds and productivity. Impact of hydrocarbons, unmitigated on invertebrates and vegetation could decrease prey species and equally affect adult brook lamprey nearby or hinder their restoration.	Elevated but low risk, of other construction and/or decommissioning works at other project sites adding to the risk for the Project alone.
Positive change in distribution, population structure of juveniles, juvenile density in fine sediment, extent and distribution of spawning habitat or availability of juvenile habitat for **river lamprey**	R	As for brook lamprey.	As for brook lamprey.
Positive change in distribution, population structure and extent and distribution of spawning habitat of **twaite shad.**	R	Low risk, due to twaite shad populations being located a considerable distance from the Project. Breeding grounds could be nearer and therefore based on the precautionary principle, suspended solids from the Project unmitigated could impact spawning sites or	Elevated but low risk, of other construction and/or decommissioning works at other project sites adding to the risk for the Project alone.

Conservation objective (summary)	Maintain or Restore	For the Project Alone	For the Project inCombination with other plans and projects
		hinder the restoration of spawning sites.	
Positive changes in water quality and spawning habitat quality of **twaite shad.**	R	Low risk - hydrological pathway so release of pollutants risks impacting water quality and suspended solids, which could negatively impact spawning habitat or hinder their restoration. However, twaite shad populations are considerably far downstream (~60km), therefore there will be considerable dilution of any pollutant or suspended solids.	Elevated but low risk, of other construction and/or decommissioning works at other project sites adding to the risk for the Project alone.
Positive changes in distribution, adult spawning fish, **Atlantic salmon** fry abundance and out-migrating smolt abundance.	R	Low risk, hydrological pathway, so release of pollutants risks impacting water quality and suspended solids, which could negatively impact or hinder the restoration of spawning habitat if unmitigated.	Elevated but low risk, of other construction and/or decommissioning works at other project sites adding to the risk for the Project alone.
Increase in number and distribution of redds and water quality for **Atlantic salmon.**	R	Low risk - hydrological pathway, so release of pollutants risks impacting water quality and suspended solids, which could negatively impact spawning habitat or hinder its restoration.	Elevated but low risk, of other construction and/or decommissioning works at other project sites adding to the risk for the Project alone.
Increase in distribution, extent of terrestrial habitat, extent of marine habitat, extent of freshwater habitat (river & lake), and couching sites and holts for **otter**.	R	No risk as no current or prior otter habitat inside the SAC will be affected by the project, and therefore it will not hinder the restoration of otter distribution or its habitat with the SAC.	As alone.
Increase in fish biomass available for **otter**.	R	Low risk - water pollution via suspended sediment could negatively affect fish spawning gravels, vegetation or invertebrates that fish forage upon.	Elevated but low risk, of other construction and/or decommissioning works at other project sites adding to the risk for the Project alone.
Increase in distribution, population size (adult mussel numbers), population structure	R	Low risk, due to hydrological connection and potential impact upon salmon breeding areas and	Elevated but low risk, of other construction and/or decommissioning works at other project sites adding to

Conservation objective (summary)	Maintain or Restore	For the Project Alone	For the Project inCombination with other plans and projects
(recruitment & adult mortality), habitat extent, hydrological regime (flow and host fish) for **Nore freshwater pearl mussel**.		individuals, Nore freshwater pearl mussel could be impacted by declines in host population. In addition, pollution of water unmitigated could impact the mussels directly.	the risk for the Project alone.
Increase in substratum quality (sediment, oxygen availability & filamentous algae/macrophytes) and water quality for **Nore freshwater pearl mussel**.	R	Low risk - water pollution including suspended sediment and nutrients could decrease water quality and change the sediment quality for Nore freshwater pearl mussel.	Elevated but low risk, of other construction and/or decommissioning works at other project sites adding to the risk for the Project alone.
Maintain habitat distribution, habitat area, hydrological regime (river flow & groundwater discharge), substratum composition, water chemistry (minerals, suspended sediment, nutrients), vegetation composition: typical species and flood plain connectivity for **Water courses of plain to montane levels with the *Ranunculion fluitantis* and *Callitricho-Batrachion* vegetation**	M	Low risk, substratum composition, within the target says '*…and free from fine sediments*' there is a risk that the Project unmitigated could release fine sediment into hydrologically connected water courses. Water chemistry could also change, as discharge is likely to be of a lower pH due to the coniferous forestry. There is also the potential to spread non-native invasive plant species, in particular Japanese knotweed recorded in the quarry, to connected water courses. If a non-native species becomes established this could change the vegetation composition. Potentially outcompeting the QI feature.	Elevated but low risk, of other construction and/or decommissioning works at other project sites adding to the risk for the Project alone.
Maintain habitat distribution, habitat area,hydrological regime (flooding depth/height of water table), vegetation structure: (sward height), vegetation composition (broadleaf herb: grass ratio, typical species & negative indicator species) for **Hydrophilous tall herb fringe communities of plains**	M	Low risk there is a risk of spreading non- native invasive plant species, in particular Japanese knotweed recorded in the quarry, to a connected water course. If a non-native species becomes established within the SAC this could change the vegetation composition. Potentially outcompeting the QI feature.	Elevated but low risk, of other construction and/or decommissioning works at other project sites also have the potential to disperse non- native plant species, adding to the risk for the Project alone.

Conservation objective (summary)	Maintain or Restore	For the Project Alone	For the Project inCombination with other plans and projects
and of the montane to alpine levels			

4.8.2 River Nore SPA

The unmitigated risks for the Project to undermine the conservation objectives of the River Nore SPA are related to the release of suspended solids or other pollutants into the catchment and the River Nore. This has the potential to impact the prey (fish) of kingfisher (the only qualifying interest species) or cloud the water and prevent/ reduce the success of kingfisher foraging. This would only occur during construction and/or decommissioning and the risk is low that there would be an impact due to the length of the river, and mobility of kingfishers to forage elsewhere along the river. In combination, the risk is low but elevated as other projects could also release pollution into connected watercourses.

4.9 Step 3: Effects on the Integrity of the European Sites

4.9.1 River Barrow and River Nore SAC

As set out in **Table 4-10**, without mitigation, there is a low risk of undermining the conservation objectives for the River Barrow and River Nore SAC during construction and/or decommissioning works as a result of the release of suspended solids and/or other water pollutants and the risk of transferring non- native species or disease.

4.9.2 River Nore SPA

Without mitigation, there is a low risk of undermining the conservation objectives for the River Nore SPA during construction and/ or decommissioning works as a result of the release of suspended solids and/or other water pollutants into the catchment.

4.10 Step 4: Mitigation Measures

4.10.1 Mitigation by avoidance and design

The following measures are incorporated into the proposed wind farm design to reduce impacts on designated sites, flora and fauna through avoidance and design, refer to **Table 4-11**.

Table 4-11: Design based mitigation measures

Mitigation measures	How measures will avoid an impact	Evidence of how measures are secured	Who will implement measures	Timescale
The hard-standing area of the wind farm has been kept to the minimum necessary for the maximum turbine envelope proposed, including all site	Keeping excavated substrate to a minimum	Design, refer to description of project, section 4.1.4 and **Appendix 1**.	Built into design	Construction

Mitigation measures	How measures will avoid an impact	Evidence of how measures are secured	Who will implement measures	Timescale
clearance works to minimise land take of habitats and flora;				
Site design and layout deliberately avoided direct impacts on designated sites	Location of Project is not within a European site.	Location, refer to **Appendix 1**.	Built into design	Construction, operation and decommissioning
All cabling for the project will be placed underground; this significantly reduces collision risk to birds over the lifetime of the wind farm (Drewitt and Langston, 2006[61]);	No collision of bird species with cabling	Design, refer to description of project, section 4.1.4 and **Appendix 1**.	Built into design	Construction, operation and decommissioning
The grid connection routes have been selected to minimise land take of potentially sensitive habitats by following the site access tracks and public roads	Avoidance of sensitive habitats.	Design, refer to description of project, section 4.1.4 and **Appendix 1**.	Built into design	Construction
Care has been taken to ensure that sufficient buffers are in place between wind farm infrastructure and hydrological features such as rivers and streams.	Avoidance of sensitive habitats.	Design, refer to description of project, section 4.1.4 and **Appendix 1**.	Built into design	Construction
The design of the grid connection was also carried out with cognisance to ecological features. Cables will be placed underneath public roads where possible to avoid impact to roadside hedgerows and away from streams discharging to the River Nore and River Barrow SAC.	Avoidance of sensitive habitats.	Design, refer to description of project, section 4.1.4 and **Appendix 1**.	Built into design	Construction

[61] Drewitt, A. L and Langston, R.H.W (2006) Assessing the impacts of wind farms on birds IBIS 148 S1 29-42

Mitigation measures	How measures will avoid an impact	Evidence of how measures are secured	Who will implement measures	Timescale

4.10.2 Construction phase mitigation measures

All mitigation measures have been developed in accordance with national and international legislative guidance for the protection and management of flora, habitats of conservation importance, fauna and aquatic ecological interest. The description of mitigation measures is provided in terms of the hierarchy of mitigation by avoidance, reduction and remediation.

Erosion and sediment control guidance

The Project will adopt the most stringent practices regarding erosion and sediment control on the site and comply with all relevant guidance contained in the following documents in relation to the planning, development and operation of the proposed development:

- Forestry and Water Quality Guidelines – Forestry Service (DMNR, 2000)[62];
- Code of Best Forest Practice – Ireland[63;]
- Forestry and Freshwater Pearl Mussel Requirements – Site Assessment and Mitigation Measures (Forestry Service, 2009)[64;] and
- Forest Operations & Water Quality Guidelines (Coillte, 2009).

The Forestry Service of the Department of Agriculture, Fisheries and Food implements the principles of Sustainable Forest Management through its environmental guidelines 'Code for best forestry practice Ireland' and its inspection and monitoring procedures. The Forestry Service also has guidance in relation to freshwater pearl mussel: 'Forestry and Freshwater Pearl Mussel Requirements – Site Assessment and Mitigation Measures' in order to further develop its commitment to environmental protection. This document gives specific mitigation measures which are mandatory in specific locations and circumstances in the designated Freshwater Pearl Mussel catchments such as the Barrow and Nore. Within these catchments particular emphasis is placed upon the area that lies within 6km hydrological distance of an identified Freshwater Pearl Mussel (FPM) population. From the River Barrow and River Nore SAC Conservation objectives, the location of Pearl mussel is between approximately 17km (direct) and 25km (hydrological) from the Project, and therefore the mitigation methods for FPM will not be required and the 'Forest Service Guideline' will be required instead.

A Construction Environment Management Plan (CEMP) or Construction Method Statement (CMS) and a Surface Water Management Plan (SWMP) incorporating all mitigation measures included in the NIS and the EIAR and will be followed to ensure compliance with the conservation objectives of the River Barrow and River Nore SAC, and

[62] Forest Service (2018) Forest and Water Achieving objectives under Ireland's River Basin Management Plan 2018-2021

[63] Forest service (2000) Code of best forestry practice -Ireland ISBN 0-9538874-1-3 https://www.skog.is/wp-content/uploads/2019/02/codeireland1.pdf

[64] Forest service (2009) Forestry and Freshwater Pearl mussel requirements: Site assessment and mitigation measures https://assets.gov.ie/179639/f56bf340-b5dc-4de0-860b-5b31874135a3.pdf

the River Nore SPA. The CEMP/ CMS and SWMP will implemented and agreed with IFI, NPWS and the Planning Authority. The CEMP will be a key construction document that the contractor will be required to comply with in order to ensure the environment is protected. Any further requirements set out as conditions of consent will be included and there will be a schedule of environmental commitments that will include mitigation measures. The CEMP will be used an Environmental Audit Checklist Tool to ensure compliance by the appointed contractor and will be completed during environmental monitoring of the works.

Drainage will be based on a Sustainable Drainage System (SuDS) through minimising, interception, treatment dispersal and dilution. The SWMP will specify how water pollution will not occur as a result of construction activity for the Project. It has also been designed to regulate the rate of surface water run- off, encourage settlement of sediment locally and to minimise the quantity of sediment laden storm water.

Erosion control (i.e. preventing sediment runoff) is more effective than sediment control for the prevention of water pollution, this principle is adopted in the SWMP. Erosion control measures are less likely to fail during times of high rainfall, require less maintenance and are more cost effective. Controls will be in place before site clearance or earth works are commenced, erosion, sediment, drainage and run-off control. The works programme will include ensuring the following controls are in place before site clearance or earth works are commenced:

- Erosion control;
- Sediment control;
- Drainage control; and
- Runoff control.

Once works on site have commenced, the area of exposed ground will be minimised, runoff will be prevented from entering the site from adjacent ground, appropriate control and containment measures will be undertaken. Monitoring and maintenance of erosion and sediment controls will occur throughout the project. Establishing vegetation as soon as practical where soil is exposed will also be a priority.

All silt and erosion control measures will be based on the peak flow set out in CIRIA (2006)[65].

4.10.3 Erosion and sediment control details

Measures to control erosion and sediment deposition will be incorporated into each element of the Project. The works have been broken down into the following stages:

- Upgrading of existing drainage network;
- Upgrading of existing access tracks and roadside swales;
- New access tracks;
- Crane hardstanding areas and turbine foundations;
- Substation compound/ temporary construction compound; and

[65] CIRIA (2006) Control of water pollution from Construction sites

* All such features to be assigned unique reference number to facilitate ongoing inspection and monitoring of same during the course of the works.

- Cable trenches.

All measures will be based on the peak flow set out in CIRIA (2006). The following measures will be used for each element of work (where relevant) and measures are detailed in **Table 4-12**.

Table 4-12: Erosion and sediment control mitigation measures

Mitigation measures	How measures will avoid an impact	Evidence of how measures are secured	Who will implement measures	Timescale
Installation of interception drains installed upslope of proposed work areas	Prevent water reaching works areas, therefore preventing water running over works areas and colleting sediment.	CEMP	Construction site staff and drainage engineers	Installed pre-construction.
Silt trap installation at discharge points from trackside swales	Collect silt present in any runoff water before discharge to water courses	CEMP	Construction site staff and drainage engineers	Installed pre-construction.
Blocking of any drains that collect discharge from roadside swales and discharge directly into water courses	Prevent discharge of water containing silt into water courses.	CEMP	Construction site staff and drainage engineers	Blocked pre-construction.
Perimeter swales to collect dirty surface water runoff from crane hardstanding area/ turbine bases including locations of proposed: check-dams, cross-drains, sediment traps and discharge points*	Collect water from the most likely sources of pollution and prevent discharge to water courses.	CEMP	Construction site staff and drainage engineers	Preconstruction, construction, operation and decommissioning.
Settlement ponds to facilitate the treatment of potential silt laden water*	Allow for silt to be removed from water before discharge to water courses	CEMP	Drainage engineer (design), construction team (installation) and site staff (ongoing monitoring).	Preconstruction, construction, operation and decommissioning.

4.10.4 Best practice pollution control measures

The following best practice pollution control measures, detailed in **Table 4-13** will be employed during the construction phase when working in or near (50m) the minor watercourses in the study area to prevent the transport of deleterious substances to River Barrow and River Nore SAC, and River Nore SPA. Release of suspended solids to all surface waters will be controlled by interception (e.g. silt traps) and management of site run-off.

Any surface water run-off must be treated to ensure that it is free from suspended solids, oil or any other polluting materials.

Table 4-13: Pollution prevention mitigation measures

Mitigation measures	How measures will avoid an impact	Evidence of how measures are secured	Who will implement measures	Timescale
Silty water will be treated using silt trays/settlement ponds and temporary interceptors and traps will be installed until such time as permanent facilities are constructed;	Collection of silt and prevention of discharge to water courses	CEMP, **Appendix 5**	Drainage engineer (design). On site construction staff (implementation).	Construction, ahead of permanent silt settlement facilities
Straw bales or silt fences will be appropriately located near watercourses to help prevent untreated surface water run-off entering any watercourse;	Prevention of silt entering water courses.	CEMP, **Appendix 5**	Drainage engineer (location of bales). On site construction staff (implementation and monitoring).	Construction
All fuels, lubricants and hydraulic fluids will be kept in secure bunded areas away from watercourses. The bunded area will accommodate 110% of the total capacity of the containers within it;	Prevent spills from potential pollutants reaching water courses.	CEMP, **Appendix 5**	On site construction, operation and decommissioning staff (implementation and compliance).	Construction, operation and decommissioning.
Containers will be properly secured to prevent unauthorised access and misuse. An effective spillage procedure will be put in place with all staff properly briefed;	Prevent spills of potential pollutants, if spills occur ensure proper reporting and protocol is followed to prevent discharge to water courses	CEMP, **Appendix 5**	On site construction, operation and decommissioning staff (implementation and compliance).	Construction, operation and decommissioning
Any waste oils or hydraulic fluids will be collected, stored in appropriate containers and disposed of offsite in an appropriate manner;	Prevent spills of potential pollutants, if spills occur ensure proper reporting and protocol is followed to prevent discharge to water courses	CEMP, **Appendix 5**	On site construction, operation and decommissioning staff (implementation and compliance).	Construction, operation and decommissioning

Mitigation measures	How measures will avoid an impact	Evidence of how measures are secured	Who will implement measures	Timescale
Fuelling and lubrication will not be conducted within 50m of watercourses	Prevent spills of potential pollutants, if spills occur ensure proper reporting and protocol is followed to prevent discharge to water courses	CEMP, **Appendix 5**	On site construction, operation and decommissioning staff (implementation and compliance).	Construction, operation and decommissioning
Storage areas, machinery depots and site offices will be located at least 50m from the nearest watercourse;	Prevent spills of potential pollutants, if spills occur ensure proper reporting and protocol is followed to prevent discharge to water courses	Design of construction compounds, site layout, refer to **Appendix 1**	On site construction staff locating construction compounds and site offices where specified in the plan	Construction, operation and decommissioning
Foul drainage from the site offices and facilities will be properly treated and removed to a suitable treatment facility;	Prevent pollution of water courses vis discharge of foul water.	CEMP , **Appendix 5**	On site construction and operation staff.	Construction, operation and decommissioning
Spill kits will be made available close to streams and all staff will be properly trained on correct use.	Prevent spills of potential pollutants, if spills occur ensure proper reporting and protocol is followed to prevent discharge to water courses	CEMP, **Appendix 5**	Construction staff (construction and decommissioning) Site staff (operation)	Construction, operation and decommissioning
Disposal of raw or uncured waste concrete will be controlled to ensure that watercourses or other sensitive areas will not be impacted.	Prevent concrete entering water courses and then degrading within the water course, leading to siltation.	CEMP, **Appendix 5**	Construction staff and maintenance staff	Construction and operation.
Attenuation ponds and a constructed wetland shall be designed, allowing 24hr settlement before discharge into the surrounding watercourses.	Allow for sedimentation process so that suspended solids do not enter water courses.	CEMP, **Appendix 5**	Drainage engineer (design), construction staff (creation) and site staff (maintenance).	Construction, operation and decommissioning.

Works adjacent to, within or over water courses will following guidelines will be followed for instream works and/ or construction of new tracks:

- Guidelines on Protection of Fisheries during Construction Works in and Adjacent to Waters (IFI, 2016)[66]; in summary these are:
    - Use of clear span bridges and bottomless culverts in preference to insufficient water depth culverts, culverts with perched inlets, outfalls and excessive slopes.
    - Bridge foundations should be designed and positioned at least 2.5 metres form the river bank, so there is no impact on riparian habitat.
    - If a clear span bridge is not viable, any culvert for a crossing structure needs to be made of metal or concrete pipes a minimum of 900mm diameter and be laid in a manner to maintain the existing stream profile.
    - If culverts are used, these should be positioned where the watercourse is straightest and aligned with the bed.
    - Allow sufficient depth over bridge aprons/ sour slabs, to allow fish movement.
    - Any crossing should avoid physical alterations to stream channels that could alter hydrological characteristics, change stream profile (specifically width, depth, gradient and speed).
    - Any crossing should have capacity to convey the full range of flood flows likely to be encountered, without the crossing being overtopped and allow for passing of debris that might arise).
    - Crossings need to be covered in clean inert material to allow safe crossing of the widest items of plant and equipment, without cover material being dislodged and entering the water.
    - Time in water works between July and September.
    - Creation of fords for access is prohibited.
    - Crossing of water courses at natural fords is not permitted.
    - Bank protection works are often required upstream and downstream of new structures to ensure no undercutting or destabilisation, rock armour is preferred to gabions.
    - Pre- cast concrete should be used whenever possible to prevent risks to aquatic life.
    - When cast in place concrete is required, all work must be done in the dry and effectively isolated from flowing water for a period sufficient to ensure no leachate from concrete.
    - Designated impermeable cement washout areas must be provided.
    - Abstraction of water for dust suppression should not occur where invasive aquatic species have been identified, to prevent spreading of such species and should only occur in large enough waters identified to allow abstraction without adverse effect.

[66] Inland Fisheries Ireland (2016) Guidelines on protection of fisheries during construction works in and adjacent to waters

- Guidelines for the crossing of watercourses during the construction of national road schemes (NRA, 2005)[67]. In summary these are:
  - Avoid disturbing watercourses and riverbanks above and below crossings
  - Implementing measures to control or minimise risk of siltation including bunding and diversion of site run-off to settlement ponds, stripping of top soil and covering temporary stockpiles
  - Culverts should be constructed to allow the passage of fish and mammals;
  - Temporary crossings should not impede fish passage; and
  - Where temporary watercourse crossings are required, suitable materials should be used for construction to not give rise to rutting, ponding and silt run-off; and to direct silt run-off to silt lagoons with precise measures specified according to gradient, with buffer zones incorporated between ponds and watercourses.

4.10.5 Additional measures for conserving water quality and aquatic life

Disturbed Sediment Entrainment Mats (SEDIMATS[68]) will be used in all watercourses that drain from the site. These will provide a further level of protection in relation to silt release. These will be installed by the manufacturer’s instructions at locations agreed by the NPWS, IFI and the Planning Authority.

Additional measures to protect water quality will be implemented. Lagoon-type sediment trap and plant filtration beds are a recommendation in the Altmüller and Dettmer (2006)[69] study, this will be incorporated into the SWMP. Although the Altmüller and Dettmer study specifically looked at FPM and the populations are between approximately 17 km (generic) and 25km (hydrological) from the Project, these measures will further protect water quality and aquatic life.

The CEMP includes details of the machinery and methodology to be employed to undertake the proposed works. This includes details on the exact location of storage materials, and equipment, how access will be managed to limit disturbance outside of the Project area, protection of water quality with the avoidance of spills and the use of bio-degradable oils. All construction machinery operating near any watercourse will be systematically checked in order to avoid leaks of oils, hydraulic fluids and fuels.

There will also be a method statement in relation to cleaning machinery and the avoidance of importing/spreading non-native invasive species, specifically associated with the treatment of quarry materials to ensure that invasive third schedule Japanese knotweed (or other non- native plants) is not spread during construction works and any works near watercourses must not spread invasive third schedule Canadian pondweed. A pre-construction confirmatory survey of the works corridor will confirm the presence of any invasive/non-native species that may have escaped into the area since the baseline surveys were conducted. Any plant or equipment that may have worked in environments where invasive species are present (including but not restricted to crayfish plague, zebra

[67] National Roads Authority (NRA) Guidelines for the crossing of watercourses during the construction of national road schemes.

[68]SediMat example: https://www.hy-tex.co.uk/product/sedimats/

[69]Altmüller R. & Dettmer, R. 2006. Successful species protection measures for the Freshwater Pearl Mussel (*Margaritifera margaritifera*) through the reduction of unnaturally high loading of silt and sand in running waters – Experiences within the scope of the Lutterproject.

mussel *Dreissena polymorpha*, curly waterweed *Lagarosiphon major*, Japanese knotweed (and other members of the Knotweed family), Indian balsam *Impatiens glandulifera*, giant hogweed *Heracleum mantegazzianum*, *rhododendron ponticum,* New Zealand flatworm *Arthurdendyus triangulata*), shall be suitably cleaned by high pressure hose, disinfected and dried before being used on site to prevent the spread of invasive species. Water used for this washing process shall always be intercepted and prevented from draining back into watercourses. A specific Habitat and Species Management Plan (HASMP) will be used to prevent the spread of invasive and non-native plant species, refer to **Appendix 7**.

Any stockpiling of material, topsoil or spoil will be within the proposed site compound. All storage and stockpiling of material must be at a minimum of 50m from any surface water drainage on the site.

Temporary fencing (paling with 25mm mesh) will be erected around the required site works to delineate the works area and to minimise the potential for disturbance impacts outside of the works area. As no otter holts were identified within the Project area of the proposed development, there is no specific mitigation required for the protection of this species in relation to relocation/construction of artificial dwellings.

4.10.6 Operational phase mitigation measures

Maintenance of the wind farm drainage system will ensure the system is operating effectively and will be undertaken in accordance with CIRIA C697 SuDS and Maintenance Manual[70]. Some measures detailed in **Table 4-13** are relevant to operation as well and will be undertaken as specified in that table. A review of the ecological mitigation measures will be required during the operational phase and further Project specific mitigation will be provided as appropriate where measures are required. The following additional mitigation measures are generic and will be added to as appropriate:

- Site access will be restricted by gates to prevent illegal dumping , use by off road vehicles etc; and
- As during construction, any stockpiled material will be within the proposed site compound or a minimum of 50m from any surface water drainage.

1.1.1 Mitigation Measures during decommissioning

Mitigation measures for decommissioning will be similar to those set out above and in the CEMP for the construction phase, however the magnitude required will be less, as track and turbine installation will not be required.

5.0 Conclusion

This NIS contains information which the competent authorities, may consider in making its own complete, precise and definitive findings and conclusions and upon which it is capable of determining that all reasonable scientific doubt has been removed as to the effects of the Project on the integrity of the relevant European sites. With the identified mitigation measures in place, it can be concluded, beyond all reasonable scientific doubt that the Project, either alone or in combination with other plans or projects will not undermine the conservation objectives of any European Sites. It can therefore be concluded that the project would not have an adverse effect on the integrity of any European site. This NIS

[70]CIRIA (2015) C697 The SuDS Manual

comprehensively assesses all scenarios within the Turbine Range which is described in 4.1.4. The potential impacts that could arise from the Project during the construction, operational and decommissioning phases are set out in this conclusion. There will be no change to the potential impacts or predicted effects irrespective of which turbine is selected within the Turbine Range. As such, the predicted significance of the effect applies to all scenarios with the range.

A proposed mitigation scheme for the construction, operational and decommissioning phases is described in this chapter and these mitigation measures are required and will be implemented in full for the turbine selected within the Turbine Range.

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Appendix 1

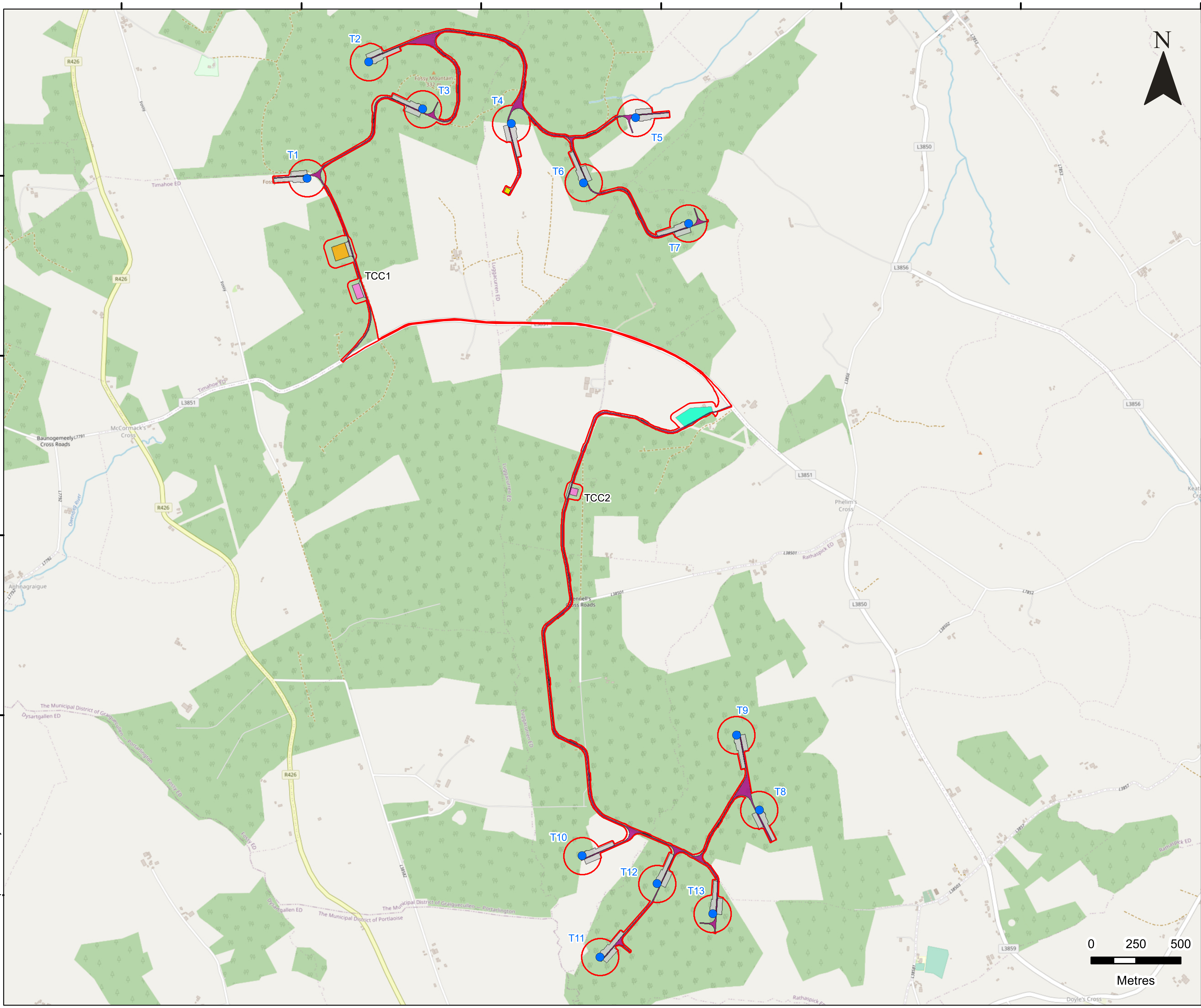
Site Location and Layout

Coolglass Wind Farm NIS

Coolglass Wind Farm Limited

SLR Project No.: 501.V00727.00006

11 July 2023



LEGEND

- Proposed Development Site Boundary
- Proposed Turbine Layout
- Proposed Substation Compound
- Proposed Temporary Construction Compound
- Proposed Borrow Pit
- Proposed Hardstanding
- Proposed Access Track
- Proposed Met Mast Hardstanding

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COOLGLASS WIND FARM ENVIRONMENTAL IMPACT ASSESSMENT REPORT

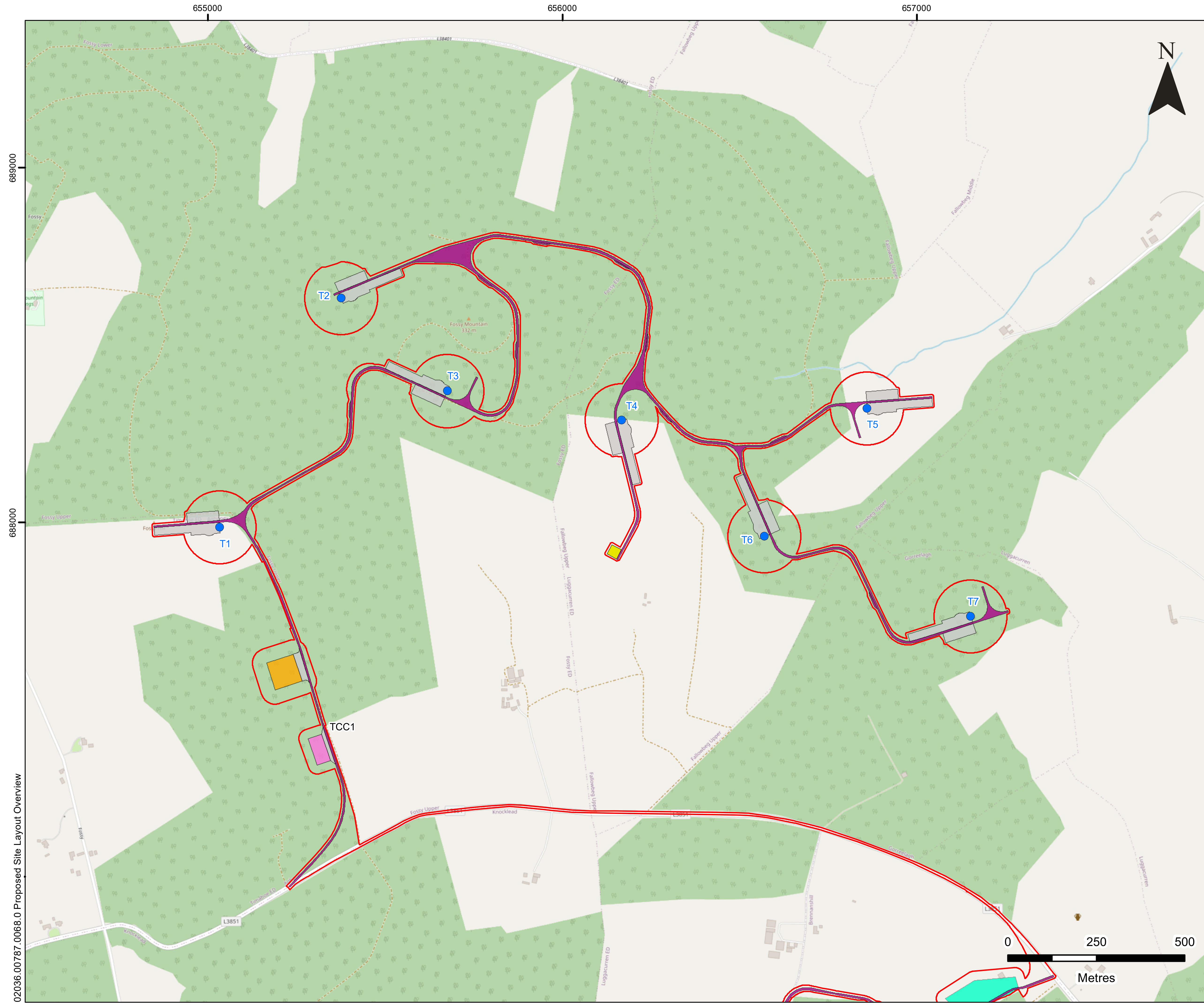
DESCRIPTION OF THE DEVELOPMENT

PROPOSED SITE LAYOUT OVERVIEW

FIGURE 3-1-a

Scale	Date
1:20,000 @ A3	JUNE 2023

02036.00787.0068.0 Proposed Site Layout Overview



LEGEND

- Proposed Development Site Boundary
- Proposed Turbine Layout
- Proposed Substation Compound
- Proposed Temporary Construction Compound
- Proposed Borrow Pit
- Proposed Hardstanding
- Proposed Access Track
- Proposed Met Mast Hardstanding

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COOLGLASS WIND FARM
ENVIRONMENTAL IMPACT ASSESSMENT REPORT

DESCRIPTION OF THE DEVELOPMENT

PROPOSED SITE LAYOUT NORTHERN CLUSTER

FIGURE 3-1-b

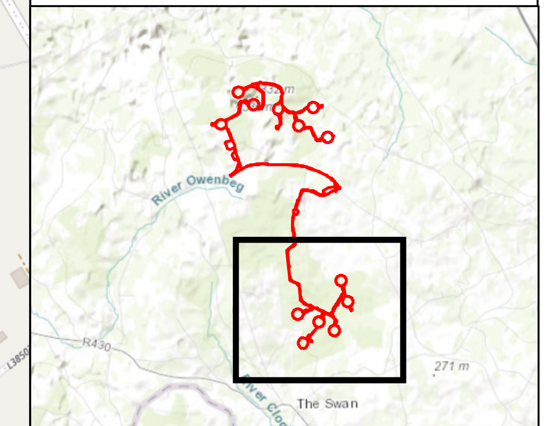
Scale 1:10,000 @ A3

Date JUNE 2023

02036.00787.0068.0 Proposed Site Layout Overview

LEGEND

- Proposed Development Site Boundary
- Proposed Turbine Layout
- Proposed Hardstanding
- Proposed Access Track



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COOLGLASS WIND FARM
ENVIRONMENTAL IMPACT ASSESSMENT REPORT

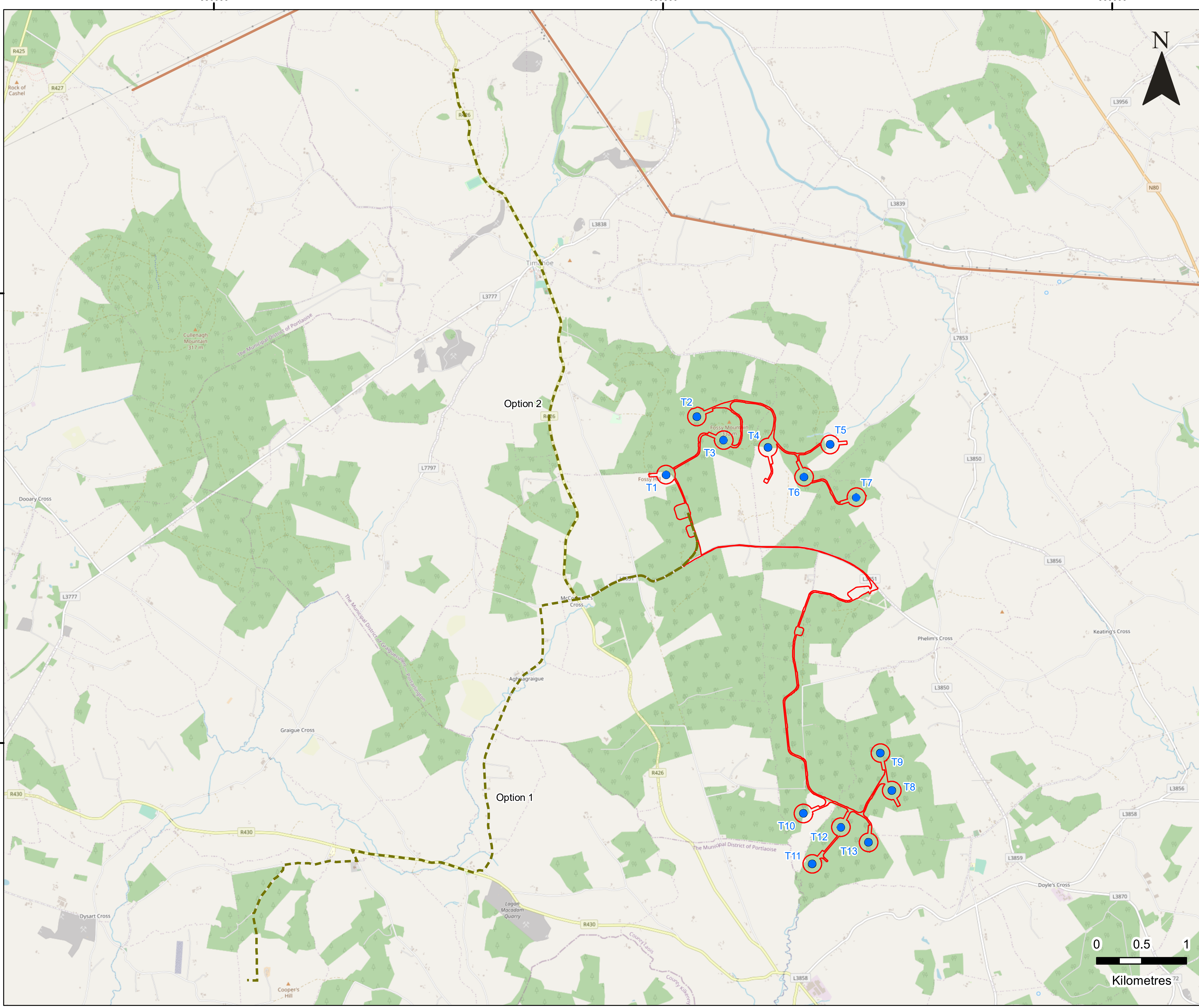
DESCRIPTION OF THE DEVELOPMENT

PROPOSED SITE LAYOUT SOUTHERN CLUSTER

FIGURE 3-1-c

Scale	Date
1:10,000 @ A3	JUNE 2023

02036.00787.0068.0 Proposed Site Layout Overview



LEGEND

- Proposed Development Site Boundary
- Proposed Turbine Layout
- Proposed Cable Routes to be Assessed (Separate Planning Application)
- Existing High Voltage Transmission Line

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COOLGLASS WIND FARM
ENVIRONMENTAL IMPACT
ASSESSMENT REPORT

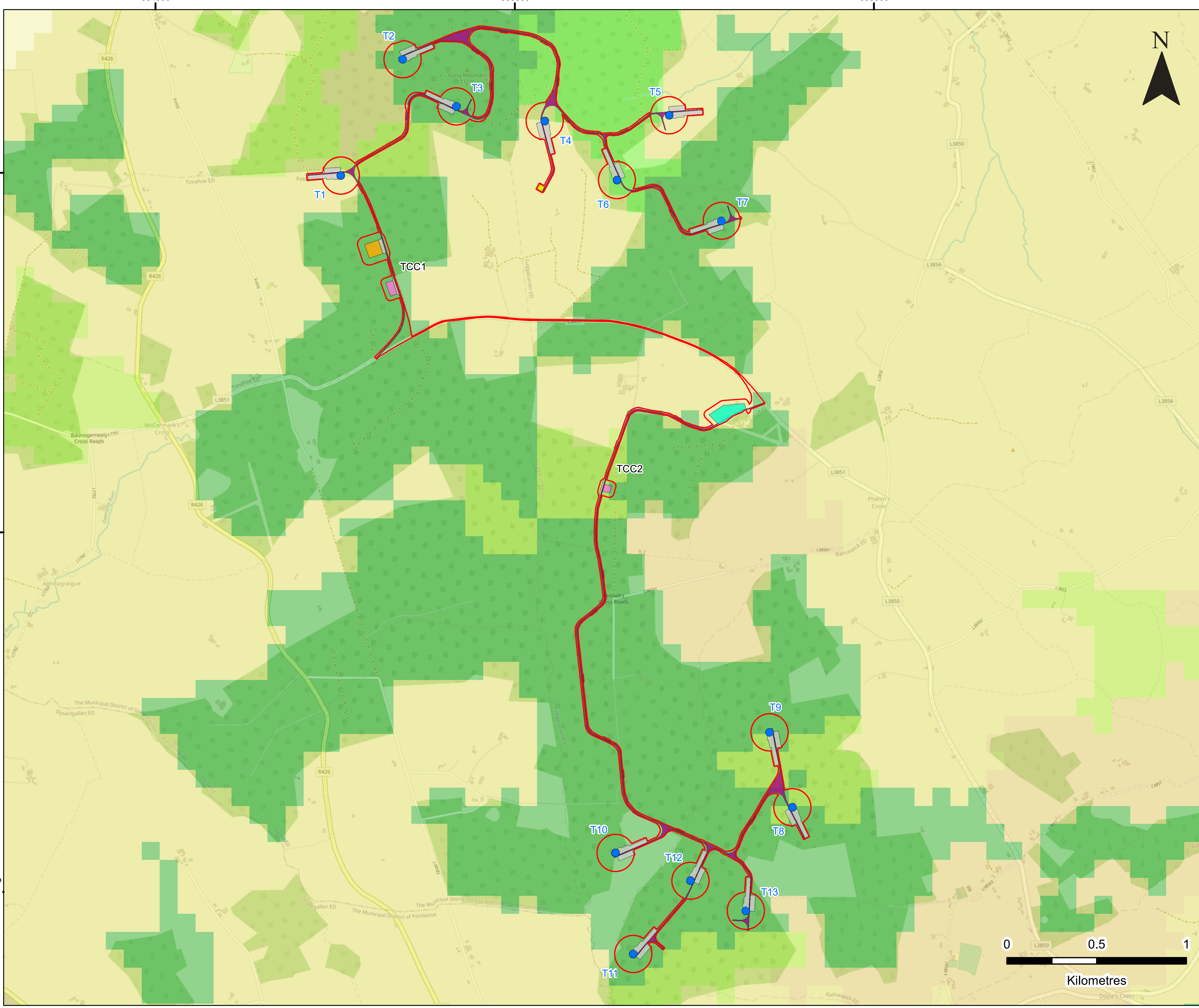
DESCRIPTION OF THE DEVELOPMENT

CABLE ROUTES

FIGURE 3-2

Scale	Date
1:40,000 @ A3	JUNE 2023

02036.00787.0069.0 Grid Connection Route

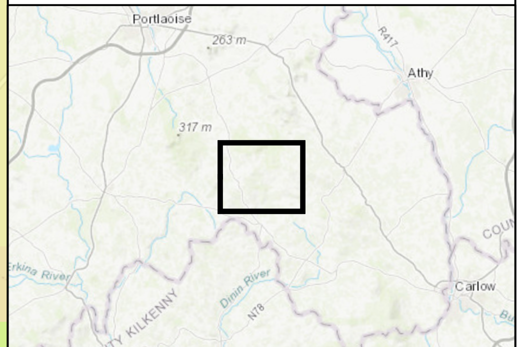


LEGEND

- Proposed Development Site Boundary
- Proposed Turbine Layout
- Proposed Substation Compound
- Proposed Temporary Construction Compound
- Proposed Borrow Pit
- Proposed Hardstanding
- Proposed Access Track
- Proposed Met Mast Hardstanding

Corrine Land Cover (2018)

- Non-Irrigated Arable Land
- Pastures
- Land Principally Occupied By Agriculture, With Significant Areas Of Natural Vegetation
- Coniferous Forest
- Mixed Forest
- Transitional Woodland-Shrub



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COOLGLASS WIND FARM
ENVIRONMENTAL IMPACT ASSESSMENT REPORT

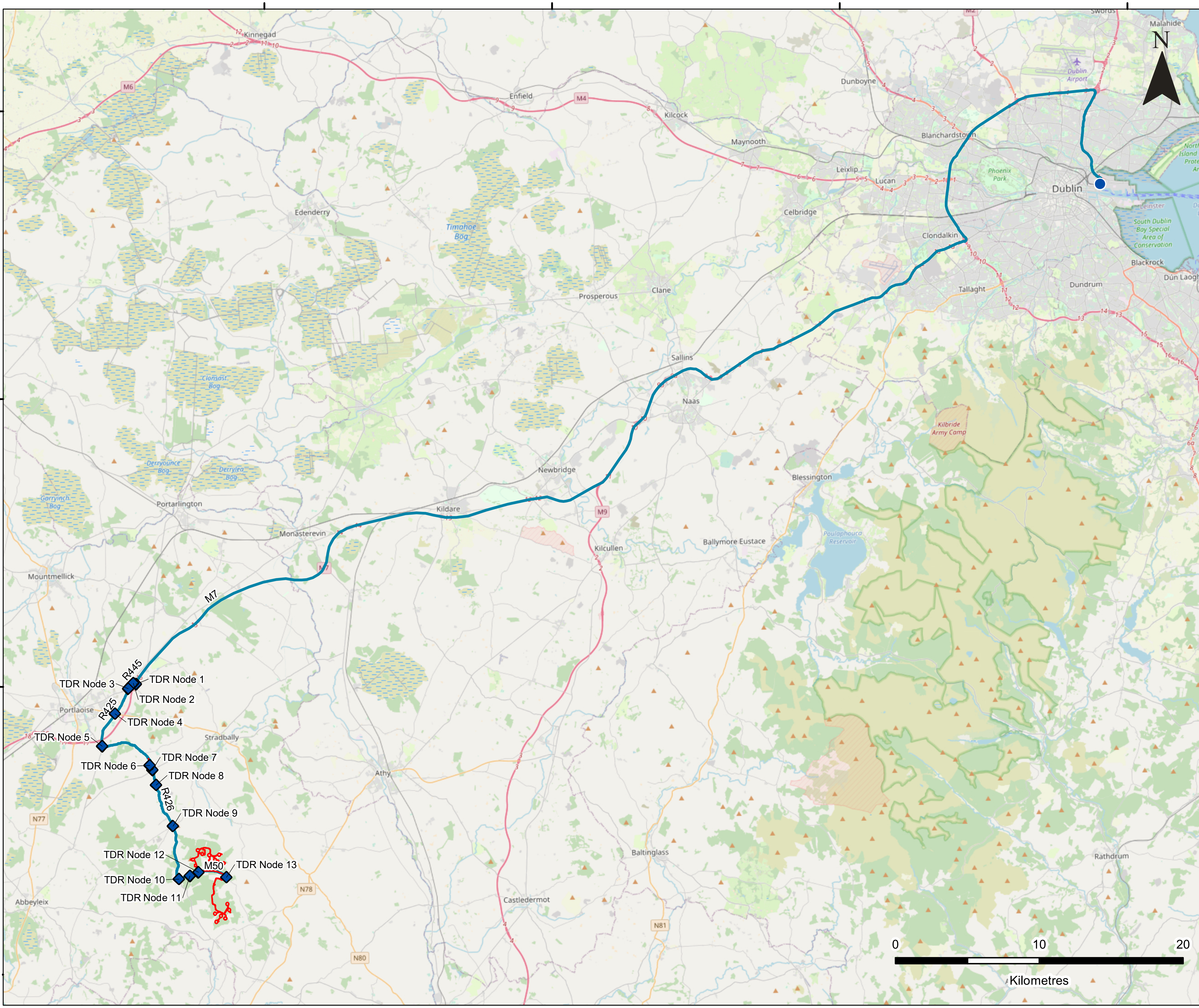
DESCRIPTION OF THE DEVELOPMENT

**CORINE LAND COVER 2018
EXISTING LAND USE**

FIGURE 3-3

Scale	Date
1:20,000 @ A3	JUNE 2023

02036.00787.0070.0 Existing Landuse



LEGEND

- Proposed Development Site Boundary
- Dublin Port
- Proposed Turbine Delivery Route Node
- Proposed Turbine Delivery Route

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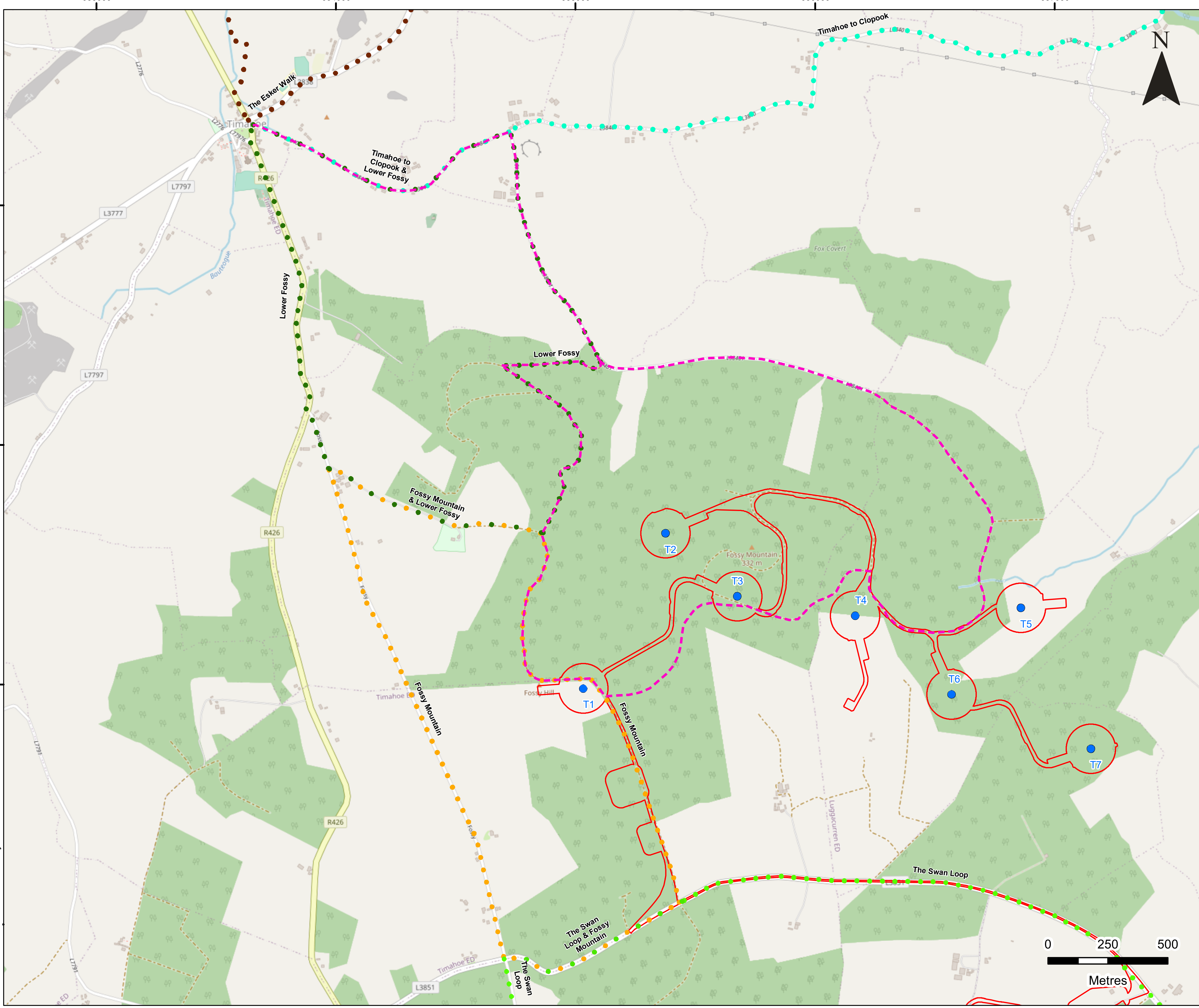
DESCRIPTION OF THE DEVELOPMENT

PROPOSED TURBINE DELIVERY ROUTE OVERVIEW

FIGURE 3-5

Scale	Date
1:250,000 @ A3	JUNE 2023

02036.00787.0072.0 TDR



LEGEND

Proposed Development Site Boundary

Proposed Turbine Layout

Proposed Recreational Amenity Trail to be Assessed (Separate Planning Application)

Existing Trail Routes

Fossy Mountain

Lower Fossy

Timahoe to Clopook

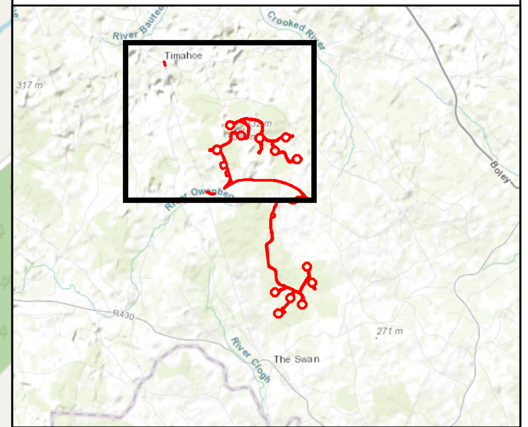
The Esker Walk

The Swan Loop

Fossy Mountain & Lower Fossy

The Swan Loop & Fossy Mountain

Timahoe to Clopook & Lower Fossy



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COOLGLASS WIND FARM ENVIRONMENTAL IMPACT ASSESSMENT REPORT

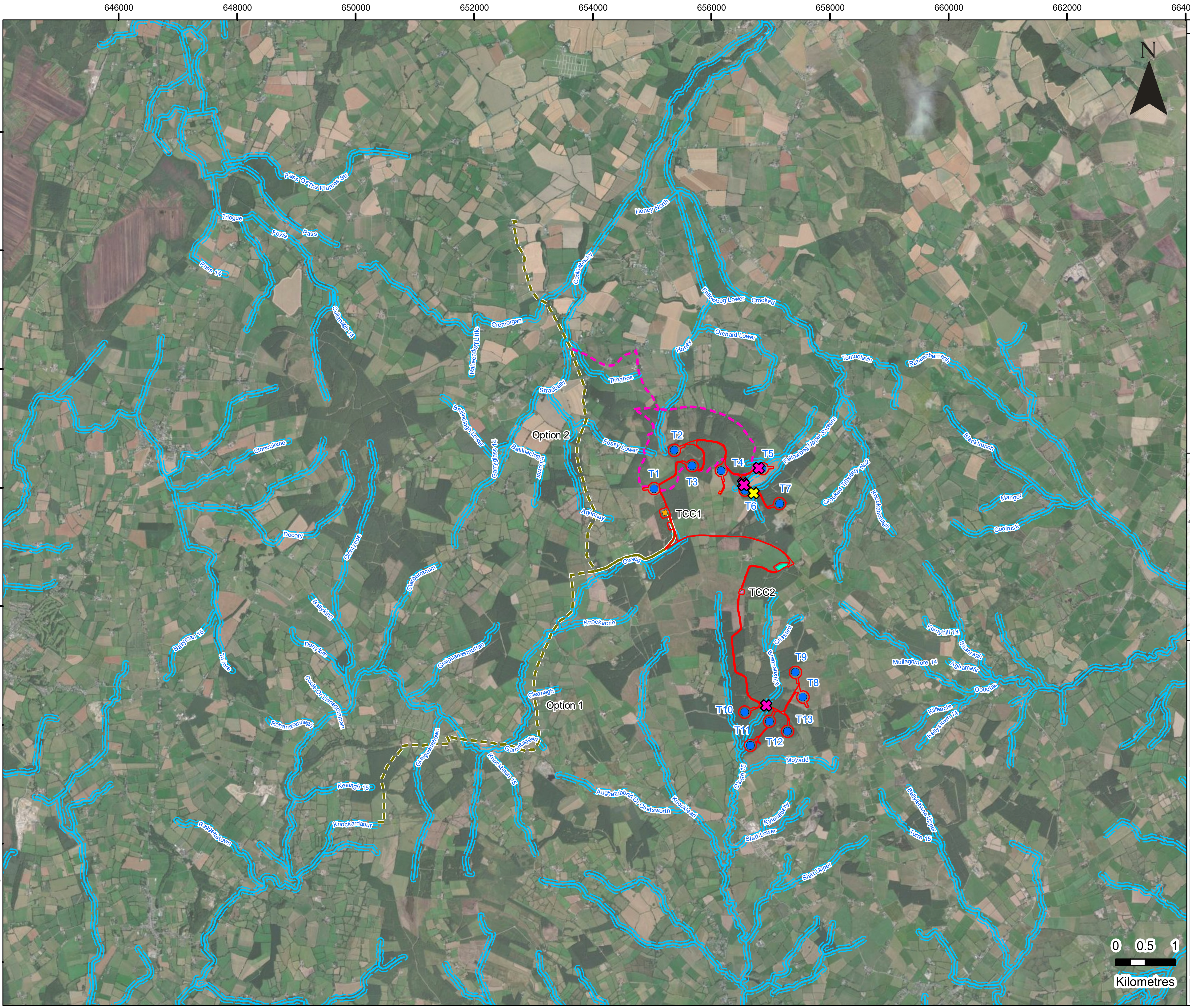
DESCRIPTION OF THE DEVELOPMENT

PROPOSED RECREATIONAL AMENITY TRAIL

FIGURE 3-6

Scale	Date
1:15,000 @ A3	JUNE 2023

02036.00787.0089.0 Forest Amenity Trail



LEGEND

- Proposed Development Site Boundary
- Proposed Turbine Layout
- Proposed Substation Compound
- Proposed Temporary Construction Compound
- Proposed Borrow Pit
- Proposed Met Mast Hardstanding
- Proposed Cable Routes to be Assessed (Separate Planning Application)
- Proposed Recreational Amenity Trail to be Assessed (Separate Planning Application)
- Existing Watercourse Crossing
- Proposed Watercourrse Crossing
- Watercourse
- Watercourse 50 m Buffer

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ENVIRONMENTAL IMPACT ASSESSMENT REPORT

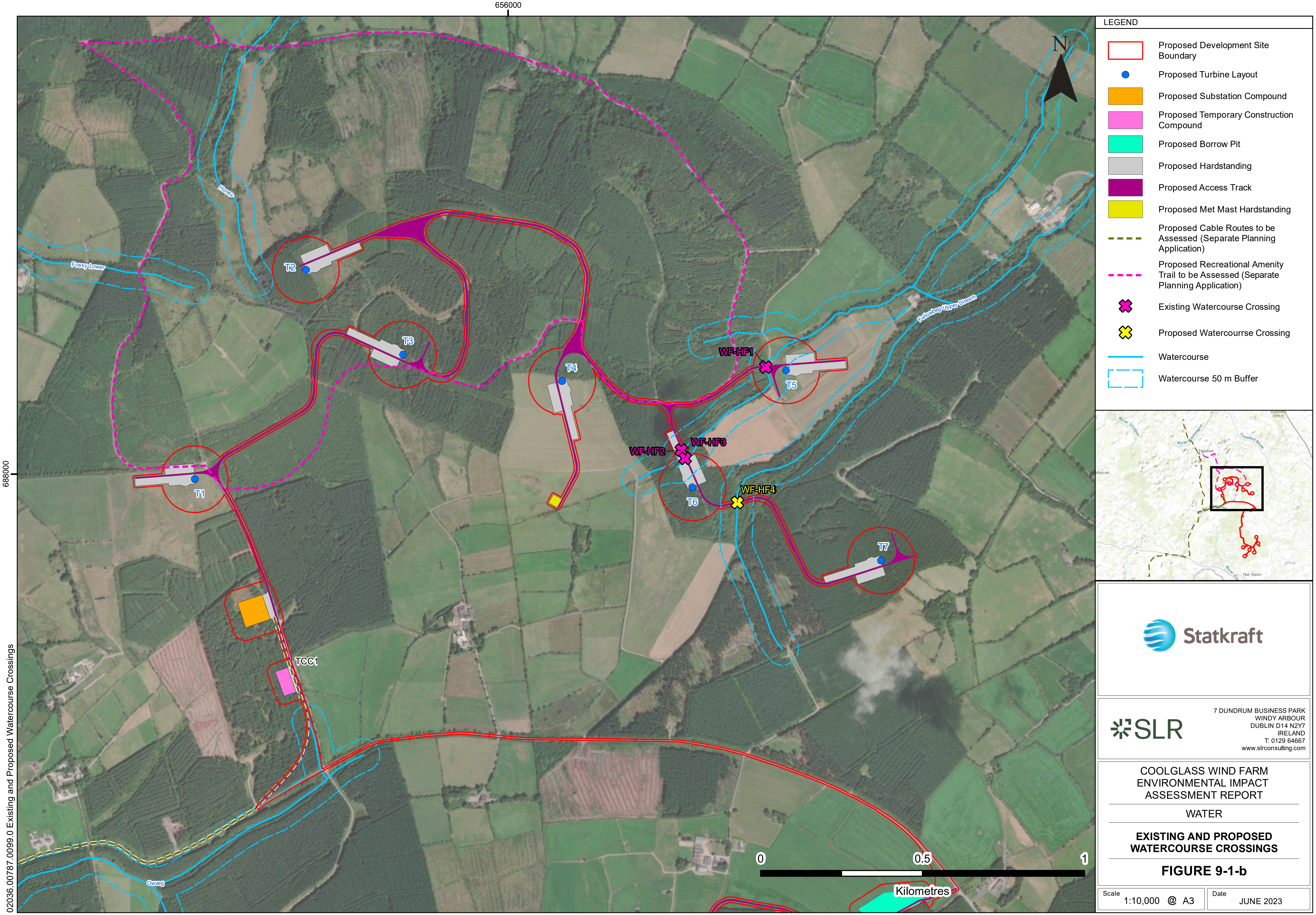
WATER

EXISTING AND PROPOSED WATERCOURSE CROSSINGS

FIGURE 9-1-a

Scale	Date
1:60,000 @ A3	JUNE 2023

02036.00787.0099.0 Existing and Proposed Watercourse Crossings



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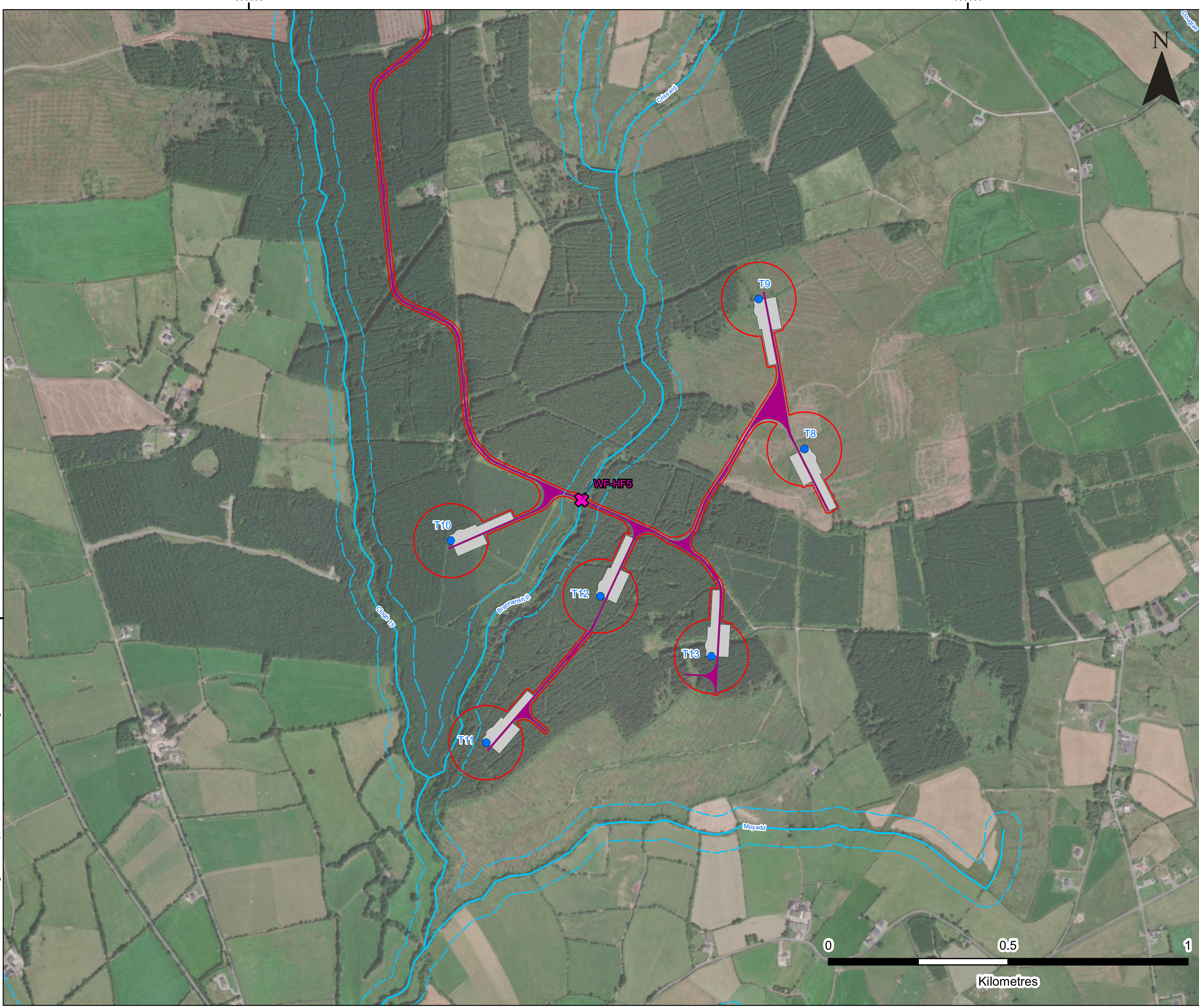
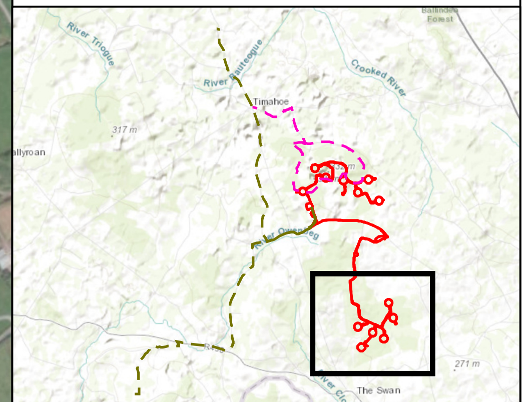
656000 658000



LEGEND

- Proposed Development Site Boundary
- Proposed Turbine Layout
- Proposed Hardstanding
- Proposed Access Track
- Existing Watercourse Crossing
- Watercourse
- Watercourse 50 m Buffer



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COOLGLASS WIND FARM
ENVIRONMENTAL IMPACT
ASSESSMENT REPORT

WATER

EXISTING AND PROPOSED WATERCOURSE CROSSINGS

FIGURE 9-1-c

Scale	Date
1:10,000 @ A3	JUNE 2023

02036.00787.0099.0 Existing and Proposed Watercourse Crossings

SLR

Appendix 2

Baseline Bird Reports and Collision Risk Model

Coolglass Wind Farm NIS

Coolglass Wind Farm Limited

SLR Project No.: 501.V00727.00006

11 July 2023

Winter 2017/18 bird survey data

1.0 Introduction

Fehily Timoney and Company (FT) were commissioned by Coolglass Wind Farm Ltd to carry out a bird survey programme for the proposed Coolglass Wind Farm, Co. Laois (hereafter 'the Project') during the non-breeding bird period in 2017/18.

The results of these surveys were supplied to SLR Consulting Ireland Ltd (hereafter 'SLR') in the format of an Excel spreadsheet and GIS shapefiles showing flight lines and vantage point locations. None of these results have been reported on.

As SLR did not carry out the work, only a brief description of the methods and results have been described insofar as can be inferred from the raw data.

1.1 Background to the Project

No previous planning permission has been sought on the application site (hereafter 'the Project Site') for the development of a wind farm by Coolglass Wind Farm Ltd or any other party. Breeding and non-breeding bird surveys were carried out by FT from 2012 to 2018 while the Project was in gestation. These surveys included flight activity, breeding wader, barn owl and merlin surveys.

1.2 Project Site Description

The Project Site is located within the townlands of Brennanshill, Coolglass, Crissard, Fallowbeg Upper, Coolglass Upper, Gorreelagh, Kylenabehy and Scotland in Co. Laois. The dominant habitats within the boundaries of the Project Site are conifer plantation and improved agricultural grassland. There are also numerous eroding/upland rivers including the Fallowbeg Upper, Owveg [Nore], Clogh 15 and Brennanshill. The north of the Project Site is focused on Fossy Mountain, which is a small hill, 323 m above sea level in height.

1.3 Scope of Work

The scope of survey work was largely based on NatureScot (NS) (formerly Scottish Natural Heritage; SNH) guidance[1]. This survey methods guidance is recognised as standard best practice guidance throughout the UK and Ireland for surveying birds to inform impact assessment for onshore wind farms. The scope of survey work undertaken is provided in **Table 1-1**. Further details are provided in Sections 2.2.2 to 2.2.5.

Table 1-1
Scope of Ornithological Survey Work, Non-breeding Season 2017/18

Survey Type	Summary Methodology (see Section 2 for further details)
Vantage Point (VP) surveys	At least 36 hours of survey were carried out from VPs 1-3 and 6, 32 hours at VP4, 24 hours at VP5 and 30 hours at VP7, from September 2017 to March 2018.

[1] Scottish Natural Heritage (2017). Recommended Bird Survey Methods to Inform Impact Assessment of Onshore Wind Farms V2. Scottish Natural Heritage, Inverness.

Survey Type	Summary Methodology (see Section 2 for further details)
Winter Transect surveys	Nine visits were conducted across two transects between November 2017 to February 2022.

1.4 Target Species

Target species for the surveys were defined by legal and/or conservation status and vulnerability to impacts caused by wind turbines, as defined in NS guidance. Note that all species were recorded as primary target species at the time of surveys and are shown as such in Appendices; however, for the figures, the definition of primary and secondary target species as outlined below has been retrospectively applied. This reflects any updates to conservation status since the time of surveys.

1.4.1 Primary Target Species

Primary target species was limited to species upon which effects are most likely to be potentially significant in EIA and Appropriate Assessment (AA) terms e.g., species forming qualifying features for nearby Special Protection Areas (SPAs) or species listed on Annex 1 of the Birds Directive[2].

This distinction should enable recording to focus on the species of greatest importance without the distraction of having to record detailed flight data for a larger number of more common species. This approach was not undertaken for the 2017/18 surveys and so some species that were recorded as primary targets have been relegated to secondary status (details shown below).

Primary target species included the following bird species:

- All Annex 1 raptor/owl species;
- Qualifying interest species for nearby SPAs[3]; and
- Other raptors, waders or wildfowl red-listed on the latest Birds of Conservation Concern in Ireland (BoCCI)[4] scheme.

1.4.2 Secondary Species

Local circumstances may indicate that survey information should also be acquired on other species, especially those of regional conservation concern. Such species are termed secondary species. Recording of secondary species is subsidiary to recording of primary target species.

[2] Annex 1 of the Birds Directive (Directive 2009/147/EC)

[3] The relevant SPAs are listed in SLR baseline reports: SLR (2022a). Coolglass Wind Farm. Breeding 2021 and non-breeding 2021/22 bird survey report; SLR (2022b). Coolglass Wind Farm. Breeding 2022 bird survey report.

[4] Gilbert, G., Stanbury, A. and Lewis, L. (2021). Birds of Conservation Concern in Ireland 2020–2026. Irish Birds 43: 1–22

Secondary target species included:

- Any other wildfowl and wader species;
- Common buzzard *Buteo buteo;*
- Eurasian sparrowhawk *Accipiter nisus*;
- Northern raven *Corvus corax*;
- Grey heron *Ardea cinerea;*
- Great cormorant *Phalacrocorax carbo;* and
- Gulls *Larus* and *Chroicocephalus sp*.

Carrion crow *Corvus corrone*, common buzzard, Eurasian sparrowhawk, lesser black-backed gull *Larus fuscus* and grey heron were all originally recorded as primary target species; however, as none of these species fulfil the criteria for primary targets listed above, they have been considered as secondary species for the purposes of this Appendix.

1.5 Terminology

For this report, "flight line" refers to the line drawn to record avian movement during a VP survey. A single flight line may be used indicate the collective movement of a flock of birds. Each individual bird moving within the same flight line is referred to as "a flight". Note that the "cumulative number of flights" reflects the occupancy of the study area by a particular species. It is not equivalent to the total number of unique individuals and should not be used to infer abundance.

1.6 Purpose of the report

These data will be used to inform a separate ecological impact assessment for the Project. The assessment of potential impacts is beyond the scope of this Appendix.

2.0 Methodology

No information on the desk-based review undertaken by FT to inform these surveys is available.

2.1 Flight Activity Surveys

Seven vantage point (VP) locations were used for surveys during the 2017/18 non-breeding seasons. Following this survey seasons, the Project Site was reduced in size. Consequently, only five vantage point (VP) locations are now required to provide visibility of the remaining optioned lands and a 500 m buffer surrounding the same; however, for transparency, the full set of seven VPs is shown in the figures and results. The adequacy of these VPs was checked by carrying out a desk-based viewshed analysis using a bespoke GIS tool for calculating the visible area from each vantage point (VP). The Zones of Theoretical Visibility (ZTV) from each VP were calculated using ArcMAP 10.5.1 Spatial Analyst using a terrain model derived from EU-DEM data with a vertical accuracy of ± 7 m. The ZTVs have been calculated using a surface offset of 30 m, to match the lowest point swept by the rotors of the proposed turbines. The ZTVs are based on a viewing height of 1.8 m above ground level. VP locations, viewing arcs and viewsheds are shown in **Figure 1**.

During the non-breeding season (monthly visits September-March inclusive), a total of 36 hours minimum of watches were undertaken at VPs 1-3 and 6-7. Survey effort was less at VPs 4 and 5 (see Section 2.3). The VP survey effort undertaken during the non-breeding season of 2017/18 is summarised in **Table 2-1** with full details of survey dates, times and observers provided in Appendix 01 and details of weather conditions during the surveys provided in Appendix 02.

Table 2-1
VP survey effort undertaken at the Project Site from October 2017 to March 2018

Month	Survey duration (hh:mm)						
	VP1	VP2	VP3	VP4	VP5	VP6	VP7
September	15	6	0	0	6	0	6
October	6	6	0	0	0	0	0
November	6	0	6	6	6	12	6
December	6	6	9	8:30	6	6	6
January	6	13:34	16	12	6	6	6
February	0	0	0	6	6	6	0
March	12	12	9	0	0	6	12
Total hrs	**51:00**	**43:34**	**40:00**	**32:30**	**30:00**	**36:00**	**36:00**
VP Locations ITM (**Figure 1**)	654401, 690069	656779, 690605	654861, 687912	656794, 685742	655853, 683303	658449, 683337	659971, 680602

VP surveys aimed to quantify the flight activity of primary target species (as defined in Section 1.4) within the study area.

The main purpose of VP watches is to collect data on primary target species that will enable estimates to be made of:

- The time spent flying over the site;
- The relative use by birds of different parts of the site;
- The proportion of flying time spent within the provisional upper and lower risk height limits as determined by the potential rotor diameter and rotor hub height; and
- Ultimately, the analysis of the potential risk of collision of birds with rotating turbines.

For each primary target species observation, the following details were recorded:

- Time of observation;
- Duration of flying bout;
- Species, age and sex (where determinable);
- Time spent within each height band and;
- Notes on observation.

In the absence of detailed information regarding turbine specifications at the time of commencing surveys, a precautionary approach was taken in relation to recording height bands. Height bands were determined allowing for the maximum rotor tip height of 180 m and a lowest rotor swept height of 30 m. Flight heights were attributed to five distinct height bands as follows:

- 1 = < 30 m (below the likely rotor swept area);
- 2 = 30 m to 40m (within the likely rotor swept area);
- 3 = 40 m to 50 m (within the likely rotor swept area);
- 4 = 50 m to 170 m (within the likely rotor swept area); and
- 5 = >170 m (above the likely rotor swept area, at least in part).

2.2 Winter Transect Surveys

These surveys are not part of NS guidance; however, they were used to provide information on the assemblage of winter birds using the Project Site.

The methodology involved walking a pre-defined transect and recording the number of species detected according to three distance categories, approximately following the Countryside Bird Survey (CBD) methodology[5]. The distance categories are as follows:

- 1 = out to 25 m on either side of transect line;
- 2 = between 25 m and 100 m either side of the transect line;
- 3 = more than 100 m either side of the transect line; and
- F = birds flying over (but not landing).

[5] https://birdwatchireland.ie/app/uploads/2019/03/CBS_Manual_June2012_web_resolution.pdf Accessed 24/11/2022

Two transects were used in the northern turbine cluster and another two in an area that has now been dropped from the Project. For transparency, both sets of transects are shown in **Figure 3** as are both sets of results.

Nine surveys were undertaken between November 2017 and February 2022 with details shown in Appendices 01 and 02.

2.3 Survey Limitations

The majority of VP surveys were undertaken in optimal weather conditions. However, during such an extensive series of surveys carried out it was inevitable that some surveys were completed in suboptimal conditions. There were 2 out of the total of 89.7 no. 3-hour surveys with weather data during which the visibility was recorded as “moderate”, i.e. 1-2 km. This comprises 0.7% of the total survey effort but in almost all cases all of the relevant 2 km viewing arc was visible and this is not considered to significantly affect the validity of the data collected. Visibility fell below 1 km for 10 out of 89.7 no. 3-hour surveys (3.7% of data), but it is likely that visibility was better than this for part of the relevant survey. As such, given the low proportion of surveys affected this is not considered to significantly affect the validity of the data collected. Further details regarding weather conditions during surveys are provided in Appendix 02.

VP survey effort fell below the 36 hours required per season for VPs 4 and 5. While the level of effort for VPs 4 and 5 is slightly lower than that recommended by NS guidance, it is not considered to significantly affect the survey results for the purposes of impact assessment. This is because there is still a good spread of survey hours throughout the winter season and for other VP locations, survey effort was at least (and sometimes in exceedance) of the recommended 36 hours. Furthermore, any collision risk model will account for the level of survey hours, so the resulting levels of collision risk will not be affected.

Some areas of the 500 m buffer surrounding the northern cluster and a small area of the southern were not visible according to the viewshed analyses (**Figure 1**). This is not thought to have a significant effect on the results, as all the habitats outside the viewsheds are found throughout the areas that are covered.

3.0 Results

3.1 Breeding Season Flight Activity Surveys

Flight lines of primary target species recorded throughout the 2017/18 non-breeding season are presented in **Figures 2.1** to **2.2** and a summary of the survey findings are provided in Sections 3.1.1 and 3.1.2 for primary and secondary target species, respectively. Flight data for both primary and secondary target species are provided in Appendix 03 (note that all species were classified as primary during the surveys and the raw data are provided in this format; however, for the results below some species have been relegated to secondary status).

3.1.1 Primary Target Species

In total, seven primary target species were recorded flying within the study area on and around the Project Site during the survey period. Flight activity recorded for primary target species is summarised in **Table 3-1**.

Table 3-1
Number of Primary Target Species Flights from the Project Site for All VPs Combined – October 2017 to March 2018

Species	Number of flight lines by month							Total number of flight lines	Time at risk height* (s)	Cumulative number of flights
	Sep	Oct	Nov	Dec	Jan	Feb	Mar			
Common kestrel *Falco tinnunculus*	12	0	12	17	6	2	12	61	3,170	61
Common snipe *Gallinago gallinago*	0	0	5	5	2	3	0	15	155	34
European golden plover *Pluvialis apricaria*	0	0	4	4	0	9	0	17	2,860	838
Hen harrier *Circus cyaneus*	1	0	0	0	3	0	0	4	0	4
Merlin *Falco columbarius*	0	0	0	1	0	2	0	3	112	3
Northern lapwing *Vanellus vanellus*	0	0	0	0	0	0	1	1	93	1
Peregrine falcon *Falco peregrinus*	1	0	0	2	0	0	1	4	249	4
Total	**13**	**0**	**21**	**29**	**11**	**16**	**14**	**105**	**6,549**	**945**
* precautionary risk height assumed to be between 30 m – 180 m										

A summary of flight activity by species is presented below.

Common kestrel

Sixty-one common kestrel flights were recorded over the same number of flight lines during the flight activity surveys. The maximum number of flight lines was recorded in December 2017 (n=17). This species was recorded in all survey months except for October 2017.

Common snipe

Thirty-four common snipe flights were recorded over 15 flight lines during the flight activity surveys. Most flight lines consisted of single flights but there was one flight line consisting of 17 flights. The maximum number of flight lines was recorded in November and December 2017 (n=5 per month). This species was recorded in all survey months except for October 2017 and March 2019.

European golden plover

838 European golden plover flights were recorded over 17 flight lines during the flight activity surveys. The maximum number of flight lines was recorded in November and December 2017 (n=5 per month). Most of the flight lines were recorded from VP6 outside of the 500 m buffer. Flocks were up to 100 birds in size but again, these were outside the 500 m buffer. Only a few flight lines were inside this buffer and consisted typically of 2-3 flights per flight line.

Hen harrier

Four hen harrier flights were recorded over three flight lines during flight activity surveys. All flights were below potential collision heights and were of birds commuting over the forestry.

Merlin

Three merlin flight lines were recorded from VP6, consisting of one flight line in December 2017 and two in February 2018. All flight lines comprised of one flight per flight line. All observations were of birds commuting. None of these flight lines are within 500 m of the current Project site.

Northern lapwing

Only a single flight line of a single northern lapwing was recorded from VP3 in March 2018.

Peregrine falcon

Peregrine falcons were recorded in September and December 2017, and March 2019 only, with four flights recorded over four flight lines. Two of these flight lines were recorded from VP6 in areas now outside of the 500 m buffer surrounding the Project Site.

3.1.2 Secondary Species

Secondary species activity at the Project Site is summarised in **Table 3.3**. There were five secondary species recorded throughout the non-breeding season. Common buzzard was the most frequently recorded secondary species (in 66 five-minute periods out of a possible 3,228). It was also the most was the most numerous of the recorded secondary species, with three birds seen circling together.

Table 3-2
Secondary Species Activity Summary for All VPs Combined – September 2017 to March 2018

Species	Number of 5 min periods recorded	Peak count of birds recorded in any 5 min period	Comments
Carrion crow	1	1	
Common buzzard	66	3	
Grey heron	1	1	
Lesser black-backed gull	3	1	
Eurasian sparrowhawk	33	2	

3.2 Winter Transect Surveys

Table 3.3 shows the peak count for each species recorded during winter transect surveys split by month. It was not possible to distinguish between species recorded at different transects based on the raw data. Therefore, the species recorded include those both within and outside the survey area for the current Project Site.

Across all surveys there were 35 species recorded. Of these, the species with largest peak count in any given month was fieldfare (n=102 birds). Of particular interest are species red- or amber-listed under the current BoCCI scheme. These include common snipe, goldcrest *Regulus regulus*, common linnet *Linaria cannabina*, meadow pipit *Anthus pratensis*, redwing *Turdus iliacus*, common starling *Sturnus vulgaris* and Eurasian woodcock *Scolopax rusticola*.

Table 3-3
Peak Count of Species Recorded at Winter Transects by Month, October 2017 to March 2018

Species	Peak count			
	Nov	Dec	Jan	Feb
Common blackbird *Turdus merula*	17	10	10	10

Species	Peak count			
	Nov	Dec	Jan	Feb
Eurasian blue tit *Cyanistes caeruleus*	0	6	1	0
Eurasian bullfinch *Pyrrhula pyrrhula*	5	3	1	0
Common chaffinch *Fringilla coelebs*	1	1	2	4
Coal tit *Periparus ater*	4	18	20	15
Common snipe	0	5	14	2
Red crossbill *Loxia curvirostra*	23	49	6	2
Dunnock *Prunella modularis*	2	15	8	5
Fieldfare *Turdus pilaris*	2	0	102	30
Goldcrest	22	18	23	12
European goldfinch *Carduelis carduelis*	0	0	0	1
Great tit *Parus major*	0	0	2	1
Hooded crow *Corvus cornix*	4	7	4	1

Species	Peak count			
	Nov	Dec	Jan	Feb
Western jackdaw *Coloeus monedula*	7	0	0	0
Jack snipe *Lymnocryptes minimus*	0	1	2	0
Eurasian jay *Garralus glandarius*	0	1	0	0
Lesser redpoll *Acanthis cabaret*	0	24	0	0
Common linnet	0	1	2	0
Long-tailed tit *Aegithalos caudatus*	0	21	18	1
Eurasian magpie *Pica pica*	2	1	1	0
Meadow pipit	2	1	6	11
Mistle thrush *Turdus viscivorus*	2	2	4	0
White wagtail *Motacilla alba*	0	0	1	0
Northern raven	0	0	4	0
Redwing	1	15	4	5
Common reed bunting *Emberiza schoeniculus*	0	0	1	0

Species	Peak count			
	Nov	Dec	Jan	Feb
European robin *Erithacus rubecula*	25	27	44	19
Rook *Corvus frugilegus*	48	20	35	0
Eurasian siskin *Spinus spinus*	0	0	17	0
Song thrush *Turdus philomelos*	3	2	8	1
Common starling	60	5	100	0
Eurasian treecreeper *Certhia familiaris*	0	3	0	1
Eurasian woodcock	1	1	1	0
Common wood pigeon *Columba palumbus*	0	27	6	0
Eurasian wren *Troglodytes troglodytes*	10	28	16	10

4.0 Conclusions and Summary

A range of ornithology surveys were carried out at the Project Site during the 2017/18 non-breeding season. These were:

- Flight activity (VP) surveys; and
- Winter transect surveys.

The following primary target species were recorded during flight activity surveys at the Project Site:

- Common kestrel;
- Northern lapwing;
- Peregrine falcon;
- Hen harrier;
- Merlin;
- Common snipe; and
- Eurasian woodcock.

The most frequent flight activity during the breeding season was by common kestrel (61 flight lines), with other target species activity less frequent. The next most frequently recorded species was European golden plover (17 flight lines). Most of the European golden plover flight lines were recorded in an area that is no longer within the 500 m survey buffer surrounding the Project Site. The same is true for all merlin flight lines recorded.

Thirty-five species were recorded during winter transect surveys. Those of conservation concern included:

- Common linnet;
- Common snipe;
- Common starling;
- Eurasian woodcock;
- Goldcrest;
- Meadow pipit; and
- Redwing.

It is likely that the linnet and redwing use the rough grasslands, hedgerow and scrub habitats for foraging. Common snipe, common starling and meadow pipit are likely to use improved agricultural grassland for foraging, with Eurasian woodcock and goldcrest favouring the conifer plantations present.

It was not possible to separate the transect survey results according to survey area and one of the survey areas relates to an area that is no longer part of the Project Site; therefore, the peak counts obtained will likely overestimate abundance for the current Project Site.

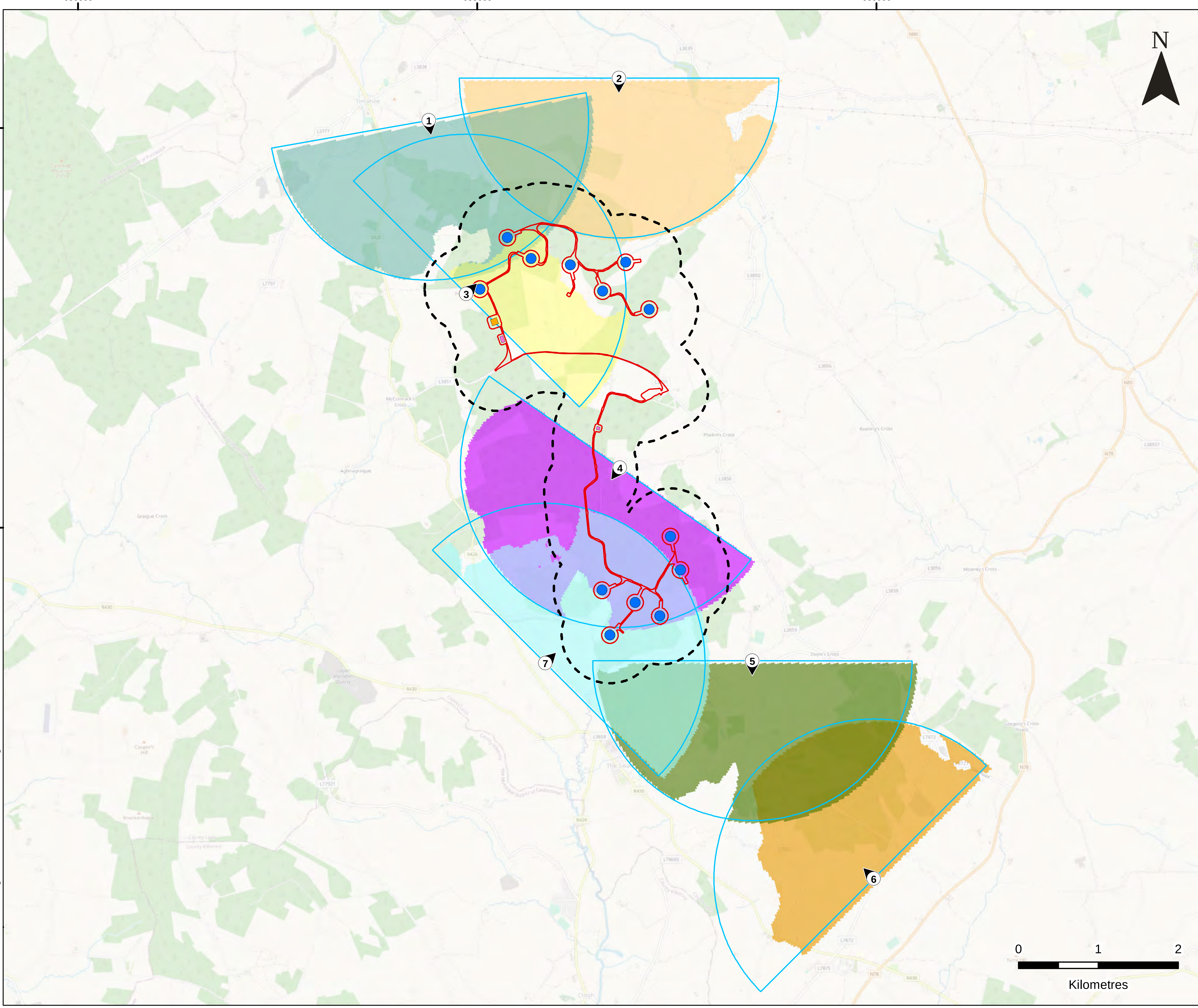
5.0 Legal and Conservation Status

Table 4-1 summarises the legal and conservation status of the primary and secondary target species recorded during the range of ornithology surveys mentioned above, along with any other red- or amber-listed passerines. All Irish bird species are afforded general protection by the Wildlife Acts 2000 (as amended).

Table 5-1
Legal and Conservation Status of Target Species

Primary or Secondary Target	Species (BTO code)	Legal & Conservation Status in Ireland
Primary	Common kestrel	BoCCI4 Red
	Northern lapwing	BoCCI4 Red
	Peregrine falcon	Annex 1; BoCCI4 Green
	Eurasian woodcock	BoCCI4 Red
	Common snipe	BoCCI4 Red
	Merlin	Annex 1; BoCCI4 Amber
	Hen harrier	Annex 1; BoCCI4 Amber
Secondary	Carrion crow	BoCCI4 Green
	Common buzzard	BoCCI4 Green
	Grey heron	BoCCI4 Green
	Lesser black-backed gull	BoCCI4 Amber
	Eurasian sparrowhawk	BoCCI4 Green
Red- or amber-listed passerines	Common linnet	BoCCI4 Amber
	Common starling	BoCCI4 Amber
	Goldcrest	BoCCI4 Amber
	Meadow pipit	BoCCI4 Red
	Redwing	BoCCI4 Red
	Key	Annex 1 – the species is listed in Annex 1 of the EC Birds Directive; and
		BoCCI4 status (green, amber or red) – indicates the current Birds of Conservation Concern in Ireland[4] status category.

6.0 Figures



NOTES

1. The ZTV is calculated with a surface offset 30m & from a viewing height of 1.8m above ground level. The terrain model is derived from EU-DEM data with a vertical accuracy of ± 7m. The ZTV was calculated using ArcMAP 10.5.1 software.
2. Vantage Points 5 & 6 Cover an area of the site which was included as part of a previous design iteration but has since been removed.

LEGEND

- Proposed Development Site Boundary
- Proposed Development Site Boundary 500 m Buffer
- Proposed Turbine Layout
- Proposed Substation Compound
- Proposed Temporary Construction Compound
- Vantage Point
- Vantage Point 2 km Viewing Arc
- Area Visible from VP1
- Area Visible from VP2
- Area Visible from VP3
- Area Visible from VP4
- Area Visible from VP5
- Area Visible from VP6
- Area Visible from VP7

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COOLGLASS WIND FARM

BIRD SURVEY REPORT
NON-BREEDING SEASON 2017/18

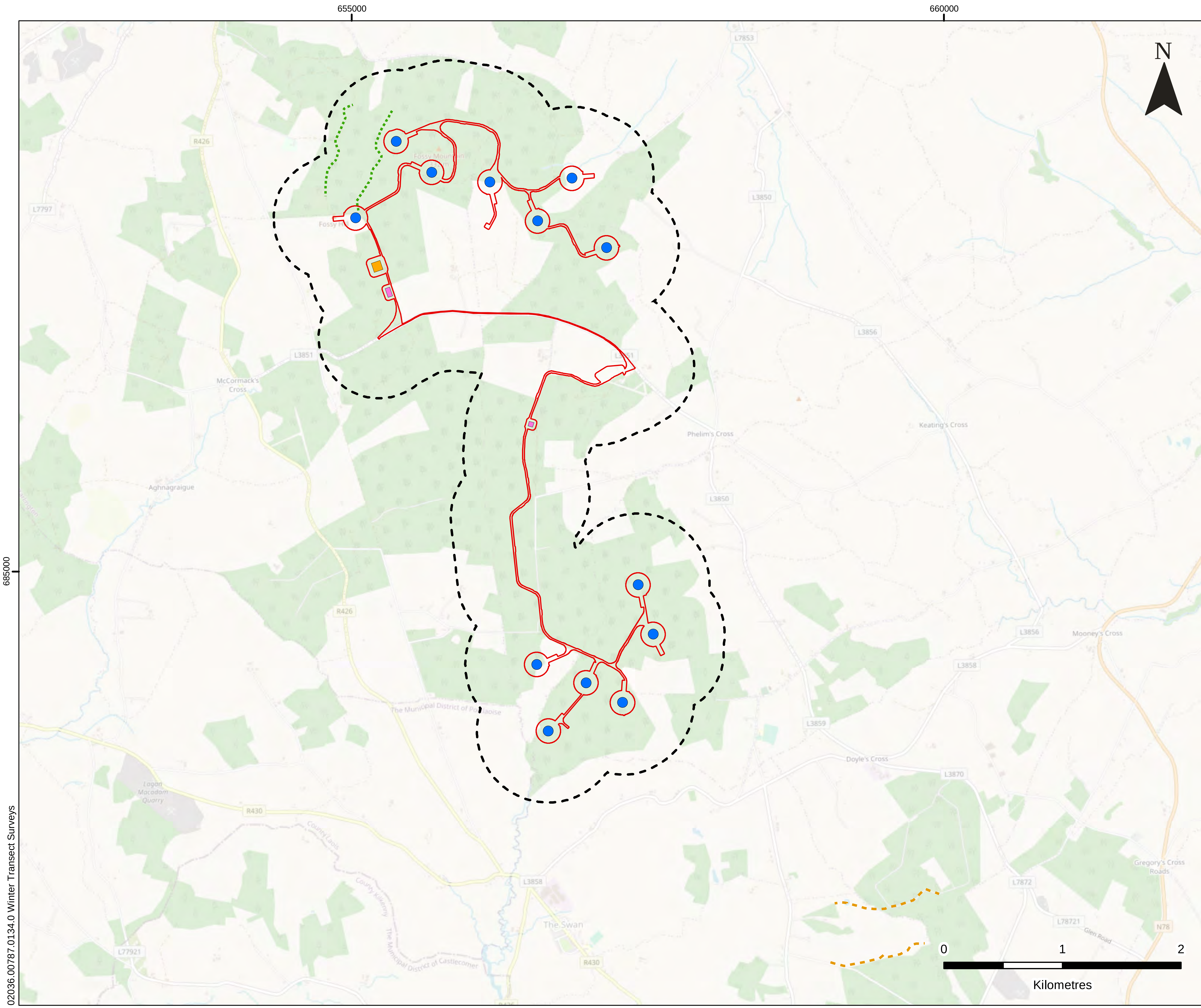
VANTAGE POINT LOCATIONS & VIEWING ARCS

FIGURE 1

Scale 1:45,000 @ A3

Date JULY 2023

02036.00787.0120.0 Vantage Point Locations and Viewing Arcs



LEGEND

- Proposed Development Site Boundary
- Proposed Development Site Boundary 500 m Buffer
- Proposed Turbine Layout
- Proposed Substation Compound
- Proposed Temporary Construction Compound
- Vantage Point
- Dropped Cluster Transect Route
- North Cluster Transect Route

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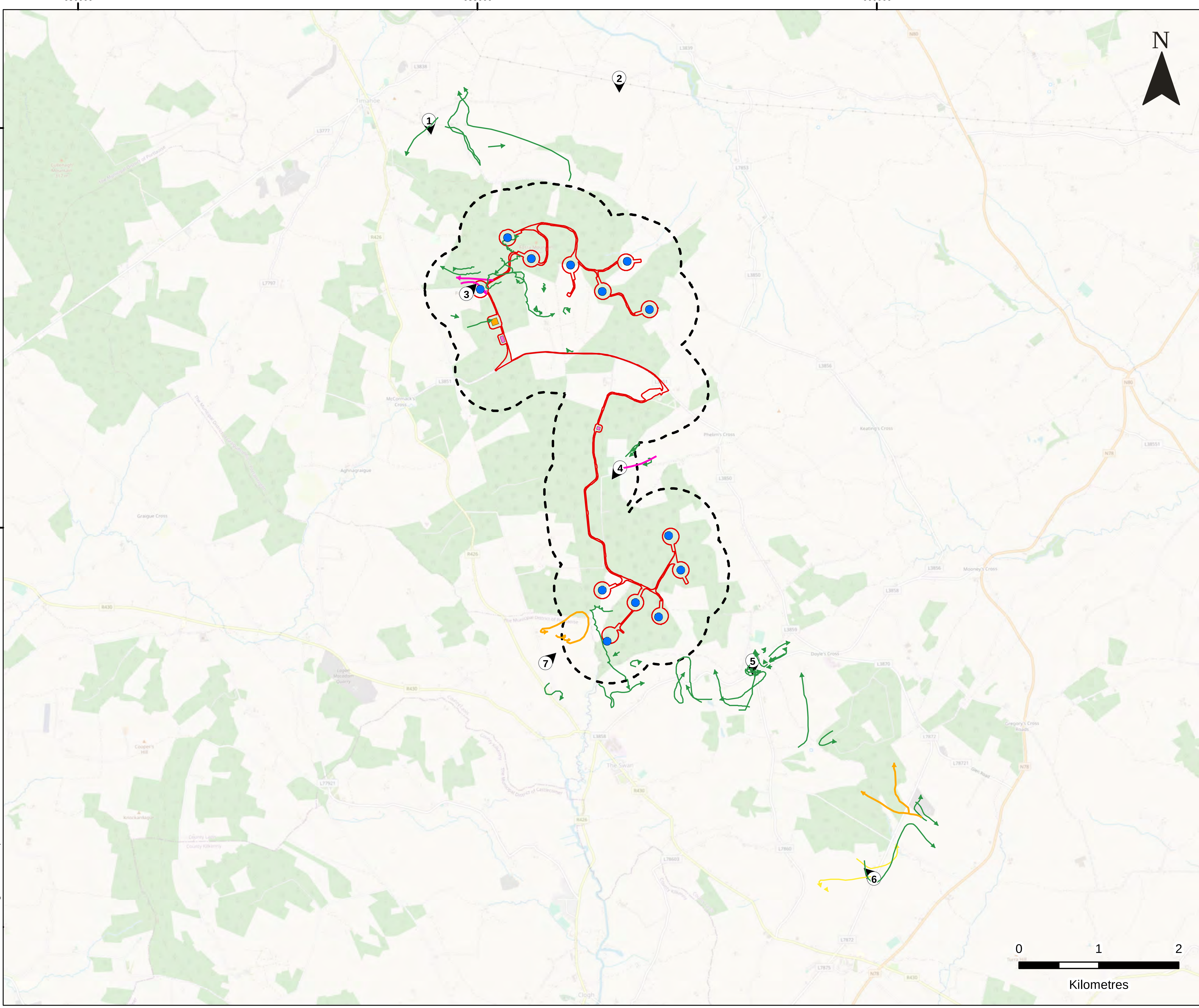
WINTER TRANSECT SURVEY

FIGURE 2

Scale 1:30,000 @ A3 | Date JULY 2023

02036.00787.0134.0 Winter Transect Surveys

Inset Map:© OpenStreetMap (and) contributors, CC-BY-SA
Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), (c) OpenStreetMap contributors, and the GIS User Community

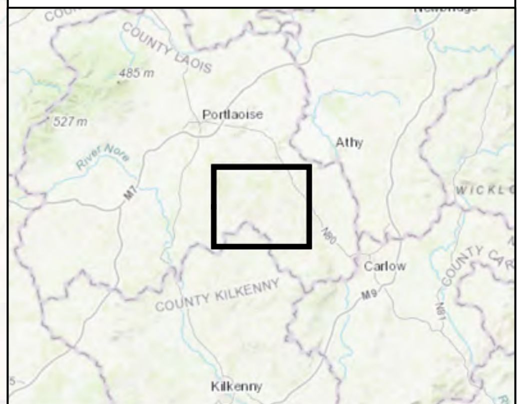


LEGEND

- Proposed Development Site Boundary
- Proposed Development Site Boundary 500 m Buffer
- Proposed Turbine Layout
- Proposed Substation Compound
- Proposed Temporary Construction Compound
- Vantage Point

Species

- Hen Harrier
- Kestrel
- Merlin
- Peregrine



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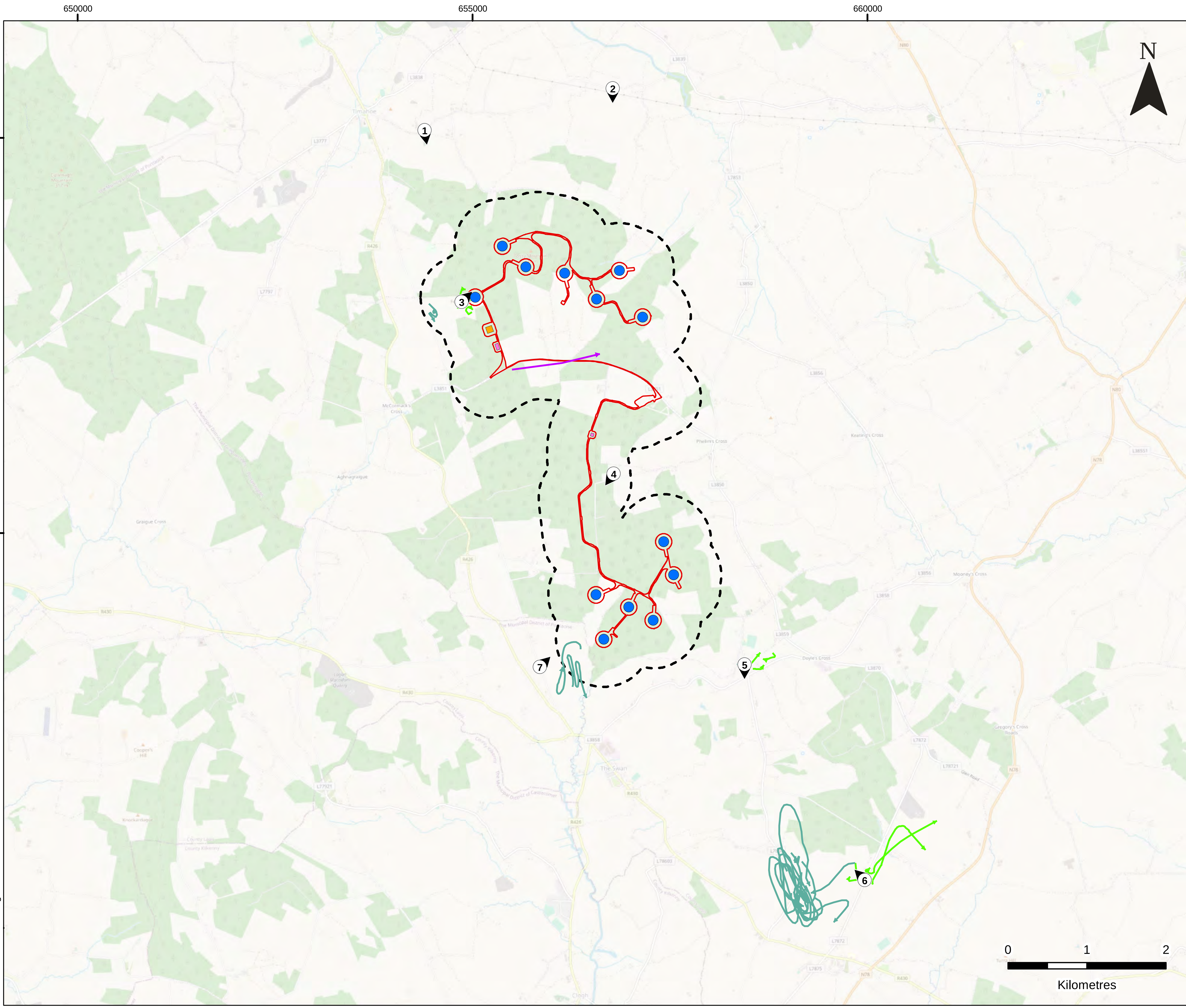
BIRD SURVEY REPORT
NON-BREEDING SEASON 2017/18

FLIGHT LINES RAPTORS

FIGURE 3.1

Scale	Date
1:45,000 @ A3	JULY 2023

02036.00787.0121.0 Flight Lines Raptors



LEGEND

- Proposed Development Site Boundary
- Proposed Development Site Boundary 500 m Buffer
- Proposed Turbine Layout
- Proposed Substation Compound
- Proposed Temporary Construction Compound
- Vantage Point

Species

- Golden Plover
- Lapwing
- Snipe

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COOLGLASS WIND FARM

BIRD SURVEY REPORT
NON-BREEDING SEASON 2017/18

FLIGHT LINES WADERS

FIGURE 3.2

Scale	Date
1:45,000 @ A3	JULY 2023

02036.00787.0122.0 Flight Lines Waders

Inset Map:© OpenStreetMap (and) contributors, CC-BY-SA
Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), (c) OpenStreetMap contributors, and the GIS User Community

APPENDIX I

Survey dates, times and observers[6]

[6] Surveyor initials: BOD = Ben O'Dwyer, BP = Brian Porter, DOH = Donna O'Halloran, SR = Seán Ronayne, JK = Jon Kearney

Table AI-1
Details of flight activity surveys undertaken from Vantage Point 1

Date	Surveyor	Start	End	Survey Duration (hrs : mins)	Comments
07/09/2017	JK	11:02	14:02	03:00	
07/09/2017	JK	14:30	17:30	03:00	
07/09/2017	JK	11:02	14:02	03:00	
15/09/2017	BOD	09:20	12:20	03:00	
15/09/2017	BOD	12:20	15:20	03:00	
25/10/2017	BOD	12:00	15:00	03:00	
25/10/2017	BOD	15:00	18:00	03:00	
21/11/2017	BOD	09:30	13:25	03:00	09:30-10:30, 11:00-11:30, 11:45-12:20, 12:30-13:35, Interrupted due to bad weather.
21/11/2017	BOD	13:25	16:25	03:00	
08/12/2017	BOD	09:55	12:55	03:00	
08/12/2017	BOD	12:55	15:55	03:00	
19/01/2018	BOD	09:45	12:45	03:00	
19/01/2018	BOD	12:45	15:45	03:00	
07/03/2018	BP	14:40	17:40	03:00	
08/03/2018	BP	07:25	10:25	03:00	
29/03/2018	BOD	10:00	13:00	03:00	
29/03/2018	BOD	07:00	10:00	03:00	
Total Hours				**51:00**	

Table AI-2
Details of flight activity surveys undertaken from Vantage Point 2

Date	Surveyor	Start	End	Survey Duration (hrs : mins)	Comments
08/09/2017	JK	10:23	13:23	03:00	
08/09/2017	JK	14:05	17:05	03:00	
26/10/2017	BOD	10:00	13:00	03:00	
26/10/2017	BOD	13:00	16:00	03:00	
05/12/2017	DOH	09:16	12:16	03:00	New site.
05/12/2017	DOH	12:45	15:45	03:00	New site.
10/01/2018	DOH	10:00	16:30	06:30	Sunrise: 08:31, Sunset: 16:35. Time includes 30-minute break
23/01/2018	DOH	09:23	15:57	06:34	Time includes 30-minute break.
07/03/2018	BP	11:00	14:00	03:00	
09/03/2018	BP	11:40	14:40	03:00	
27/03/2018	BP	07:40	10:40	03:00	
27/03/2018	BP	14:50	17:50	03:00	
Total Hours				**43:04**	Excluding break

Table AI-3
Details of flight activity surveys undertaken from Vantage Point 3

Date	Surveyor	Start	End	Survey Duration (hrs : mins)	Comments
02/11/2017	BP	12:20	15:20	03:00	
03/11/2017	BP	12:50	15:50	03:00	
01/12/2017	DOH	10:00	13:00	03:00	
01/12/2017	DOH	13:15	16:15	03:00	
19/12/2017	DOH	10:30	13:30	03:00	30 minutes surveyable due to fog.
11/01/2018	DOH	10:00	16:30	06:30	Due to low lying cloud, only 3 hours surveyable. Sunset: 16:35.
18/01/2018	BOD	10:40	13:40	03:00	
22/01/2018	DOH	10:30	17:00	06:30	Including 30 minute break. Sunset: 4:55.
08/03/2018	BP	11:10	14:10	03:00	
24/03/2018	BP	15:00	18:00	03:00	
24/03/2018	BP	11:20	14:20	03:00	
Total Hours				**39:00**	Excluding breaks

Table AI-4
Details of flight activity surveys undertaken from Vantage Point 4

Date	Surveyor	Start	End	Survey Duration (hrs : mins)	Comments
01/11/2017	BP	12:00	15:00	03:00	
02/11/2017	BP	08:30	11:30	03:00	
04/12/2017	BOD	10:20	13:20	03:00	
04/12/2017	BOD	13:20	16:20	03:00	
18/12/2017	SR	09:30	12:00	02:30	
10/01/2018	JK	10:15	13:15	03:00	
10/01/2018	JK	13:45	16:45	03:00	
24/01/2018	DOH	09:10	12:10	03:00	
24/01/2018	DOH	12:50	15:50	03:00	
27/02/2018	BOD	10:05	13:05	03:00	
27/02/2018	BOD	13:20	16:20	03:00	
Total Hours				**32:30**	

Table AI-5
Details of flight activity surveys undertaken from Vantage Point 5

Date	Surveyor	Start	End	Survey Duration (hrs : mins)	Comments
28/09/2017	BOM	10:00	16:00	06:00	
23/11/2017	SR	07:50	10:50	03:00	Sunrise: 08:05
23/11/2017	SR	11:20	14:20	03:00	Sunset: 16:24
06/12/2017	SR	12:55	15:55	03:00	Sunset: 16:14
06/12/2017	SR	09:25	12:25	03:00	Sunrise: 08:27
24/01/2018	SR	08:30	11:30	03:00	Sunrise: 08:24
24/01/2018	SR	12:00	15:00	03:00	Sunset: 16:58
06/02/2018	SR	08:00	11:00	03:00	Sunrise: 08:04
06/02/2018	SR	11:30	14:30	03:00	Sunset: 17:21
Total Hours				**30:00**	

Table AI-6
Details of flight activity surveys undertaken from Vantage Point 6

Date	Surveyor	Start	End	Survey Duration (hrs : mins)	Comments
01/11/2017	BP	08:10	11:10	03:00	
03/11/2017	BP	09:00	12:00	03:00	
21/11/2017	SR	09:00	12:00	03:00	Sunrise: 08:04
21/11/2017	SR	12:30	15:30	03:00	Sunset: 16:26
07/12/2017	SR	08:40	11:40	03:00	Sunrise: 08:28
07/12/2017	SR	12:10	15:10	03:00	Sunrise: 16:13
23/01/2018	SR	09:30	12:30	03:00	Sunrise: 08:25
23/01/2018	SR	13:00	16:00	03:00	Sunset: 16:56
05/02/2018	SR	12:00	15:00	03:00	Sunset: 17:19
05/02/2018	SR	08:30	11:30	03:00	Sunrise: 08:06
28/03/2018	BOD	09:50	12:50	03:00	
28/03/2018	BOD	13:30	16:30	03:00	Brief hail showers.
Total Hours				**36:00**	

Table AI-7
Details of flight activity surveys undertaken from Vantage Point 7

Date	Surveyor	Start	End	Survey Duration (hrs : mins)	Comments
29/07/2017	BOM	09:00	15:00	06:00	
20/11/2017	BOD	10:30	13:30	03:00	
20/11/2017	BOD	13:30	16:30	03:00	
07/12/2017	BOD	10:15	13:15	03:00	
07/12/2017	BOD	13:15	16:15	03:00	
18/01/2018	BOD	14:00	17:00	03:00	
30/01/2018	BOD	11:20	14:20	03:00	
07/03/2018	BP	07:30	10:30	03:00	
09/03/2018	BP	08:05	11:05	03:00	
24/03/2018	BP	07:50	10:50	03:00	
27/03/2018	BP	11:15	14:15	03:00	
Total Hours				**36:00**	

Table AI-8
Details of winter bird transect surveys undertaken during the winter 2017/18 season

Date	Surveyor	Transect	Start	End	Survey Duration (hrs : mins)	Comments
22/11/2017	SR	No location on survey sheet	14:10	14:50	00:40	Second half of survey cancelled due to heavy rain, completed on the 23/11/2017.
22/11/2017	SR	No location on survey sheet	10:12	12:51	02:39	
23/11/2017	SR	No location on survey sheet	11:45	12:20	00:35	Completed the second half of survey from the 22/11/2017 that was cancelled due to heavy rain.
08/12/2017	SR	Southern Site	11:00	12:15	01:15	
08/12/2017	SR	Northern Site	08:40	10:05	01:25	
25/01/2018	SR	1	08:30	09:45	01:15	
25/01/2018	SR	2	10:30	11:30	01:00	
07/02/2018	SR	1	Not recorded	Not recorded	Not recorded	
07/02/2018	SR	2	Not recorded	Not recorded	Not recorded	
	Total Hours				**08:49**	

APPENDIX II

Weather Data[7]

[7] Surveyor initials: BOD = Ben O'Dwyer, BP = Brian Porter, DOH = Donna O'Halloran, SR = Seán Ronayne, JK = Jon Kearney

Table AII-1
Weather data collected during flight activity surveys undertaken at VP1

Date	Surveyor	Start	End	Wind Direction	Wind Speed (Beaufort)	Rain	Cloud Cover (%)	Visibility
07/09/2017	JK	11:02	14:02	N/A	2	2	66-100	5
07/09/2017	JK	14:30	17:30	N/A	3	2	66-100	5
07/09/2017	JK	11:02	14:02	N/A	2	2	87.5	5
15/09/2017	BOD	09:20	12:20	N	2-3	1	33-100	5
15/09/2017	BOD	12:20	15:20	N	2-3	1	33-100	5
25/10/2017	BOD	12:00	15:00	NW	1-2	1	33-66	5
25/10/2017	BOD	15:00	18:00	W	1-2	1-2	66	5
21/11/2017	BOD	09:30	13:25	SW	5-6	3	100	3-5
21/11/2017	BOD	13:25	16:25	SW	4-5	1	100	3-5
08/12/2017	BOD	09:55	12:55	W	0-2	1	0-33	5
08/12/2017	BOD	12:55	15:55	NW	1-2	1	0-100	5
19/01/2018	BOD	09:45	12:45	W	3-4	1-2	50-100	5
19/01/2018	BOD	12:45	15:45	W	3-4	1-3	33-66	5
07/03/2018	BP	14:40	17:40	SW	2	1	0-100	5
08/03/2018	BP	07:25	10:25	SW	2-3	1	33-100	5
29/03/2018	BOD	10:00	13:00	SE	0-1	3	25-100	5
29/03/2018	BOD	07:00	10:00	SE	1-2	1-2	66-100	3-4

Rain/ Precipitation

None	1
Drizzle mist	2
Light showers	3
Heavy showers	4

Visibility

Poor (<1km)	3
Moderate (1-2km)	4
Good (>2km)	5

Table AII-2
Weather data collected during flight activity surveys undertaken at VP2

Date	Surveyor	Start	End	Wind Direction	Wind Speed (Beaufort)	Rain	Cloud Cover (%)	Visibility
08/09/2017	JK	10:23	13:23	SW	1	1-3	66-100	5
08/09/2014	JK	14:05	17:05	SW	1	1-3	66-100	5
26/10/2017	BOD	10:00	13:00	NW	0-1	1-2	100	4-5
26/10/2017	BOD	13:00	16:00	Various	0-1	2	100	3-5
05/12/2017	DOH	09:16	12:16	SW	0-1	1	100	5
05/12/2017	DOH	12:45	15:45	SW	0-2	2	100	5
10/01/2018	DOH	10:00	16:30		0	1	33-100	5
23/01/2018	DOH	09:23	15:57	SW	4	1-2	66-100	5
07/03/2018	BP	11:00	14:00	SW	2-3	1	0-100	5
09/03/2018	BP	11:40	14:40	E	1-2	1	100	5
27/03/2018	BP	07:40	10:40	W	3-4	1	66-100	5
27/03/2018	BP	14:50	17:50	WNW	3-4	1-2	66-100	5

Rain/ Precipitation		**Visibility**	
None	1	Poor (<1km)	3
Drizzle mist	2	Moderate (1-2km)	4
Light showers	3	Good (>2km)	5
Heavy showers	4		

Table AII-3
Weather data collected during flight activity surveys undertaken at VP3

Date	Surveyor	Start	End	Wind Direction	Wind Speed (Beaufort)	Rain	Cloud Cover (%)	Visibility
02/11/2017	BP	12:20	15:20	NW-W	0-1	1	100	5
03/11/2017	BP	12:50	15:50	SW	1-2	1	100	5
01/12/2017	DOH	10:00	13:00	N	1	1	0-33	5
01/12/2017	DOH	13:15	16:15	N	2	1	0-100	5
19/12/2017	DOH	10:30	13:30	W-NW	1	1	0-33	5
11/01/2018	DOH	10:00	16:30	Not observed	0-1		0-33	5
18/01/2018	BOD	10:40	13:40	Not observed	3-4	1	33-100	5
22/01/2018	DOH	10:30	17:00	Not observed	2-3	1-2	100	5
08/03/2018	BP	11:10	14:10	WSW	2	1	66-100	5
24/03/2018	BP	15:00	18:00	N	0-2	1	33-100	5
24/03/2018	BP	11:20	14:20	NNW-NW	1-2	1	33-66	5

Rain/ Precipitation		Visibility	
None	1	Poor (<1km)	3
Drizzle mist	2	Moderate (1-2km)	4
Light showers	3	Good (>2km)	5
Heavy showers	4		

Table AII-4
Weather data collected during flight activity surveys undertaken at VP4

Date	Surveyor	Start	End	Wind Direction	Wind Speed (Beaufort)	Rain	Cloud Cover (%)	Visibility
01/11/2017	BP	12:00	15:00	SSW-SW	1	1	0-66	5
02/11/2017	BP	08:30	11:30	N-NW	0-1	1	66-100	5
04/12/2017	BOD	10:20	13:20	N	0-1	2	66-100	4-5
04/12/2017	BOD	13:20	16:20	N	1	1	100	5
18/12/2017	SR	09:30	12:00	S	1	1	33-66	5
10/01/2018	JK	10:15	13:15	Not observed	1	1	66-100	5
10/01/2018	JK	13:45	16:45	Not observed	1	1	66-100	5
24/01/2018	DOH	09:10	12:10	S-SW	3-5	1-2	0-100	5
24/01/2018	DOH	12:50	15:50	S-SW	3-5	1-2	0-100	5
27/02/2018	BOD	10:05	13:05	NNE	3-4		33-100	4-5
27/02/2018	BOD	13:20	16:20	NNE	3-5		0-100	3-5

Rain/ Precipitation		**Visibility**	
None	1	Poor (<1km)	3
Drizzle mist	2	Moderate (1-2km)	4
Light showers	3	Good (>2km)	5
Heavy showers	4		

Table AII-5
Weather data collected during flight activity surveys undertaken at VP5

Date	Surveyor	Start	End	Wind Direction	Wind Speed (Beaufort)	Rain	Cloud Cover (%)	Visibility
28/09/2017	BOM	10:00	16:00	SW	3	1	N/A	5
23/11/2017	SR	07:50	10:50	WSW	4	4	33-66	5
23/11/2017	SR	11:20	14:20	WNW	3	4	0-33	5
06/12/2017	SR	12:55	15:55	SSW	4	2	66-100	5
06/12/2017	SR	09:25	12:25	S	5	2	66-100	5
24/01/2018	SR	08:30	11:30	WNW	4	2	66-100	5
24/01/2018	SR	12:00	15:00	SW	4	1	33-66	5
06/02/2018	SR	08:00	11:00	Not observed	1-2	1	33-66	5
06/02/2018	SR	11:30	14:30	Not observed	2-3	1	33-66	5

Rain/ Precipitation		**Visibility**	
None	1	Poor (<1km)	3
Drizzle mist	2	Moderate (1-2km)	4
Light showers	3	Good (>2km)	5
Heavy showers	4		

Table AII-6
Weather data collected during flight activity surveys undertaken at VP6

Date	Surveyor	Start	End	Wind Direction	Wind Speed (Beaufort)	Rain	Cloud Cover (%)	Visibility
01/11/2017	BP	08:10	11:10	S	0-1	1	66-100	5
21/11/2017	SR	09:00	12:00	Not observed	2	2-3	100	5
21/11/2017	SR	12:30	15:30	Not observed	3	1	100	4
07/12/2017	SR	08:40	11:40	W	3	1	0-33	5
07/12/2017	SR	12:10	15:10	W	3	1	33-66	5
23/01/2018	SR	09:30	12:30	SW	4	1-3	66-100	5
23/01/2018	SR	13:00	16:00	SW	3-4	1	33-66	5
05/02/2018	SR	12:00	15:00	Not observed	1	1	66-100	5
05/02/2018	SR	08:30	11:30	Not observed	1	1	66-100	5
28/03/2018	BOD	09:50	12:50	NW	1-3	1	66-100	5
28/03/2018	BOD	13:30	16:30	NW	2-3	1	33-66	4-5
03/11/2017	BP	09:00	12:00	SW	0-1	1	87.5-100	5

Rain/ Precipitation		**Visibility**	
None	1	Poor (<1km)	3
Drizzle mist	2	Moderate (1-2km)	4
Light showers	3	Good (>2km)	5
Heavy showers	4		

Table AII-7
Weather data collected during flight activity surveys undertaken at VP7

Date	Surveyor	Start	End	Wind Direction	Wind Speed (Beuafort)	Rain	Cloud Cover (%)	Visibility
29/09/2017	BOM	09:00	15:00	SW	3	1	N/A	5
20/11/2017	BOD	10:30	13:30	W	3	1	100	4-5
20/11/2017	BOD	13:30	16:30	W	2-3	2	100	3-5
07/12/2017	BOD	10:15	13:15	W	0-5	1-3	33-66	5
07/12/2017	BOD	13:15	16:15	W	5-6		33	5
18/01/2018	BOD	14:00	17:00	Not observed	4-5	1-2	66-100	5
30/01/2018	BOD	11:20	14:20	W	1-3	1	33-100	5
07/03/2018	BP	07:30	10:30	SW	2	1	0-100	5
09/03/2018	BP	08:05	11:05	E	0-1	1	66-100	5
24/03/2018	BP	07:50	10:50	NNW	2	1	0-66	5
27/03/2018	BP	11:15	14:15	W	3-4	1-2	66-100	5

Rain/ Precipitation

None	1
Drizzle mist	2
Light showers	3
Heavy showers	4

Visibility

Poor (<1km)	3
Moderate (1-2km)	4
Good (>2km)	5

Table AII-8
Weather data collected during winter bird transect surveys during the winter 2017/18 season

Date	Surveyor	Transect	Start	End	Wind Direction	Wind Speed	Rain	Cloud Cover (%)	Visibility
22/11/2017	SR	No location on survey sheet.	14:10	14:50	Not observed	2	3	100	4-5
22/11/2017	SR	No location on survey sheet.	10:12	12:51	Not observed	5	3	100	3-5
23/11/2017	SR	No location on survey sheet.	11:45	12:20	Not observed	2	1	33-66	5
08/12/2017	SR	Southern Site	11:00	12:15	Not observed	2-5	1-3	33	5
08/12/2017	SR	Northern Site	08:40	10:05	Not observed	3	1	66-100	5
25/01/2018	SR	1	08:30	09:45	Not observed	3-5	3	33-100	5
25/01/2018	SR	2	10:30	11:30	Not observed	3-5	1	0-100	5
07/02/2018	SR	1	Not recorded	Not recorded	Not observed	2-3	1	66-100	5
07/02/2018	SR	2	Not recorded	Not recorded	Not observed	2-3	1	0-66	5

Rain/ Precipitation		Visibility	
None	1	Poor (<1km)	3
Drizzle mist	2	Moderate (1-2km)	4
Light showers	3	Good (>2km)	5
Heavy showers	4		

APPENDIX III

Flight activity survey data[8]

[8] BTO codes: BZ = common buzzard, K. = common kestrel, SH = Eurasian sparrowhawk, LB = lesser black-backed gull, C. = carrion crow, GP = European golden plover, HH = hen harrier, SN = common snipe, L. = northern lapwing, H. = grey heron, PE = peregrine falcon and ML = merlin.

Table AIII-1
Target species recorded during flight activity surveys undertaken at VP1

Date	Surveyor	Obs. No	Species	Num. Birds	Obs. Time	Inside site	Outside site	Flight duration	Band 1 (0 – 30m)	Band 2 (30 – 40m)	Band 3 (40 – 50m)	Band 4 (50 – 170m)	Band 5 (>170m)
07/09/2017	JK	2	K.	1	15:05			205	205				
15/09/2017	BOD	2	HH	1	11:31	Y	Y	3 (IN), 19 (OUT)	3 (IN), 19 (OUT)				
25/10/2017	BOD	1	BZ	1	13:59		Y	136	136				
25/10/2017	BOD	2	BZ	1	14:08		Y	24	24				
25/10/2017	BOD	3	BZ	1	16:25		Y	37	37				
25/10/2017	BOD	4	BZ	2	16:27		Y	208	187	21			
25/10/2017	BOD	5	BZ	2	17:15		Y	30	30				
21/11/2017	BOD	1	BZ	1	09:31		Y	5	5				
21/11/2017	BOD	2	BZ	1	09:40	Y	Y	23 (IN), 23 (OUT)	23 (IN), 23 (OUT)				
21/11/2017	BOD	3	K.	1	12:53		Y	10	10				
21/11/2017	BOD	4	BZ	1	13:37		Y	18	18				
21/11/2017	BOD	5	BZ	1	13:51		Y	16	16				
21/11/2017	BOD	6	BZ	1	14:01		Y	7	7				
21/11/2017	BOD	7	K.	1	15:09		Y	145	130	15			
21/11/2017	BOD	8	K.	1	15:51		Y	270	270				
21/11/2017	BOD	9	K.	1	16:03		Y	75	75				
08/12/2017	BOD	1	BZ	2	13:21	Y	Y	16 (IN), 20 (OUT)	16 (IN), 20 (OUT)				
08/12/2017	BOD	2	BZ	1	14:37	Y		50	50				
08/12/2017	BOD	3	BZ	2	14:41	Y		32	32				
08/12/2017	BOD	4	BZ	1	15:13		Y	18	18				
08/12/2017	BOD	5	BZ	1	15:16		Y	15	15				
19/01/2018	BOD	1	SH	1	10:10		Y	7	7				
19/01/2018	BOD	2	BZ	1	11:10		Y	18	18				
19/01/2018	BOD	3	BZ	1	11:35		Y	3	3				
19/01/2018	BOD	1	BZ	1	12:52		Y	52	52				

Date	Surveyor	Obs. No	Species	Num. Birds	Obs. Time	Inside site	Outside site	Flight duration	Band 1 (0 – 30m)	Band 2 (30 – 40m)	Band 3 (40 – 50m)	Band 4 (50 – 170m)	Band 5 (>170m)
19/01/2018	BOD	2	BZ	1	13:15		Y	4	4				
08/03/2018	BP	13	BZ	1	08:52	Y	Y	47 (IN), 34 (OUT)	34 (IN)	13 (IN), 10 (OUT)	24 (IN)		
08/03/2018	BP	14	LB	1	09:47		Y	45			10	35	
29/03/2018	BOD	1	BZ	1	11:35		Y	7	7				
29/03/2018	BOD	2	BZ	1	11:37		Y	12	12				
29/03/2018	BOD	3	BZ	3	12:35		Y	445		44	45	222	134

Table AIII-2
Target species recorded during flight activity surveys undertaken at VP2

Date	Surveyor	Obs. No	Species	Num. Birds	Obs. Time	Inside site	Outside site	Flight duration	Band 1 (0 – 30m)	Band 2 (30 – 40m)	Band 3 (40 – 50m)	Band 4 (50 – 170m)	Band 5 (>170m)
08/09/2014	JK	1	K.	1	12:14	Y		40	40				
26/10/2017	BOD	1	BZ	1	10:42		Y	1	1				
26/10/2017	BOD	2	BZ	1	10:43		Y	30	30				
26/10/2017	BOD	3	BZ	1	10:45		Y	10	10				
26/10/2017	BOD	4	BZ	1	11:16		Y	71	71				
05/12/2017	DOH	1	BZ	1	13:33	Y		48	48				
10/01/2018	DOH	2	SH	1	14:06	Y	Y	55	55				
10/01/2018	DOH	3	SH	1	14:06	Y	Y	45	45				
10/01/2018	DOH	1	SH	1	10:57		Y	10	10				
07/03/2018	BP	10	BZ	1	12:04	Y		110			5	105	
07/03/2018	BP	11	BZ	1	12:55	Y	Y	273 (IN), 46 (OUT)				62 (IN), 21 (OUT)	211 (IN), 25 (OUT)
07/03/2018	BP	12	K.	1	13:02		Y	112			18	94	
09/03/2018	BP	13	BZ	1	11:47	Y		284		4	28	251	
27/03/2018	BP	55	BZ	1	14:50	Y		63	63				
27/03/2018	BP	48	K.	1	09:04	Y		0					

Table AIII-3
Target species recorded during flight activity surveys undertaken at VP3

Date	Surveyor	Obs. No	Species	Num.	Obs. Time	Inside site	Outside	Flight duration	Band 1 (0 – 30m)	Band 2 (30 – 40m)	Band 3 (40 – 50m)	Band 4 (50 – 170m)	Band 5 (>170m)
02/11/2017	BP	10	SN	1	14:36	N/A	N/A						
02/11/2017	BP	7	SN	1	12:56	Y	27	2	1	1	23		
02/11/2017	BP	11	C.	1	14:48	Y	Y	96 (IN), 92 (OUT)	70 (IN), 8 (OUT)	5 (IN), 2 (OUT)	5 (IN), 2 9OUT)	16 (IN), 80 (OUT)	
02/11/2017	BP	12	K.	1	14:49	Y		32	32				
03/11/2017	BP	19	GP	2	14:58	Y		42	22	10	10		
03/11/2017	BP	20	K.	1	15:16	Y		16	16				
01/12/2017	DOH	1	BZ	1	11:46	Y		3	3				
19/12/2017	DOH	1	BZ	1	11:46	Y		5	5				
11/01/2018	DOH	1	HH	1	15:33	Y		35	35				
11/01/2018	DOH	2	HH	1	15:38	Y	Y	20 (IN), 10 (OUT)	20 (IN), 10 (OUT)				
22/01/2018	DOH	1	SN	1	12:53	Y		6	6				
22/01/2018	DOH	2	BZ	1	14:08	Y		39	39				
22/01/2018	DOH	3	BZ	1	14:39	Y		77	46	31			
08/03/2018	BP	15	K.	1	12:12		Y	282	5	1	107	169	
08/03/2018	BP	17	K.	1	13:27		Y	210	194	16			
08/03/2018	BP	18	BZ	1	14:06	Y		114				114	
08/03/2018	BP	19	L.	1	14:54		Y	93				93	
08/03/2018	BP	21	BZ	1	15:10		Y	172		14	39	119	
08/03/2018	BP	20	SH	1	15:08		Y	38	38				
08/03/2018	BP	22	K.	1	16:07		Y	296					
08/03/2018	BP	23	K.	1	16:23		Y	238	2	1	1	234	
08/03/2018	BP	24	BZ	1	16:47		Y	417	274	40	40	63	
08/03/2018	BP	43	K.	1	15:09		Y	193					
24/03/2018	BP	44	BZ	2	15:29	Y	Y	220 (IN), 155 (OUT)				220 (IN), 25 (OUT)	130 (OUT)
24/03/2018	BP	45	K.	1	15:54		Y	73				73	
24/03/2018	BP	46	K.	1	16:23	Y		38			4	34	
24/03/2018	BP	47	BZ	1	16:27		Y	146				146	

Date	Surveyor	Obs. No	Species	Num.	Obs. Time	Inside site	Outside	Flight duration	Band 1 (0 – 30m)	Band 2 (30 – 40m)	Band 3 (40 – 50m)	Band 4 (50 – 170m)	Band 5 (>170m)
24/03/2018	BP	37	BZ	3	11:32		Y	185	24	15	15	131	
24/03/2018	BP	38	BZ	1	11:44		Y	90				90	
24/03/2018	BP	39	SH	1	11:50		Y	410				56	354
24/03/2018	BP	41	SH	1	13:57		Y	132			11	121	
24/03/2018	BP	42	K.	1	14:09		Y	48				48	

Table AIII-4
Target species recorded during flight activity surveys undertaken at VP4

Date	Surveyor	Obs. No	Species	Num. Birds	Obs. Time	Inside site	Outside site	Flight duration	Band 1 (0 – 30m)	Band 2 (30 – 40m)	Band 3 (40 – 50m)	Band 4 (50 – 170m)	Band 5 (>170m)
01/11/2017	BP	3	K.	1	12:50		Y	22	22				
02/11/2017	BP	5	K.	1	08:38		Y	34	34				
04/12/2017	BOD	1	BZ	1	12:30		Y	95	95				
18/12/2017	SR	1	GP	24	11:55			106					106
10/01/2018	JK	1	BZ	1	11:40	Y		320	320				
10/01/2018	JK	2	BZ	1	14:02		Y	180	180				
10/01/2018	JK	3	BZ	1	14:03	Y	Y	120 (IN), 260 (OUT)	120 (IN),260 (OUT)	30 (IN)			
24/01/2018	DOH	1	H.	1	09:16		Y	30	30				
24/01/2018	DOH	2	HH	1	12:56		Y	10	10				
24/01/2018	DOH	3	BZ	1	12:59	Y	Y	27	7 (IN), 20 (OUT)				
24/01/2018	DOH	4	BZ	1	12:45	Y		4260	4260				
24/01/2018	DOH	5	BZ	1	13:56	Y		32	32				
24/01/2018	DOH	6	K.	1	14:29	Y		17	17				
27/02/2018	BOD	3	K.	1	14:04		Y	5	5				
27/02/2018	BOD	1	BZ	1	10:39		Y						
27/02/2018	BOD	2	BZ	1	11:44		Y	11	11				

Table AIII-5
Target species recorded during flight activity surveys undertaken at VP5

Date	Surveyor	Obs. No	Species	Num. Birds	Obs. Time	Inside site	Outside site	Flight duration	Band 1 (0 – 30m)	Band 2 (30 – 40m)	Band 3 (40 – 50m)	Band 4 (50 – 170m)	Band 5 (>170m)
28/09/2017	BOM	2	K.	1	13:23		Y	32	32				
28/09/2017	BOM	3	PE	1	13:25		Y	118	50	42	6	20	
23/11/2017	SR	1	K.	1	13:46		Y	176	5	10	5	156	
23/11/2017	SR	2	SN	1	14:23		Y	5	5				
23/11/2017	SR	3	K.	1	14:49		Y	236	5	5	20	206	
23/11/2017	SR	4	K.	1	14:56		Y	41			41		
23/11/2017	SR	5	K.	1	15:00		Y	209	25		184		
06/12/2017	SR	1	SN	1	10:29		Y	15	15				
06/12/2017	SR	2	K.	1	10:45		Y	50			50		
06/12/2017	SR	3	K.	1	10:59		Y	5	5				
06/12/2017	SR	4	K.	1	11:02		Y	112			112		
06/12/2017	SR	5	GP	11	11:02		Y	20				20	
06/12/2017	SR	6	SN	2	11:06		Y	5	5				
06/12/2017	SR	7	K.	1	11:10		Y	171	121	50			
06/12/2017	SR	8	K.	1	11:13		Y	179	20	159			
06/12/2017	SR	9	K.	1	12:02		Y	65	65				
06/12/2017	SR	10	K.	1	12:08		Y	27	27				
06/12/2017	SR	11	K.	1	12:14		Y	128			128		
06/12/2017	SR	12	K.	1	13:25	Y		100				100	
06/12/2017	SR	13	K.	1	13:29		Y	127	87	40			
06/12/2017	SR	14	K.	1	13:30		Y	30	30				
06/12/2017	SR	15	K.	1	13:44		Y	28	28				
06/12/2017	SR	16	K.	1	13:46		Y	71		71			
06/12/2017	SR	17	SH	1	13:53		Y	45	45				
06/12/2017	SR	18	K.	1	13:58		Y	204		80	124		
06/12/2017	SR	19	K.	1	15:07		Y	20	20				
06/12/2017	SR	20	K.	1	15:24		Y	180		180			
24/01/2018	SR	1	SN	1	08:41		Y	5	5				
24/01/2018	SR	2	BZ	1	10:41	Y		55			55		

Date	Surveyor	Obs. No	Species	Num. Birds	Obs. Time	Inside site	Outside site	Flight duration	Band 1 (0 – 30m)	Band 2 (30 – 40m)	Band 3 (40 – 50m)	Band 4 (50 – 170m)	Band 5 (>170m)
24/01/2018	SR	3	SH	1	13:42	Y		101		101			
24/01/2018	SR	4	K.	1	13:43		Y	960	960				
06/02/2018	SR	1	SN	3	08:50		Y	15	15				
06/02/2018	SR	2	LB	1	09:30		Y	93		93			
06/02/2018	SR	3	K.	1	12:51		Y	26	26				

Table AIII-6
Target species recorded during flight activity surveys undertaken at VP6

Date	Surveyor	Obs. No	Species	Num. Birds	Obs. Time	Inside site	Outside site	Flight duration	Band 1 (0 – 30m)	Band 2 (30 – 40m)	Band 3 (40 – 50m)	Band 4 (50 – 170m)	Band 5 (>170m)
01/11/2017	BP	1	GP	33	09:32	Y	Y	196 (IN), 155 (OUT)		74 (IN)		122 (IN), 155 (OUT)	
03/11/2017	BP	14	GP	42	09:03	Y		19	19				
03/11/2017	BP	15	GP	42	09:08	Y	Y	285 (IN), 710 (OUT)				285 (IN), 710 (OUT)	
03/11/2017	BP	16	BZ	1	10:01	Y	Y	37 (IN), 26 (OUT)	37 (IN), 26 (OUT)				
21/11/2017	SR	1	SN	1	11:45		Y	14					
21/11/2017	SR	2	SN	1	11:50		Y	68					
21/11/2017	SR	3	SN	17	11:55	Y	Y	131					30 (IN), 101 (OUT)
21/11/2017	SR	4	BZ	1	13:49	Y		26	26				
21/11/2017	SR	5	BZ	1	15:25		Y	125	125				
07/12/2017	SR	1	SN	2	08:41		Y	5	5				
07/12/2017	SR	2	PE	1	09:58	Y	Y	110 (IN), 10 (OUT)			110 (IN), 10 (OUT)		
07/12/2017	SR	3	PE	1	10:04	Y	Y	13 (IN), 17 (OUT)	13 (IN), 17 (OUT)				
07/12/2017	SR	4	SH	2	10:11	Y		54		54			
07/12/2017	SR	5	SH	1	10:54	Y	Y	3 (IN), 12 (OUT)	3 (IN), 12 (OUT)				
07/12/2017	SR	6	SH	1	13:37	Y	Y	16 (IN), 23 (OUT)	16 (IN), 23 (OUT)				
07/12/2017	SR	7	SN	1	13:38		Y	7	7				
07/12/2017	SR	8	BZ	1	13:42	Y		109		20	89		
07/12/2017	SR	9	BZ	1	13:47		Y	19		19			

Date	Surveyor	Obs. No	Species	Num. Birds	Obs. Time	Inside site	Outside site	Flight duration	Band 1 (0 – 30m)	Band 2 (30 – 40m)	Band 3 (40 – 50m)	Band 4 (50 – 170m)	Band 5 (>170m)
07/12/2017	SR	10	SN	1	14:09		Y	12	12				
07/12/2017	SR	11	ML	1	14:55	Y	Y	20 (IN), 32 (OUT)		20 (IN), 32 (OUT)			
23/01/2018	SR	1	BZ	1	09:46		Y	14	14				
23/01/2018	SR	2	BZ	1	09:55	Y	Y	15 (IN), 15 (OUT)	15 (IN), 15 (OUT)				
23/01/2018	SR	3	SH	1	10:50	Y	Y	70 (IN), 8 (OUT)	70 (IN), 8 (OUT)				
23/01/2018	SR	4	SH	1	11:27	Y		31	31				
23/01/2018	SR	5	K.	1	13:06		Y	150	100	50			
23/01/2018	SR	6	K.	1	13:18		Y	45	45				
23/01/2018	SR	7	SH	1	15:05	Y		5	5				
05/02/2018	SR	14	SH	1	14:43			31	31				
05/02/2018	SR	1	SH	1	09:28		Y	34	34				
05/02/2018	SR	2	GP	100	10:08	Y	Y	70 (IN), 110 (OUT)	5	5	150		
05/02/2018	SR	3	GP	100	10:43	Y	Y	250 (IN), 250 (OUT)					50 (IN), 50 (OUT)
05/02/2018	SR	4	GP	50	10:59		Y	78	8	20	20	30	
05/02/2018	SR	5	SH	1	12:19	Y	Y	32 (IN), 20 (OUT)	10	42			
05/02/2018	SR	6	GP	70	12:24	Y	Y	5 (IN), 153 (OUT)	2	2	2	2	150
05/02/2018	SR	7	GP	100	13:03		Y	240	5	5	10	200	20
05/02/2018	SR	8	GP	100	13:31		Y	351	5	5	10	10	321
05/02/2018	SR	9	GP	100	13:46		Y	171	5	5	10	10	141
05/02/2018	SR	10	ML	1	13:48	Y	Y	20 (IN), 40 (OUT)		20 (IN), 40 (OUT)			
05/02/2018	SR	11	ML	1	13:49		Y	2460	2460				

Date	Surveyor	Obs. No	Species	Num. Birds	Obs. Time	Inside site	Outside site	Flight duration	Band 1 (0 – 30m)	Band 2 (30 – 40m)	Band 3 (40 – 50m)	Band 4 (50 – 170m)	Band 5 (>170m)
05/02/2018	SR	12	GP	40	14:05		Y	43					
05/02/2018	SR	13	GP	20	14:22		Y	128		128			
28/03/2018	BOD	1	BZ	1	10:42		Y	52					52

Table AIII-7
Target species recorded during flight activity surveys undertaken at VP7

Date	Surveyor	Obs. No	Species	Num. Birds	Obs. Time	Inside site	Outside site	Flight duration	Band 1 (0 – 30m)	Band 2 (30 – 40m)	Band 3 (40 – 50m)	Band 4 (50 – 170m)	Band 5 (>170m)
29/09/2017	BOM	3	K.	1	11:00	Y	Y	60 (IN), 77 (OUT)	12 (IN), 20 (OUT)	4 (IN)	44 (IN), 77 (OUT)		
29/09/2017	BOM	1	K.	1	1:45	Y		257	257				
29/09/2017	BOM	2	K.	1	10:51	Y		28			28		
29/09/2017	BOM	4	K.	1	11:07	Y		21	21				
29/09/2017	BOM	5	K.	1	12:07		Y	6	6				
29/09/2017	BOM	6	K.	1	13:18	Y		8	8				
29/09/2017	BOM	7	K.	1	13:49		Y	126		126			
29/09/2017	BOM	10	K.	1	14:11		Y	84			84		
29/09/2017	BOM	11	K.	1	14:18	Y	Y	55 (IN), 3 (OUT)			55 (IN), 3 (OUT)		
20/11/2017	BOD	1	BZ	1	10:48	Y		5	5				
07/12/2017	BOD	1	K.	1	12:53		Y	105	105				
07/12/2017	BOD	1	SH	1	13:53		Y	5	5				
07/12/2017	BOD	2	GP	1	15:16		Y	45	30	15			
07/12/2017	BOD	3	SH	1	15:45		Y	9	9				
07/12/2017	BOD	4	SH	1	15:48		Y	4	4				
07/12/2017	BOD	5	GP	3	16:00		Y	25	25	7			
18/01/2018	BOD	1	SH	1	14:20		Y	6	6				
18/01/2018	BOD	2	SH	1	15:04		Y	8	8				
30/01/2018	BOD	1	K.	1	11:56		Y	360	360				
30/01/2018	BOD	2	K.	1	12:26		Y	35	35				
07/03/2018	BP	1	SH	1	09:04	Y		370		195		175	
07/03/2018	BP	2	SH	1	09:14	Y		132	24	5	5	98	
07/03/2018	BP	3	K.	1	09:20	Y	Y	133 (IN), 110 (OUT)				88 (IN)	45 (IN), 110 (OUT)
07/03/2018	BP	4	BZ	1	09:26	Y		885		8	26	851	

Date	Surveyor	Obs. No	Species	Num. Birds	Obs. Time	Inside site	Outside site	Flight duration	Band 1 (0 – 30m)	Band 2 (30 – 40m)	Band 3 (40 – 50m)	Band 4 (50 – 170m)	Band 5 (>170m)
07/03/2018	BP	5	SH	1	09:50	Y	Y	405 (IN), 16 (OUT)			10 (IN), 5 (OUT)	359 (IN), 11 (OUT)	36 (IN)
07/03/2018	BP	6	BZ	1	10:05	Y	Y	7 (IN), 91 (OUT)				7 (IN), 91 (OUT)	
07/03/2018	BP	8	BZ	1	10:16	Y	Y	404 (IN), 63 (OUT)	14 (IN)	40 (IN)	30 (IN)	320 (IN), 63 (OUT)	
07/03/2018	BP	9	BZ	1	10:27	Y	Y	68 (IN), 23 (OUT)	37 (IN), 23 (OUT)	31 (IN)			
09/03/2018	BP	26	SH	1	09:00	Y	Y	68 (IN), 71 (OUT)	18 (OUT)	11 (IN), 53 (OUT)	57 (IN)		
09/03/2018	BP	27	BZ	1	09:08	Y	Y	157 (IN), 15 (OUT)	117 (IN), 15 (OUT)	20 (IN)	20 (IN)		
09/03/2018	BP	28	BZ	1	10:09	Y		133	107	26			
09/03/2018	BP	29	SH	1	10:14	Y		37	28	9			
09/03/2018	BP	30	PE	1	10:45	Y	Y	18 (IN), 88 (OUT)	45 (OUT)	22 (OUT)	7 (IN), 21 (OUT)	11 (IN)	
24/03/2018	BP	32	SH	2	08:27	Y		304		304			
24/03/2018	BP	34	SH	2	10:10	Y		243		138		104	
24/03/2018	BP	35	BZ	1	10:16		Y	33		33			
24/03/2018	BP	36	SH	2	10:22	Y	Y	237 (IN), 44 (OUT)		10 (IN)	10 (IN)	134 (IN)	83 (IN), 44 (OUT)
27/03/2018	BP	49	K.	1	11:28		Y	17	17				
27/03/2018	BP	50	BZ	1	11:31	Y		34	34				
27/03/2018	BP	51	SH	1	11:55		Y	148		23		125	
27/03/2018	BP	52	BZ	2	12:11	Y	Y	87 (IN), 167 (OUT)	43 (IN)	2 (IN)	2 (IN)	40 (IN), 167 (OUT)	
27/03/2018	BP	53	BZ	1	13:20	Y	Y	168 (IN), 175 (OUT)	12 (IN), 20 (OUT)	5 (IN), 7 (OUT)	12 (IN), 1 (OUT)	139 (IN), 147 (OUT)	

BIRD SURVEY REPORT BREEDING AND NON-BREEDING SEASON 2021/2022

Coolglass Wind Farm

Prepared for: Coolglass Wind Farm Ltd

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BASIS OF REPORT

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APPENDICES

1.0 Introduction

SLR Consulting Ireland (SLR) was commissioned by Coolglass Wind Farm Ltd in April 2021 to carry out a bird survey programme for the proposed Coolglass Wind Farm, Co. Laois (hereafter 'the Project') during the breeding bird period in 2021 and non-breeding bird period in 2021/22. A further breeding season has been completed in 2022 and a winter 2022/23 season is currently underway. These reports will be provided at a later date.

1.1 Background to the Commission

No previous planning permission has been sought on the application site (hereafter 'the Project Site') for the development of a wind farm by Coolglass Wind Farm Ltd or any other party. Breeding and non-breeding bird surveys were previously carried out by Fehily Timoney and Company on the Project Site from 2012 to 2018 while the Project was in gestation. These surveys included flight activity, breeding wader, barn owl, and merlin surveys. This data is available in raw format but has not been reported on. For the purposes of impact assessment, the 2017/18 winter season will be used.

1.2 Project Site Description

The Project Site is located within the townlands of Brennanshill, Coolglass, Crissard, Fallowbeg Upper, Coolglass Upper, Gorreelagh Kylenabehy and Scotland in Co. Laois. The dominant habitats within the boundaries of the Project Site are conifer plantation and improved agricultural grassland. There are also numerous eroding/upland rivers including the Fallowbeg Upper, Owveg [Nore], Clogh 15 and Brennanshill. The north of the Project Site is focused on Fossy Mountain, which is a small hill, 323 m above sea level in height.

1.3 Scope of Work

The scope of survey work was based on existing knowledge of the area and took into account current NatureScot (NS) (formerly Scottish Natural Heritage; SNH) guidance[1]. This survey methods guidance is recognised as standard best practice guidance throughout the UK and Ireland for surveying birds to inform impact assessment for onshore wind farms. The scope of survey work undertaken is provided in **Table 1-1**. Further details are provided in Sections 2.2.2 to 2.2.5.

Table 1-1
Scope of Ornithological Survey Work, Breeding Season 2021 and Non-breeding Season 2021/22

Survey Type	Summary Methodology (see Section 2 for further details)
Vantage Point (VP) surveys	Six hours of survey per month were carried out from each of the 7 VPs between April 2021 to September 2021 (breeding) and 6 hours per month from October 2021 to April 2022 (non-breeding) inclusive (see section 2.5 on limitations).

[1] Scottish Natural Heritage (2017). *Recommended Bird Survey Methods to Inform Impact Assessment of Onshore Wind Farms V2.* Scottish Natural Heritage, Inverness.

Survey Type	Summary Methodology (see Section 2 for further details)
Breeding raptor surveys	Four surveys were undertaken from April to July 2021 to search for any raptors breeding within 2 km of the wind farm boundary.
Feeding distribution surveys	Feeding distribution surveys were carried out on a twice-monthly basis from October 2021 to March 2022 inclusive to search for swans and/or geese using the fields for foraging within 500 m of the wind farm boundary.

1.4 Target Species

Target species for the surveys were defined by legal and/or conservation status and vulnerability to impacts caused by wind turbines, as defined in NS guidance.

1.4.1 Primary Target Species

Primary target species were limited to species upon which effects are most likely to be potentially significant in EIA and Appropriate Assessment (AA) terms e.g., species forming qualifying features for nearby Special Protection Areas (SPAs) or species listed on Annex 1 of the Birds Directive[2]. This enabled recording to focus on the species of greatest importance without the distraction of having to record detailed flight data for a larger number of more common species.

Primary target species included the following bird species:

- All Annex 1 raptor/owl species;
- Qualifying interest species for nearby SPAs[3]; and
- Other raptors, waders or wildfowl red-listed on the latest Birds of Conservation Concern in Ireland (BoCCI)[4] scheme.

1.4.2 Secondary Species

Local circumstances may indicate that survey information should also be acquired on other species, especially those of regional conservation concern. Such species are termed secondary species. Recording of secondary species is subsidiary to recording of primary target species.

Secondary target species included:

- Any other wildfowl and wader species;
- Common buzzard *Buteo buteo;*

[2] Annex 1 of the Birds Directive (Directive 2009/147/EC)
[3] The relevant SPAs are listed in Section 3.1.
[4] Gilbert, G., Stanbury, A. and Lewis, L. (2021). Birds of Conservation Concern in Ireland 2020–2026. Irish Birds 43: 1–22

- Eurasian sparrowhawk *Accipiter nisus*;
- Northern raven *Corvus corax*;
- Grey heron *Ardea cinerea;*
- Great cormorant *Phalacrocorax carbo;* and
- Gulls *Larus* and *Chroicocephalus sp*.

1.5 Terminology

For this report, "flight line" refers to the line drawn to record avian movement during a VP survey. A single flight line may be used indicate the collective movement of a flock of birds. Each individual bird moving within the same flight line is referred to as "a flight". Note that the "cumulative number of flights" reflects the occupancy of the study area by a particular species i.e. the total number of flights for all surveys in a given season added together. It does not reflect the total number of unique individuals and should not be used to infer abundance.

1.6 Purpose of the Report

The aim of this report is to provide robust baseline ornithological survey data for the breeding period in 2021 and non-breeding period in 2021/22. These data will be used to inform a separate ecological impact assessment and appropriate assessment for the Project. The assessment of potential impacts is beyond the scope of this report.

2.0 Methodology

2.1 Desk-based Review

The desk-based review collated available information collected to date on the bird movements in and around the Project Site. The websites of the National Parks and Wildlife Service (NPWS) www.npws.ie, the National Biodiversity Data Centre (NBDC) http://maps.biodiversityireland.ie/#/Map, and the UK and Ireland Bird Atlas 2007-2011 https://app.bto.org/mapstore/StoreServlet were also accessed for information on sites designated for nature conservation in the vicinity of the Project Site and notable bird species in the local area.

2.2 Field Surveys

2.2.1 Field Survey Team: Evidence of Technical Competence and Experience

Jonathon Dunn (JD) – Project Manager and Lead Ornithologist

Jonathon is a Senior Ecologist with SLR and holds a BA (Hons) in Natural Sciences from the University of Cambridge, an MSc in Ecology Evolution and Conservation from Imperial College London and a PhD in Avian Ecology from Newcastle University. He is a Full member of the Chartered Institute of Ecology and Environmental Management (MCIEEM). Jonathon is a highly skilled and experienced bird surveyor with six years' post graduate experience as a professional consultant ecologist. Jonathon managed this project through liaison with the client, coordination of the survey team, supervision of the health and safety of the team, collating, quality controlling and assessing the survey data.

Paul Connaughton (PC) – Bird Surveyor

Paul has been an active birder for over 30 years and is the current Chairman of the Birdwatch Ireland's West Cork Branch. He holds an ESAS qualification for sea bird survey techniques. Paul carried out flight activity surveys and breeding raptor surveys from April 2021 to April 2022.

Nick Veale (NV) – Bird Surveyor

Nick has over 19 years professional experience as a consulting ecologist/ornithologist and has worked for several environmental / ecological consultancies including Mouchel, RPS Group and Golder Associates. He holds an ESAS qualification for sea bird survey techniques. Nick carried out flight activity surveys and feeding and distribution surveys from April 2021 to March 2022.

2.2.2 Flight Activity Surveys

Seven vantage point (VP) locations were initially chosen to provide visibility of the optioned lands and a 500 m buffer surrounding the same. The adequacy of these VPs was checked by carrying out a desk-based viewshed analysis using a bespoke GIS tool for calculating the visible area from each vantage point (VP). The Zones of Theoretical Visibility (ZTV) from each VP were calculated using ArcMAP 10.5.1 Spatial Analyst using a terrain model derived from EU-DEM data with a vertical accuracy of ± 7 m. The ZTVs have been calculated using a surface offset of 30 m, to match the lowest point swept by the rotors of the proposed turbines. The ZTVs are based on a viewing height of 1.8 m above ground level. VP locations, viewing arcs and viewsheds are shown in **Figure 1**.

Note that since surveys were completed, the layout was refined so that the Project Site is considerably smaller. This updated layout is shown in all figures in this report. For completeness, the results for the larger survey area are presented in this report.

Breeding Season

A total of 36 hours of watches were undertaken at each of seven VP locations during the breeding season (monthly visits April-September inclusive). The VP survey effort undertaken during the breeding season of 2021 is summarised in **Table 2-1** with full details of survey dates, times and observers provided in Appendix 01 and details of weather conditions during the surveys provided in Appendix 02.

Table 2-1
VP survey effort undertaken at the Project Site from April 2021 to September 2021.

Month	VP1 (hours)	VP2 (hours)	VP3 (hours)	VP4 (hours)	VP5 (hours)	VP6 (hours)	VP7 (hours)
April	06:00	06:00	06:00	06:00	03:00	06:00	03:00
May	06:00	06:00	06:00	06:00	09:00	06:00	09:00
June	03:00	03:00	03:00	03:00	06:00	06:00	06:00
July	09:00	09:00	09:00	09:00	06:00	06:00	06:00
August	06:00	06:00	06:00	06:00	06:00	06:00	06:00
September[5]	06:00	06:00	06:00	06:00	06:00	06:00	06:00
Total hrs	**36:00**	**36:00**	**36:00**	**36:00**	**36:00**	**36:00**	**36:00**
VP Locations ITM (**Figure 1**)	654390, 690092	656470, 687421	654877, 687955	657231, 685790	658442, 683352	659975, 680614	655847, 683304

Non-Breeding Season

A total of 36 hours of watches were undertaken at each of seven VP locations during the non-breeding season (monthly visits October-March inclusive). The VP survey effort undertaken during the non-breeding season of 2021/2022 is summarised in **Table 2-2** with full details of survey dates, times and observers provided in Appendix 01 and details of weather conditions during the surveys provided in Appendix 02.

Table 2-2
VP survey effort undertaken at the Project Site from October 2021 to April 2022.

Month	VP1 (hours)	VP2 (hours)	VP3 (hours)	VP4 (hours)	VP5 (hours)	VP6 (hours)	VP7 (hours)
October	-	03:00	06:00	-	06:00	06:00	06:00
November	06:00	06:00	-	06:00	06:00	06:00	06:00
December	12:00	09:00	12:00	12:00	06:00	06:00	03:00
January	-	03:00	-	03:00	06:00	03:00	06:00
February	12:00	09:00	09:00	09:00	06:00	09:00	06:00
March	-	-	03:00	-	06:00	06:00	06:00
April[6]	06:00	06:00	06:00	06:00	-	-	-
Total hrs	**36:00**	**36:00**	**36:00**	**36:00**	**36:00**	**36:00**	**36:00**

[5] While it is unlikely birds were breeding in September, it has been included here as part of the survey effort for the breeding season.
[6] While April does not officially form part of the non-breeding season, weather conditions prevented surveys from being completed in March 2022 and so the March surveys were completed in early April. See section 2.5 for further details.

Month	VP1 (hours)	VP2 (hours)	VP3 (hours)	VP4 (hours)	VP5 (hours)	VP6 (hours)	VP7 (hours)
VP Locations ITM (**Figure 1**)	654390, 690092	656470, 687421	654877, 687955	657231, 685790	658442, 683352	659975, 680614	655847, 683304

VP surveys aimed to quantify the flight activity of primary and secondary target species (as defined in Section 1.4) within the study area.

The main purpose of VP watches is to collect data on primary target species that will enable estimates to be made of:

- The time spent flying over the site;
- The relative use by birds of different parts of the site;
- The proportion of flying time spent within the provisional upper and lower risk height limits as determined by the potential rotor diameter and rotor hub height; and
- Ultimately, the analysis of the potential risk of collision of birds with rotating turbines.

For each primary target species observation, the following details were recorded:

- Time of observation;
- Duration of flying bout;
- Species, age and sex (where determinable);
- Time spent within each height band and;
- Notes on observation.

In the absence of detailed information regarding turbine specifications at the time of commencing surveys, a precautionary approach was taken in relation to recording height bands. Height bands were determined allowing for the maximum rotor tip height of 180 m and a lowest rotor swept height of 30 m. Flight heights were attributed to five distinct height bands as follows:

- 1 = < 15 m (below the likely rotor swept area);
- 2 = 15 m to 30m (below the likely rotor swept area);
- 3 = 30 m to 150 m (within the likely rotor swept area);
- 4 = 150 m to 200 m (within the likely rotor swept area, at least in part);
- 5 = >200 m (above the likely rotor swept area).

In addition, a summary of observations of secondary target species was recorded at the end of each five-minute period during each VP watch to provide an index of flight activity for secondary target species within the Project Site, in accordance with current NS guidance.

2.3 Breeding Raptor Surveys

NS recommends that all potential breeding territories within a 2 km radius of the Project Site be surveyed throughout the breeding season. A driven transect was undertaken within this buffer, stopping at potential raptor breeding habitats as defined by Hardey *et al.* (2013)[7] and focusing on areas not visible from the fixed vantage points. This transect was undertaken two times in May 2021 and three times in July 2021. Details of survey dates, times and observers are provided in Appendix 01 and a record of weather conditions during surveys is provided in Appendix 02.

The location, movement and behaviour of all raptor species were recorded onto the field maps using standard BTO species codes.

2.4 Feeding Distribution Surveys

NS guidance recommends that for whooper swan *Cygnus cygnus*, Greenland white-fronted goose *Anser albrifons flavirostris* and other geese species, feeding distribution surveys should be undertaken in areas of suitable habitat when the survey area lies within the core foraging distance of SPAs or other major roosts for these species, unless it can be established from existing data that the area is not utilised for feeding. Although there was no evidence of swans or geese feeding in the area, feeding distribution surveys were undertaken as a precaution.

The Project Site and a 500 m buffer was used to define the survey area for swan and geese feeding distribution surveys in accordance with NS guidance. Surveys were undertaken via driven transects once a fortnight between October 2021 to March 2022, stopping on a regular basis to check all fields for goose and swan feeding activity. No “blind spots” were present and suitable visibility of all potential swan and goose foraging areas was achieved. Survey dates are shown in Appendix 01 and weather conditions in Appendix 02.

2.5 Survey Limitations

Twenty-four flight activity survey hours during the non-breeding season were carried out in the first two days of April, which is technically the breeding season, due to inclement weather conditions in March 2022. However, as these surveys were carried out in the first two days of April, when birds are unlikely to have started breeding, and a total of 36 hours was achieved at each VP between October 2021 and April 2022, this does not present a significant limitation to the survey results. For the purposes of impact assessment, the 2017/18 winter season survey will also be used, along with the 2022/23 season, when completed.

The majority of VP surveys were undertaken in optimal weather conditions. However, during such an extensive series of surveys carried out it was inevitable that some surveys were completed in suboptimal conditions. There were 31 hours out of the total of 549 during which the visibility was recorded as “moderate”, i.e. 1-3 km. This comprises 5.6% of the total survey effort but in almost all cases all of the relevant 2 km viewing arc was visible and this is not considered to significantly affect the validity of the data collected. There was also 1 hour (0.2% of the total survey effort) in which the visibility was recorded as “poor”, i.e., less than 1 km. However, in no cases did visibility fall below 500 m (when the survey would have been suspended) and in many cases visibility was better than this for part of the relevant hour. As such, given the low proportion of surveys affected this is not considered to significantly affect the validity of the data collected. Further details regarding weather conditions during surveys are provided in Appendix 02.

[7] Hardey, J., Crick, H., Wernham, C., Riley, H., Etheridge, B. and Thompson, D. (2013). Raptors: A Field Guide to Survey and Monitoring (3rd Edition). The Stationery Office, Edinburgh.

3.0 Results

3.1 Desk-based Review

3.1.1 Natura 2000 Sites

There are no Special Protection Areas (SPA) within the Project Site. However, there is one SPA within a 20 km[8] radius of the survey area.

Details of this SPA are shown in **Table 3-1**, which also shows the qualifying interests for the site.

Table 3-1
SPAs within 20 km of the proposed Coolglass Wind Farm and their qualifying interests

Site Name	Site Code	Distance / Direction from Project Site	Species of Special Conservation Interest Relevant to the Non-Breeding Season
River Nore SPA	004233	11.7 km southwest of the Project Site (18.2 km instream distance via Owveg River)	Common kingfisher *Alcedo atthis*

3.1.2 Previous Survey Data

Breeding and non-breeding bird surveys were previously carried out by Fehily Timoney at the Project Site from 2012 to 2018 (raw data available only). These surveys included flight activity, breeding wader, barn owl, and merlin surveys.

The following primary target species were observed either on-site or within the surrounding 500 m buffer during the previous surveys:

- Merlin *Falco columbarius;*
- European golden plover *Pluvialis apricaria*;
- Common kestrel *Falco tinnunculus*;
- Peregrine falcon *Falco peregrinus*;
- Hen harrier *Circus cyaneus;*
- Common snipe *Gallinago gallinago*; and
- Eurasian woodcock *Scolopax rusticola.*

Barn owl surveys were carried out in September 2013. Potentially suitable nesting sites were noted during this survey, but no confirmed nesting or roosting sites were identified.

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[8] 20 km is the maximum distance typically applied when considering wildfowl ranging from roost sites to foraging sites.

No confirmed signs of breeding were identified during the merlin surveys.

The following secondary target species were observed either on-site or within the surrounding 500 m buffer during the previous surveys:

- Common buzzard *Buteo buteo*; and
- Eurasian sparrowhawk *Accipiter nisus*.

3.2 Breeding Season Flight Activity Surveys

Flight lines of primary target species recorded throughout the 2021 breeding season are presented in **Figures 2.1** to **2.2** and a summary of the survey findings are provided in Sections 3.2.1 and 3.2.2 for primary and secondary target species, respectively. Flight data for both primary and secondary target species are provided in Appendix 03.

3.2.1 Primary Target Species

In total, four primary target species were recorded flying within the study area on and around the Project Site during the six-month survey period. Flight activity recorded for primary target species is summarised in **Table 3-2.**

Table 3-2
Primary Target Species Flight Lines from the Project Site for All VPs Combined – April 2021 – September 2021

Species	Number of flight lines by month						Total number of flight lines	Time at risk height* (s)	Cumulative number of flights
	Apr	May	Jun	Jul	Aug	Sep			
Common kestrel	11	27	20	17	3	8	86	153	92
Peregrine falcon	2	2	2	2	2	0	10	120	10
Common snipe	0	0	1	0	0	2	3	0	5
Eurasian woodcock	0	0	0	3	0	0	3	0	3
Total	**13**	**29**	**23**	**22**	**5**	**10**	**102**	**273**	**110**
* precautionary risk height assumed to be between 30 m – 180 m									

A summary of flight activity by species is presented below.

Common kestrel

Eighty-six flight lines of common kestrel were recorded during the flight activity surveys (**Figure 2.1**). The largest number of flight lines was recorded in May 2021 (n=27). Flight lines were recorded across all seven VP locations, within both the Project Site and the 500 m buffer. Flight durations varied from 8 seconds to over 4 minutes.

Peregrine falcon

Ten peregrine falcon flight lines were recorded during the flight activity surveys (**Figure 2.1**). Observations were evenly distributed across all months except September 2021, where no peregrines were recorded. Peregrine falcon flight lines were recorded from all VP locations except VP3. Flight durations varied from 40 seconds to 9 minutes.

Common snipe

Three flight lines of common snipe were recorded during the flight activity surveys (**Figure 2.2**) in June and September 2021. The maximum number of flight lines (n=2) was recorded in September. These flight lines were observed within both the Project Site and the 500 m buffer, and at VP locations 4, 5, and 7. No flight lines were recorded at potential collision risk heights. Flight durations were short, with all three less than 40 seconds in duration.

Eurasian woodcock

Three flight lines of Eurasian woodcock were recorded during the flight activity surveys (**Figure 2.2**) in July 2021. These flight lines were recorded from VP locations 6 and 7, within both the Project Site and the 500 m buffer. None of these flight lines were at potential collision risk heights. Flight durations were short, all three lasting for 70 seconds or less.

3.2.2 Secondary Species

Secondary species activity at the Project Site is summarised in **Table 3-3**. There were 11 secondary species recorded throughout the breeding season. Common buzzard was the most frequently recorded secondary species (in 216 five-minute periods out of a possible 3,024). Black-headed gull *Chroicocephalus ridibundus* was the most numerous of the recorded secondary species (maximum flock size of 23).

Table 3-3
Secondary Species Activity Summary for All VPs Combined – April 2021 – September 2021

Species	Number of 5 min periods recorded	Peak count of birds recorded in any 5 min period	Comments
Black-headed gull	11	23	Activity in all months except April 2021, within the Project Site, survey buffer and beyond.
Common buzzard	216	5	Activity in all months, within the Project Site, survey buffer and beyond.
Great cormorant	3	1	Activity in May and August 2021, within the Project Site, survey buffer and beyond.
Common gull *Larus canus*	3	11	Activity in September 2021 only, within the Project Site and survey buffer.
Grey heron	17	2	Activity in all months except April 2021, within the Project Site and survey buffer.
European herring gull *Larus argentatus*	4	6	Activity in August and September 2021, within the Project Site, survey buffer and beyond.
Lesser black-backed gull *Larus fuscus*	14	15	Activity in all months, within the Project Site, survey buffer and beyond.
Mallard *Anas platyrhynchos*	10	4	Activity in all months except April 2021, within the Project Site and survey buffer.
Northern raven	93	10	Activity in all months, within the Project Site, survey buffer and beyond.

Species	Number of 5 min periods recorded	Peak count of birds recorded in any 5 min period	Comments
Eurasian sparrowhawk	14	1	Activity in all months, within the Project Site, survey buffer and beyond.
Eurasian whimbrel *Numenius phaeopus*	2	1	Activity in April 2021 only, within the survey buffer and beyond.

3.3 Non-Breeding Season Flight Activity Surveys

Flight lines of primary target species recorded throughout the 2021/22 non-breeding season (including those in early April 2022) are presented in **Figures 2.1 to 2.2** and a summary of the survey findings are provided in Sections 3.3.1 and 3.3.2 for primary and secondary target species, respectively. Flight data for both primary and secondary target species are provided in Appendix 03.

3.3.1 Primary Target Species

In total, five primary target species were recorded flying within the study area during the non-breeding season on and around the Project Site during the six-month survey period. Flight activity recorded from the Project Site by primary target species is summarised in **Table 3-4**.

Table 3-4
Primary Target Species Flight Lines from the Project Site All VPs Combined – October 2021 – April 2022

Species	Number of flight lines by month							Total number of flight lines	Time at risk height* (s)	Cumulative number of flights
	Oct	Nov	Dec	Jan	Feb	Mar	Apr			
Common kestrel	6	13	7	5	11	9	0	51	42	52
Peregrine falcon	0	3	2	0	1	1	0	7	60	7
Common snipe	2	2	0	1	2	2	1	10	0	16
European golden plover	2	0	4	0	4	2	0	12	183	4,405
Northern lapwing *Vanellus vanellus*	2	0	1	0	0	0	0	3	63	50
Total	**12**	**18**	**14**	**6**	**18**	**14**	**1**	**83**	**348**	**4530**
** precautionary risk height assumed to be between 30 m – 180 m										

A summary of flight activity by species is presented below.

Common kestrel

A total of 51 common kestrel flight lines were recorded at the Project Site during the non-breeding season flight activity surveys (**Figure 2.1**) in all months except April 2022. Kestrel flight lines were recorded across all VP locations, with the exception of VP2 and were observed both within the Project Site and the 500 m buffer. Flight durations ranged from 20 to 180 seconds.

Peregrine falcon

Seven peregrine falcon flight lines were recorded at the Project Site during the non-breeding season flight activity surveys (**Figure 2.1**) in November and December 2021, and February and March 2022. These flight lines were recorded across VPs 1, 2, 4, 6, and 7, and were located within the Project Site and the 500 m buffer. Durations varied from 10 to 140 seconds.

Common snipe

Ten common snipe flight lines were recorded at the Project site during the non-breeding season flight activity surveys (**Figure 2.2**). The flight lines were evenly distributed across all months, with the exception of December 2021 where no snipe flights were recorded. Snipe were observed flying at VPs 2, 5, 6, and 7 only, but no flight lines occurred at potential collision risk heights. Flight line durations were typically short, consisting of 70 seconds duration or less.

European golden plover

A total of 12 golden plover flight lines were recorded at the Project Site during the non-breeding season flight activity surveys (**Figure 2.2**) in October and December 2021, and February and March 2022. Flight lnes were observed at all VP locations except VP2 and VP7. Golden plovers were most numerous in February, with a cumulative total of 4,006 flights observed in that month split over four flight lines. Golden plovers were observed flying over the Project Site as well as the 500 m buffer. Flight durations varied from 10 seconds to over 5 minutes.

Northern lapwing

Three lapwing flight lines were recorded at the Project Site during the non-breeding season flight activity surveys (**Figure 2.2**) in October and December 2021. The largest number of flight lines (n=2) were observed in October. Two of the flight lines were recorded at VP6 and the other was recorded at VP7. Lapwings were observed both at the Project Site and within the 500 m buffer. Flight line durations were typically long, between 64 and 220 seconds.

3.3.2 Secondary Species

Secondary species activity during the non-breeding season at the Project Site is summarised in **Table 3-5**. There were 11 secondary species recorded throughout the season. Common buzzard was the most frequently recorded secondary species (in 142 five-minute periods out of a possible 3,024). Black-headed gull was the most numerous of the recorded secondary species (maximum flock size of 20).

Table 3-5
Secondary Species Activity Summary for All VPs Combined – October 2021 – March 2022

Species	Number of 5 min periods recorded	Peak count of birds recorded in any 5 min period	Comments
Black-headed gull	9	20	Activity in all months except April 2022, within the Project Site, survey buffer and beyond.
Common buzzard	142	6	Activity in all months, within the Project Site, survey buffer and beyond.
Great cormorant	1	4	Activity in November 2021 only, beyond the survey buffer and Project Site.
Common gull	6	13	Activity in October, November, and December 2o21, within the Project Site, survey buffer and beyond.
Grey heron	9	1	Activity in October, November and December 2021, and February and March 2022, within the Project Site, and survey buffer.
European herring gull	6	3	Activity in December 2021, and January, February, and March 2022, within the Project Site, survey buffer and beyond.
Lesser black-backed gull	2	6	Activity in November and December 2021, within the Project Site only.
Mallard	7	2	Activity in October 2021, and February and March 2022, within the Project Site, and survey buffer.
Northern raven	84	4	Activity in all months, within the Project Site, survey buffer and beyond.

Species	Number of 5 min periods recorded	Peak count of birds recorded in any 5 min period	Comments
Eurasian sparrowhawk	32	2	Activity in all months except October 2021, within the Project Site, survey buffer and beyond.
Jack snipe *Lymnocryptes minimus*	1	1	Activity in February 2022 only, within the survey buffer.

3.4 Breeding Raptor Surveys

A total of four species of raptor was recorded during the surveys. The following species accounts provide summary details of the primary raptor species encountered during the 2021 surveys (all surveys combined). The results of the breeding raptor surveys can be seen in **Figure 3**.

3.4.1 Peregrine Falcon

Two peregrine falcons were observed during the breeding raptor surveys. An immature female peregrine falcon was observed flying over the Project Site in May 2021 and a female peregrine falcon was observed at a quarry 3.3 km from the Project Site. No evidence of breeding peregrines was recorded within 2 km of the Project Site.

3.4.2 Common Kestrel

One common kestrel was observed flying within the 500 m buffer during the breeding raptor surveys in July 2021. This individual was recorded flying over suitable breeding habitat, but no evidence of breeding was detected.

3.4.3 Secondary Target Species

Several common buzzard territories were identified on-site during the breeding raptor surveys. A pair of individuals was heard calling in suitable breeding woodland habitat. Common buzzards were observed throughout the entire Project Site during these surveys. However, no nests were identified on-site.

Eurasian sparrowhawks were identified during two of the breeding raptor surveys in July 2021. A pair of sparrowhawks were heard calling in a suitable breeding woodland habitat outside the Project Site 500 m buffer but within the 2 km survey area. Eurasian sparrowhawk was also observed flying over parts of the Project Site during these surveys. However, no nests were identified on-site.

3.4.4 Incidental Records of Other Species

No incidental records of other target species were made during breeding raptor surveys.

3.5 Feeding Distribution Surveys

No aggregations or individual observations of swans or geese were observed during the feeding distribution surveys (**Figure 4**).

3.5.1 Incidental Records of Other Species

Incidental species records during the feeding distribution surveys were:

- Wildfowl: mallard, grey heron, little grebe *Tachybaptus ruficollis and* common moorhen *Gallinula chloropus*;
- Waders: European golden plover; and
- Gulls: black-headed gull, common gull, and European herring gull.

4.0 Summary and Conclusions

A range of ornithology surveys were carried out at the Project Site during the 2021 breeding and 2021/22 non-breeding seasons. These were:

- Flight activity (VP) surveys;
- Breeding raptor surveys; and
- Feeding distribution surveys.

The following primary target species were recorded during flight activity surveys at the Project Site:

- European golden plover;
- Common kestrel;
- Northern lapwing;
- Peregrine falcon;
- Common snipe; and
- Eurasian woodcock.

The most frequent flight activity during the breeding season was by common kestrel (86 flight lines), with other target species activity less frequent. The next most frequently recorded species was peregrine falcon (10 flight lines). Common snipe and Eurasian woodcock were both recorded across three flight lines.

The most frequent flight activity during the non-breeding season was also by common kestrel (51 flight lines), with other target species activity less frequent. The next most frequently recorded species were European golden plover (12 flight lines) and common snipe (10 flight lines). All other species were recorded across seven flight lines or less.

Breeding raptor surveys recorded two primary target species and two secondary target species:

- Peregrine falcon: no evidence of breeding.
- Common kestrel: no evidence of breeding.
- Common buzzard: suspected breeding on-site.
- Eurasian sparrowhawk: suspected breeding on-site.

Feeding distribution surveys recorded no target species.

Incidental records were made during taxon-specific surveys of other species of conservation concern including:

- Wildfowl: mallard, grey heron, little grebe, common moorhen;
- Waders: European golden plover; and
- Gulls: black-headed gull, common gull, and European herring gull.

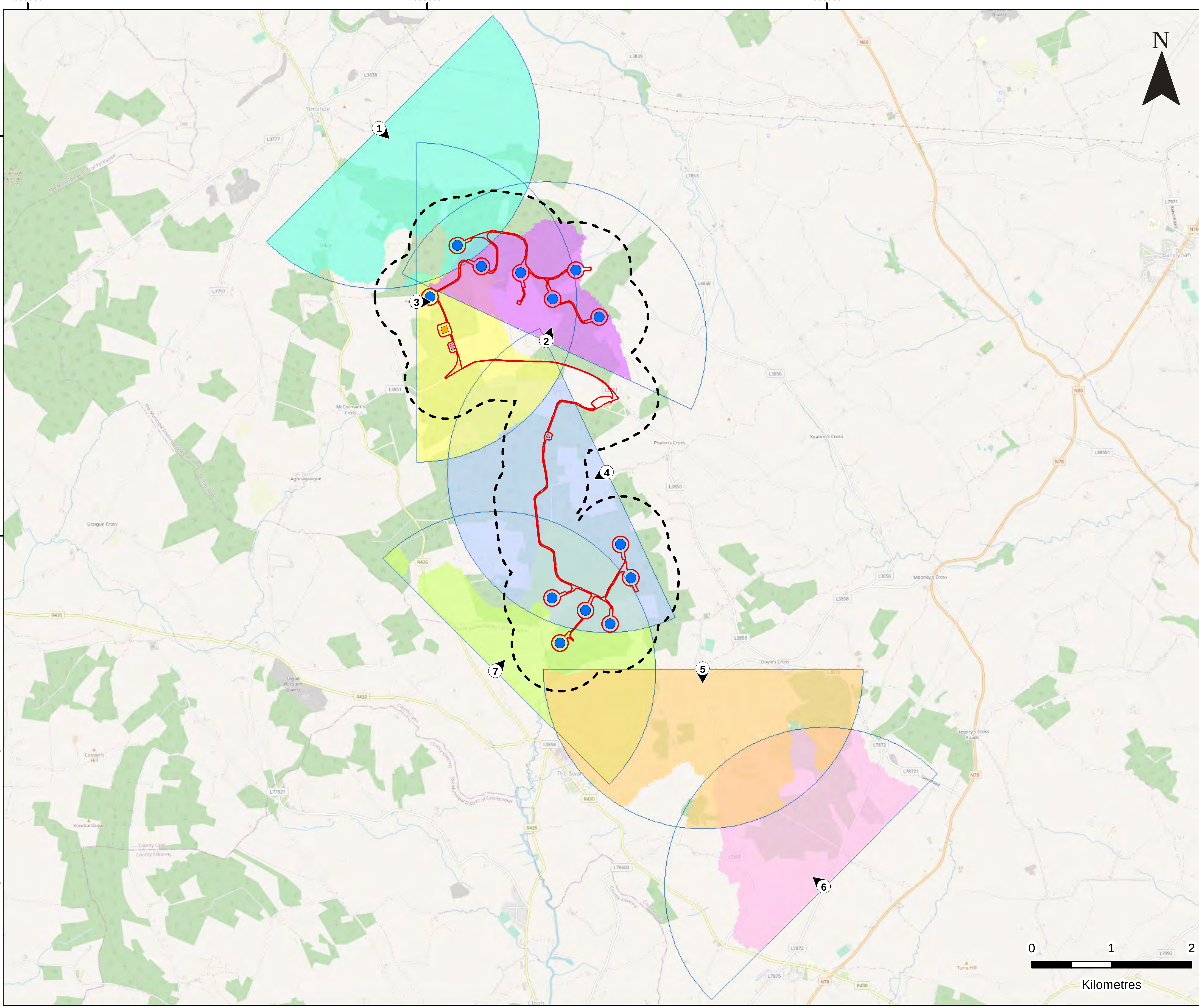
5.0 Legal and Conservation Status of Target Species Recorded

Table 5-1 summarises the legal and conservation status of the primary and secondary target species recorded during the range of ornithology surveys mentioned above. All Irish bird species are afforded general protection by the Wildlife Acts 2000 (as amended).

Table 5-1
Legal and Conservation Status of Target Species

Primary or Secondary Target	Species (BTO code)	Legal & Conservation Status in Ireland
Primary	European golden plover (GP)	Annex 1; BoCCI4 Red
	Common kestrel (K.)	BoCCI4 Red
	Northern lapwing (L.)	BoCCI4 Red
	Peregrine falcon (PE)	Annex 1; BoCCI4 Green
	Eurasian woodcock (WK)	BoCCI4 Red
	Common snipe (SN)	BoCCI4 Red
Secondary	Black-headed gull (BH)	BoCCI4 Amber
	Common buzzard (BZ)	BoCCI4 Green
	Great cormorant (CA)	BoCCI4 Amber
	Common gull (CM)	BoCCI4 Amber
	Grey heron (H.)	BoCCI4 Amber
	Herring gull (HG)	BoCCI4 Amber
	Lesser black-backed gull (LB)	BoCCI4 Amber
	Mallard (MA)	BoCCI4 Amber
	Northern raven (RN)	BoCCI4 Amber
	Eurasian sparrowhawk (SH)	BoCCI4 Amber
	Whimbrel (WM)	BoCCI4 Green
	Jack snipe (JS)	BoCCI4 Green
	Little grebe (LG)	BoCCI4 Green
	Moorhen (MH)	BoCCI4 Green
Key		Annex 1 – the species is listed in Annex 1 of the EC Birds Directive; and BoCCI4 status (green, amber or red) – indicates the current Birds of Conservation Concern in Ireland[4] status category.

FIGURES



NOTES

1. The ZTV is calculated with a surface offset 30m & from a viewing height of 1.8m above ground level. The terrain model is derived from EU-DEM data with a vertical accuracy of ± 7m. The ZTV was calculated using ArcMAP 10.5.1 software.

LEGEND

- Proposed Development Site Boundary
- Proposed Development Site Boundary 500 m Buffer
- Proposed Turbine Layout
- Proposed Substation Compound
- Proposed Temporary Construction Compound
- Vantage Point
- Vantage Point 2 km Viewing Arc
- Area Visible from Vantage Point 1
- Area Visible from Vantage Point 2
- Area Visible from Vantage Point 3
- Area Visible from Vantage Point 4
- Area Visible from Vantage Point 5
- Area Visible from Vantage Point 6
- Area Visible from Vantage Point 7

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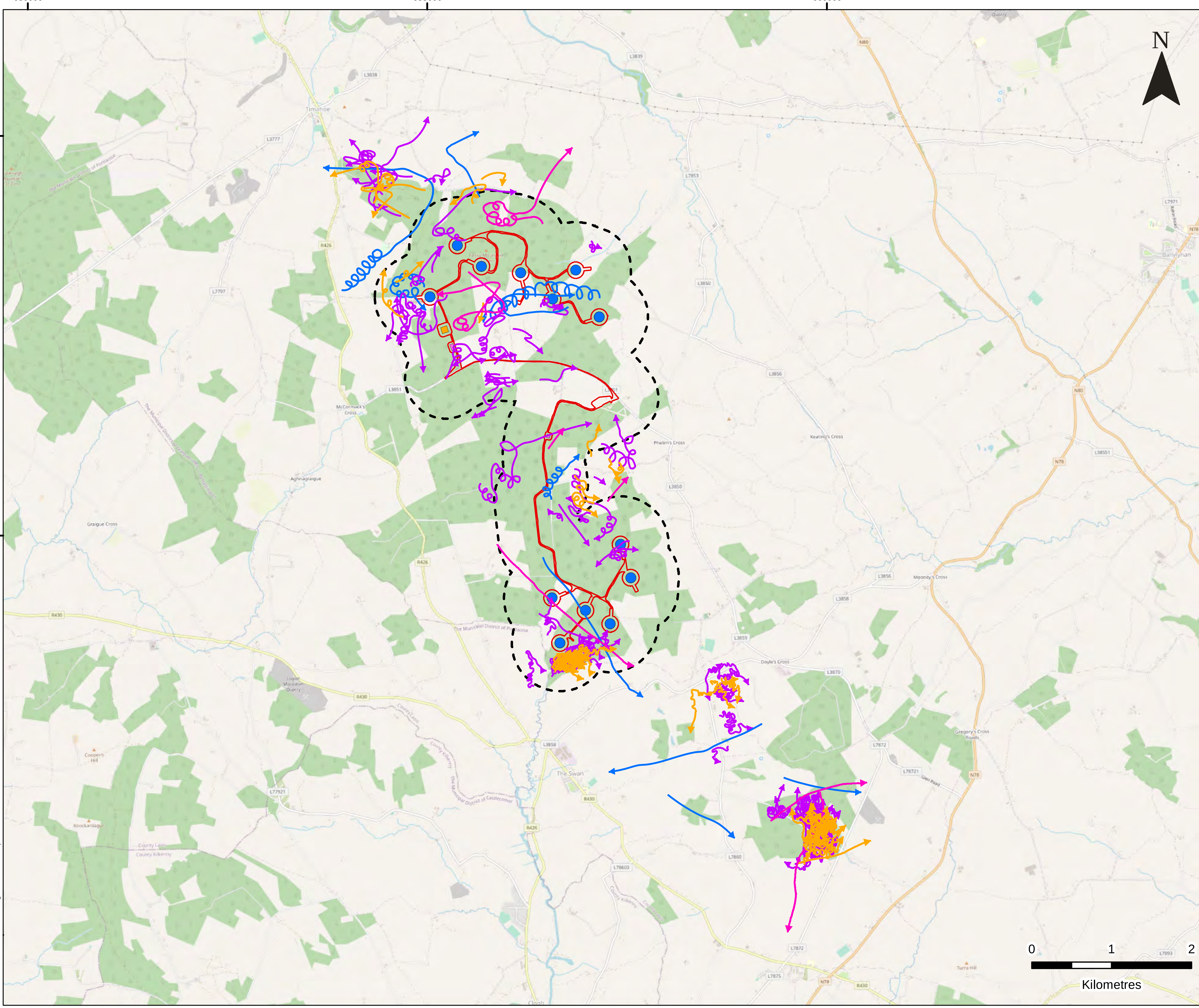
BIRD SURVEY REPORT
BREEDING SEASON 2021 &
NON-BREEDING SEASON 2021/22

VANTAGE POINT LOCATIONS & VIEWING ARCS

FIGURE 1

Scale	Date
1:45,000 @ A3	JULY 2023

02036.00787.0076.0 Vantage Point Locations and Viewing Arcs



LEGEND

- Proposed Development Site Boundary
- Proposed Development Site Boundary 500 m Buffer
- Proposed Turbine Layout
- Proposed Substation Compound
- Proposed Temporary Construction Compound

Flight Lines

- Kestrel (Breeding Season 2021)
- Peregrine (Breeding Season 2021)
- Kestrel (Non-Breeding Season 2021/22)
- Peregrine (Non-Breeding Season 2021/22)

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BIRD SURVEY REPORT
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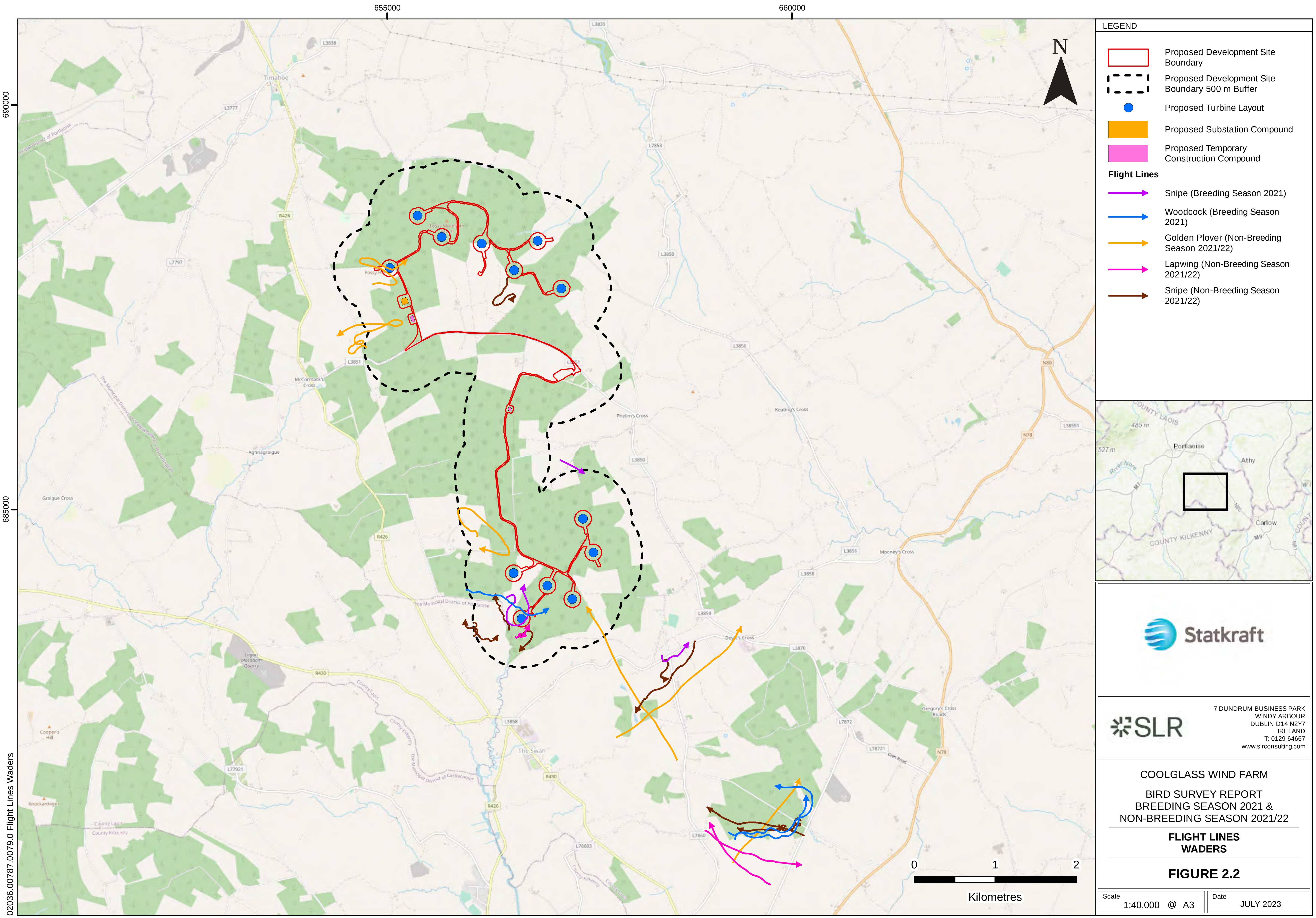
NON-BREEDING SEASON 2021/22

FLIGHT LINES RAPTORS

FIGURE 2.1

Scale	Date
1:45,000 @ A3	JULY 2023

02036.00787.0075.0 Flight Lines Raptors


655000
660000
690000
685000
N
LEGEND
Proposed Development Site Boundary
Proposed Development Site Boundary 500 m Buffer
Proposed Turbine Layout
Proposed Substation Compound
Proposed Temporary Construction Compound
Flight Lines
Snipe (Breeding Season 2021)
Woodcock (Breeding Season 2021)
Golden Plover (Non-Breeding Season 2021/22)
Lapwing (Non-Breeding Season 2021/22)
Snipe (Non-Breeding Season 2021/22)
Portlaoise
Athy
Carlow
COUNTY LAOIS
COUNTY KILKENNY
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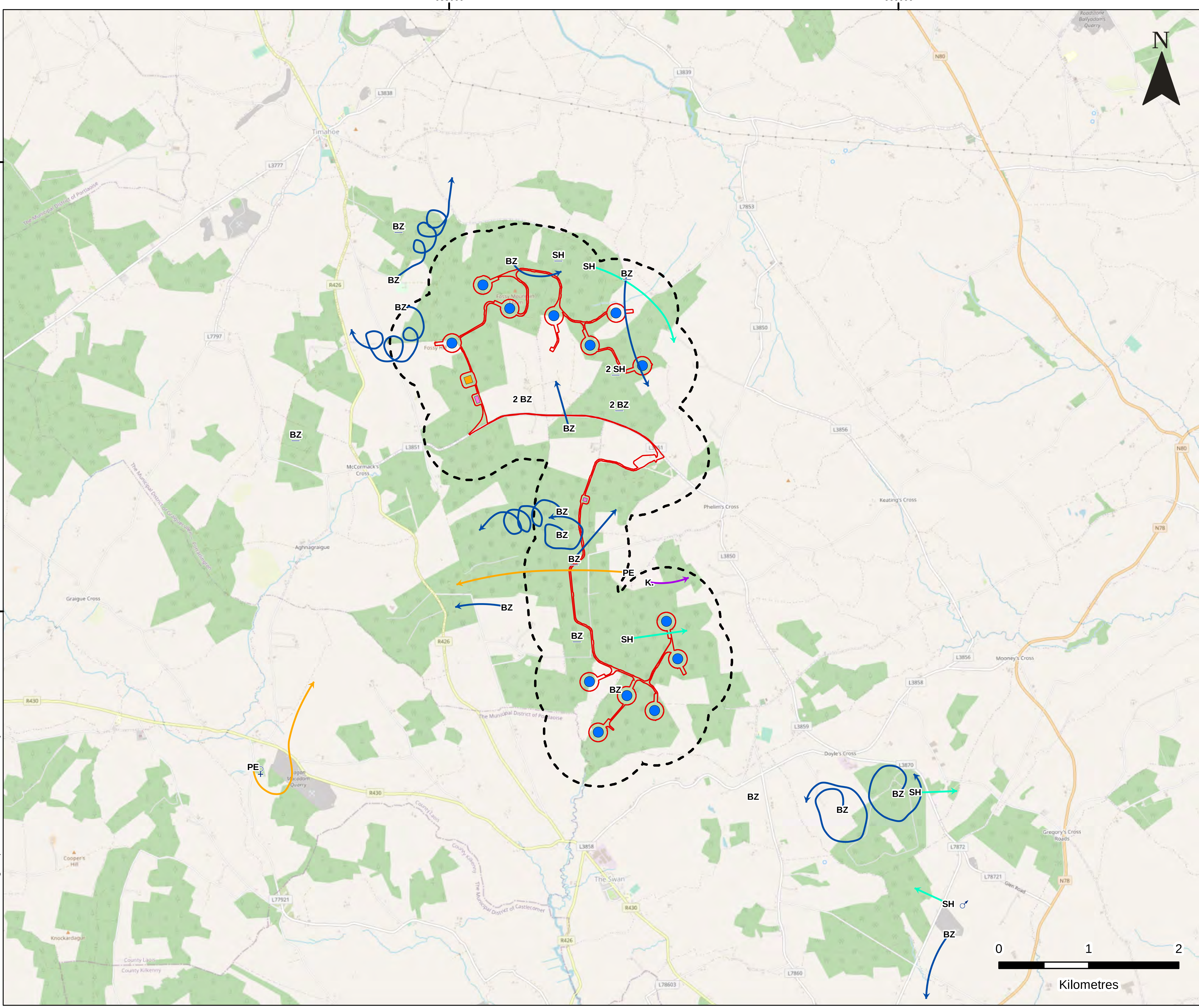
FLIGHT LINES
WADERS
FIGURE 2.2
Scale
1:40,000 @ A3
Date
JULY 2023
0
1
2
Kilometres
02036.00787.0079.0 Flight Lines Waders



LEGEND

- Proposed Development Site Boundary
- Proposed Development Site Boundary 500 m Buffer
- Proposed Turbine Layout
- Proposed Substation Compound
- Proposed Temporary Construction Compound

BTO Species Activity

- No Activity Observed
- ♂ Male
- ♀ Female
- — Calling

Raptor Species Flight Line

- Buzzard (BZ)
- Kestrel (K.)
- Peregrine (PE)
- Sparrowhawk (SH)

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BIRD SURVEY REPORT
BREEDING SEASON 2021 &
NON-BREEDING SEASON 2021/22

BREEDING RAPTOR DRIVEN TRANSECT SURVEY RESULTS

FIGURE 3

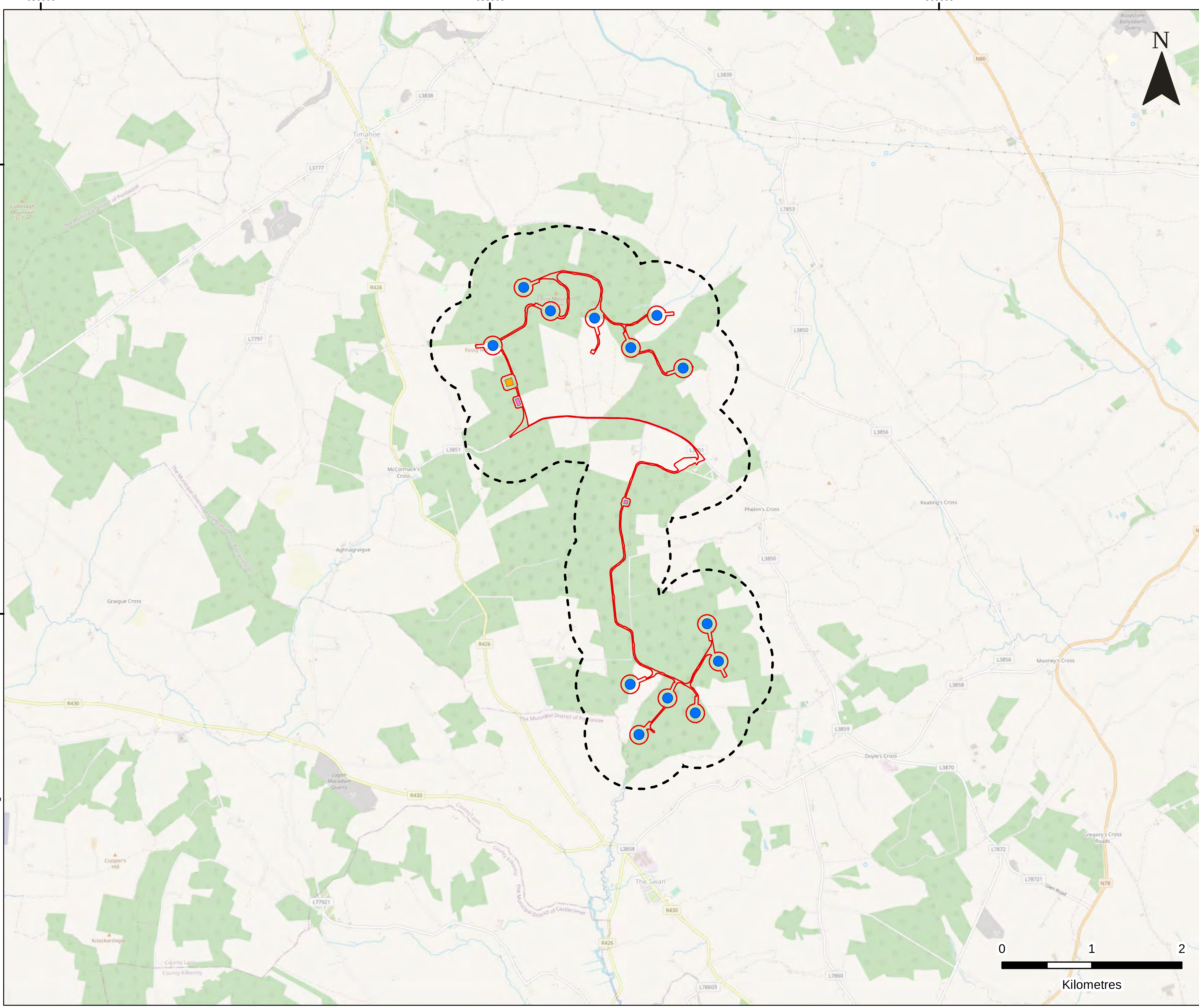
Scale	Date
1:40,000 @ A3	JULY 2023

02036.00787.0081.0 Breeding Raptor Driven Transect Survey Results

650000 655000 660000

690000

685000



LEGEND

- Proposed Development Site Boundary
- Proposed Development Site Boundary 500 m Buffer
- Proposed Turbine Layout
- Proposed Substation Compound
- Proposed Temporary Construction Compound

***No Swan or Geese Species Recorded Throughout the Season.**

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SWAN AND GOOSE FEEDING DISTRIBUTION SURVEY RESULTS

FIGURE 4

Scale	Date
1:40,000 @ A3	JULY 2023

02036.00787.0085.0 Swan and Goose Feeding Distribution

APPENDIX 01

Survey dates, times and observers

Table A1-1
Details of VP surveys undertaken from Coolglass Wind Farm Vantage Point 1

Date	Surveyor	Start	End	Survey Duration
28/04/2021	PC	14:00	17:00	03:00
28/04/2021	PC	17:30	20:30	03:00
19/05/2021	PC	17:30	20:30	03:00
30/05/2021	PC	13:30	16:30	03:00
05/06/2021	PC	07:30	10:30	03:00
05/07/2021	PC	09:00	12:00	03:00
30/07/2021	PC	07:10	10:10	03:00
31/07/2021	PC	09:30	12:30	03:00
27/08/2021	PC	16:30	19:30	03:00
28/08/2021	PC	07:00	10:00	03:00
11/09/2021	PC	08:00	11:00	03:00
13/09/2021	PC	17:15	20:15	03:00
04/11/2021	PC	07:02	10:02	03:00
04/11/2021	PC	10:32	13:32	03:00
04/12/2021	PC	08:30	11:30	03:00
10/12/2021	PC	13:20	16:20	03:00
21/12/2021	PC	09:30	12:30	03:00
29/12/2021	PC	13:30	16:30	03:00
03/02/2022	PC	07:40	10:40	03:00
04/02/2022	PC	11:10	14:10	03:00
16/02/2022	PC	07:15	10:15	03:00
28/02/2022	PC	13:48	16:48	03:00
02/04/2022	PC	06:33	09:33	03:00
02/04/2022	PC	10:03	13:03	03:00
Total Hours				**72**

Table A1-2
Details of VP surveys undertaken from Coolglass Wind Farm Vantage Point 2

Date	Surveyor	Start	End	Survey Duration
29/04/2021	PC	14:00	17:00	03:00
30/04/2021	PC	17:30	20:30	03:00
25/05/2021	PC	09:30	12:30	03:00
27/05/2021	PC	14:30	17:30	03:00
05/06/2021	PC	14:30	17:30	03:00
05/07/2021	PC	12:30	15:30	03:00
29/07/2021	PC	09:00	12:00	03:00
30/07/2021	PC	14:10	17:10	03:00
27/08/2021	PC	06:00	09:00	03:00
28/08/2021	PC	10:30	13:30	03:00
11/09/2021	PC	11:30	14:30	03:00
14/09/2021	PC	16:30	19:30	03:00
30/10/2021	PC	07:50	10:50	03:00
05/11/2021	PC	12:00	15:00	03:00
24/11/2021	PC	13:50	16:50	03:00
06/12/2021	PC	10:15	13:15	03:00
22/12/2021	PC	08:10	11:10	03:00
22/12/2021	PC	11:40	14:40	03:00
24/01/2022	PC	09:15	12:15	03:00
03/02/2022	PC	14:40	17:40	03:00
15/02/2022	PC	11:40	14:40	03:00
28/02/2022	PC	15:10	17:10	02:00
01/04/2022	PC	10:05	13:05	03:00
01/04/2022	PC	17:05	20:05	03:00
Total Hours				**72**

Table A1-3
Details of VP surveys undertaken from Coolglass Wind Farm Vantage Point 3

Date	Surveyor	Start	End	Survey Duration
27/04/2021	PC	14:00	17:00	03:00
29/04/2021	PC	17:30	20:30	03:00
19/05/2021	PC	14:00	17:00	03:00
25/05/2021	PC	16:30	19:30	03:00
05/06/2021	PC	18:00	21:00	03:00
05/07/2021	PC	16:00	19:00	03:00
29/07/2021	PC	18:00	21:00	03:00
30/07/2021	PC	10:40	13:40	03:00
27/08/2021	PC	09:30	12:30	03:00
28/08/2021	PC	17:30	20:30	03:00
14/09/2021	PC	09:30	12:30	03:00
15/09/2021	PC	13:00	16:00	03:00
30/10/2021	PC	11:20	14:20	03:00
30/10/2021	PC	14:50	17:50	03:00
04/12/2021	PC	12:00	15:00	03:00
09/12/2021	PC	13:00	16:00	03:00
21/12/2021	PC	13:00	16:00	03:00
22/12/2021	PC	15:10	16:40	01:30
23/12/2021	PC	08:40	10:10	01:30
04/02/2022	PC	07:40	10:40	03:00
04/02/2022	PC	14:40	17:40	03:00
17/02/2022	PC	07:10	10:10	03:00
01/03/2022	PC	08:30	11:30	03:00
01/04/2022	PC	06:35	09:35	03:00
02/04/2022	PC	17:03	20:03	03:00
Total Hours				**72**

Table A1-4
Details of VP surveys undertaken from Coolglass Wind Farm Vantage Point 4

Date	Surveyor	Start	End	Survey Duration
27/04/2021	PC	17:30	20:30	03:00
30/04/2021	PC	14:00	17:00	03:00
25/05/2021	PC	13:00	16:00	03:00
30/05/2021	PC	10:00	13:00	03:00
05/06/2021	PC	11:00	14:00	03:00
09/07/2021	PC	06:15	09:15	03:00
30/07/2021	PC	17:40	20:40	03:00
31/07/2021	PC	06:00	09:00	03:00
27/08/2021	PC	13:00	16:00	03:00
28/08/2021	PC	14:00	17:00	03:00
14/09/2021	PC	13:00	16:00	03:00
15/09/2021	PC	09:30	12:30	03:00
04/11/2021	PC	14:00	17:00	03:00
05/11/2021	PC	08:30	11:30	03:00
06/12/2021	PC	13:45	16:45	03:00
10/12/2021	PC	09:50	12:50	03:00
23/12/2021	PC	10:40	12:10	01:30
29/12/2021	PC	08:30	10:00	01:30
29/12/2021	PC	10:00	13:00	03:00
04/01/2022	PC	12:45	15:45	03:00
03/02/2022	PC	11:10	14:10	03:00
28/02/2022	PC	06:48	09:48	03:00
28/02/2022	PC	10:18	13:18	03:00
01/04/2022	PC	13:35	16:35	03:00
02/04/2022	PC	13:33	16:33	03:00
Total Hours				**72**

Table A1-5
Details of VP surveys undertaken from Coolglass Wind Farm Vantage Point 5

Date	Surveyor	Start	End	Survey Duration
30/04/2021	NV	11:30	14:30	03:00
01/05/2021	NV	10:25	13:25	03:00
15/05/2021	NV	10:35	13:35	03:00
15/05/2021	NV	14:05	17:05	03:00
14/06/2021	NV	09:20	12:20	03:00
14/06/2021	NV	12:50	15:50	03:00
14/07/2021	NV	14:45	17:45	03:00
15/07/2021	NV	13:45	16:45	03:00
09/08/2021	NV	07:30	10:30	03:00
11/08/2021	NV	17:30	20:30	03:00
20/09/2021	NV	13:40	16:40	03:00
20/09/2021	NV	17:05	20:05	03:00
22/10/2021	NV	07:30	10:30	03:00
22/10/2021	NV	15:45	18:45	03:00
10/11/2021	NV	12:20	15:20	03:00
11/11/2021	NV	14:10	17:10	03:00
17/12/2021	NV	10:10	13:10	03:00
17/12/2021	NV	13:40	16:40	03:00
05/01/2022	NV	08:05	11:05	03:00
05/01/2022	NV	11:35	14:35	03:00
10/02/2022	NV	07:40	10:40	03:00
10/02/2022	NV	15:00	18:00	03:00
12/03/2022	NV	12:50	15:50	03:00
12/03/2022	NV	06:50	09:50	03:00
Total Hours				**72**

Table A1-6
Details of VP surveys undertaken from Coolglass Wind Farm Vantage Point 6

Date	Surveyor	Start	End	Survey Duration
28/04/2021	NV	14:05	17:05	03:00
28/04/2021	NV	17:35	20:35	03:00
14/05/2021	NV	05:00	08:00	03:00
14/05/2021	NV	08:30	11:30	03:00
09/06/2021	NV	13:30	16:30	03:00
09/06/2021	NV	17:00	20:00	03:00
14/07/2021	NV	11:15	14:15	03:00
14/07/2021	NV	19:16	22:16	03:00
09/08/2021	NV	11:00	14:00	03:00
11/08/2021	NV	14:00	17:00	03:00
20/09/2021	NV	06:40	09:40	03:00
20/09/2021	NV	10:10	13:10	03:00
23/10/2021	NV	07:35	10:35	03:00
23/10/2021	NV	15:45	18:45	03:00
10/11/2021	NV	08:50	11:50	03:00
11/11/2021	NV	10:40	13:40	03:00
13/12/2021	NV	08:05	11:05	03:00
13/12/2021	NV	13:45	16:45	03:00
06/01/2022	NV	14:00	17:00	03:00
06/02/2022	NV	08:20	11:20	03:00
12/02/2022	NV	11:20	14:20	03:00
12/02/2022	NV	15:00	18:00	03:00
14/03/2022	NV	14:00	17:00	03:00
14/03/2022	NV	10:30	13:30	03:00
Total Hours				**72**

Table A1-7
Details of VP surveys undertaken from Coolglass Wind Farm Vantage Point 7

Date	Surveyor	Start	End	Survey Duration
30/04/2021	NV	08:00	11:00	03:00
01/05/2021	NV	06:55	09:55	03:00
14/05/2021	NV	14:20	17:20	03:00
14/05/2021	NV	18:50	21:50	03:00
10/06/2021	NV	13:50	16:50	03:00
10/06/2021	NV	17:20	20:20	03:00
15/07/2021	NV	10:15	13:15	03:00
15/07/2021	NV	19:15	22:15	03:00
09/08/2021	NV	14:30	17:30	03:00
11/08/2021	NV	10:30	13:30	03:00
17/09/2021	NV	13:20	16:20	03:00
17/09/2021	NV	16:50	19:50	03:00
12/10/2021	NV	11:15	14:15	03:00
12/10/2021	NV	14:45	17:45	03:00
08/11/2021	NV	14:10	17:10	03:00
12/11/2021	NV	09:40	12:40	03:00
20/12/2021	NV	13:45	16:45	03:00
04/01/2022	NV	09:00	12:00	03:00
04/01/2022	NV	12:30	15:30	03:00
11/02/2022	NV	12:30	15:30	03:00
11/02/2022	NV	09:00	12:00	03:00
15/03/2022	NV	14:30	17:30	03:00
15/03/2022	NV	11:00	14:00	03:00
Total Hours				**72**

Table A1-8
Details of breeding raptor surveys undertaken at Coolglass Wind Farm

Date	Surveyor	Start	End	Survey Duration
19/05/2021	PC	10:00	14:00	04:00
27/05/2021	PC	10:30	14:30	04:00
08/07/2021	PC	13:00	17:00	04:00
29/07/2021	PC	12:00	18:00	06:00
31/07/2021	PC	12:30	19:30	07:00
Total Hours				**25**

Table A1-9
Details of feeding distribution surveys undertaken at Coolglass Wind Farm

Date	Surveyor	Start	End	Survey Duration
22/10/2021	NV	10:30	14:10	03:40
23/10/2021	NV	10:35	14:35	04:00
13/12/2021	NV	11:05	13:45	02:40
29/12/2021	NV	11:10	14:10	03:00
04/01/2022	NV	15:30	17:00	01:30
05/01/2022	NV	14:35	16:00	01:25
10/02/2022	NV	10:40	13:40	03:00
11/02/2022	NV	07:50	09:00	01:10
11/02/2022	NV	15:30	18:00	02:30
14/03/2022	NV	07:00	10:00	03:00
15/03/2022	NV	07:05	10:05	03:00
Total Hours				**28:55**

APPENDIX 02

Weather Data

Table A2-1

Weather data collected during flight activity surveys undertaken at VP1

Date	Surveyor	Start	End	Survey Hour	Wind Speed	Wind Direction	Rain	Cloud Cover	Cloud Height	Visibility	Snow	Frost	Temp (°c)
28/04/2021	PC	14:00	17:00	1	3	NE	0	5	2	2	0	0	8
28/04/2021	PC	14:00	17:00	2	3	NE	0	4	2	2	0	0	8
28/04/2021	PC	14:00	17:00	3	3	NE	0	6	2	2	0	0	8
28/04/2021	PC	17:30	20:30	1	3	NE	0	5	2	2	0	0	8
28/04/2021	PC	17:30	20:30	2	3	NE	0	6	2	2	0	0	8
28/04/2021	PC	17:30	20:30	3	3	NE	0	6	2	2	0	0	8
19/05/2021	PC	17:30	20:30	1	2	W	0	4	2	2	0	0	12
19/05/2021	PC	17:30	20:30	2	2	W	0	5	2	2	0	0	12
19/05/2021	PC	17:30	20:30	3	2	W	2	8	2	2	0	0	11
30/05/2021	PC	13:30	16:30	1	2	S	0	6	2	2	0	0	17
30/05/2021	PC	13:30	16:30	2	2	S	0	5	2	2	0	0	18
30/05/2021	PC	13:30	16:30	3	2	S	0	5	2	2	0	0	18
05/06/2021	PC	07:30	10:30	1	2	S	2	7	2	2	0	0	12
05/06/2021	PC	07:30	10:30	2	2	S	2	7	2	2	0	0	14
05/06/2021	PC	07:30	10:30	3	2	S	2	8	2	2	0	0	14
05/07/2021	PC	09:00	12:00	1	2	S	0	2	2	2	0	0	15
05/07/2021	PC	09:00	12:00	2	2	S	0	4	2	2	0	0	17
05/07/2021	PC	09:00	12:00	3	2	S	0	6	2	2	0	0	14
30/07/2021	PC	07:10	10:10	1	2	NW	1	8	1	2	0	0	12

Date	Surveyor	Start	End	Survey Hour	Wind Speed	Wind Direction	Rain	Cloud Cover	Cloud Height	Visibility	Snow	Frost	Temp (°c)
30/07/2021	PC	07:10	10:10	2	1	NW	2	8	1	2	0	0	13
30/07/2021	PC	07:10	10:10	3	2	NW	1	8	1	2	0	0	13
31/07/2021	PC	09:30	12:30	1	2	W	1	8	1	2	0	0	13
31/07/2021	PC	09:30	12:30	2	2	W	2	8	1	2	0	0	15
31/07/2021	PC	09:30	12:30	3	2	W	0	8	1	2	0	0	15
27/08/2021	PC	16:30	19:30	1	1	E	0	1	2	2	0	0	22
27/08/2021	PC	16:30	19:30	2	1	E	0	1	2	2	0	0	22
27/08/2021	PC	16:30	19:30	3	2	E	0	1	2	2	0	0	20
28/08/2021	PC	07:00	10:00	1	1	E	0	0	0	2	0	0	11
28/08/2021	PC	07:00	10:00	2	1	E	0	0	0	2	0	0	14
28/08/2021	PC	07:00	10:00	3	1	E	0	0	0	2	0	0	15
11/09/2021	PC	08:00	11:00	1	2	NW	1	8	0	1	0	0	14
11/09/2021	PC	08:00	11:00	2	2	NW	1	7	0	2	0	0	15
11/09/2021	PC	08:00	11:00	3	2	NW	2	8	0	2	0	0	16
13/09/2021	PC	17:15	20:15	1	2	S	2	8	2	2	0	0	14
13/09/2021	PC	17:15	20:15	2	3	S	2	7	2	2	0	0	12
13/09/2021	PC	17:15	20:15	3	3	S	0	8	2	2	0	0	11
04/11/2021	PC	07:02	10:02	1	0	N	0	1	2	2	0	0	0
04/11/2021	PC	07:02	10:02	2	0	N	0	1	2	2	0	0	4
04/11/2021	PC	07:02	10:02	3	2	N	0	1	2	2	0	0	6
04/11/2021	PC	10:32	13:32	1	2	N	0	1	2	2	0	0	9

Date	Surveyor	Start	End	Survey Hour	Wind Speed	Wind Direction	Rain	Cloud Cover	Cloud Height	Visibility	Snow	Frost	Temp (°c)
04/11/2021	PC	10:32	13:32	2	3	N	0	1	2	2	0	0	10
04/11/2021	PC	10:32	13:32	3	3	N	0	2	2	2	0	0	10
04/12/2021	PC	08:30	11:30	1	2	N	0	8	1	2	0	0	4
04/12/2021	PC	08:30	11:30	2	2	N	0	8	1	2	0	0	5
04/12/2021	PC	08:30	11:30	3	2	N	0	8	1	2	0	0	5
10/12/2021	PC	13:20	16:20	1	3	W	0	2	2	2	0	0	4
10/12/2021	PC	13:20	16:20	2	3	W	0	2	2	2	0	0	4
10/12/2021	PC	13:20	16:20	3	3	W	0	3	2	2	0	0	4
21/12/2021	PC	09:30	12:30	1	1	SE	0	8	1	2	0	0	5
21/12/2021	PC	09:30	12:30	2	2	SE	0	8	1	2	0	0	5
21/12/2021	PC	09:30	12:30	3	2	SE	0	8	1	2	0	0	5
29/12/2021	PC	13:30	16:30	1	4	SW	0	8	1	2	0	0	14
29/12/2021	PC	13:30	16:30	2	4	SW	2	8	1	2	0	0	14
29/12/2021	PC	13:30	16:30	3	4	SW	1	8	1	2	0	0	13
03/02/2022	PC	07:40	10:40	1	3	SW	0	5	3	2	0	0	7
03/02/2022	PC	07:40	10:40	2	3	SW	0	4	3	2	0	0	9
03/02/2022	PC	07:40	10:40	3	4	SW	2	7	2	2	0	0	9
04/02/2022	PC	11:10	14:10	1	4	W	0	6	1	2	0	0	4
04/02/2022	PC	11:10	14:10	2	4	W	0	4	1	2	0	0	5
04/02/2022	PC	11:10	14:10	3	4	W	0	4	1	2	0	0	5
16/02/2022	PC	07:15	10:15	1	4	W	0	7	1	2	0	0	12

Date	Surveyor	Start	End	Survey Hour	Wind Speed	Wind Direction	Rain	Cloud Cover	Cloud Height	Visibility	Snow	Frost	Temp (°c)
16/02/2022	PC	07:15	10:15	2	5	W	1	8	1	2	0	0	12
16/02/2022	PC	07:15	10:15	3	5	W	4	8	1	1	0	0	12
28/02/2022	PC	13:48	16:48	1	1	W	1	8	1	2	0	0	8
28/02/2022	PC	13:48	16:48	2	1	W	0	6	2	2	0	0	8
28/02/2022	PC	13:48	16:48	3	1	W	0	5	2	2	0	0	7
02/04/2022	PC	06:33	09:33	1	2	NW	0	8	1	2	0	0	2
02/04/2022	PC	06:33	09:33	2	2	NW	0	8	1	2	0	0	3
02/04/2022	PC	06:33	09:33	3	2	NW	2	8	1	2	0	0	4
02/04/2022	PC	10:03	13:03	1	2	NW	1	8	1	2	0	0	6
02/04/2022	PC	10:03	13:03	2	1	NW	0	7	1	2	0	0	6
02/04/2022	PC	10:03	13:03	3	1	NW	0	7	1	2	0	0	6

Rain/ Precipitation
None 0
Drizzle 1
Light showers/snow 2
Heavy showers/snow 3
Heavy rain/snow 4

Cloud Cover
Expressed in oktas (n/8)

Cloud Height
Height of cloud above average height of viewshed
<150m 0
150-500m 1
>500m 2

Visibility
Poor (<1km) 0
Moderate (1-3km) 1
Good (>3km) 2

Lying Snow
None 0
On site 1
On higher ground 2

Frost
None 0
Ground 1
All day 2

Table A2-2
Weather data collected during flight activity surveys undertaken at VP2

Date	Surveyor	Start	End	Survey Hour	Wind Speed	Wind Direction	Rain	Cloud Cover	Cloud Height	Visibility	Snow	Frost	Temp (°c)
29/04/2021	PC	14:00	17:00	1	2	E	3	6	2	2	0	0	9
29/04/2021	PC	14:00	17:00	2	2	E	3	7	2	2	0	0	9
29/04/2021	PC	14:00	17:00	3	2	E	0	6	2	2	0	0	10
30/04/2021	PC	17:30	20:30	1	2	N	0	6	2	2	0	0	11
30/04/2021	PC	17:30	20:30	2	2	N	0	6	2	2	0	0	10
30/04/2021	PC	17:30	20:30	3	2	N	2	6	2	2	0	0	10
25/05/2021	PC	09:30	12:30	1	3	NW	0	8	1	2	0	0	10
25/05/2021	PC	09:30	12:30	2	3	NW	2	8	1	2	0	0	10
25/05/2021	PC	09:30	12:30	3	3	NW	2	6	2	2	0	0	11
27/05/2021	PC	14:30	17:30	1	3	SE	1	8	1	2	0	0	12
27/05/2021	PC	14:30	17:30	2	3	SE	1	8	1	2	0	0	10
27/05/2021	PC	14:30	17:30	3	3	SE	1	8	1	2	0	0	9
05/06/2021	PC	14:30	17:30	1	2	S	0	8	1	2	0	0	16
05/06/2021	PC	14:30	17:30	2	2	S	0	8	1	2	0	0	16
05/06/2021	PC	14:30	17:30	3	2	S	0	7	1	2	0	0	16
05/07/2021	PC	12:30	15:30	1	2	S	2	6	1	2	0	0	15
05/07/2021	PC	12:30	15:30	2	1	S	0	6	1	2	0	0	16
05/07/2021	PC	12:30	15:30	3	1	S	2	6	1	2	0	0	16
29/07/2021	PC	09:00	12:00	1	3	W	0	6	1	2	0	0	15
29/07/2021	PC	09:00	12:00	2	3	W	0	7	1	2	0	0	16

Date	Surveyor	Start	End	Survey Hour	Wind Speed	Wind Direction	Rain	Cloud Cover	Cloud Height	Visibility	Snow	Frost	Temp (°c)
29/07/2021	PC	09:00	12:00	3	3	W	0	7	1	2	0	0	16
30/07/2021	PC	14:10	17:10	1	3	NW	3	8	0	2	0	0	13
30/07/2021	PC	14:10	17:10	2	3	NW	3	6	1	2	0	0	15
30/07/2021	PC	14:10	17:10	3	4	NW	2	7	1	2	0	0	15
27/08/2021	PC	06:00	09:00	1	1	NE	0	0	0	2	0	0	11
27/08/2021	PC	06:00	09:00	2	1	NE	0	0	0	2	0	0	12
27/08/2021	PC	06:00	09:00	3	1	NE	0	0	0	2	0	0	15
28/08/2021	PC	10:30	13:30	1	1	E	0	1	1	2	0	0	16
28/08/2021	PC	10:30	13:30	2	2	E	0	1	1	2	0	0	17
28/08/2021	PC	10:30	13:30	3	1	E	0	2	1	2	0	0	18
11/09/2021	PC	11:30	14:30	1	2	NW	3	7	0	2	0	0	16
11/09/2021	PC	11:30	14:30	2	2	NW	3	7	0	2	0	0	16
11/09/2021	PC	11:30	14:30	3	2	NW	4	8	0	2	0	0	16
14/09/2021	PC	16:30	19:30	1	2	S	0	8	2	2	0	0	15
14/09/2021	PC	16:30	19:30	2	2	S	2	7	2	2	0	0	15
14/09/2021	PC	16:30	19:30	3	2	S	0	8	2	2	0	0	14
30/10/2021	PC	07:50	10:50	1	1	SW	0	0	0	2	0	0	5
30/10/2021	PC	07:50	10:50	2	1	SW	0	0	0	2	0	0	5
30/10/2021	PC	07:50	10:50	3	1	SW	0	0	0	2	0	0	6
05/11/2021	PC	12:00	15:00	1	2	W	0	8	0	2	0	0	10
05/11/2021	PC	12:00	15:00	2	3	W	0	8	0	2	0	0	10

Date	Surveyor	Start	End	Survey Hour	Wind Speed	Wind Direction	Rain	Cloud Cover	Cloud Height	Visibility	Snow	Frost	Temp (°c)
05/11/2021	PC	12:00	15:00	3	2	W	0	8	0	2	0	0	10
24/11/2021	PC	13:50	16:50	1	3	NW	0	3	1	2	0	0	7
24/11/2021	PC	13:50	16:50	2	2	NW	0	3	1	2	0	0	7
24/11/2021	PC	13:50	16:50	3	2	NW	0	2	1	2	0	0	6
06/12/2021	PC	10:15	13:15	1	3	W	3	6	1	2	0	0	4
06/12/2021	PC	10:15	13:15	2	3	W	0	4	1	2	0	0	5
06/12/2021	PC	10:15	13:15	3	3	W	0	4	1	2	0	0	5
22/12/2021	PC	08:10	11:10	1	3	SE	1	8	1	2	0	0	6
22/12/2021	PC	08:10	11:10	2	3	SE	1	8	1	2	0	0	7
22/12/2021	PC	08:10	11:10	3	3	SE	2	7	1	2	0	0	7
22/12/2021	PC	11:40	14:40	1	3	SE	1	8	0	1	0	0	6
22/12/2021	PC	11:40	14:40	2	3	SE	1	8	0	1	0	0	6
22/12/2021	PC	11:40	14:40	3	3	SE	1	8	0	1	0	0	6
24/01/2022	PC	09:15	12:15	1	2	SE	0	8	1	2	0	0	5
24/01/2022	PC	09:15	12:15	2	2	SE	0	8	1	2	0	0	5
24/01/2022	PC	09:15	12:15	3	2	SE	0	8	1	2	0	0	5
03/02/2022	PC	14:40	17:40	1	4	SW	0	5	1	2	0	0	9
03/02/2022	PC	14:40	17:40	2	4	SW	0	3	2	2	0	0	9
03/02/2022	PC	14:40	17:40	3	4	SW	0	8	1	2	0	0	8
15/02/2022	PC	11:40	14:40	1	4	W	0	8	0	1	0	0	8
15/02/2022	PC	11:40	14:40	2	3	W	0	8	1	2	0	0	9

Date	Surveyor	Start	End	Survey Hour	Wind Speed	Wind Direction	Rain	Cloud Cover	Cloud Height	Visibility	Snow	Frost	Temp (°c)
15/02/2022	PC	11:40	14:40	3	3	W	2	8	1	2	0	0	9
28/02/2022	PC	15:10	17:10	1	3	W	1	8	1	2	0	0	7
28/02/2022	PC	15:10	17:10	2	3	W	4	8	1	1	0	0	7
01/04/2022	PC	10:05	13:05	1	1	N	0	2	1	2	0	0	3
01/04/2022	PC	10:05	13:05	2	2	N	0	6	1	2	0	0	4
01/04/2022	PC	10:05	13:05	3	2	N	0	4	1	2	0	0	5
01/04/2022	PC	17:05	20:05	1	3	N	0	8	1	2	0	0	6
01/04/2022	PC	17:05	20:05	2	2	N	0	8	1	2	0	0	6
01/04/2022	PC	17:05	20:05	3	2	N	2	8	1	2	0	0	5

Rain/ Precipitation	Cloud Cover	Visibility	Lying Snow	Frost
None 0 Drizzle 1 Light showers/snow 2 Heavy showers/snow 3 Heavy rain/snow 4	Expressed in oktas (n/8) **Cloud Height** Height of cloud above average height of viewshed <150m 0 150-500m 1 >500m 2	Poor (<1km) 0 Moderate (1-3km) 1 Good (>3km) 2	None 0 On site 1 On higher ground 2	None 0 Ground 1 All day 2

Table A2-3
Weather data collected during flight activity surveys undertaken at VP3

Date	Surveyor	Start	End	Survey Hour	Wind Speed	Wind Direction	Rain	Cloud Cover	Cloud Height	Visibility	Snow	Frost	Temp (°c)
27/04/2021	PC	14:00	17:00	1	1	S	0	6	2	2	0	0	11
27/04/2021	PC	14:00	17:00	2	2	S	0	6	2	2	0	0	11
27/04/2021	PC	14:00	17:00	3	2	S	0	6	2	2	0	0	11
29/04/2021	PC	17:30	20:30	1	2	NE	0	4	2	2	0	0	10
29/04/2021	PC	17:30	20:30	2	1	NE	0	5	2	2	0	0	10
29/04/2021	PC	17:30	20:30	3	1	NE	0	5	2	2	0	0	9
19/05/2021	PC	14:00	17:00	1	3	W	2	6	2	2	0	0	13
19/05/2021	PC	14:00	17:00	2	2	W	0	5	2	2	0	0	13
19/05/2021	PC	14:00	17:00	3	2	W	0	4	2	2	0	0	13
25/05/2021	PC	16:30	19:30	1	3	NW	2	6	2	2	0	0	11
25/05/2021	PC	16:30	19:30	2	3	NW	2	7	2	2	0	0	10
25/05/2021	PC	16:30	19:30	3	3	NW	2	6	2	2	0	0	9
05/06/2021	PC	18:00	21:00	1	3	S	0	7	1	2	0	0	16
05/06/2021	PC	18:00	21:00	2	2	S	0	6	1	2	0	0	15
05/06/2021	PC	18:00	21:00	3	2	S	0	6	1	2	0	0	14
05/07/2021	PC	16:00	19:00	1	3	S	0	6	2	2	0	0	16
05/07/2021	PC	16:00	19:00	2	3	S	2	7	1	2	0	0	15
05/07/2021	PC	16:00	19:00	3	3	S	2	7	1	2	0	0	14
29/07/2021	PC	18:00	21:00	1	2	W	0	8	1	2	0	0	16
29/07/2021	PC	18:00	21:00	2	2	W	3	8	1	2	0	0	14

Date	Surveyor	Start	End	Survey Hour	Wind Speed	Wind Direction	Rain	Cloud Cover	Cloud Height	Visibility	Snow	Frost	Temp (°c)
29/07/2021	PC	18:00	21:00	3	2	W	4	8	1	2	0	0	13
30/07/2021	PC	10:40	13:40	1	3	NW	0	8	0	2	0	0	13
30/07/2021	PC	10:40	13:40	2	3	NW	2	8	0	2	0	0	13
30/07/2021	PC	10:40	13:40	3	3	NW	2	8	0	2	0	0	13
27/08/2021	PC	09:30	12:30	1	3	NE	0	2	0	2	0	0	19
27/08/2021	PC	09:30	12:30	2	3	E	0	1	1	2	0	0	19
27/08/2021	PC	09:30	12:30	3	2	E	0	1	2	2	0	0	21
28/08/2021	PC	17:30	20:30	1	2	E	0	4	1	2	0	0	21
28/08/2021	PC	17:30	20:30	2	2	E	0	4	1	2	0	0	19
28/08/2021	PC	17:30	20:30	3	2	E	0	3	1	2	0	0	18
14/09/2021	PC	09:30	12:30	1	2	S	0	8	0	1	0	0	14
14/09/2021	PC	09:30	12:30	2	2	S	0	6	1	2	0	0	15
14/09/2021	PC	09:30	12:30	3	2	S	0	5	1	2	0	0	15
15/09/2021	PC	13:00	16:00	1	3	W	2	8	1	2	0	0	15
15/09/2021	PC	13:00	16:00	2	2	W	0	8	1	2	0	0	15
15/09/2021	PC	13:00	16:00	3	2	W	0	7	1	2	0	0	15
30/10/2021	PC	11:20	14:20	1	3	SW	0	3	1	2	0	0	10
30/10/2021	PC	11:20	14:20	2	3	SW	0	4	1	2	0	0	10
30/10/2021	PC	11:20	14:20	3	3	SW	0	4	1	2	0	0	10
30/10/2021	PC	14:50	17:50	1	3	SW	0	5	1	2	0	0	10
30/10/2021	PC	14:50	17:50	2	3	SW	0	5	1	2	0	0	10

Date	Surveyor	Start	End	Survey Hour	Wind Speed	Wind Direction	Rain	Cloud Cover	Cloud Height	Visibility	Snow	Frost	Temp (°c)
30/10/2021	PC	14:50	17:50	3	3	SW	0	6	1	2	0	0	9
04/12/2021	PC	12:00	15:00	1	2	N	0	8	1	2	0	0	6
04/12/2021	PC	12:00	15:00	2	2	N	0	8	1	2	0	0	6
04/12/2021	PC	12:00	15:00	3	2	N	0	8	1	2	0	0	5
09/12/2021	PC	13:00	16:00	1	3	W	0	7	1	2	0	0	4
09/12/2021	PC	13:00	16:00	2	3	W	1	7	1	2	0	0	4
09/12/2021	PC	13:00	16:00	3	3	W	1	8	1	2	0	0	3
21/12/2021	PC	13:00	16:00	1	3	SE	0	8	1	2	0	0	5
21/12/2021	PC	13:00	16:00	2	3	SE	0	8	1	2	0	0	5
21/12/2021	PC	13:00	16:00	3	3	SE	0	8	1	2	0	0	5
22/12/2021	PC	15:10	16:40	1	3	SE	1	8	0	1	0	0	6
22/12/2021	PC	15:10	16:40	2	3	SE	1	8	0	1	0	0	5
23/12/2021	PC	08:40	10:10	1	2	SW	0	8	1	2	0	0	9
23/12/2021	PC	08:40	10:10	2	2	SW	0	7	1	2	0	0	11
04/02/2022	PC	07:40	10:40	1	3	W	0	2	2	2	0	0	0
04/02/2022	PC	07:40	10:40	2	3	W	0	2	2	2	0	0	2
04/02/2022	PC	07:40	10:40	3	3	W	0	3	2	2	0	0	4
04/02/2022	PC	14:40	17:40	1	3	W	2	5	1	2	0	0	5
04/02/2022	PC	14:40	17:40	2	3	W	0	3	2	2	0	0	5
04/02/2022	PC	14:40	17:40	3	3	NW	0	3	2	2	0	0	5
17/02/2022	PC	07:10	10:10	1	3	W	0	6	1	2	0	0	3

Date	Surveyor	Start	End	Survey Hour	Wind Speed	Wind Direction	Rain	Cloud Cover	Cloud Height	Visibility	Snow	Frost	Temp (°c)
17/02/2022	PC	07:10	10:10	2	4	W	2	7	1	2	0	0	4
17/02/2022	PC	07:10	10:10	3	3	W	0	8	1	2	0	0	4
01/03/2022	PC	08:30	11:30	1	1	NE	0	2	2	2	0	1	0
01/03/2022	PC	08:30	11:30	2	1	NE	0	3	2	2	0	1	0
01/03/2022	PC	08:30	11:30	3	1	NE	0	3	2	2	0	1	2
01/04/2022	PC	06:35	09:35	1	0	N	0	0	0	2	0	1	-2
01/04/2022	PC	06:35	09:35	2	1	N	0	0	0	2	0	1	-1
01/04/2022	PC	06:35	09:35	3	1	N	0	0	0	2	0	1	0
02/04/2022	PC	17:03	20:03	1	2	N	2	5	1	2	0	0	8
02/04/2022	PC	17:03	20:03	2	1	N	0	5	1	2	0	0	6
02/04/2022	PC	17:03	20:03	3	1	N	3	7	1	2	0	0	6

Rain/ Precipitation
None 0
Drizzle 1
Light showers/snow 2
Heavy showers/snow 3
Heavy rain/snow 4

Cloud Cover
Expressed in oktas (n/8)
Cloud Height
Height of cloud above average height of viewshed
<150m 0
150-500m 1
>500m 2

Visibility
Poor (<1km) 0
Moderate (1-3km) 1
Good (>3km) 2

Lying Snow
None 0
On site 1
On higher ground 2

Frost
None 0
Ground 1
All day 2

Table A2-4
Weather data collected during flight activity surveys undertaken at VP4

Date	Surveyor	Start	End	Survey Hour	Wind Speed	Wind Direction	Rain	Cloud Cover	Cloud Height	Visibility	Snow	Frost	Temp (°c)
27/04/2021	PC	17:30	20:30	1	2	S	0	5	2	2	0	0	11
27/04/2021	PC	17:30	20:30	2	2	SE	0	6	2	2	0	0	11
27/04/2021	PC	17:30	20:30	3	2	SE	0	6	2	2	0	0	10
30/04/2021	PC	14:00	17:00	1	2	N	0	3	3	2	2	0	11
30/04/2021	PC	14:00	17:00	2	2	N	0	4	4	2	2	0	11
30/04/2021	PC	14:00	17:00	3	2	N	0	5	5	2	2	0	11
25/05/2021	PC	13:00	16:00	1	3	NW	0	7	2	2	0	0	11
25/05/2021	PC	13:00	16:00	2	3	NW	2	7	2	2	0	0	11
25/05/2021	PC	13:00	16:00	3	3	NW	2	6	2	2	0	0	11
30/05/2021	PC	10:00	13:00	1	2	S	0	3	2	2	0	0	16
30/05/2021	PC	10:00	13:00	2	2	S	0	4	2	2	0	0	17
30/05/2021	PC	10:00	13:00	3	2	S	0	6	2	2	0	0	17
05/06/2021	PC	11:00	14:00	1	2	S	2	8	1	2	0	0	15
05/06/2021	PC	11:00	14:00	2	2	S	2	7	1	2	0	0	15
05/06/2021	PC	11:00	14:00	3	1	S	2	8	1	2	0	0	15
09/07/2021	PC	06:15	09:15	1	2	S	0	8	1	2	0	0	12
09/07/2021	PC	06:15	09:15	2	2	S	0	8	1	2	0	0	13
09/07/2021	PC	06:15	09:15	3	3	S	0	8	1	2	0	0	13
30/07/2021	PC	17:40	20:40	1	4	NW	2	7	1	2	0	0	15
30/07/2021	PC	17:40	20:40	2	4	NW	0	7	1	2	0	0	15

Date	Surveyor	Start	End	Survey Hour	Wind Speed	Wind Direction	Rain	Cloud Cover	Cloud Height	Visibility	Snow	Frost	Temp (°c)
30/07/2021	PC	17:40	20:40	3	3	NW	0	7	1	2	0	0	14
31/07/2021	PC	06:00	09:00	1	3	W	0	8	0	2	0	0	12
31/07/2021	PC	06:00	09:00	2	3	W	0	8	0	2	0	0	13
31/07/2021	PC	06:00	09:00	3	3	W	1	8	0	2	0	0	13
27/08/2021	PC	13:00	16:00	1	2	E	0	1	2	2	0	0	21
27/08/2021	PC	13:00	16:00	2	2	E	0	1	2	2	0	0	21
27/08/2021	PC	13:00	16:00	3	2	E	0	1	2	2	0	0	21
28/08/2021	PC	14:00	17:00	1	3	E	0	3	1	2	0	0	19
28/08/2021	PC	14:00	17:00	2	2	E	0	3	1	2	0	0	21
28/08/2021	PC	14:00	17:00	3	2	E	0	4	1	2	0	0	21
14/09/2021	PC	13:00	16:00	1	2	S	0	7	2	2	0	0	15
14/09/2021	PC	13:00	16:00	2	3	S	0	7	2	2	0	0	15
14/09/2021	PC	13:00	16:00	3	2	S	0	8	2	2	0	0	15
15/09/2021	PC	09:30	12:30	1	1	W	0	8	0	0	0	0	14
15/09/2021	PC	09:30	12:30	2	1	W	0	8	1	2	0	0	15
15/09/2021	PC	09:30	12:30	3	1	W	0	8	1	2	0	0	15
04/11/2021	PC	14:00	17:00	1	3	N	0	6	1	2	0	0	9
04/11/2021	PC	14:00	17:00	2	2	N	0	7	1	2	0	0	9
04/11/2021	PC	14:00	17:00	3	3	N	0	7	1	2	0	0	7
05/11/2021	PC	08:30	11:30	1	2	W	0	8	0	2	0	0	8
05/11/2021	PC	08:30	11:30	2	2	W	0	8	0	2	0	0	9

Date	Surveyor	Start	End	Survey Hour	Wind Speed	Wind Direction	Rain	Cloud Cover	Cloud Height	Visibility	Snow	Frost	Temp (°c)
05/11/2021	PC	08:30	11:30	3	2	W	0	8	0	2	0	0	9
06/12/2021	PC	13:45	16:45	1	3	W	0	4	1	2	0	0	4
06/12/2021	PC	13:45	16:45	2	3	W	0	6	1	2	0	0	4
06/12/2021	PC	13:45	16:45	3	3	W	3	7	1	2	0	0	4
10/12/2021	PC	09:50	12:50	1	2	W	0	2	1	2	0	1	2
10/12/2021	PC	09:50	12:50	2	3	W	0	3	1	2	0	1	3
10/12/2021	PC	09:50	12:50	3	3	W	0	1	1	2	0	0	4
23/12/2021	PC	10:40	12:10	1	2	SW	0	8	1	2	0	0	11
23/12/2021	PC	10:40	12:10	2	3	SW	0	3	1	2	0	0	12
29/12/2021	PC	08:30	10:00	1	4	SW	0	8	1	2	0	0	8
29/12/2021	PC	08:30	10:00	2	4	SW	0	8	1	2	0	0	9
29/12/2021	PC	10:00	13:00	1	4	SW	2	8	1	2	0	0	10
29/12/2021	PC	10:00	13:00	2	4	SW	2	8	1	2	0	0	12
29/12/2021	PC	10:00	13:00	3	4	SW	0	8	1	2	0	0	14
04/01/2022	PC	12:45	15:45	1	3	S	0	8	0	1	0	0	5
04/01/2022	PC	12:45	15:45	2	2	S	0	8	0	1	0	0	5
04/01/2022	PC	12:45	15:45	3	2	S	0	8	0	1	0	0	5
03/02/2022	PC	11:10	14:10	1	4	SW	1	8	1	1	0	0	9
03/02/2022	PC	11:10	14:10	2	4	SW	2	8	1	2	0	0	10
03/02/2022	PC	11:10	14:10	3	4	SW	0	6	1	2	0	0	10
28/02/2022	PC	06:48	09:48	1	2	W	0	8	2	1	0	0	7

Date	Surveyor	Start	End	Survey Hour	Wind Speed	Wind Direction	Rain	Cloud Cover	Cloud Height	Visibility	Snow	Frost	Temp (°c)
28/02/2022	PC	06:48	09:48	2	1	W	0	8	1	1	0	0	7
28/02/2022	PC	06:48	09:48	3	1	W	0	8	1	2	0	0	8
28/02/2022	PC	10:18	13:18	1	1	W	0	8	1	2	0	0	8
28/02/2022	PC	10:18	13:18	2	2	W	2	8	1	2	0	0	8
28/02/2022	PC	10:18	13:18	3	2	W	1	8	1	2	0	0	8
01/04/2022	PC	13:35	16:35	1	3	N	0	4	1	2	0	0	6
01/04/2022	PC	13:35	16:35	2	3	N	0	5	1	2	0	0	6
01/04/2022	PC	13:35	16:35	3	3	N	0	7	1	2	0	0	6
02/04/2022	PC	13:33	16:33	1	2	NW	3	7	1	2	0	0	6
02/04/2022	PC	13:33	16:33	2	2	NW	3	5	1	2	0	0	8
02/04/2022	PC	13:33	16:33	3	2	NW	3	6	1	2	0	0	9

Rain/ Precipitation
None 0
Drizzle 1
Light showers/snow 2
Heavy showers/snow 3
Heavy rain/snow 4

Cloud Cover
Expressed in oktas (n/8)

Cloud Height
Height of cloud above average height of viewshed
<150m 0
150-500m 1
>500m 2

Visibility
Poor (<1km) 0
Moderate (1-3km) 1
Good (>3km) 2

Lying Snow
None 0
On site 1
On higher ground 2

Frost
None 0
Ground 1
All day 2

Table A2-5
Weather data collected during flight activity surveys undertaken at VP5

Date	Surveyor	Start	End	Survey Hour	Wind Speed	Wind Direction	Rain	Cloud Cover	Cloud Height	Visibility	Snow	Frost	Temp (°c)
30/04/2021	NV	11:30	14:30	1	2	NE	0	6	2	2	0	0	11
30/04/2021	NV	11:30	14:30	2	3	NE	2	6	2	2	0	0	11
30/04/2021	NV	11:30	14:30	3	3	NE	2	7	2	2	0	0	10
01/05/2021	NV	10:25	13:25	1	1	SE	0	0	0	2	0	0	8
01/05/2021	NV	10:25	13:25	2	1	SE	0	0	0	2	0	0	9
01/05/2021	NV	10:25	13:25	3	1	SE	0	0	0	2	0	0	10
15/05/2021	NV	10:35	13:35	1	1	SW	0	3	2	2	0	0	11
15/05/2021	NV	10:35	13:35	2	1	SW	0	3	2	2	0	0	13
15/05/2021	NV	10:35	13:35	3	2	S	0	2	2	2	0	0	14
15/05/2021	NV	14:05	17:05	1	2	S	0	2	2	2	0	0	15
15/05/2021	NV	14:05	17:05	2	2	SE	0	1	2	2	0	0	15
15/05/2021	NV	14:05	17:05	3	2	SE	0	1	2	2	0	0	16
14/06/2021	NV	09:20	12:20	1	2	NW	0	0	2	2	0	0	16
14/06/2021	NV	09:20	12:20	2	2	W	0	0	2	2	0	0	17
14/06/2021	NV	09:20	12:20	3	1	SW	0	1	2	2	0	0	19
14/06/2021	NV	12:50	15:50	1	1	SW	0	1	2	2	0	0	19
14/06/2021	NV	12:50	15:50	2	1	SW	0	0	2	2	0	0	21
14/06/2021	NV	12:50	15:50	3	1	SW	0	0	2	2	0	0	21
14/07/2021	NV	14:45	17:45	1	1	W	0	0	2	2	0	0	22
14/07/2021	NV	14:45	17:45	2	1	W	0	0	2	2	0	0	23

Date	Surveyor	Start	End	Survey Hour	Wind Speed	Wind Direction	Rain	Cloud Cover	Cloud Height	Visibility	Snow	Frost	Temp (°c)
14/07/2021	NV	14:45	17:45	3	1	W	0	1	2	2	0	0	22
15/07/2021	NV	13:45	16:45	1	2	SW	0	0	n/a	2	0	0	22
15/07/2021	NV	13:45	16:45	2	2	S	0	0	n/a	2	0	0	23
15/07/2021	NV	13:45	16:45	3	2	S	0	0	n/a	2	0	0	23
09/08/2021	NV	07:30	10:30	1	2	SW	0	1	2	2	0	0	18
09/08/2021	NV	07:30	10:30	2	2	SW	0	2	2	2	0	0	17
09/08/2021	NV	07:30	10:30	3	2	W	0	2	2	2	0	0	18
11/08/2021	NV	17:30	20:30	1	2	W	0	1	2	2	0	0	18
11/08/2021	NV	17:30	20:30	2	2	W	0	2	2	2	0	0	18
11/08/2021	NV	17:30	20:30	3	1	W	0	1	2	2	0	0	17
20/09/2021	NV	13:40	16:40	1	3	W	0	6	1	2	0	0	15
20/09/2021	NV	13:40	16:40	2	2	W	2	7	1	2	0	0	15
20/09/2021	NV	13:40	16:40	3	2	NW	2	7	1	2	0	0	15
20/09/2021	NV	17:05	20:05	1	2	NW	2	6	1	2	0	0	15
20/09/2021	NV	17:05	20:05	2	2	NW	0	6	1	2	0	0	15
20/09/2021	NV	17:05	20:05	3	2	NW	0	5	1	2	0	0	14
22/10/2021	NV	07:30	10:30	1	3	W	1	6	1	2	0	0	7
22/10/2021	NV	07:30	10:30	2	3	W	0	7	1	2	0	0	8
22/10/2021	NV	07:30	10:30	3	3	W	0	7	1	2	0	0	9
22/10/2021	NV	15:45	18:45	1	2	W	0	6	1	2	0	0	9
22/10/2021	NV	15:45	18:45	2	2	W	0	6	1	2	0	0	8

Date	Surveyor	Start	End	Survey Hour	Wind Speed	Wind Direction	Rain	Cloud Cover	Cloud Height	Visibility	Snow	Frost	Temp (°c)
22/10/2021	NV	15:45	18:45	3	1	SW	0	5	1	2	0	0	8
10/11/2021	NV	12:20	15:20	1	1	SW	0	7	1	2	0	0	10
10/11/2021	NV	12:20	15:20	2	2	SW	0	6	1	2	0	0	10
10/11/2021	NV	12:20	15:20	3	2	SW	0	6	1	2	0	0	10
11/11/2021	NV	14:10	17:10	1	3	SE	0	6	2	2	0	0	11
11/11/2021	NV	14:10	17:10	2	3	SE	0	8	1	2	0	0	12
11/11/2021	NV	14:10	17:10	3	4	SE	3	8	1	2	0	0	11
17/12/2021	NV	10:10	13:10	1	2	SE	0	5	1	2	0	0	8
17/12/2021	NV	10:10	13:10	2	2	SE	0	6	1	2	0	0	8
17/12/2021	NV	10:10	13:10	3	2	SE	0	5	1	2	0	0	7
17/12/2021	NV	13:40	16:40	1	2	SE	0	8	1	2	0	0	8
17/12/2021	NV	13:40	16:40	2	2	SE	0	7	1	2	0	0	7
17/12/2021	NV	13:40	16:40	3	1	SE	0	7	1	2	0	0	7
05/01/2022	NV	08:05	11:05	1	3	W	0	3	2	2	0	1	-1
05/01/2022	NV	08:05	11:05	2	2	WNW	0	4	2	2	0	1	0
05/01/2022	NV	08:05	11:05	3	2	WNW	0	3	2	2	0	0	0
05/01/2022	NV	11:35	14:35	1	2	WNW	0	5	2	2	0	0	2
05/01/2022	NV	11:35	14:35	2	2	WNW	0	3	2	2	0	0	2
05/01/2022	NV	11:35	14:35	3	1	W	0	3	2	2	0	0	2
10/02/2022	NV	07:40	10:40	1	3	W	0	8	1		1	0	9
10/02/2022	NV	07:40	10:40	2	4	W	1	8	1		1	0	10

Date	Surveyor	Start	End	Survey Hour	Wind Speed	Wind Direction	Rain	Cloud Cover	Cloud Height	Visibility	Snow	Frost	Temp (°c)
10/02/2022	NV	07:40	10:40	3	4	WNW	1	8	1		1	0	10
10/02/2022	NV	15:00	18:00	1	2	W	0	5	1	1	0	0	7
10/02/2022	NV	15:00	18:00	2	2	W	0	6	1	2	0	0	7
10/02/2022	NV	15:00	18:00	3	3	WNW	2	6	1	1	0	0	6
12/03/2022	NV	06:50	09:50	1	2	WSW	0	3	1	2	0	0	7
12/03/2022	NV	06:50	09:50	2	2	WSW	0	4	1	2	0	0	8
12/03/2022	NV	06:50	09:50	3	2	SW	1	6	1	1	0	0	9
12/03/2022	NV	12:50	15:50	1	2	WSW	0	5	1	2	0	0	8
12/03/2022	NV	12:50	15:50	2	2	SW	0	6	1	2	0	0	9
12/03/2022	NV	12:50	15:50	3	1	SW	0	6	1	2	0	0	9

Rain/ Precipitation

None	0
Drizzle	1
Light showers/snow	2
Heavy showers/snow	3
Heavy rain/snow	4

Cloud Cover

Expressed in oktas (n/8)

Cloud Height

Height of cloud above average height of viewshed

<150m	0
150-500m	1
>500m	2

Visibility

Poor (<1km)	0
Moderate (1-3km)	1
Good (>3km)	2

Lying Snow

None	0
On site	1
On higher ground	2

Frost

None	0
Ground	1
All day	2

Table A2-6
Weather data collected during flight activity surveys undertaken at VP6

Date	Surveyor	Start	End	Survey Hour	Wind Speed	Wind Direction	Rain	Cloud Cover	Cloud Height	Visibility	Snow	Frost	Temp (°c)
28/04/2021	NV	14:05	17:05	1	1	NE	0	3	2	2	0	0	12
28/04/2021	NV	14:05	17:05	2	1	NE	0	3	2	2	0	0	13
28/04/2021	NV	14:05	17:05	3	1	NE	0	4	2	2	0	0	12
28/04/2021	NV	17:35	20:35	1	1	NE	0	4	2	2	0	0	12
28/04/2021	NV	17:35	20:35	2	2	NE	0	5	2	2	0	0	11
28/04/2021	NV	17:35	20:35	3	2	NE	0	4	2	2	0	0	11
14/05/2021	NV	05:00	08:00	1	1	SW	0	3	2	2	0	0	8
14/05/2021	NV	05:00	08:00	2	1	SW	0	3	2	2	0	0	11
14/05/2021	NV	05:00	08:00	3	2	SE	0	4	2	2	0	0	14
14/05/2021	NV	08:30	11:30	1	1	SE	0	2	2	2	0	0	13
14/05/2021	NV	08:30	11:30	2	1	SE	0	1	2	2	0	0	14
14/05/2021	NV	08:30	11:30	3	1	S	0	1	2	2	0	0	15
09/06/2021	NV	13:30	16:30	1	3	SW	0	5	2	2	0	0	15
09/06/2021	NV	13:30	16:30	2	3	SW	0	5	2	2	0	0	15
09/06/2021	NV	13:30	16:30	3	3	SW	0	6	2	2	0	0	16
09/06/2021	NV	17:00	20:00	1	3	SW	0	6	2	2	0	0	10
09/06/2021	NV	17:00	20:00	2	2	SW	0	5	2	2	0	0	16
09/06/2021	NV	17:00	20:00	3	2	SW	0	5	2	2	0	0	15
14/07/2021	NV	11:15	14:15	1	1	NW	0	1	2	2	0	0	19
14/07/2021	NV	11:15	14:15	2	0	n/a	0	0	n/a	2	0	0	21

Date	Surveyor	Start	End	Survey Hour	Wind Speed	Wind Direction	Rain	Cloud Cover	Cloud Height	Visibility	Snow	Frost	Temp (°c)
14/07/2021	NV	11:15	14:15	3	1	NW	0	0	n/a	2	0	0	22
14/07/2021	NV	19:16	22:16	1	1	W	0	1	2	2	0	0	21
14/07/2021	NV	19:16	22:16	2	1	W	0	1	2	2	0	0	20
14/07/2021	NV	19:16	22:16	3	1	NW	0	2	2	2	0	0	20
09/08/2021	NV	11:00	14:00	1	2	SW	0	2	2	2	0	0	18
09/08/2021	NV	11:00	14:00	2	1	SW	0	2	2	2	0	0	19
09/08/2021	NV	11:00	14:00	3	1	SW	2	3	2	2	0	0	19
11/08/2021	NV	14:00	17:00	1	3	SW	0	3	2	2	0	0	19
11/08/2021	NV	14:00	17:00	2	3	SW	0	3	2	2	0	0	19
11/08/2021	NV	14:00	17:00	3	3	SW	0	2	2	2	0	0	18
20/09/2021	NV	06:40	09:40	1	1	SW	1	8	1	2	0	0	13
20/09/2021	NV	06:40	09:40	2	2	SW	0	8	1	2	0	0	15
20/09/2021	NV	06:40	09:40	3	2	SW	0	8	1	2	0	0	16
20/09/2021	NV	10:10	13:10	1	2	SW	0	6	1	2	0	0	16
20/09/2021	NV	10:10	13:10	2	3	W	0	7	1	2	0	0	16
20/09/2021	NV	10:10	13:10	3	3	W	0	6	1	2	0	0	15
23/10/2021	NV	07:35	10:35	1	1	S	0	5	1	2	0	0	10
23/10/2021	NV	07:35	10:35	2	3	S	0	5	1	2	0	0	11
23/10/2021	NV	07:35	10:35	3	3	SW	0	7	1	2	0	0	13
23/10/2021	NV	15:45	18:45	1	3	SW	0	6	1	2	0	0	12
23/10/2021	NV	15:45	18:45	2	3	SW	0	6	2	2	0	0	10

Date	Surveyor	Start	End	Survey Hour	Wind Speed	Wind Direction	Rain	Cloud Cover	Cloud Height	Visibility	Snow	Frost	Temp (°c)
23/10/2021	NV	15:45	18:45	3	2	SW	0	5	2	2	0	0	10
10/11/2021	NV	08:50	11:50	1	1	W	0	7	1	1	0	0	6
10/11/2021	NV	08:50	11:50	2	1	W	0	8	1	2	0	0	7
10/11/2021	NV	08:50	11:50	3	1	SW	0	8	1	2	0	0	7
11/11/2021	NV	10:40	13:40	1	2	SE	1	8	1	2	0	0	10
11/11/2021	NV	10:40	13:40	2	2	SE	0	8	1	2	0	0	10
11/11/2021	NV	10:40	13:40	3	3	SE	1	8	1	2	0	0	10
13/12/2021	NV	08:05	11:05	1	0	N/A	0	6	2	2	0	0	6
13/12/2021	NV	08:05	11:05	2	1	VAR	0	7	2	2	0	0	6
13/12/2021	NV	08:05	11:05	3	1	NW	0	7	2	2	0	0	6
13/12/2021	NV	13:45	16:45	1	1	W	0	8	2	2	0	0	7
13/12/2021	NV	13:45	16:45	2	1	W	0	8	2	2	0	0	6
13/12/2021	NV	13:45	16:45	3	1	W	0	8	2	2	0	0	6
06/01/2022	NV	14:00	17:00	1	3	WSW	2	6	1	2	0	0	7
06/01/2022	NV	14:00	17:00	2	2	WSW	0	5	1	2	0	0	7
06/01/2022	NV	14:00	17:00	3	2	SW	0	5	1	2	0	0	5
06/02/2022	NV	08:20	11:20	1	3	S	1	8	1	2	0	0	6
06/02/2022	NV	08:20	11:20	2	3	SW	1	8	1	2	0	0	7
06/02/2022	NV	08:20	11:20	3	2	SW	1	8	1	2	0	0	7
12/02/2022	NV	11:20	14:20	1	3	SSW	0	7	1	2	0	0	8
12/02/2022	NV	11:20	14:20	2	3	SSW	2	7	1	1	0	0	8

Date	Surveyor	Start	End	Survey Hour	Wind Speed	Wind Direction	Rain	Cloud Cover	Cloud Height	Visibility	Snow	Frost	Temp (°c)
12/02/2022	NV	11:20	14:20	3	3	SW	0	6	1	2	0	0	9
12/02/2022	NV	15:00	18:00	1	3	SW	0	6	1	2	0	0	10
12/02/2022	NV	15:00	18:00	2	2	SSW	0	5	1	2	0	0	9
12/02/2022	NV	15:00	18:00	3	2	SSW	0	6	1	2	0	0	9
14/03/2022	NV	10:30	13:30	1	1	SW	1	7	1	1	0	0	7
14/03/2022	NV	10:30	13:30	2	1	SW	0	6	1	1	0	0	8
14/03/2022	NV	10:30	13:30	3	2	SW	0	6	2	2	0	0	10
14/03/2022	NV	14:00	17:00	1	2	SSW	0	6	2	2	0	0	11
14/03/2022	NV	14:00	17:00	2	2	S	0	5	2	2	0	0	12
14/03/2022	NV	14:00	17:00	3	1	S	0	5	2	2	0	0	12

Rain/ Precipitation None 0 Drizzle 1 Light showers/snow 2 Heavy showers/snow 3 Heavy rain/snow 4	**Cloud Cover** Expressed in oktas (n/8) **Cloud Height** Height of cloud above average height of viewshed <150m 0 150-500m 1 >500m 2	**Visibility** Poor (<1km) 0 Moderate (1-3km) 1 Good (>3km) 2	**Lying Snow** None 0 On site 1 On higher ground 2	**Frost** None 0 Ground 1 All day 2

Table A2-7
Weather data collected during flight activity surveys undertaken at VP7

Date	Surveyor	Start	End	Survey Hour	Wind Speed	Wind Direction	Rain	Cloud Cover	Cloud Height	Visibility	Snow	Frost	Temp (°c)
30/04/2021	NV	08:00	11:00	1	2	NE	0	3	2	2	0	0	9
30/04/2021	NV	08:00	11:00	2	2	NE	0	3	2	2	0	0	11
30/04/2021	NV	08:00	11:00	3	2	NE	0	4	2	2	0	0	12
01/05/2021	NV	06:55	09:55	1	0	n/a	0	0	2	2	0	0	1
01/05/2021	NV	06:55	09:55	2	1	NE	0	1	2	2	0	0	3
01/05/2021	NV	06:55	09:55	3	1	NE	0	1	2	2	0	0	8
14/05/2021	NV	14:20	17:20	1	1	SE	0	2	2	2	0	0	14
14/05/2021	NV	14:20	17:20	2	2	SE	0	2	2	2	0	0	15
14/05/2021	NV	14:20	17:20	3	1	S	0	3	2	2	0	0	15
14/05/2021	NV	18:50	21:50	1	2	SW	0	2	2	2	0	0	15
14/05/2021	NV	18:50	21:50	2	1	SW	0	3	2	2	0	0	13
14/05/2021	NV	18:50	21:50	3	1	S	0	2	2	2	0	0	13
10/06/2021	NV	13:50	16:50	1	3	SW	2	6	1	2	0	0	15
10/06/2021	NV	13:50	16:50	2	3	SW	0	5	1	2	0	0	15
10/06/2021	NV	13:50	16:50	3	2	SW	0	5	1	2	0	0	16
10/06/2021	NV	17:20	20:20	1	2	SW	0	5	1	2	0	0	16
10/06/2021	NV	17:20	20:20	2	2	S	0	4	1	2	0	0	16
10/06/2021	NV	17:20	20:20	3	2	S	0	2	2	2	0	0	15
15/07/2021	NV	10:15	13:15	1	1	SW	0	1	2	2	0	0	17
15/07/2021	NV	10:15	13:15	2	2	SW	0	1	2	2	0	0	18

Date	Surveyor	Start	End	Survey Hour	Wind Speed	Wind Direction	Rain	Cloud Cover	Cloud Height	Visibility	Snow	Frost	Temp (°c)
15/07/2021	NV	10:15	13:15	3	2	SW	0	0	n/a	2	0	0	21
15/07/2021	NV	19:15	22:15	1	1	S	0	0	n/a	2	0	0	21
15/07/2021	NV	19:15	22:15	2	1	SW	0	0	n/a	2	0	0	20
15/07/2021	NV	19:15	22:15	3	1	SW	0	0	n/a	2	0	0	18
09/08/2021	NV	14:30	17:30	1	1	SW	0	2	2	2	0	0	20
09/08/2021	NV	14:30	17:30	2	1	SW	0	2	2	2	0	0	20
09/08/2021	NV	14:30	17:30	3	1	SW	0	1	2	2	0	0	19
11/08/2021	NV	10:30	13:30	1	4	NW	0	5	2	2	0	0	15
11/08/2021	NV	10:30	13:30	2	3	W	0	3	2	2	0	0	16
11/08/2021	NV	10:30	13:30	3	3	W	0	3	2	2	0	0	16
17/09/2021	NV	13:20	16:20	1	1	W	2	6	1	1	0	0	16
17/09/2021	NV	13:20	16:20	2	1	W	0	5	1	2	0	0	17
17/09/2021	NV	13:20	16:20	3	2	W	0	5	1	2	0	0	17
17/09/2021	NV	16:50	19:50	1	2	W	0	6	1	2	0	0	17
17/09/2021	NV	16:50	19:50	2	2	WSW	0	7	1	2	0	0	17
17/09/2021	NV	16:50	19:50	3	2	WSW	0	6	1	2	0	0	16
12/10/2021	NV	11:15	14:15	1	2	W	0	3	2	2	0	0	12
12/10/2021	NV	11:15	14:15	2	2	W	0	2	2	2	0	0	12
12/10/2021	NV	11:15	14:15	3	2	W	0	3	2	2	0	0	14
12/10/2021	NV	14:45	17:45	1	2	W	0	3	2	2	0	0	12
12/10/2021	NV	14:45	17:45	2	2	NW	0	2	2	2	0	0	12

Date	Surveyor	Start	End	Survey Hour	Wind Speed	Wind Direction	Rain	Cloud Cover	Cloud Height	Visibility	Snow	Frost	Temp (°c)
12/10/2021	NV	14:45	17:45	3	1	NW	0	2	2	2	0	0	11
08/11/2021	NV	14:10	17:10	1	2	SW	0	6	1	2	0	0	13
08/11/2021	NV	14:10	17:10	2	2	SW	0	5	1	2	0	0	13
08/11/2021	NV	14:10	17:10	3	2	SW	0	7	1	2	0	0	13
12/11/2021	NV	09:40	12:40	1	3	SW	2	8	1	2	0	0	11
12/11/2021	NV	09:40	12:40	2	3	SW	2	8	1	2	0	0	12
12/11/2021	NV	09:40	12:40	3	3	SW	0	8	1	2	0	0	12
20/12/2021	NV	13:45	16:45	1	2	NE	0	7	2	2	0	0	5
20/12/2021	NV	13:45	16:45	2	2	NE	0	7	2	2	0	0	5
20/12/2021	NV	13:45	16:45	3	1	E	0	6	2	2	0	0	3
04/01/2022	NV	09:00	12:00	1	2	WNW	0	3	2	2	2	0	1
04/01/2022	NV	09:00	12:00	2	2	W	0	2	2	2	0	0	1
04/01/2022	NV	09:00	12:00	3	2	W	0	2	2	2	0	0	1
04/01/2022	NV	12:30	15:30	1	3	W	0	2	2	2	0	0	2
04/01/2022	NV	12:30	15:30	2	3	W	0	0	NA	2	0	0	3
04/01/2022	NV	12:30	15:30	3	3	W	0	0	NA	2	0	0	3
11/02/2022	NV	09:00	12:00	1	1	W	0	3	2	2	2	1	-1
11/02/2022	NV	09:00	12:00	2	2	WNW	0	3	2	2	2	0	-1
11/02/2022	NV	09:00	12:00	3	2	W	0	2	2	2	2	0	0
11/02/2022	NV	12:30	15:30	1	2	WNW	0	3	2	2	2	0	1
11/02/2022	NV	12:30	15:30	2	2	W	0	2	2	2	0	0	1

Date	Surveyor	Start	End	Survey Hour	Wind Speed	Wind Direction	Rain	Cloud Cover	Cloud Height	Visibility	Snow	Frost	Temp (°c)
11/02/2022	NV	12:30	15:30	3	2	W	0	2	2	2	0	0	1
15/03/2022	NV	11:00	14:00	1	1	Var	0	0		2	0	0	9
15/03/2022	NV	11:00	14:00	2	1	S	0	0		2	0	0	9
15/03/2022	NV	11:00	14:00	3	2	SSW	0	2	2	2	0	0	10
15/03/2022	NV	14:30	17:30	1	2	SSW	0	3	2	2	0	0	11
15/03/2022	NV	14:30	17:30	2	2	SSW	0	3	2	2	0	0	11
15/03/2022	NV	14:30	17:30	3	2	SSW	0	4	2	2	0	0	11

Rain/ Precipitation
None 0
Drizzle 1
Light showers/snow 2
Heavy showers/snow 3
Heavy rain/snow 4

Cloud Cover
Expressed in oktas (n/8)

Cloud Height
Height of cloud above average height of viewshed
<150m 0
150-500m 1
>500m 2

Visibility
Poor (<1km) 0
Moderate (1-3km) 1
Good (>3km) 2

Lying Snow
None 0
On site 1
On higher ground 2

Frost
None 0
Ground 1
All day 2

APPENDIX 03

Flight activity survey data

Table A3-1
Primary target species recorded during flight activity surveys undertaken at VP1

Date	Surveyor	Flight ID	Species	Num. Birds	Age	Sex	Obs. Time	Flight time (s)
28/04/2021	PC	1	K.	1	Ad	M	14:27	120
28/04/2021	PC	2	K.	3	Ad	2M, 1F	14:32	165
28/04/2021	PC	1	K.	1	U	U	19:08	110
28/04/2021	PC	2	PE	1	Ad	F	19:14	40
19/05/2021	PC	1	PE	1	U	U	18:16	90
19/05/2021	PC	2	K.	1	Ad	M	18:25	30
19/05/2021	PC	3	K.	1	Ad	M	18:46	210
19/05/2021	PC	4	K.	1	U	U	19:01	260
19/05/2021	PC	5	PE	1	U	U	19:26	540
30/05/2021	PC	1	K.	1	Ad	M	14:39	40
05/07/2021	PC	1	K.	2	Ad	M&F	11:43	120
04/11/2021	PC	2	PE	1	Imm	U	12:26	140
04/11/2021	PC	3	K.	1	U	U	12:28	50
04/11/2021	PC	4	K.	1	U	U	13:36	35
04/12/2021	PC	1	K.	1	U	U	09:52	30
04/12/2021	PC	2	K.	1	U	U	10:41	40
04/02/2022	PC	1	K.	1	U	U	12:51	110
04/02/2022	PC	2	K.	1	U	U	12:57	50
28/02/2022	PC	1	GP	2,000	U	U	14:46	330

Table A3-2
Primary target species recorded during flight activity surveys undertaken at VP2

Date	Surveyor	Flight ID	Species	Num. Birds	Age	Sex	Obs. Time	Flight time (s)
29/04/2021	PC	1	PE	1	U	M	14:56	210
25/05/2021	PC	1	K.	1	Ad	M	09:43	150
25/05/2021	PC	2	K.	1	U	U	09:48	30
05/06/2021	PC	1	K.	1	Ad	M	15:59	265
05/06/2021	PC	2	K.	1	Ad	M	16:35	25
29/07/2021	PC	1	PE	1	U	U	11:57	50
04/01/2022	NV	1	SN	2	U	U	13:41	47
03/02/2022	PC	1	PE	1	Ad	F	14:49	35
01/04/2022	PC	1	SN	1	U	U	17:33	25

Table A3-3
Primary target species recorded during flight activity surveys undertaken at VP3

Date	Surveyor	Flight ID	Species	Num. Birds	Age	Sex	Obs. Time	Flight time (s)
27/04/2021	PC	1	K.	1	U	U	15:07	18
19/05/2021	PC	1	K.	1	U	U	15:49	55
19/05/2021	PC	2	K.	1	U	U	15:53	80
19/05/2021	PC	3	K.	1	Ad	M	15:59	170
19/05/2021	PC	5	K.	1	Ad	M	16:20	35
19/05/2021	PC	6	K.	1	Ad	F	16:20	10
19/05/2021	PC	7	K.	1	Ad	M	16:31	25
19/05/2021	PC	8	K.	1	U	U	16:35	60
25/05/2021	PC	1	K.	1	Ad	M	17:26	40
25/05/2021	PC	2	K.	1	Ad	M	18:14	70
05/06/2021	PC	1	K.	1	Ad	M	18:36	40
05/06/2021	PC	2	K.	1	Ad	M	18:39	70
05/07/2021	PC	1	K.	1	U	U	18:01	180
05/07/2021	PC	2	K.	1	U	U	18:07	30
15/09/2021	PC	1	K.	1	U	U	14:04	35
15/09/2021	PC	2	K.	1	Imm	M	14:11	70
30/10/2021	PC	1	K.	1	Ad	M	11:56	85
30/10/2021	PC	2	K.	1	Ad	M	12:25	20
30/10/2021	PC	1	K.	1	Ad	M	15:13	30
04/11/2021	PC	1	K.	1	U	U	14:09	35
04/11/2021	PC	2	K.	1	U	U	14:17	30
04/11/2021	PC	3	K.	1	U	U	14:55	50
06/12/2021	PC	1	GP	5	U	U	10:55	30
06/12/2021	PC	2	GP	19	U	U	12:49	50
04/02/2022	PC	1	GP	3	U	U	15:54	10
04/02/2022	PC	2	GP	3	U	U	15:55	25
01/03/2022	PC	1	GP	9	U	U	09:36	25

Table A3-4
Primary target species recorded during flight activity surveys undertaken at VP4

Date	Surveyor	Flight ID	Species	Num. Birds	Age	Sex	Obs. Time	Flight time (s)
27/04/2021	PC	1	K.	1	Ad	M	17:35	15
27/04/2021	PC	2	K.	2	U	U	17:56	48
05/06/2021	PC	1	K.	1	U	U	11:25	25
09/07/2021	PC	1	K.	1	Imm	M	08:50	120
30/07/2021	PC	1	K.	1	U	U	19:24	8
30/07/2021	PC	2	K.	1	Juv	U	19:29	65
27/08/2021	PC	1	PE	1	U	U	13:18	55
28/08/2021	PC	1	K.	1	U	U	15:13	270
14/09/2021	PC	1	K.	1	Ad	M	14:03	65
14/09/2021	PC	2	K.	1	Juv	U	14:09	60
14/09/2021	PC	3	K.	1	Juv	U	14:14	95
15/09/2021	PC	1	SN	1	U	U	10:23	8
06/12/2021	PC	1	K.	1	U	U	13:55	20
06/12/2021	PC	2	K.	1	Ad	F	14:07	50
06/12/2021	PC	3	K.	1	Ad	F	14:52	20
06/12/2021	PC	4	GP	41	U	U	15:11	40
06/12/2021	PC	5	GP	23	U	U	15:33	35
06/12/2021	PC	6	PE	1	U	U	15:35	10
29/12/2021	PC	1	PE	1	U	U	09:46	19
03/02/2022	PC	1	K.	1	Ad	F	13:23	35
03/02/2022	PC	2	K.	1	Ad	F	13:27	30
03/02/2022	PC	3	K.	1	Ad	F	13:43	40
28/02/2022	PC	1	K.	1	Ad	M	12:08	40
28/02/2022	PC	2	K.	1	Ad	M	12:09	55

Table A3-5
Primary target species recorded during flight activity surveys undertaken at VP5

Date	Surveyor	Flight ID	Species	Num. Birds	Age	Sex	Obs. Time	Flight time (s)
15/05/2021	NV	1	K.	1	Ad	M	11:14	90
15/05/2021	NV	2	K.	1	Ad	M	12:28	30
14/06/2021	NV	1	PE	1	U	U	09:55	68
14/06/2021	NV	2	K.	1	Ad	M	10:31	55
14/06/2021	NV	3	K.	1	Ad	M	10:48	85
15/07/2021	NV	1	K.	1	Ad	M	14:08	145
15/07/2021	NV	2	K.	1	Ad	F	15:23	121
20/09/2021	NV	1	SN	2	U	U	15:12	36
20/09/2021	NV	2	K.	1	Ad	M	16:36	16
22/10/2021	NV	1	GP	16	U	U	08:11	145
11/11/2021	NV	1	K.	1	Ad	F	15:26	102
11/11/2021	NV	2	K.	1	Ad	F	15:55	78
05/01/2022	NV	1	K.	1	Ad	M	12:18	82
10/02/2022	NV	1	K.	1	Ad	M	15:27	
10/02/2022	NV	2	SN	2	U	U	16:14	
12/03/2022	NV	1	SN	2	U	U	07:05	67
12/03/2022	NV	2	GP	250	U	U	08:16	170

Table A3-6
Primary target species recorded during flight activity surveys undertaken at VP6

Date	Surveyor	Flight ID	Species	Num. Birds	Age	Sex	Obs. Time	Flight time (s)
28/04/2021	NV	1	K.	1	Ad	M	15:06	160
28/04/2021	NV	2	K.	1	Ad	M	15:52	140
28/04/2021	NV	1	K.	1	Ad	M	17:55	115
28/04/2021	NV	2	K.	1	Ad	M	18:41	190
14/05/2021	NV	1	K.	1	Ad	M	06:38	170
14/05/2021	NV	2	K.	1	Ad	M	07:20	140
14/05/2021	NV	1	K.	1	Ad	M	08:48	90
14/05/2021	NV	2	K.	1	Ad	M	09:41	120
14/05/2021	NV	3	K.	1	Ad	F	11:02	270
14/05/2021	NV	4	K.	1	Ad	M	11:21	45
09/06/2021	NV	1	K.	1	Ad	M	13:34	51
09/06/2021	NV	2	PE	1	Ad	M	14:07	42

Date	Surveyor	Flight ID	Species	Num. Birds	Age	Sex	Obs. Time	Flight time (s)
09/06/2021	NV	3	K.	1	Ad	M	14:16	16
09/06/2021	NV	4	K.	1	Ad	M	14:42	94
09/06/2021	NV	5	K.	1	Ad	M	15:28	80
09/06/2021	NV	6	K.	1	Ad	M	16:09	47
09/06/2021	NV	1	K.	1	Ad	M	17:16	110
09/06/2021	NV	2	K.	1	Ad	M	17:42	52
09/06/2021	NV	3	K.	1	Ad	M	18:21	64
09/06/2021	NV	4	K.	1	Ad	M	18:55	31
14/07/2021	NV	1	K.	1	Ad	M	11:47	175
14/07/2021	NV	2	K.	2	Ad	M&F	12:31	41
14/07/2021	NV	3	K.	1	Ad	F	13:04	68
14/07/2021	NV	1	K.	1	Ad	F	19:52	126
14/07/2021	NV	2	WK	1	Ad	U	21:40	70
14/07/2021	NV	3	WK	1	Ad	U	21:53	48
09/08/2021	NV	1	K.	2	Juv	U	13:04	31
20/09/2021	NV	1	K.	1	Imm	U	08:42	94
20/09/2021	NV	2	K.	1	Imm	U	09:05	32
23/10/2021	NV	1	GP	36	U	U	08:04	70
23/10/2021	NV	2	K.	1	Ad	M	08:52	140
23/10/2021	NV	3	L.	18	U	U	09:38	85
23/10/2021	NV	4	SN	1	U	U	10:22	35
23/10/2021	NV	1	K.	1	Ad	M	16:01	170
23/10/2021	NV	2	L.	22	U	U	18:06	64
10/11/2021	NV	1	K.	1	Ad	M	09:41	125
10/11/2021	NV	2	PE	1	Imm	M	11:04	52
11/11/2021	NV	1	K.	1	Imm	M	11:07	92
11/11/2021	NV	2	K.	1	Imm	M	11:52	63
11/11/2021	NV	4	K.	1	Ad	F	13:32	130
13/12/2021	NV	1	K.	1	Ad	M	14:12	108
06/01/2022	NV	1	K.	1	Ad	F	15:32	
06/01/2022	NV	2	K.	2	U	U	16:08	
12/02/2022	NV	1	SN	2	U	U	16:07	51
14/03/2022	NV	1	K.	1	Ad	M	14:09	71
14/03/2022	NV	2	K.	1	Ad	F	15:02	33
14/03/2022	NV	3	SN	2	U	U	15:12	58
14/03/2022	NV	4	PE	1	Yr1	M	16:14	87

Date	Surveyor	Flight ID	Species	Num. Birds	Age	Sex	Obs. Time	Flight time (s)
14/03/2022	NV	5	K.	1	Ad	M	16:29	45
14/03/2022	NV	1	K.	1	Ad	M	10:51	
14/03/2022	NV	2	K.	1	Ad	M	11:26	
14/03/2022	NV	3	K.	1	Ad	M	11:50	
14/03/2022	NV	4	K.	1	Ad	M	12:18	

Table A3-7
Primary target species recorded during flight activity surveys undertaken at VP7

Date	Surveyor	Flight ID	Species	Num. Birds	Age	Sex	Obs. Time	Flight time (s)
30/04/2021	NV	1	K.	1	Ad	M	09:26	95
01/05/2021	NV	1	K.	1	Ad	M	08:32	100
01/05/2021	NV	2	K.	1	Ad	M	09:18	55
14/05/2021	NV	1	K.	1	Ad	M	19:03	82
14/05/2021	NV	2	K.	1	Ad	M	20:08	30
10/06/2021	NV	1	K.	1	Ad	F	14:23	130
10/06/2021	NV	2	K.	1	Ad	M	14:58	71
10/06/2021	NV	3	K.	1	Ad	M	16:31	34
10/06/2021	NV	1	K.	1	Ad	M	17:38	125
10/06/2021	NV	2	SN	2	U	U	20:02	28
15/07/2021	NV	1	PE	1	Ad	U	11:17	162
15/07/2021	NV	2	K.	1	Ad	M	13:02	126
15/07/2021	NV	1	K.	1	Ad	M	19:18	110
15/07/2021	NV	2	K.	1	Ad	M	19:37	48
15/07/2021	NV	3	K.	1	Ad	F	20:01	18
15/07/2021	NV	4	WK	1	Ad	U	21:41	63
31/07/2021	PC	1	K.	1	Imm	M	09:35	120
11/08/2021	NV	1	PE	1	Juv	U	19:06	95
11/08/2021	NV	1	K.	1	Juv	U	11:08	82
12/10/2021	NV	1	SN	1	U	U	13:18	35
12/10/2021	NV	2	K.	1	Ad	M	16:17	95
08/11/2021	NV	1	K.	1	Ad	F	14:32	65
08/11/2021	NV	2	SN	1	U	U	16:41	18
12/11/2021	NV	1	SN	2	U	U	10:08	18
12/11/2021	NV	2	PE	1	Imm	U	11:32	85
12/11/2021	NV	3	K.	1	Ad	F	12:04	170

Date	Surveyor	Flight ID	Species	Num. Birds	Age	Sex	Obs. Time	Flight time (s)
20/12/2021	NV	1	K.	1	Ad	M	14:12	82
20/12/2021	NV	2	L.	10	Ad	U	16:11	220
04/01/2022	NV	1	K.	1	Ad	M	13:02	80
04/01/2022	NV	2	K.	1	Ad	F	13:58	110
11/02/2022	NV	1	K.	1	Ad	M	13:02	80
11/02/2022	NV	2	K.	1	Ad	F	13:58	110
11/02/2022	NV	1	K.	1	Ad	M	09:53	52
15/03/2022	NV	1	K.	1	Ad	M	11:29	103
15/03/2022	NV	2	K.	1	Ad	M	13:48	160

Table A3-8
Secondary target species recorded during flight activity surveys undertaken at VP1

Date	Survey Start	Survey End	Species	Count	5 Min Period
28/04/2021	14:00	17:00	BZ	2	14:20
28/04/2021	14:00	17:00	BZ	2	14:35
28/04/2021	14:00	17:00	BZ	2	14:35
28/04/2021	14:00	17:00	BZ	2	14:40
28/04/2021	14:00	17:00	BZ	2	15:15
28/04/2021	14:00	17:00	BZ	4	15:30
28/04/2021	14:00	17:00	BZ	3	15:45
28/04/2021	14:00	17:00	BZ	1	15:45
28/04/2021	14:00	17:00	BZ	2	16:05
28/04/2021	14:00	17:00	BZ	2	16:10
28/04/2021	14:00	17:00	BZ	2	16:10
28/04/2021	14:00	17:00	RN	2	16:15
28/04/2021	14:00	17:00	BZ	4	16:55
28/04/2021	17:30	20:30	RN	1	17:45
28/04/2021	17:30	20:30	BZ	1	17:45
28/04/2021	17:30	20:30	SH	1	17:50
28/04/2021	17:30	20:30	BZ	1	18:05
28/04/2021	17:30	20:30	BZ	1	18:30
28/04/2021	17:30	20:30	BZ	1	19:35
19/05/2021	17:30	20:30	BZ	1	17:40
19/05/2021	17:30	20:30	BZ	1	17:40
19/05/2021	17:30	20:30	LB	1	17:45
19/05/2021	17:30	20:30	BZ	1	18:00

Date	Survey Start	Survey End	Species	Count	5 Min Period
19/05/2021	17:30	20:30	BZ	1	18:00
19/05/2021	17:30	20:30	BZ	1	18:05
19/05/2021	17:30	20:30	BZ	2	18:15
19/05/2021	17:30	20:30	BZ	1	18:20
19/05/2021	17:30	20:30	LB	1	18:20
19/05/2021	17:30	20:30	RN	2	18:20
19/05/2021	17:30	20:30	BZ	1	18:25
19/05/2021	17:30	20:30	RN	1	18:25
19/05/2021	17:30	20:30	BZ	1	18:25
19/05/2021	17:30	20:30	BZ	2	18:45
19/05/2021	17:30	20:30	BZ	1	18:45
19/05/2021	17:30	20:30	BZ	1	19:05
19/05/2021	17:30	20:30	BZ	1	19:05
19/05/2021	17:30	20:30	BZ	1	19:35
19/05/2021	17:30	20:30	BZ	1	19:45
30/05/2021	13:30	16:30	BZ	1	13:35
30/05/2021	13:30	16:30	BZ	1	13:40
30/05/2021	13:30	16:30	BZ	1	14:10
30/05/2021	13:30	16:30	BZ	2	14:20
30/05/2021	13:30	16:30	BZ	1	14:30
30/05/2021	13:30	16:30	BZ	1	14:30
30/05/2021	13:30	16:30	BZ	1	14:55
30/05/2021	13:30	16:30	BZ	1	15:10
30/05/2021	13:30	16:30	BZ	1	15:45
30/05/2021	13:30	16:30	BZ	1	15:55
30/05/2021	13:30	16:30	BZ	2	16:05
30/05/2021	13:30	16:30	BZ	1	16:15
05/06/2021	07:30	10:30	RN	1	07:45
05/06/2021	07:30	10:30	BZ	1	07:55
05/06/2021	07:30	10:30	BZ	1	08:15
05/06/2021	07:30	10:30	BZ	1	08:40
05/07/2021	09:00	12:00	BZ	1	10:00
05/07/2021	09:00	12:00	SH	1	10:30
05/07/2021	09:00	12:00	SH	1	11:05
05/07/2021	09:00	12:00	BZ	2	11:05
05/07/2021	09:00	12:00	BZ	1	11:30

Date	Survey Start	Survey End	Species	Count	5 Min Period
30/07/2021	07:10	10:10	RN	2	09:20
31/07/2021	09:30	12:30	LB	3	10:35
31/07/2021	09:30	12:30	RN	1	11:20
31/07/2021	09:30	12:30	BZ	1	11:40
31/07/2021	09:30	12:30	RN	2	11:40
31/07/2021	09:30	12:30	BZ	1	12:15
31/07/2021	09:30	12:30	BZ	2	12:25
27/08/2021	16:30	19:30	RN	2	17:05
27/08/2021	16:30	19:30	SH	1	17:35
27/08/2021	16:30	19:30	BZ	1	18:55
27/08/2021	16:30	19:30	BZ	1	18:55
27/08/2021	16:30	19:30	RN	2	19:00
28/08/2021	07:00	10:00	SH	1	07:25
11/09/2021	08:00	11:00	RN	2	08:55
11/09/2021	08:00	11:00	LB	4	09:50
11/09/2021	08:00	11:00	RN	1	10:05
11/09/2021	08:00	11:00	LB	8	10:25
11/09/2021	08:00	11:00	RN	1	10:25
13/09/2021	17:15	20:15	RN	2	17:35
13/09/2021	17:15	20:15	RN	3	17:55
13/09/2021	17:15	20:15	RN	1	18:45
13/09/2021	17:15	20:15	RN	2	18:55
13/09/2021	17:15	20:15	RN	1	19:20
04/11/2021	07:02	10:02	LB	5	09:00
04/11/2021	07:02	10:02	RN	1	09:45
04/11/2021	07:02	10:02	RN	2	09:45
04/11/2021	07:02	10:02	SH	1	09:55
04/11/2021	10:32	13:32	SH	1	10:55
04/11/2021	10:32	13:32	RN	2	11:10
04/11/2021	10:32	13:32	BZ	1	11:30
04/11/2021	10:32	13:32	RN	1	11:40
04/11/2021	10:32	13:32	BZ	1	11:40
04/11/2021	10:32	13:32	RN	2	11:45
04/11/2021	10:32	13:32	BZ	1	12:10
04/11/2021	10:32	13:32	SH	1	13:05
04/11/2021	10:32	13:32	BZ	1	13:10

Date	Survey Start	Survey End	Species	Count	5 Min Period
04/11/2021	10:32	13:32	BZ	1	13:20
04/11/2021	10:32	13:32	BZ	3	13:25
04/11/2021	10:32	13:32	RN	2	13:25
04/11/2021	10:32	13:32	RN	1	13:25
04/11/2021	10:32	13:32	RN	1	13:25
04/12/2021	08:30	11:30	RN	2	10:55
04/12/2021	08:30	11:30	RN	2	11:10
04/12/2021	08:30	11:30	BZ	1	11:10
04/12/2021	08:30	11:30	BZ	2	11:15
04/12/2021	08:30	11:30	BZ	1	11:20
10/12/2021	13:20	16:20	BZ	2	13:40
10/12/2021	13:20	16:20	SH	1	14:10
10/12/2021	13:20	16:20	RN	1	15:25
21/12/2021	09:30	12:30	RN	2	11:15
21/12/2021	09:30	12:30	RN	2	11:25
21/12/2021	09:30	12:30	RN	2	11:50
29/12/2021	13:30	16:30	RN	2	13:40
29/12/2021	13:30	16:30	RN	2	13:50
29/12/2021	13:30	16:30	RN	1	14:10
29/12/2021	13:30	16:30	BZ	1	14:20
29/12/2021	13:30	16:30	BZ	1	15:20
29/12/2021	13:30	16:30	BZ	1	15:30
29/12/2021	13:30	16:30	SH	1	15:40
29/12/2021	13:30	16:30	RN	2	15:55
03/02/2022	07:40	10:40	SH	1	09:10
04/02/2022	11:10	14:10	SH	1	12:00
04/02/2022	11:10	14:10	BZ	1	12:40
04/02/2022	11:10	14:10	BZ	1	12:45
04/02/2022	11:10	14:10	RN	4	13:00
04/02/2022	11:10	14:10	SH	1	13:00
04/02/2022	11:10	14:10	BZ	1	13:05
04/02/2022	11:10	14:10	BZ	1	13:05
04/02/2022	11:10	14:10	BZ	2	13:05
04/02/2022	11:10	14:10	BZ	1	13:10
04/02/2022	11:10	14:10	BZ	3	13:15
04/02/2022	11:10	14:10	BZ	1	13:15

Date	Survey Start	Survey End	Species	Count	5 Min Period
04/02/2022	11:10	14:10	BZ	6	13:20
04/02/2022	11:10	14:10	BZ	1	13:30
16/02/2022	07:15	10:15	BZ	1	07:50
16/02/2022	07:15	10:15	SH	1	08:25
28/02/2022	13:48	16:48	BZ	1	14:35
28/02/2022	13:48	16:48	BZ	1	14:55
28/02/2022	13:48	16:48	SH	1	15:00
28/02/2022	13:48	16:48	BZ	1	15:20
28/02/2022	13:48	16:48	BZ	1	15:25
28/02/2022	13:48	16:48	RN	2	16:05
28/02/2022	13:48	16:48	BZ	1	16:25
02/04/2022	06:33	09:33	BZ	1	07:35
02/04/2022	06:33	09:33	BZ	2	07:40
02/04/2022	06:33	09:33	BZ	1	08:10
02/04/2022	06:33	09:33	BZ	1	08:35
02/04/2022	06:33	09:33	SH	1	08:35
02/04/2022	06:33	09:33	BZ	1	08:45
02/04/2022	10:03	13:03	RN	1	09:40
02/04/2022	10:03	13:03	BZ	1	11:45
02/04/2022	10:03	13:03	BZ	1	12:05
02/04/2022	10:03	13:03	BZ	1	12:55

Table A3-9
Secondary target species recorded during flight activity surveys undertaken at VP2

Date	Survey Start	Survey End	Species	Count	5 Min Period
29/04/2021	14:00	17:00	BZ	1	14:50
29/04/2021	14:00	17:00	BZ	2	16:05
30/04/2021	17:30	20:30	BZ	1	17:45
30/04/2021	17:30	20:30	BZ	1	18:10
30/04/2021	17:30	20:30	BZ	1	18:15
30/04/2021	17:30	20:30	BZ	1	18:40
30/04/2021	17:30	20:30	BZ	2	18:45
30/04/2021	17:30	20:30	BZ	1	19:25
30/04/2021	17:30	20:30	BZ	1	19:35
30/04/2021	17:30	20:30	BZ	1	20:05
25/05/2021	09:30	12:30	RN	1	09:35

Date	Survey Start	Survey End	Species	Count	5 Min Period
25/05/2021	09:30	12:30	BZ	1	09:50
25/05/2021	09:30	12:30	BZ	1	10:00
25/05/2021	09:30	12:30	BZ	1	10:05
25/05/2021	09:30	12:30	BZ	1	12:20
25/05/2021	09:30	12:30	BZ	1	12:25
27/05/2021	14:30	17:30	BZ	1	14:55
27/05/2021	14:30	17:30	RN	1	15:45
05/06/2021	14:30	17:30	BZ	1	15:15
05/06/2021	14:30	17:30	BZ	2	15:45
05/06/2021	14:30	17:30	BZ	1	16:05
05/06/2021	14:30	17:30	BZ	1	16:20
05/06/2021	14:30	17:30	BZ	1	17:10
05/06/2021	14:30	17:30	BZ	2	17:15
05/06/2021	14:30	17:30	BZ	1	17:15
05/06/2021	14:30	17:30	BZ	1	17:25
05/07/2021	12:30	15:30	LB	1	14:25
05/07/2021	12:30	15:30	BZ	1	14:30
05/07/2021	12:30	15:30	BZ	1	14:50
29/07/2021	09:00	12:00	RN	2	10:25
29/07/2021	09:00	12:00	RN	1	10:30
29/07/2021	09:00	12:00	BZ	1	11:05
29/07/2021	09:00	12:00	RN	1	11:55
30/07/2021	14:10	17:10	BZ	1	16:35
27/08/2021	06:00	09:00	RN	1	08:35
28/08/2021	10:30	13:30	RN	2	12:20
28/08/2021	10:30	13:30	RN	2	12:35
11/09/2021	11:30	14:30	RN	1	13:15
11/09/2021	11:30	14:30	RN	2	13:20
14/09/2021	16:30	19:30	RN	1	17:15
14/09/2021	16:30	19:30	RN	2	17:35
14/09/2021	16:30	19:30	BZ	1	18:15
14/09/2021	16:30	19:30	BZ	1	18:55
30/10/2021	07:50	10:50	RN	2	09:00
30/10/2021	07:50	10:50	RN	1	09:55
30/10/2021	07:50	10:50	BZ	1	10:10
05/11/2021	12:00	15:00	RN	3	12:55

Date	Survey Start	Survey End	Species	Count	5 Min Period
05/11/2021	12:00	15:00	BZ	1	13:15
05/11/2021	12:00	15:00	BZ	1	13:30
05/11/2021	12:00	15:00	BZ	1	13:45
05/11/2021	12:00	15:00	BZ	1	13:50
24/11/2021	13:50	16:50	BZ	1	14:10
24/11/2021	13:50	16:50	BZ	1	15:55
24/11/2021	13:50	16:50	BZ	1	16:25
22/12/2021	08:10	11:10	RN	1	09:15
22/12/2021	08:10	11:10	RN	2	10:10
22/12/2021	08:10	11:10	LB	6	10:15
22/12/2021	08:10	11:10	BZ	1	10:40
22/12/2021	11:40	14:40	RN	2	12:10
22/12/2021	11:40	14:40	RN	1	13:40
22/12/2021	11:40	14:40	SH	1	13:55
24/01/2022	09:15	12:15	BZ	1	10:55
24/01/2022	09:15	12:15	BZ	1	12:10
03/02/2022	14:40	17:40	SH	1	14:45
01/04/2022	10:05	13:05	SH	1	10:40
01/04/2022	10:05	13:05	SH	1	10:45
01/04/2022	10:05	13:05	SH	1	11:25
01/04/2022	10:05	13:05	SH	1	11:45
01/04/2022	10:05	13:05	BZ	2	11:50
01/04/2022	10:05	13:05	BZ	1	12:25
01/04/2022	10:05	13:05	BZ	1	12:45
01/04/2022	17:05	20:05	BZ	1	18:20
01/04/2022	17:05	20:05	BZ	1	18:55

Table A3-10
Secondary target species recorded during flight activity surveys undertaken at VP3

Date	Survey Start	Survey End	Species	Count	5 Min Period
27/04/2021	14:00	17:00	BZ	1	14:35
27/04/2021	14:00	17:00	BZ	1	14:55
27/04/2021	14:00	17:00	SH	1	14:55
27/04/2021	14:00	17:00	BZ	1	15:25
27/04/2021	14:00	17:00	BZ	2	15:55
27/04/2021	14:00	17:00	LB	1	15:55
27/04/2021	14:00	17:00	BZ	1	16:10
27/04/2021	14:00	17:00	BZ	1	16:10
27/04/2021	14:00	17:00	BZ	1	16:35
27/04/2021	14:00	17:00	BZ	1	16:45
29/04/2021	17:30	20:30	BZ	1	18:55
19/05/2021	14:00	17:00	BZ	1	14:10
19/05/2021	14:00	17:00	BZ	1	14:15
19/05/2021	14:00	17:00	BZ	1	14:30
19/05/2021	14:00	17:00	BZ	1	15:05
19/05/2021	14:00	17:00	BZ	1	15:15
19/05/2021	14:00	17:00	BZ	1	16:15
19/05/2021	14:00	17:00	H.	1	16:15
19/05/2021	14:00	17:00	BZ	1	16:35
25/05/2021	16:30	19:30	BZ	1	16:55
25/05/2021	16:30	19:30	BZ	1	17:50
25/05/2021	16:30	19:30	BZ	1	17:55
25/05/2021	16:30	19:30	BZ	1	18:10
25/05/2021	16:30	19:30	BZ	1	18:35
25/05/2021	16:30	19:30	BZ	1	18:45
05/06/2021	18:00	21:00	BZ	1	18:30
05/06/2021	18:00	21:00	BZ	1	19:10
05/06/2021	18:00	21:00	BZ	1	19:15
05/06/2021	18:00	21:00	BZ	1	19:40
05/06/2021	18:00	21:00	BZ	2	20:00
05/06/2021	18:00	21:00	RN	1	20:10
05/07/2021	16:00	19:00	BZ	2	16:15
05/07/2021	16:00	19:00	BZ	1	16:30
29/07/2021	18:00	21:00	BZ	2	18:25

Date	Survey Start	Survey End	Species	Count	5 Min Period
29/07/2021	18:00	21:00	BZ	1	19:20
30/07/2021	10:40	13:40	LB	11	11:34
30/07/2021	10:40	13:40	RN	2	12:15
30/07/2021	10:40	13:40	BZ	1	12:25
30/07/2021	10:40	13:40	BZ	1	12:45
30/07/2021	10:40	13:40	RN	1	12:50
30/07/2021	10:40	13:40	BZ	1	13:15
30/07/2021	10:40	13:40	RN	1	13:30
27/08/2021	09:30	12:30	BZ	1	10:20
27/08/2021	09:30	12:30	RN	4	10:50
27/08/2021	09:30	12:30	RN	2	11:00
27/08/2021	09:30	12:30	RN	2	11:05
27/08/2021	09:30	12:30	BZ	1	11:25
27/08/2021	09:30	12:30	BZ	1	11:30
27/08/2021	09:30	12:30	BZ	1	11:30
27/08/2021	09:30	12:30	BZ	1	12:05
14/09/2021	09:30	12:30	RN	1	09:55
14/09/2021	09:30	12:30	RN	1	09:55
14/09/2021	09:30	12:30	BZ	1	11:20
14/09/2021	09:30	12:30	BZ	1	11:25
14/09/2021	09:30	12:30	BZ	1	12:10
15/09/2021	13:00	16:00	RN	2	13:05
15/09/2021	13:00	16:00	RN	3	13:50
15/09/2021	13:00	16:00	BZ	2	13:50
15/09/2021	13:00	16:00	RN	1	13:55
15/09/2021	13:00	16:00	RN	2	14:20
15/09/2021	13:00	16:00	BZ	2	14:50
15/09/2021	13:00	16:00	BZ	3	15:15
15/09/2021	13:00	16:00	LB	2	15:20
15/09/2021	13:00	16:00	BZ	2	15:35
15/09/2021	13:00	16:00	BZ	1	15:45
15/09/2021	13:00	16:00	RN	5	15:50
30/10/2021	11:20	14:20	RN	2	11:35
30/10/2021	11:20	14:20	RN	1	11:45
30/10/2021	11:20	14:20	BZ	1	13:20
30/10/2021	11:20	14:20	BZ	1	14:10

Date	Survey Start	Survey End	Species	Count	5 Min Period
30/10/2021	14:50	17:50	BZ	1	15:40
30/10/2021	14:50	17:50	BZ	1	15:55
30/10/2021	14:50	17:50	BZ	1	17:10
04/11/2021	14:00	17:00	BZ	1	14:50
04/11/2021	14:00	17:00	BZ	1	16:15
04/12/2021	12:00	15:00	RN	3	12:55
04/12/2021	12:00	15:00	RN	2	13:15
04/12/2021	12:00	15:00	BZ	1	14:30
04/12/2021	12:00	15:00	BZ	1	14:55
09/12/2021	13:00	16:00	BZ	1	13:00
09/12/2021	13:00	16:00	BZ	1	13:25
09/12/2021	13:00	16:00	BZ	1	13:30
09/12/2021	13:00	16:00	RN	1	14:10
09/12/2021	13:00	16:00	RN	2	15:05
09/12/2021	13:00	16:00	BZ	2	15:40
21/12/2021	13:00	16:00	SH	1	13:25
21/12/2021	13:00	16:00	BZ	1	14:10
21/12/2021	13:00	16:00	BZ	1	15:10
21/12/2021	13:00	16:00	BZ	1	15:15
21/12/2021	13:00	16:00	BZ	1	15:40
22/12/2021	15:10	16:40	BZ	1	16:05
23/12/2021	08:40	10:10	BZ	2	09:30
23/12/2021	08:40	10:10	BZ	1	09:35
23/12/2021	08:40	10:10	BZ	1	09:55
04/02/2022	14:40	17:40	RN	2	14:50
04/02/2022	14:40	17:40	RN	1	15:15
17/02/2022	07:10	10:10	BZ	1	08:05
17/02/2022	07:10	10:10	SH	2	08:25
17/02/2022	07:10	10:10	SH	2	08:35
17/02/2022	07:10	10:10	SH	1	08:40
17/02/2022	07:10	10:10	BZ	2	08:40
17/02/2022	07:10	10:10	BZ	2	08:45
17/02/2022	07:10	10:10	SH	1	09:00
17/02/2022	07:10	10:10	RN	1	09:00
17/02/2022	07:10	10:10	SH	1	09:20
01/03/2022	08:30	11:30	BZ	2	10:25

Date	Survey Start	Survey End	Species	Count	5 Min Period
01/03/2022	08:30	11:30	BZ	1	10:45
01/03/2022	08:30	11:30	BZ	2	10:50
01/03/2022	08:30	11:30	BZ	2	10:55
01/03/2022	08:30	11:30	BZ	2	11:05
01/03/2022	08:30	11:30	BZ	1	11:25
01/04/2022	06:35	09:35	BZ	1	09:05
02/04/2022	17:03	20:03	BZ	2	17:10
02/04/2022	17:03	20:03	BZ	1	17:50
02/04/2022	17:03	20:03	BZ	1	18:25
02/04/2022	17:03	20:03	BZ	1	19:10

Table A3-11
Secondary target species recorded during flight activity surveys undertaken at VP4

Date	Survey Start	Survey End	Species	Count	5 Min Period
27/04/2021	17:30	20:30	BZ	1	18:10
27/04/2021	17:30	20:30	BZ	1	18:45
27/04/2021	17:30	20:30	RN	1	18:45
27/04/2021	17:30	20:30	RN	1	19:40
30/04/2021	14:00	17:00	SH	1	15:55
30/04/2021	14:00	17:00	BZ	1	16:05
30/04/2021	14:00	17:00	WM	1	16:05
30/04/2021	14:00	17:00	BZ	1	16:10
30/04/2021	14:00	17:00	WM	1	16:11
25/05/2021	13:00	16:00	RN	1	14:20
25/05/2021	13:00	16:00	RN	1	14:30
25/05/2021	13:00	16:00	BZ	1	14:55
25/05/2021	13:00	16:00	BZ	1	15:20
25/05/2021	13:00	16:00	BZ	3	15:35
25/05/2021	13:00	16:00	BZ	3	15:40
30/05/2021	10:00	13:00	BZ	1	10:40
30/05/2021	10:00	13:00	BZ	1	10:55
30/05/2021	10:00	13:00	BZ	2	11:25
30/05/2021	10:00	13:00	BZ	2	11:45
30/05/2021	10:00	13:00	RN	1	12:00
30/05/2021	10:00	13:00	BZ	1	12:45
30/05/2021	10:00	13:00	BZ	1	12:55

Date	Survey Start	Survey End	Species	Count	5 Min Period
05/06/2021	11:00	14:00	BZ	1	11:35
05/06/2021	11:00	14:00	BZ	1	13:35
09/07/2021	06:15	09:15	RN	1	06:55
09/07/2021	06:15	09:15	SH	1	07:20
30/07/2021	17:40	20:40	LB	15	17:50
30/07/2021	17:40	20:40	BZ	1	18:20
30/07/2021	17:40	20:40	BZ	1	19:20
30/07/2021	17:40	20:40	RN	1	19:35
31/07/2021	06:00	09:00	SH	1	07:25
31/07/2021	06:00	09:00	RN	1	08:20
27/08/2021	13:00	16:00	RN	2	13:05
27/08/2021	13:00	16:00	RN	2	13:10
27/08/2021	13:00	16:00	RN	1	13:25
27/08/2021	13:00	16:00	RN	1	13:25
27/08/2021	13:00	16:00	RN	2	13:25
27/08/2021	13:00	16:00	RN	5	13:35
27/08/2021	13:00	16:00	BZ	1	13:45
27/08/2021	13:00	16:00	LB	2	13:55
27/08/2021	13:00	16:00	BZ	1	14:05
27/08/2021	13:00	16:00	BZ	2	14:05
28/08/2021	14:00	17:00	RN	2	14:00
28/08/2021	14:00	17:00	RN	10	14:35
28/08/2021	14:00	17:00	SH	1	14:40
28/08/2021	14:00	17:00	BZ	1	15:10
28/08/2021	14:00	17:00	BZ	1	15:20
28/08/2021	14:00	17:00	RN	2	15:20
28/08/2021	14:00	17:00	RN	2	15:25
28/08/2021	14:00	17:00	BZ	1	15:30
28/08/2021	14:00	17:00	RN	4	15:55
28/08/2021	14:00	17:00	BZ	1	16:40
28/08/2021	14:00	17:00	BZ	1	16:45
14/09/2021	13:00	16:00	RN	2	13:25
14/09/2021	13:00	16:00	BZ	1	13:50
14/09/2021	13:00	16:00	BZ	1	13:55
14/09/2021	13:00	16:00	BZ	1	14:10
14/09/2021	13:00	16:00	BZ	3	14:45

Date	Survey Start	Survey End	Species	Count	5 Min Period
14/09/2021	13:00	16:00	BZ	5	14:50
14/09/2021	13:00	16:00	BZ	4	14:55
14/09/2021	13:00	16:00	BZ	1	15:10
15/09/2021	09:30	12:30	GS	2	11:05
05/11/2021	08:30	11:30	SH	1	09:35
05/11/2021	08:30	11:30	RN	1	09:55
05/11/2021	08:30	11:30	RN	2	10:15
05/11/2021	08:30	11:30	BZ	1	10:25
05/11/2021	08:30	11:30	BZ	1	10:40
05/11/2021	08:30	11:30	RN	2	11:05
05/11/2021	08:30	11:30	BZ	2	11:20
06/12/2021	13:45	16:45	BZ	1	14:00
06/12/2021	13:45	16:45	BZ	1	14:05
06/12/2021	13:45	16:45	BZ	1	14:15
06/12/2021	13:45	16:45	BZ	2	14:45
06/12/2021	13:45	16:45	RN	1	14:50
06/12/2021	13:45	16:45	BZ	1	14:55
06/12/2021	13:45	16:45	SH	1	15:10
06/12/2021	13:45	16:45	BZ	1	15:25
06/12/2021	13:45	16:45	RN	2	15:25
06/12/2021	13:45	16:45	RN	1	15:50
10/12/2021	09:50	12:50	RN	2	10:25
10/12/2021	09:50	12:50	RN	2	10:30
10/12/2021	09:50	12:50	BZ	1	11:15
10/12/2021	09:50	12:50	RN	1	12:40
23/12/2021	10:40	12:10	RN	2	11:20
23/12/2021	10:40	12:10	RN	1	11:20
23/12/2021	10:40	12:10	RN	2	11:25
23/12/2021	10:40	12:10	BZ	1	11:45
23/12/2021	10:40	12:10	BZ	1	12:00
29/12/2021	08:30	10:00	RN	1	09:45
29/12/2021	08:30	10:00	RN	1	09:55
29/12/2021	10:00	13:00	RN	2	10:10
29/12/2021	10:00	13:00	BZ	1	11:25
29/12/2021	10:00	13:00	BZ	2	12:10
29/12/2021	10:00	13:00	BZ	1	12:15

Date	Survey Start	Survey End	Species	Count	5 Min Period
29/12/2021	10:00	13:00	BZ	1	12:35
29/12/2021	10:00	13:00	BZ	1	12:40
04/01/2022	12:45	15:45	RN	2	14:35
03/02/2022	11:10	14:10	BZ	3	13:05
03/02/2022	11:10	14:10	BZ	1	13:30
03/02/2022	11:10	14:10	BZ	1	13:35
03/02/2022	11:10	14:10	BZ	1	13:55
03/02/2022	11:10	14:10	RN	2	13:55
28/02/2022	10:18	13:18	RN	1	11:25
28/02/2022	10:18	13:18	BZ	1	12:35
01/04/2022	13:35	16:35	SH	1	14:05
01/04/2022	13:35	16:35	BZ	1	15:20
01/04/2022	13:35	16:35	BZ	2	15:25
01/04/2022	13:35	16:35	BZ	2	15:45
01/04/2022	13:35	16:35	BZ	1	15:45
02/04/2022	13:33	16:33	BZ	1	13:35
02/04/2022	13:33	16:33	RN	1	13:35
02/04/2022	13:33	16:33	BZ	2	15:10
02/04/2022	13:33	16:33	BZ	1	15:20
02/04/2022	13:33	16:33	BZ	2	15:25

Table A3-12
Secondary target species recorded during flight activity surveys undertaken at VP5

Date	Survey Start	Survey End	Species	Count	5 Min Period
30/04/2021	11:30	14:30	RN	2	13:20
30/04/2021	11:30	14:30	BZ	1	13:50
30/04/2021	11:30	14:30	BZ	1	13:55
30/04/2021	11:30	14:30	RN	1	14:15
01/05/2021	10:25	13:25	BH	1	10:40
01/05/2021	10:25	13:25	BZ	2	11:10
01/05/2021	10:25	13:25	BZ	2	11:15
01/05/2021	10:25	13:25	BZ	1	11:50
01/05/2021	10:25	13:25	BH	2	12:40
15/05/2021	10:35	13:35	CA	1	11:05
15/05/2021	10:35	13:35	RN	2	11:10
15/05/2021	10:35	13:35	MA	1	12:10

Date	Survey Start	Survey End	Species	Count	5 Min Period
15/05/2021	10:35	13:35	BZ	2	12:30
15/05/2021	10:35	13:35	BZ	2	12:35
15/05/2021	10:35	13:35	BZ	2	13:10
15/05/2021	10:35	13:35	BZ	2	13:15
15/05/2021	14:05	17:05	BZ	2	14:05
15/05/2021	14:05	17:05	BZ	2	14:10
15/05/2021	14:05	17:05	BZ	1	15:30
15/05/2021	14:05	17:05	MA	2	16:05
15/05/2021	14:05	17:05	BZ	1	16:30
14/06/2021	09:20	12:20	H.	1	09:55
14/06/2021	09:20	12:20	LB	1	10:40
14/06/2021	09:20	12:20	BZ	2	11:10
14/06/2021	09:20	12:20	BZ	2	11:15
14/06/2021	12:50	15:50	RN	2	13:10
14/06/2021	12:50	15:50	H.	1	14:35
14/07/2021	14:45	17:45	BZ	1	15:25
14/07/2021	14:45	17:45	BZ	2	16:10
14/07/2021	14:45	17:45	BZ	2	16:15
14/07/2021	14:45	17:45	RN	2	17:00
15/07/2021	13:45	16:45	RN	1	13:45
15/07/2021	13:45	16:45	BH	1	14:45
15/07/2021	13:45	16:45	H.	1	15:15
15/07/2021	13:45	16:45	BZ	1	16:05
09/08/2021	07:30	10:30	LB	2	07:50
09/08/2021	07:30	10:30	BZ	3	08:40
09/08/2021	07:30	10:30	BZ	4	08:45
09/08/2021	07:30	10:30	CA	1	09:25
09/08/2021	07:30	10:30	BZ	1	09:45
09/08/2021	07:30	10:30	RN	2	09:45
11/08/2021	17:30	20:30	BZ	1	19:05
20/09/2021	13:40	16:40	BH	23	15:05
20/09/2021	13:40	16:40	CM	11	15:05
20/09/2021	13:40	16:40	HG	6	15:05
20/09/2021	13:40	16:40	H.	1	15:20
20/09/2021	17:05	20:05	RN	3	17:40
20/09/2021	17:05	20:05	BH	12	18:10

Date	Survey Start	Survey End	Species	Count	5 Min Period
20/09/2021	17:05	20:05	H.	2	19:10
20/09/2021	17:05	20:05	MA	2	19:30
22/10/2021	07:30	10:30	H.	1	08:05
22/10/2021	07:30	10:30	RN	3	09:25
22/10/2021	07:30	10:30	RN	1	10:05
22/10/2021	15:45	18:45	BZ	1	16:30
22/10/2021	15:45	18:45	BZ	1	17:20
22/10/2021	15:45	18:45	BZ	1	17:25
10/11/2021	12:20	15:20	RN	2	12:40
10/11/2021	12:20	15:20	RN	2	12:45
10/11/2021	12:20	15:20	BZ	1	13:30
10/11/2021	12:20	15:20	BZ	1	13:50
10/11/2021	12:20	15:20	BH	12	14:40
10/11/2021	12:20	15:20	CM	6	14:40
11/11/2021	14:10	17:10	CA	4	15:00
11/11/2021	14:10	17:10	BZ	2, 4	15:40
11/11/2021	14:10	17:10	BZ	3	16:10
17/12/2021	10:10	13:10	HG	3	11:05
17/12/2021	10:10	13:10	HG	3	11:10
17/12/2021	10:10	13:10	RN	2	12:00
17/12/2021	13:40	16:40	H.	1	14:10
17/12/2021	13:40	16:40	RN	4	16:05
05/01/2022	08:05	11:05	RN	2	09:10
05/01/2022	08:05	11:05	SH	1	10:05
05/01/2022	11:35	14:35	HG	2	12:30
05/01/2022	11:35	14:35	RN	2	13:15
10/02/2022	07:40	10:40	H.	1	09:10
10/02/2022	07:40	10:40	RN	2	10:20
10/02/2022	15:00	18:00	RN	1	16:05
10/02/2022	15:00	18:00	JS	1	16:10
10/02/2022	15:00	18:00	HG	3	16:55
12/03/2022	06:50	09:50	RN	1	08:05
12/03/2022	06:50	09:50	RN	2	08:45
12/03/2022	06:50	09:50	MA	2	09:35
12/03/2022	12:50	15:50	H.	1	13:40
12/03/2022	12:50	15:50	SH	1	15:05

Table A3-13
Secondary target species recorded during flight activity surveys undertaken at VP6

Date	Survey Start	Survey End	Species	Count	5 Min Period
28/04/2021	14:05	17:05	RN	2	15:10
28/04/2021	14:05	17:05	RN	2	15:15
28/04/2021	14:05	17:05	BZ	1	16:00
28/04/2021	14:05	17:05	RN	4	16:40
28/04/2021	14:05	17:05	RN	4	16:45
28/04/2021	17:35	20:35	RN	2	18:10
28/04/2021	17:35	20:35	BZ	1	19:10
28/04/2021	17:35	20:35	BZ	1	19:15
28/04/2021	17:35	20:35	BZ	2	19:40
28/04/2021	17:35	20:35	BZ	2	19:45
14/05/2021	05:00	08:00	RN	2	05:40
14/05/2021	05:00	08:00	RN	1	06:30
14/05/2021	05:00	08:00	BZ	1	07:10
14/05/2021	08:30	11:30	RN	1	09:40
14/05/2021	08:30	11:30	H.	1	10:20
09/06/2021	13:30	16:30	H.	1	15:05
09/06/2021	13:30	16:30	MA	1	16:00
09/06/2021	17:00	20:00	BZ	1	18:10
09/06/2021	17:00	20:00	BH	1	19:10
09/06/2021	17:00	20:00	MA	2	19:50
14/07/2021	11:15	14:15	H.	1	13:20
14/07/2021	11:15	14:15	BH	2	13:50
14/07/2021	19:16	22:16	MA	1	20:06
14/07/2021	19:16	22:16	BZ	1	20:31
14/07/2021	19:16	22:16	BZ	1	21:16
09/08/2021	11:00	14:00	MA	1	12:05
09/08/2021	11:00	14:00	RN	2	12:10
09/08/2021	11:00	14:00	H.	2	13:25
11/08/2021	14:00	17:00	BH	2	14:50
11/08/2021	14:00	17:00	SH	1	15:25
11/08/2021	14:00	17:00	RN	2	16:00
20/09/2021	06:40	09:40	RN	2	06:55
20/09/2021	06:40	09:40	HG	2	07:40
20/09/2021	06:40	09:40	RN	1	08:35

Date	Survey Start	Survey End	Species	Count	5 Min Period
20/09/2021	10:10	13:10	BZ	1	10:45
20/09/2021	10:10	13:10	HG	1	11:40
20/09/2021	10:10	13:10	RN	1	12:10
23/10/2021	07:35	10:35	MA	2	08:10
23/10/2021	07:35	10:35	BZ	1	08:40
23/10/2021	07:35	10:35	BZ	2	09:15
23/10/2021	15:45	18:45	MA	2	17:10
23/10/2021	15:45	18:45	BH	18	17:30
23/10/2021	15:45	18:45	CM	9	17:30
23/10/2021	15:45	18:45	MA	2	18:05
10/11/2021	08:50	11:50	BH	20	09:10
10/11/2021	08:50	11:50	CM	13	09:10
10/11/2021	08:50	11:50	RN	2	10:20
10/11/2021	08:50	11:50	BH	12	11:00
10/11/2021	08:50	11:50	SH	1	11:10
11/11/2021	10:40	13:40	H.	1	10:55
11/11/2021	10:40	13:40	CM	5	12:05
11/11/2021	10:40	13:40	SH	1	13:00
13/12/2021	08:05	11:05	RN	1	08:45
13/12/2021	13:45	16:45	RN	2	14:50
06/01/2022	14:00	17:00	BH	12	16:05
06/02/2022	08:20	11:20	H.	1	08:35
06/02/2022	08:20	11:20	RN	2	09:30
06/02/2022	08:20	11:20	RN	1	10:00
12/02/2022	11:20	14:20	RN	2	13:05
12/02/2022	11:20	14:20	BZ	1	14:00
12/02/2022	15:00	18:00	HG	3	15:25
12/02/2022	15:00	18:00	SH	1	16:10
12/02/2022	15:00	18:00	H.	1	17:20
12/02/2022	15:00	18:00	MA	2	17:35
14/03/2022	10:30	13:30	BZ	1	10:50
14/03/2022	10:30	13:30	BZ	1	10:55
14/03/2022	10:30	13:30	BZ	1	12:05
14/03/2022	10:30	13:30	HG	3	12:40
14/03/2022	10:30	13:30	BZ	1	13:10
14/03/2022	14:00	17:00	BZ	1	14:25

Date	Survey Start	Survey End	Species	Count	5 Min Period
14/03/2022	14:00	17:00	BZ	1	14:30
14/03/2022	14:00	17:00	BZ	1	15:20
14/03/2022	14:00	17:00	SH	1	16:10

Table A3-14
Secondary target species recorded during flight activity surveys undertaken at VP7

Date	Survey Start	Survey End	Species	Count	5 Min Period
30/04/2021	08:00	11:00	BZ	1	09:25
30/04/2021	08:00	11:00	RN	4	10:05
30/04/2021	08:00	11:00	RN	4	10:10
01/05/2021	06:55	09:55	RN	2	07:20
01/05/2021	06:55	09:55	H.	1	08:10
01/05/2021	06:55	09:55	BZ	1	09:00
01/05/2021	06:55	09:55	BZ	1	09:05
14/05/2021	14:20	17:20	LB	2	15:05
14/05/2021	14:20	17:20	BZ	1	15:30
14/05/2021	14:20	17:20	CA	1	16:40
14/05/2021	14:20	17:20	BZ	1	17:10
14/05/2021	14:20	17:20	BZ	1	17:15
14/05/2021	18:50	21:50	BZ	2	19:05
14/05/2021	18:50	21:50	BZ	2	19:10
14/05/2021	18:50	21:50	SH	1	20:10
14/05/2021	18:50	21:50	RN	2	20:40
10/06/2021	13:50	16:50	H.	2	14:20
10/06/2021	13:50	16:50	BZ	2	14:35
10/06/2021	13:50	16:50	RN	4	14:55
10/06/2021	13:50	16:50	BZ	1	15:50
10/06/2021	13:50	16:50	BZ	1	15:55
10/06/2021	13:50	16:50	SH	1	16:30
10/06/2021	17:20	20:20	MA	1	19:10
15/07/2021	10:15	13:15	MA	2	10:35
15/07/2021	10:15	13:15	RN	3	12:15
15/07/2021	10:15	13:15	BZ	3	13:00
15/07/2021	10:15	13:15	BZ	3	13:05
15/07/2021	19:15	22:15	BZ	1	19:30
15/07/2021	19:15	22:15	H.	1	20:50

Date	Survey Start	Survey End	Species	Count	5 Min Period
09/08/2021	14:30	17:30	H.	1	15:40
09/08/2021	14:30	17:30	RN	4	16:05
09/08/2021	14:30	17:30	RN	2	16:30
09/08/2021	14:30	17:30	MA	4	17:10
11/08/2021	10:30	13:30	H.	1	11:10
11/08/2021	10:30	13:30	BZ	1	12:05
11/08/2021	10:30	13:30	HG	3	13:00
17/09/2021	13:20	16:20	H.	1	14:40
17/09/2021	13:20	16:20	SH	1	15:05
17/09/2021	13:20	16:20	BZ	1	15:20
17/09/2021	13:20	16:20	BH	11	15:40
17/09/2021	13:20	16:20	CM	4	15:40
17/09/2021	16:50	19:50	BZ	1	17:10
17/09/2021	16:50	19:50	BH	18	17:40
17/09/2021	16:50	19:50	BZ	1	18:05
17/09/2021	16:50	19:50	BZ	1	18:10
17/09/2021	16:50	19:50	H.	1	18:50
17/09/2021	16:50	19:50	BH	14	19:30
17/09/2021	16:50	19:50	CM	6	19:35
12/10/2021	14:45	17:45	CM	5	16:00
12/10/2021	14:45	17:45	RN	2	16:40
12/10/2021	14:45	17:45	RN	2	16:45
12/10/2021	14:45	17:45	MA	2	17:10
08/11/2021	14:10	17:10	RN	2	14:50
08/11/2021	14:10	17:10	RN	2	14:55
08/11/2021	14:10	17:10	H.	1	16:35
12/11/2021	09:40	12:40	BZ	1	09:40
12/11/2021	09:40	12:40	RN	3	10:20
12/11/2021	09:40	12:40	BH	10	11:30
20/12/2021	13:45	16:45	RN	2	14:10
20/12/2021	13:45	16:45	BZ	1	15:20
20/12/2021	13:45	16:45	BH	7	16:10
20/12/2021	13:45	16:45	CM	5	16:10
04/01/2022	12:30	15:30	RN	1	13:10
04/01/2022	09:00	12:00	BZ	1	14:05
04/01/2022	12:30	15:30	RN	2	15:05

Date	Survey Start	Survey End	Species	Count	5 Min Period
11/02/2022	09:00	12:00	H.	1	10:25
11/02/2022	09:00	12:00	RN	2	10:55
11/02/2022	09:00	12:00	BH	6	11:20
11/02/2022	12:30	15:30	BZ	1	14:05
15/03/2022	11:00	14:00	BH	4	11:50
15/03/2022	11:00	14:00	RN	2	13:05
15/03/2022	14:30	17:30	BZ	1	15:00
15/03/2022	14:30	17:30	BZ	2	15:05
15/03/2022	14:30	17:30	BZ	2	15:10
15/03/2022	14:30	17:30	MA	1	16:20

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BIRD SURVEY REPORT BREEDING SEASON 2022

Coolglass Wind Farm

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BASIS OF REPORT

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APPENDICES

1.0 Introduction

SLR Consulting Ireland (SLR) was previously commissioned to carry out bird surveys for the breeding bird period in 2021 and non-breeding bird period in 2021/22. SLR was then commissioned by Statkraft in April 2022 to carry out a bird survey programme for the proposed Coolglass Wind Farm, Co. Laois (hereafter 'the Project') during the breeding period 2022 and non-breeding bird period in 2022/23. The non-breeding 2022/23 report will be provided at a later date.

1.1 Background to the Commission

No previous planning permission has been sought on the application site (hereafter 'the Project Site') for the development of wind farms by Statkraft or any other party. Breeding and non-breeding bird surveys were previously carried out by Fehily Timoney and Company on the Project Site from 2012 to 2018. These surveys included flight activity, breeding wader, barn owl, and merlin surveys. This data is available in raw format but has not been reported on.

1.2 Project Site Description

The Project Site is located within the townlands of Brennanshill, Coolglass, Crissard, Fallowbeg Upper, Coolglass Upper, Gorreelagh Kylenabehy and Scotland in Co. Laois. The dominant habitats within the boundaries of the Project Site are conifer plantation and improved agricultural grassland. There are also numerous eroding/upland rivers including the Fallowbeg Upper, Owveg [Nore], Clogh 15 and Brennanshill. The north of the Project Site is focused on Fossy Mountain, which is a small hill, 323 m above sea level in height.

1.3 Scope of Work

The scope of survey work was based on existing knowledge of the area and took into account current NatureScot (NS) (formerly Scottish Natural Heritage; SNH) guidance[1]. This survey methods guidance is recognised as standard best practice guidance throughout the UK and Ireland for surveying birds to inform impact assessment for onshore wind farms. The same suite of surveys was undertaken as in the breeding 2021 season, with the addition of breeding wader surveys. Breeding wader surveys were included in the 2022 season as wader flight lines were recorded in the breeding 2021 and non-breeding 2021/22 season.

The scope of survey work undertaken is provided in **Table 1-1**. Further details are provided in Sections 2.2.2 to 2.2.5.

[1] Scottish Natural Heritage (2017). *Recommended Bird Survey Methods to Inform Impact Assessment of Onshore Wind Farms V2.* Scottish Natural Heritage, Inverness.

Table 1-1
Scope of Ornithological Survey Work, Breeding Season 2022

Survey Type	Summary Methodology (see Section 2 for further details)
Vantage Point (VP) surveys	36 hours of surveys were carried out from VPs 1, 2, 4 and 7 from May to August 2022.
Breeding raptor surveys	Five surveys were undertaken from May to July 2022 to search for any raptors breeding within 2 km of the Project Site.
Breeding wader surveys	Three surveys were carried out from May to June 2022 to search for any waders breeding within the Project Site.

1.4 Target Species

Target species for the surveys were defined by legal and/or conservation status and vulnerability to impacts caused by wind turbines, as defined in NS guidance.

1.4.1 Primary Target Species

Primary target species was limited to species upon which effects are most likely to be potentially significant in EIA and Appropriate Assessment (AA) terms e.g., species forming qualifying features for nearby Special Protection Areas (SPAs) or species listed on Annex 1 of the Birds Directive[2]. This enabled recording to focus on the species of greatest importance without the distraction of having to record detailed flight data for a larger number of more common species.

Primary target species included the following bird species:

- All Annex 1 raptor/owl species;
- Qualifying interest species for nearby SPAs[3]; and
- Other raptors, waders or wildfowl red-listed on the latest Birds of Conservation Concern in Ireland (BoCCI)[4] scheme.

1.4.2 Secondary Species

Local circumstances may indicate that survey information should also be acquired on other species, especially those of regional conservation concern. Such species are termed secondary species. Recording of secondary species is subsidiary to recording of primary target species.

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[2] Annex 1 of the Birds Directive (Directive 2009/147/EC)
[3] The relevant SPAs are listed in Section 3.1.
[4] Gilbert, G., Stanbury, A. and Lewis, L. (2021). Birds of Conservation Concern in Ireland 2020–2026. Irish Birds 43: 1–22

Secondary target species included:

- Any other wildfowl and wader species;
- Common buzzard *Buteo buteo;*
- Eurasian sparrowhawk *Accipiter nisus*;
- Northern raven *Corvus corax*;
- Grey heron *Ardea cinerea;*
- Great cormorant *Phalacrocorax carbo;* and
- Gulls *Larus* and *Chroicocephalus sp*.

1.5 Terminology

For this report, “flight line” refers to the line drawn to record avian movement during a VP survey. A single flight line may be used indicate the collective movement of a flock of birds. Each individual bird moving within the same flight line is referred to as “a flight”. Note that the “cumulative number of birds recorded in flight” reflects the occupancy of the study area by a particular species. It is not equivalent to the number of unique individuals and should not be used to infer abundance.

1.6 Purpose of the Report

The aim of this report is to provide robust baseline ornithological survey data for the breeding period in 2022. These data will be used to inform a separate ecological impact assessment and appropriate assessment for the Project. The assessment of potential impacts is beyond the scope of this report.

2.0 Methodology

2.1 Desk-based Review

The desk-based review collated available information collected to date on the bird movements in and around the Project Site. The websites of the National Parks and Wildlife Service (NPWS) www.npws.ie, the National Biodiversity Data Centre (NBDC) http://maps.biodiversityireland.ie/#/Map, and the UK and Ireland Bird Atlas 2007-2011 https://app.bto.org/mapstore/StoreServlet were also accessed for information on sites designated for nature conservation in the vicinity of the Project Site and notable bird species in the local area.

2.2 Field Surveys

2.2.1 Field Survey Team: Evidence of Technical Competence and Experience

Jonathon Dunn (JD) – Project Manager and Lead Ornithologist

Jonathon is a Senior Ecologist with SLR and holds a BA (Hons) in Natural Sciences from the University of Cambridge, an MSc in Ecology Evolution and Conservation from Imperial College London and a PhD in Avian Ecology from Newcastle University. He is a Full member of the Chartered Institute of Ecology and Environmental Management (MCIEEM). Jonathon is a highly skilled and experienced bird surveyor with six years' post graduate experience as a professional consultant ecologist. Jonathon managed this project through liaison with the client, coordination of the survey team, supervision of the health and safety of the team, collating, quality controlling and assessing the survey data.

Maeve Maher-McWilliams (MMW)

Maeve is a freelance ecologist with a BSc in Biological Sciences from Queen's University Belfast and an MSc in Evolutionary and Behavioural Ecology from the University of Exeter. She is an Associate member of CIEEM and has ten years of experience as a professional consultant ecologist. Maeve carried out vantage point surveys, breeding wader and breeding raptor surveys at Coolglass wind farm during the 2022 breeding season.

Faolán Linnane (FL) – Project Ecologist

Faolán is a Project Ecologist with SLR and holds a BSc in Zoology and an MSc in Marine Biology from University College Cork. He has experience in vantage point surveys and is also involved in data input and the drafting of bird survey reports. Faolán carried out vantage point surveys at Coolglass wind farm in May 2022.

Darragh Nagle (DN) – Graduate Ecologist

Darragh Nagle is a Graduate Ecologist with SLR and a qualifying member of CIEEM. Darragh graduated from University College Cork in 2020 with a BSc degree in Ecology and Environmental Ecology. Since joining SLR Darragh's field experience includes multiple bird surveys on windfarm sites across Ireland including onshore windfarm vantage point surveys, breeding wader surveys, breeding raptor surveys and intertidal bird surveys for landfall locations for offshore wind projects. Darragh undertook surveys for this project in April 2022.

Alice Magee (AM) – Graduate Ecologist

Alice is a Graduate Ecologist with a BSc in Zoology from University College Dublin and an MSc in Ecological Management and Conservation Biology from Queen's University Belfast. She carried out vantage point surveys at Coolglass wind farm in June 2022.

2.2.2 Flight Activity Surveys

Seven vantage point (VP) locations were used for surveys during the 2021 breeding and 2021/22 non-breeding seasons. Following these two survey seasons, the Project Site was reduced in size. Consequently, for the 2022 breeding season surveys only five vantage point (VP) locations were retained to provide visibility of the remaining optioned lands and a 500 m buffer surrounding the same. The adequacy of these VPs was checked by carrying out a desk-based viewshed analysis using a bespoke GIS tool for calculating the visible area from each vantage point (VP). The Zones of Theoretical Visibility (ZTV) from each VP were calculated using ArcMAP 10.5.1 Spatial Analyst using a terrain model derived from EU-DEM data with a vertical accuracy of ± 7 m. The ZTVs have been calculated using a surface offset of 30 m, to match the lowest point swept by the rotors of the proposed turbines. The ZTVs are based on a viewing height of 1.8 m above ground level. VP locations, viewing arcs and viewsheds are shown in **Figure 1**.

During the breeding season (monthly visits May-August inclusive), a total of 36 hours of watches were undertaken at VPs 1-3 and at VP4 and VP7. The VP survey effort undertaken during the breeding season of 2022 is summarised in **Table 2-1** with full details of survey dates, times and observers provided in Appendix 01 and details of weather conditions during the surveys provided in Appendix 02.

Table 2-1
VP survey effort undertaken at the Project Site from May 2022 to August 2022

Month	VP1 (hours)	VP2 (hours)	VP3 (hours)	VP4 (hours)	VP7 (hours)
May	12:00	12:00	12:00	03:00	09:00
June	06:00	06:00	06:00	09:00	03:00
July	12:00	12:00	12:00	12:00	12:00
August	06:00	06:00	06:00	12:00	12:00
Total hrs	**36:00**	**36:00**	**36:00**	**36:00**	**36:00**
VP Locations ITM (**Figure 1**)	654390, 690092	656470, 687421	654877, 687955	657231, 685790	655847, 683304

VP surveys aimed to quantify the flight activity of primary and secondary target species (as defined in Section 1.4) within the study area.

The main purpose of VP watches is to collect data on primary target species that will enable estimates to be made of:

- The time spent flying over the site;
- The relative use by birds of different parts of the site;
- The proportion of flying time spent within the provisional upper and lower risk height limits as determined by the potential rotor diameter and rotor hub height; and
- Ultimately, the analysis of the potential risk of collision of birds with rotating turbines.

For each primary target species observation, the following details were recorded:

- Time of observation;
- Duration of flying bout;
- Species, age and sex (where determinable);
- Time spent within each height band and;
- Notes on observation.

In the absence of detailed information regarding turbine specifications at the time of commencing surveys, a precautionary approach was taken in relation to recording height bands. Height bands were determined allowing for the maximum rotor tip height of 180 m and a lowest rotor swept height of 30 m. Flight heights were attributed to five distinct height bands as follows:

- 1 = < 15 m (below the likely rotor swept area);
- 2 = 15 m to 30m (below the likely rotor swept area);
- 3 = 30 m to 150 m (within the likely rotor swept area);
- 4 = 150 m to 200 m (within the likely rotor swept area, at least in part); and
- 5 = >200 m (above the likely rotor swept area).

In addition, a summary of observations of secondary target species was recorded at the end of each five-minute period during each VP watch to provide an index of flight activity for secondary target species within the Project Site, in accordance with current NS guidance.

2.3 Breeding Wader Surveys

Breeding wader surveys followed the methodology described in O'Brien and Smith (1992)[5]. The survey involved a walked transect, which covered all habitat potentially suitable for breeding waders within the wind farm site. Access to the 500 m buffer surrounding the wind farm was not possible. The same transect was repeated three times across the 2022 breeding season twice in May and once in June 2022.

There are large plantations of mature conifer forestry which comprise the majority of the site. These habitats are not suitable for breeding waders[6] and so were excluded from the survey. As such, the transect was restricted to

[5] O'Brien, M. and Smith, K. W. (1992) Changes in the status of waders breeding on wet lowland grasslands in England and Wales between 1982 and 1989, Bird Study, 39:3, 165-176

[6] Apart from potentially for woodcock, which were not the target of surveys here.

potentially suitable habitat within the north-western section of the site near turbine T1 where several wet, improved agricultural grassland fields are present.

The location, movement and behaviour of all wader species were to be recorded onto field maps using standard BTO species codes (had any waders been recorded). The following criteria were to be recorded for each species:

- Northern lapwing *Vanellus vanellus* – the total numbers of birds seen from the transect;
- Common snipe *Gallinago gallinago* – the number of drumming plus chipping birds heard or seen from the transect; and
- Other species – the number of pairs (where 'pairs' = (paired individuals/2), displaying birds, nests or broods and other single birds not in flocks).

Birds were considered to be confirmed breeding if:

- They were observed displaying or singing on more than one visit;
- Nests, eggs, or young were located;
- Adults repeatedly alarm called;
- Distraction displays were seen; and/ or
- Territorial disputes were observed.

Birds were considered to be probably or possibly (i.e. unconfirmed) breeding if:

- They were observed displaying or singing on one visit (i.e. possibly breeding) or more than one visit (i.e. probably breeding) (with the exception of obvious passage migrants in spring); or
- A pair of birds was observed in suitable habitat for nesting. Other records were considered to be of non-breeding birds, failed breeders, birds loafing, feeding or on passage to other areas

Details of survey dates, times and observers are provided in Appendix 01 and a record of weather conditions during surveys is provided in Appendix 02.

2.4 Breeding Raptor Surveys

NS recommends that all potential breeding territories within a 2 km radius of the Project Site be surveyed throughout the breeding season. A driven transect was undertaken within this buffer, stopping at potential raptor breeding habitats as defined by Hardey *et al.* (2013)[7] and focusing on areas which were not visible from the fixed vantage points. This transect was undertaken two times in May 2022, two times in June 2022 and once in July 2022. Details of survey dates, times and observers are provided in Appendix 01 and a record of weather conditions during surveys is provided in Appendix 02.

The location, movement and behaviour of all raptor species were recorded onto the field maps using standard BTO species codes.

2.5 Survey Limitations

The majority of VP surveys were undertaken in optimal weather conditions. However, during such an extensive series of surveys carried out it was inevitable that some surveys were completed in suboptimal conditions. There were 9 hours out of the total of 180 during which the visibility was recorded as “moderate”, i.e. 1-3 km. This comprises 5% of the total survey effort but in almost all cases all of the relevant 2 km viewing arc was visible and

[7] Hardey, J., Crick, H., Wernham, C., Riley, H., Etheridge, B. and Thompson, D. (2013). Raptors: A Field Guide to Survey and Monitoring (3rd Edition). The Stationery Office, Edinburgh.

this is not considered to significantly affect the validity of the data collected. In no cases did visibility fall below 1 km, and in many cases visibility was better than this for part of the relevant hour. As such, given the low proportion of surveys affected this is not considered to significantly affect the validity of the data collected. Further details regarding weather conditions during surveys are provided in Appendix 02.

No surveys were carried during April. However, the survey effort was doubled in May and again in July at VPs 1-3, resulting in a total of 36 hours being achieved at each VP. The survey effort was doubled in July and also in August at VP4 and VP7, resulting in a total of 36 hours being achieved at each VP. The surveys are in accordance with NS guidelines, which does not specify surveys in each month, just the effort for the season.

3.0 Results

3.1 Desk-based Review

3.1.1 Natura 2000 Sites

There are no Special Protection Areas (SPA) within the Project Site. However, there is one SPA within a 20 km[8] radius of the survey area.

Details of this SPA are shown in **Table 3-1**, which also shows the qualifying interests for the site.

Table 3-1
SPAs within 20 km of the proposed Coolglass Wind Farm and their qualifying interests

Site Name	Site Code	Distance / Direction from Project Site	Species of Special Conservation Interest Relevant to the Breeding Season
River Nore SPA	004233	11.7 km southwest of the Project Site (18.2 km instream distance via Owveg River)	Common kingfisher *Alcedo atthis*

3.1.2 Previous Survey Data

Breeding and non-breeding bird surveys were previously carried out by Fehily Timoney at the Project Site from 2012 to 2018. These surveys included flight activity, breeding wader, barn owl, and merlin surveys.

The following primary target species were observed either on-site or within the surrounding 500 m buffer during the previous surveys:

- Merlin *Falco columbarius;*
- European golden plover *Pluvialis apricaria*;
- Common kestrel *Falco tinnunculus*;
- Peregrine falcon *Falco peregrinus*;
- Hen harrier *Circus cyaneus;*
- Common snipe *Gallinago gallinago*; and
- Eurasian woodcock *Scolopax rusticola.*

Barn owl surveys were carried out in September 2013. Potentially suitable nesting sites were noted during this survey, but no confirmed nesting or roosting sites were identified.

No confirmed signs of breeding were identified during the merlin surveys.

[8] 20 km is the maximum distance typically applied when considering wildfowl ranging from roost sites to foraging sites.

The following secondary target species were observed either on-site or within the surrounding 500 m buffer during the previous surveys:

- Common buzzard *Buteo buteo*; and
- Eurasian sparrowhawk *Accipiter nisus*.

3.2 Breeding Season Flight Activity Surveys

Flight lines of primary target species recorded throughout the 2022 breeding season are presented in **Figures 2.1** to **2.2** and a summary of the survey findings are provided in Sections 3.2.1 and 3.2.2 for primary and secondary target species, respectively. Flight data for both primary and secondary target species are provided in Appendix 03.

3.2.1 Primary Target Species

In total, five primary target species were recorded flying within the study area on and around the Project Site during the survey period. Flight activity recorded for primary target species is summarised in Table 3-2.

Table 3-2
Number of Primary Target Species Flights from the Project Site for All VPs Combined – May - August 2022

Species	Number of flight lines by month				Total number of flight lines	Time at risk height* (s)	Cumulative number of birds recorded in flight
	May	June	July	August			
Common kestrel	15	14	64	6	99	570	102
Northern lapwing	0	2	0	0	2	0	3
Peregrine falcon	0	0	2	4	6	126	6
Common snipe	0	0	3	0	3	0	3
Eurasian woodcock	0	1	0	0	1	0	1
Total					**112**	**696**	**116**
* precautionary risk height assumed to be between 30 m – 180 m							

A summary of flight activity by species is presented below.

Common kestrel

Ninety-nine flight lines of common kestrel were recorded during the flight activity surveys. The maximum number of flight lines was recorded in July 2022 (n=64). Flight lines were recorded across all VP locations, within both the Project Site and the 500 m buffer. Most flights were observed at an average height of 20 metres.

Northern lapwing

Two flight lines of northern lapwing were recorded from VP1 in June 2022. Both were below potential rotor swept heights.

Peregrine falcon

Peregrine falcons were recorded in July and August 2022 only, with all flight lines consisting of single birds. These flight lines were recorded at VP locations 1, 2 and 3 within both the Project Site and the 500 m buffer. Flights were observed at average heights of between 18 and 150 metres.

Common snipe

Three flight lines of common snipe were recorded from VP2 in July 2022, with all flight lines consisting of single birds. These flight lines were observed within the Project Site at average heights of between 15 and 20 metres. Flight durations were long, ranging from 15 to 88 minutes. The birds were adult males drumming, which is confirmation of breeding as they were recorded on more than one visit.

Eurasian woodcock

One Eurasian woodcock flight line was recorded from VP3 in June 2022. The single bird was observed flying within the north-western portion of the Project Site at an average height of 20 metres. This bird was not roding and was commuting only.

3.2.2 Secondary Species

Secondary species activity at the Project Site is summarised in

Table 3-3. There were nine secondary species recorded throughout the breeding season. Common buzzard was the most frequently recorded secondary species (in 438 five-minute periods out of a possible 2,100). Lesser black-backed gull *Larus fuscus* was the most numerous of the recorded secondary species (maximum flock size of 23).

Table 3-3
Secondary Species Activity Summary for All VPs Combined – April 2021 – September 2021

Species	Number of 5 min periods recorded	Peak count of birds recorded in any 5 min period	Comments
Black-headed gull	2	4	Activity in July and August only, within the Project Site, survey buffer and beyond.
Common buzzard	438	5	Activity in all months, within the Project Site, survey buffer and beyond.
Common swift *Apus apus*	1	1	Activity in June 2022 only, within the survey buffer and beyond.
Great black-backed gull *Larus marinus*	2	1	Activity in July and August 2022, within the Project Site and survey buffer.
Grey heron	2	1	Activity in May and July 2022, within the Project Site.
European herring gull *Larus argentatus*	14	17	Activity in all months, within the Project Site, survey buffer and beyond.
Lesser black-backed gull	37	23	Activity in all months, within the Project Site, survey buffer and beyond.
Northern raven	56	8	Activity in all months, within the Project Site, survey buffer and beyond.
Eurasian sparrowhawk	17	3	Activity in all months, within the Project Site, survey buffer and beyond.

3.3 Breeding Raptor Surveys

A total of four species of raptor was recorded during the surveys. The following species accounts provide summary details of the primary raptor species encountered during the 2022 surveys (all surveys combined). The results of the breeding raptor surveys can be seen in **Figure 3**.

3.3.1 Common buzzard

A total of sixteen sightings of common buzzard were recorded during breeding raptor surveys in May, June, and July 2022. Most birds were recorded either foraging or soaring. It is likely that at least one pair held a territory to the north of the Project Site, and one bird was recorded dropping into the forestry with prey within the site. No nests were identified on site or within the 2 km survey area.

3.3.2 Common kestrel

A total of six sightings of common kestrel were recorded during breeding raptor surveys in June and July 2022. All birds were recorded foraging and no evidence of breeding was detected within 2 km of the Project Site. However, a disused quarry to the north of the Project Site was recorded as a potential (but unconfirmed) kestrel roost.

3.3.3 Eurasian sparrowhawk

A total of two sightings of Eurasian sparrowhawk were recorded during breeding raptor surveys in May and July 2022. It was suspected that there was a potential territory to the north of the Project Site but no other evidence of breeding was detected within 2 km of the Project Site.

3.3.4 Peregrine Falcon

One peregrine falcon was observed during a breeding raptor survey in May 2022. The bird was observed soaring and circling at a height of 150 metres. No evidence of breeding peregrines was recorded within 2 km of the Project Site. However, a disused quarry to the north of the Project Site was recorded as a potential (but unconfirmed) peregrine falcon roost.

3.3.5 Incidental Records of Other Species

There was one incidental record of northern lapwing during a breeding raptor survey in June 2022. The bird was observed in an agricultural field to the west of the Project Site (no evidence of breeding was recorded). No other non-raptor species of conservation concern were recorded during surveys.

3.4 Breeding wader surveys

No wader species were recorded during the 2022 breeding wader surveys; however, the flight activity surveys showed common snipe was breeding c. 400 m southwest of turbine T6. No incidental records other species were made during these surveys.

4.0 Summary and Conclusions

A range of ornithology surveys were carried out at the Project Site during the 2022 breeding season. These were:

- Flight activity (VP) surveys;
- Breeding raptor surveys; and
- Breeding wader surveys.

The following primary target species were recorded during flight activity surveys at the Project Site:

- Common kestrel;
- Northern lapwing;
- Peregrine falcon;
- Common snipe; and
- Eurasian woodcock.

The most frequent flight activity during the breeding season was by common kestrel (99 flight lines), with other target species activity less frequent. The next most frequently recorded species was peregrine falcon (six flight lines). Common snipe was recorded three times, northern lapwing was recorded two times, and Eurasian woodcock were recorded once.

Breeding raptor surveys recorded two primary target species and two secondary target species:

- Peregrine falcon: no evidence of breeding;
- Common kestrel: no evidence of breeding;
- Common buzzard: suspected territory within 2 km of Project Site; and
- Eurasian sparrowhawk: suspected territory within 2 km of Project Site.

One incidental record of northern lapwing was recorded during breeding raptor surveys.

Breeding wader surveys recorded no target species and no incidental records were made. However, confirmed evidence was recorded of common snipe breeding c. 400 m to the southwest of turbine T6 during flight activity surveys.

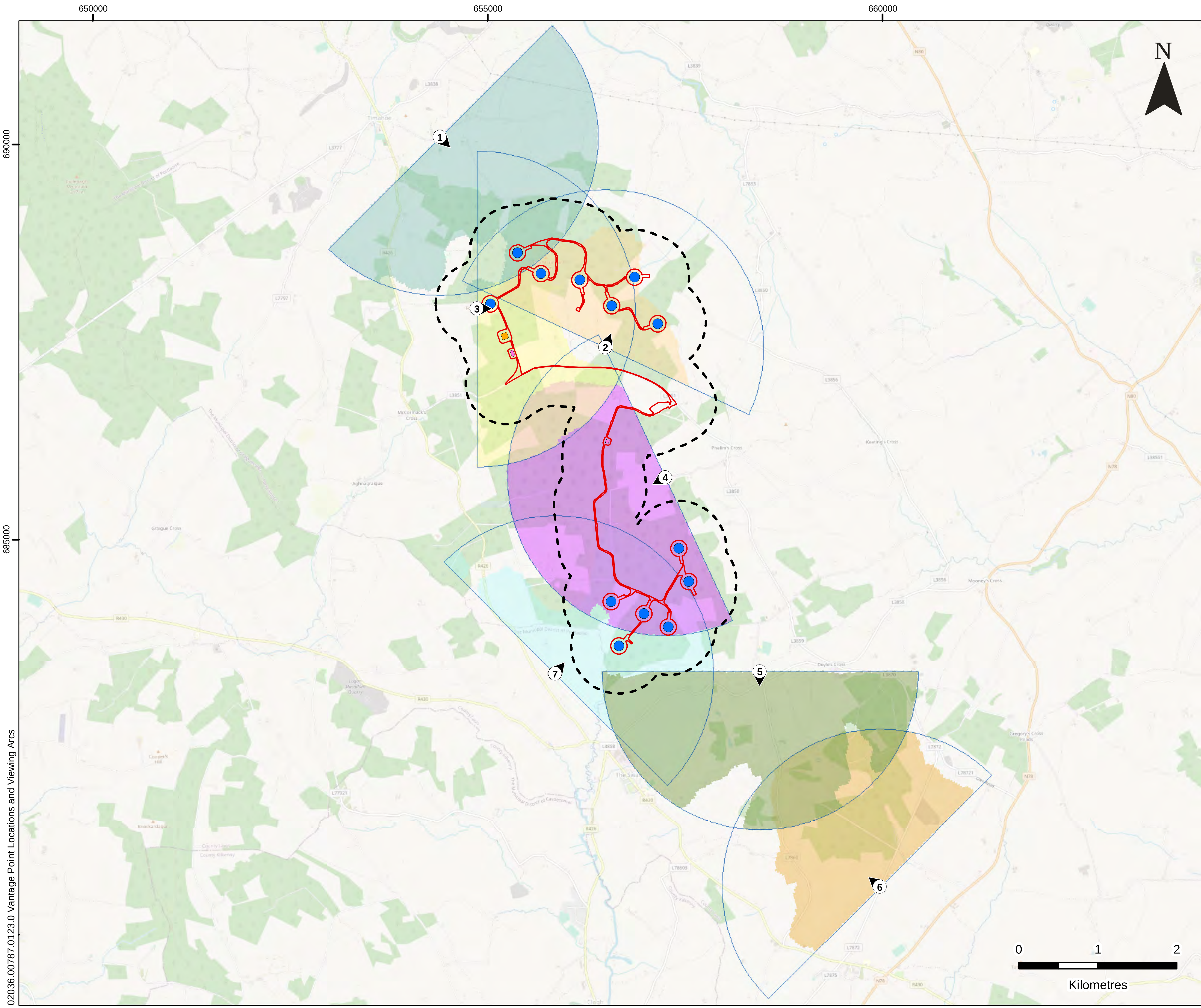
5.0 Legal and Conservation Status of Target Species Recorded

Table 5-1 summarises the legal and conservation status of the primary and secondary target species recorded during the range of ornithology surveys mentioned above. All Irish bird species are afforded general protection by the Wildlife Acts 2000 (as amended).

Table 5-1
Legal and Conservation Status of Target Species

Primary or Secondary Target	Species (BTO code)	Legal & Conservation Status in Ireland
Primary	Common kestrel	BoCCI4 Red
	Northern lapwing	BoCCI4 Red
	Peregrine falcon	Annex 1; BoCCI4 Green
	Eurasian woodcock	BoCCI4 Red
	Common snipe	BoCCI4 Red
Secondary	Black-headed gull	BoCCI4 Amber
	Common buzzard	BoCCI4 Green
	Common swift	BoCCI4 Red
	Great black-backed gull	BoCCI4 Green
	Grey heron	BoCCI4 Green
	Herring gull	BoCCI4 Amber
	Lesser black-backed gull	BoCCI4 Amber
	Northern raven	BoCCI4 Green
	Eurasian sparrowhawk	BoCCI4 Green
	Key	Annex 1 – the species is listed in Annex 1 of the EC Birds Directive; and
		BoCCI4 status (green, amber or red) – indicates the current Birds of Conservation Concern in Ireland[4] status category.

FIGURES



NOTES

1. The ZTV is calculated with a surface offset 30m & from a viewing height of 1.8m above ground level. The terrain model is derived from EU-DEM data with a vertical accuracy of ± 7m. The ZTV was calculated using ArcMAP 10.5.1 software.
2. Vantage Points 5 & 6 Cover an area of the site which was included as part of a previous design iteration but has since been removed.

LEGEND

- Proposed Development Site Boundary
- Proposed Development Site Boundary 500 m Buffer
- Proposed Turbine Layout
- Proposed Substation Compound
- Proposed Temporary Construction Compound
- Vantage Point (VP)
- Vantage Point 2 km Viewing Arc
- Area Visible from VP1
- Area Visible from VP2
- Area Visible from VP3
- Area Visible from VP4
- Area Visible from VP5
- Area Visible from VP6
- Area Visible from VP7

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COOLGLASS WIND FARM

BIRD SURVEY REPORT
BREEDING SEASON 2022

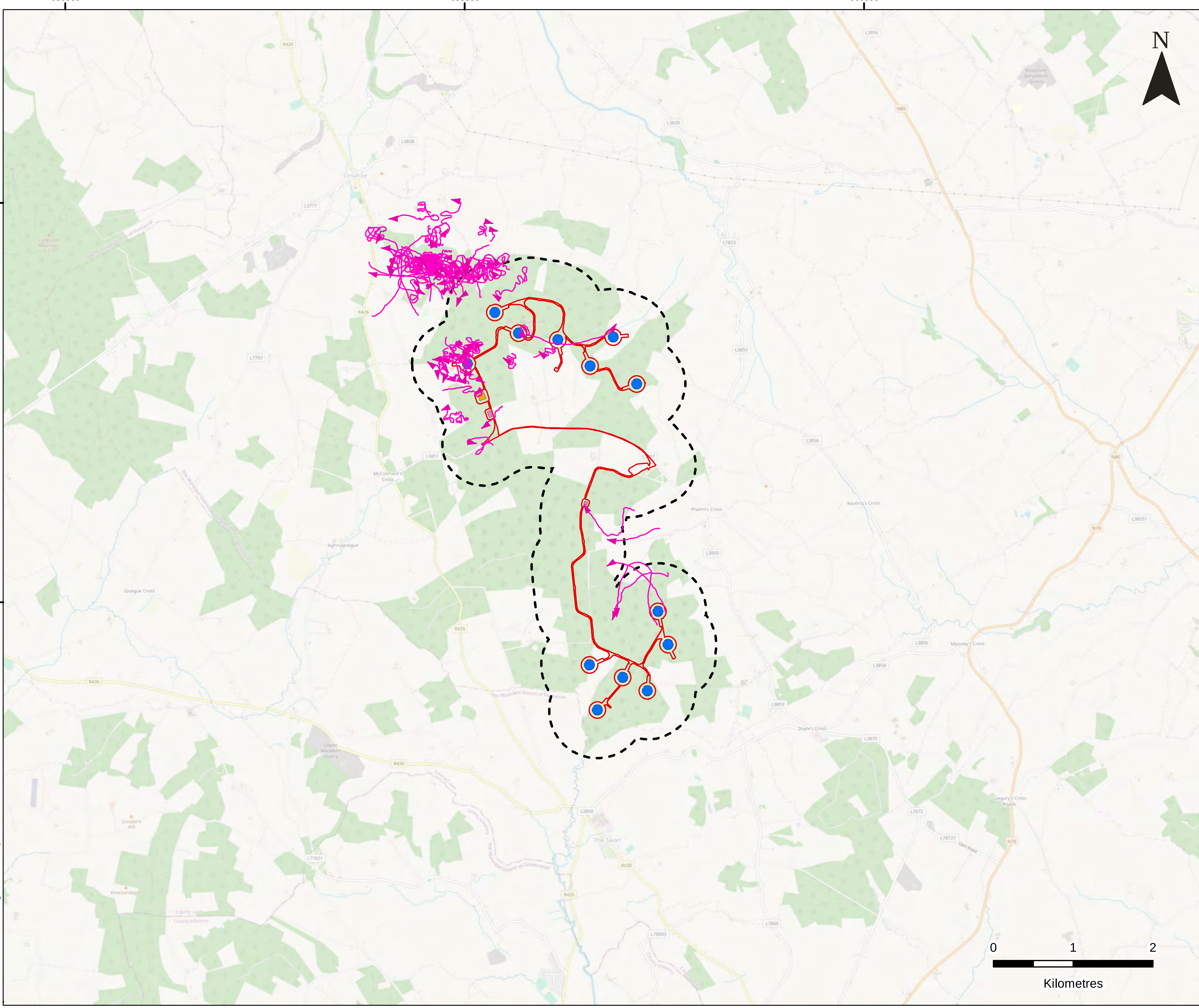
VANTAGE POINT LOCATIONS & VIEWING ARCS

FIGURE 1

Scale	Date
1:45,000 @ A3	JULY 2023

02036.00787.0123.0 Vantage Point Locations and Viewing Arcs

Inset Map:© OpenStreetMap (and) contributors, CC-BY-SA
Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), (c) OpenStreetMap contributors, and the GIS User Community



LEGEND

- Proposed Development Site Boundary
- Proposed Development Site Boundary 500 m Buffer
- Proposed Turbine Layout
- Proposed Substation Compound
- Proposed Temporary Construction Compound

Species

- Kestrel

BTO Code:
K. - Kestrel

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BIRD SURVEY REPORT
BREEDING SEASON 2022

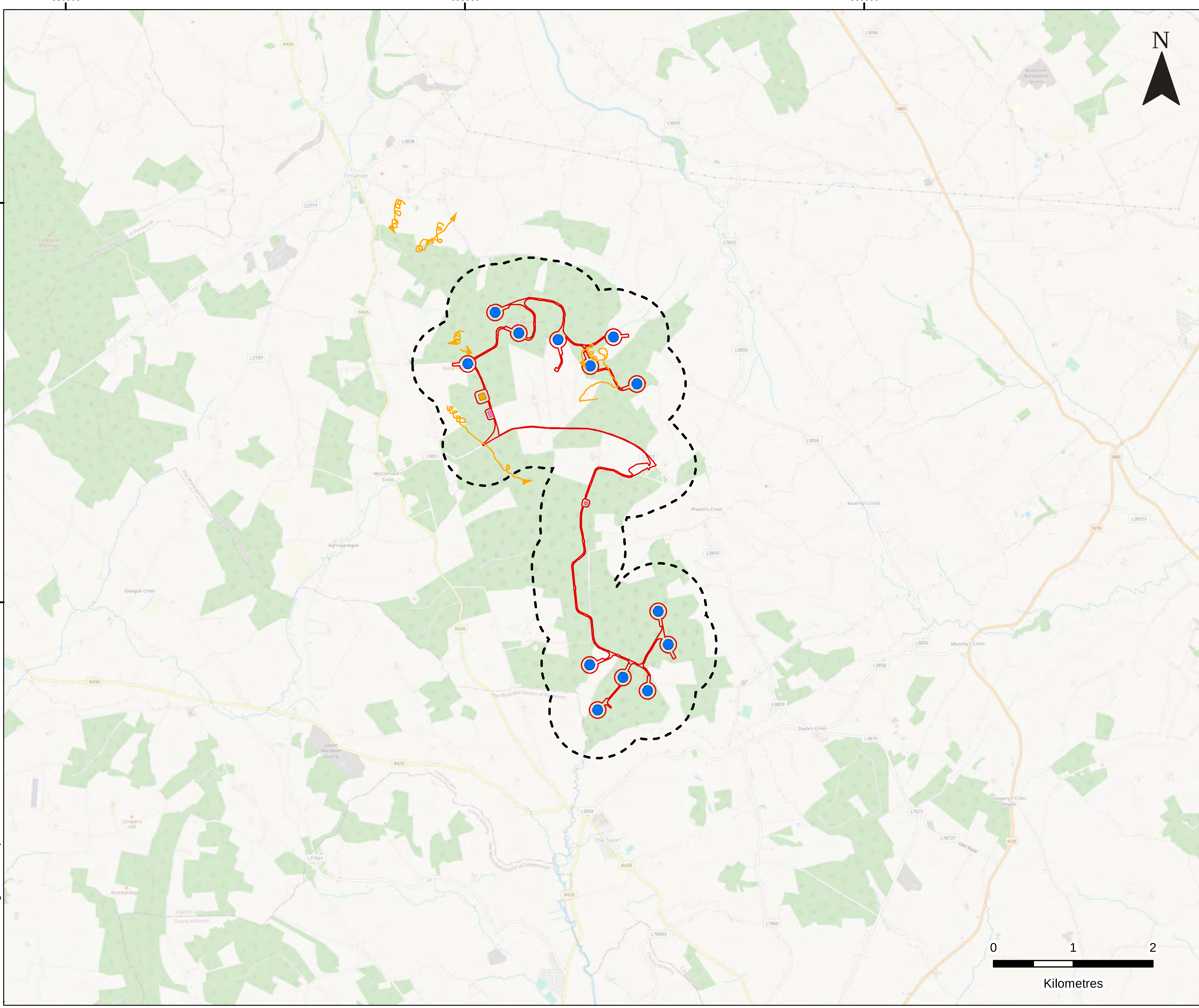
FLIGHT LINES
RAPTORS - KESTREL

FIGURE 2.1A

Scale	Date
1:45,000 @ A3	JULY 2023

02036.00787.0125.0 Flight Lines Raptors

Inset Map:© OpenStreetMap (and) contributors, CC-BY-SA
Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), (c) OpenStreetMap contributors, and the GIS User Community



LEGEND

Proposed Development Site Boundary

Proposed Development Site Boundary 500 m Buffer

Proposed Turbine Layout

Proposed Substation Compound

Proposed Temporary Construction Compound

Species

Peregrine

BTO Code:
PE - Peregrine

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BIRD SURVEY REPORT
BREEDING SEASON 2022

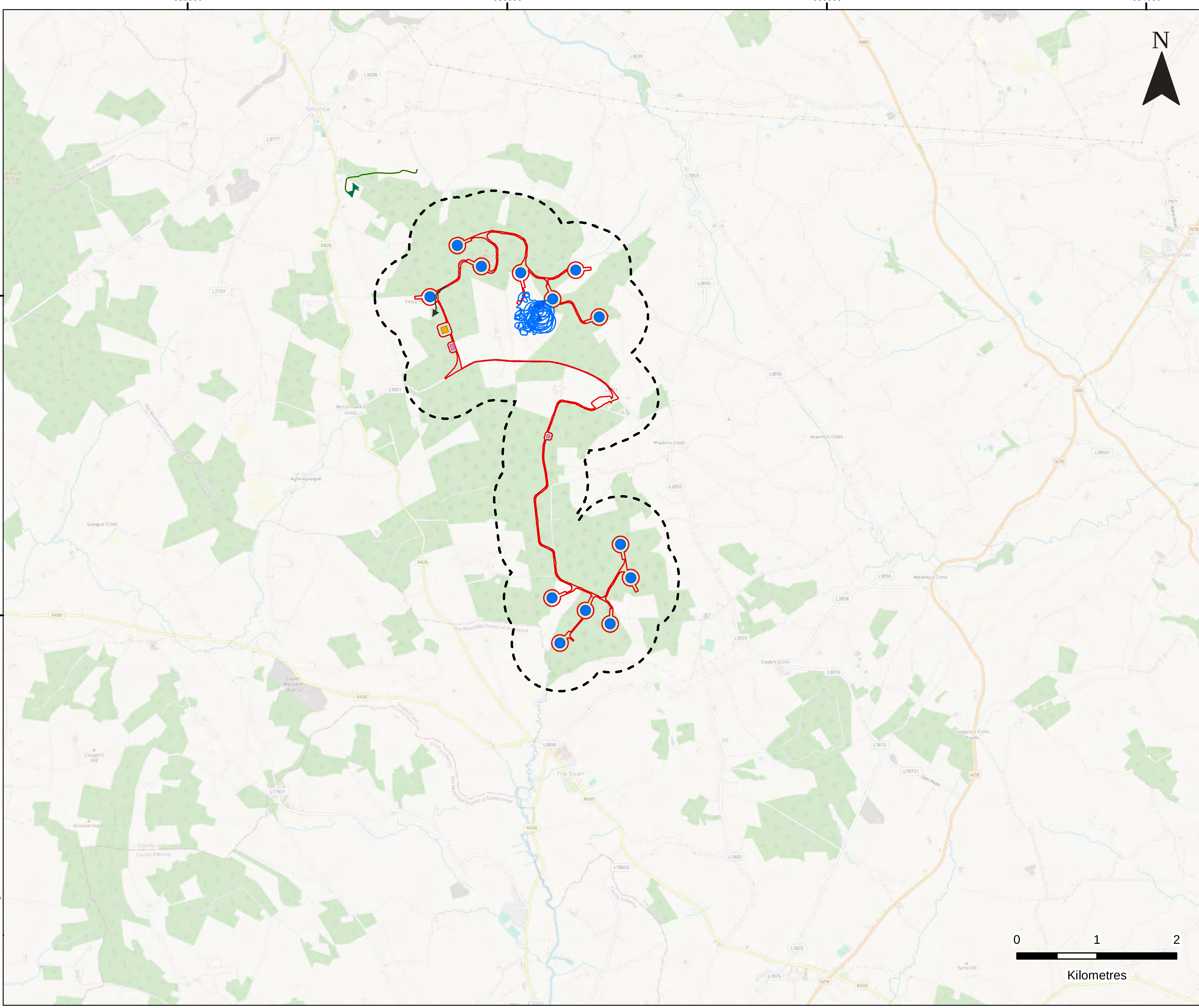
FLIGHT LINES
RAPTORS - PEREGRINE

FIGURE 2.1B

Scale 1:45,000 @ A3

Date JULY 2023

02036.00787.0125.0 Flight Lines Raptors



LEGEND

- Proposed Development Site Boundary
- Proposed Development Site Boundary 500 m Buffer
- Proposed Turbine Layout
- Proposed Substation Compound
- Proposed Temporary Construction Compound

Species

- Lapwing
- Snipe
- Woodcock

BTO Code:
L. - Lapwing
SN - Snipe
WK - Woodcock

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COOLGLASS WIND FARM

BIRD SURVEY REPORT
BREEDING SEASON 2022

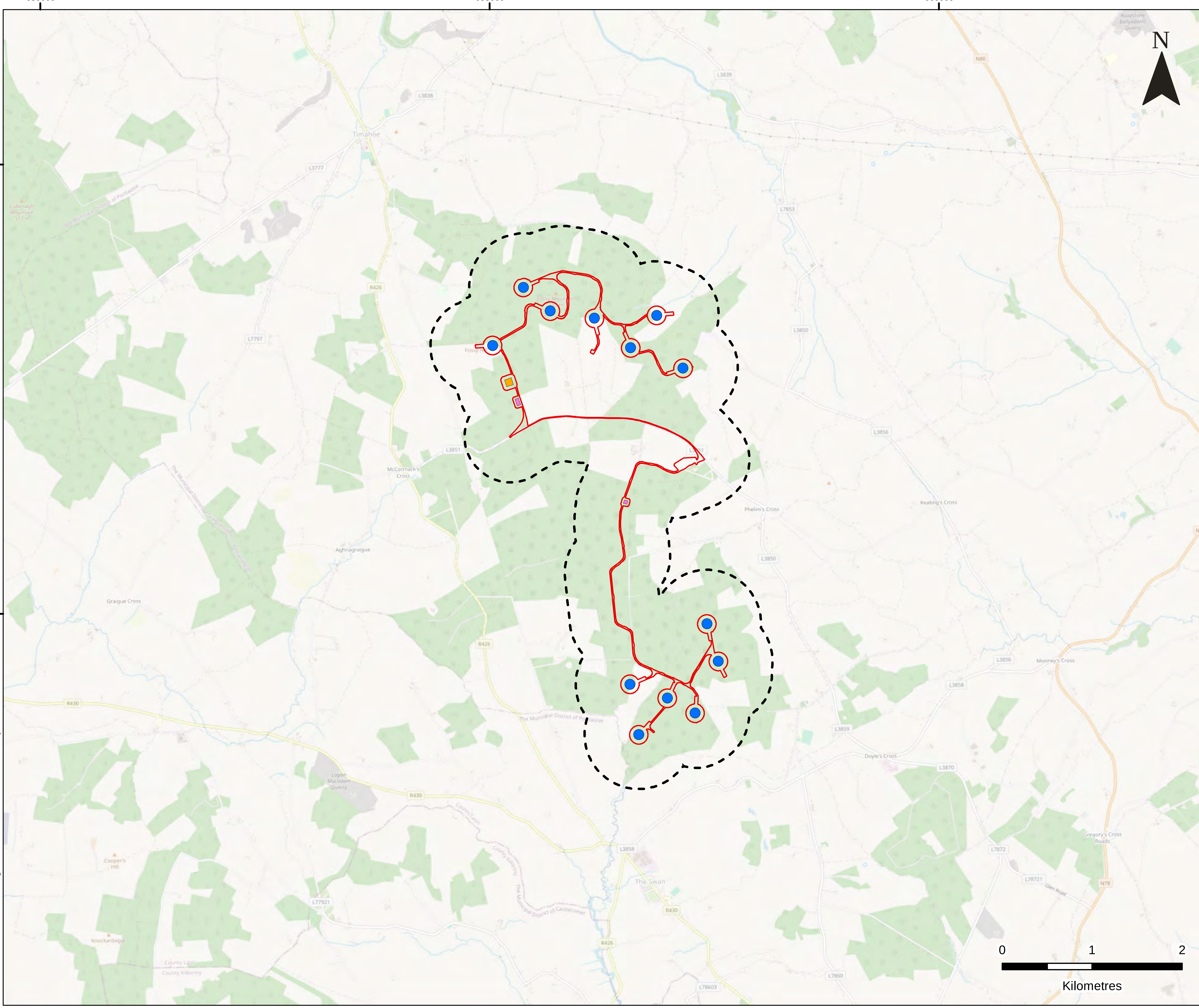
FLIGHT LINES
WADERS

FIGURE 2.2

Scale	Date
1:45,000 @ A3	JULY 2023

02036.00787.0124.0 Flight Lines Waders

Inset Map:© OpenStreetMap (and) contributors, CC-BY-SA
Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), (c) OpenStreetMap contributors, and the GIS User Community



LEGEND

- Proposed Development Site Boundary
- Proposed Development Site Boundary 500 m Buffer
- Proposed Turbine Layout
- Proposed Substation Compound
- Proposed Temporary Construction Compound

Note::
No Breeding Wader Bird Species Recorded Throughout the Season.

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BIRD SURVEY REPORT
BREEDING SEASON 2022

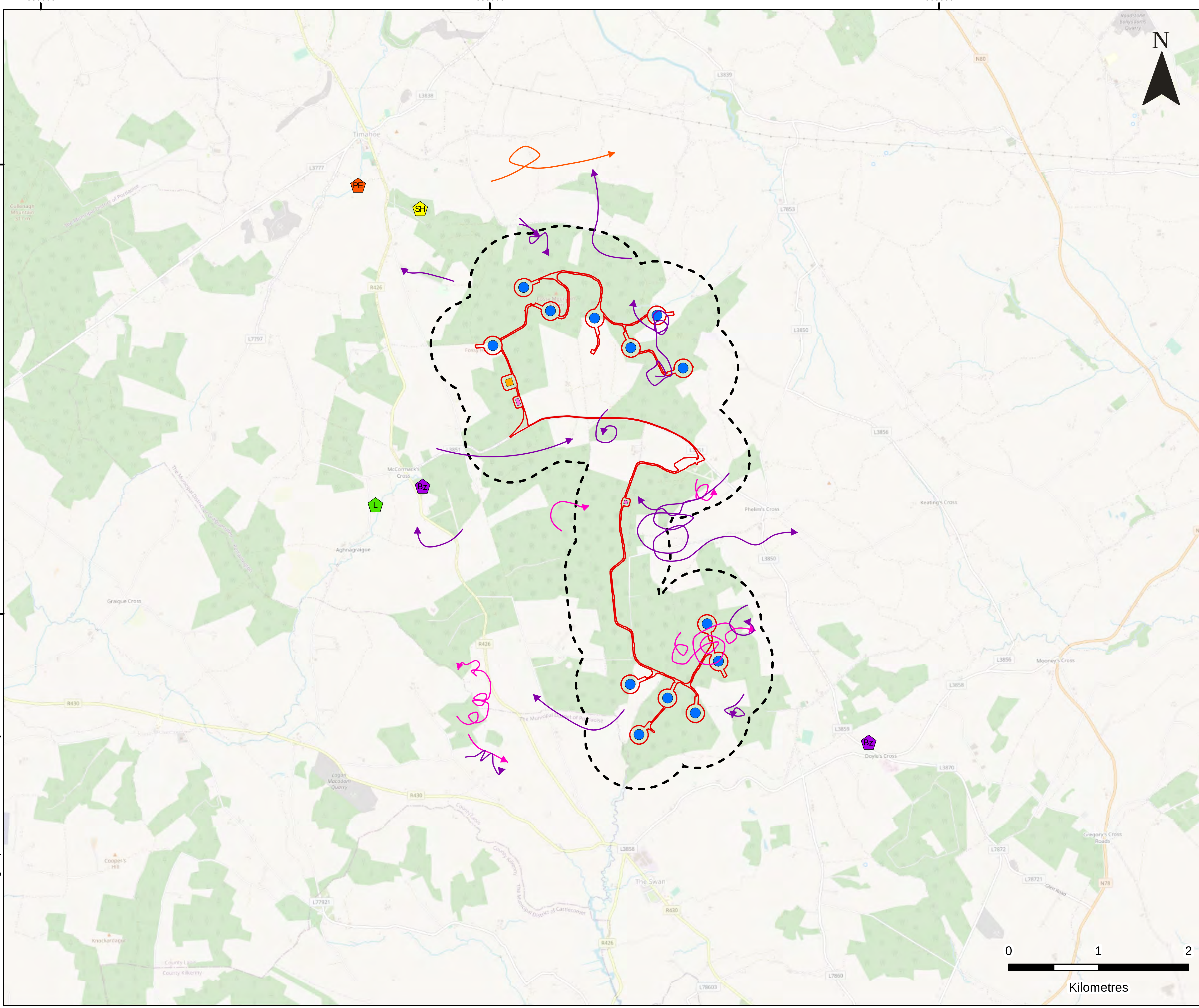
BREEDING WADER WALKED TRANSECT SURVEY RESULTS

FIGURE 3

Scale 1:40,000 @ A3 | Date JULY 2023

02036.00787.0126.0 Breeding Wader Walked Transect Survey Results

Inset Map:© OpenStreetMap (and) contributors, CC-BY-SA
Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), (c) OpenStreetMap contributors, and the GIS User Community



LEGEND

- Proposed Development Site Boundary
- Proposed Development Site Boundary 500 m Buffer
- Proposed Turbine Layout
- Proposed Substation Compound
- Proposed Temporary Construction Compound

Raptor Species Record

- Buzzard
- Peregrine
- Sparrowhawk

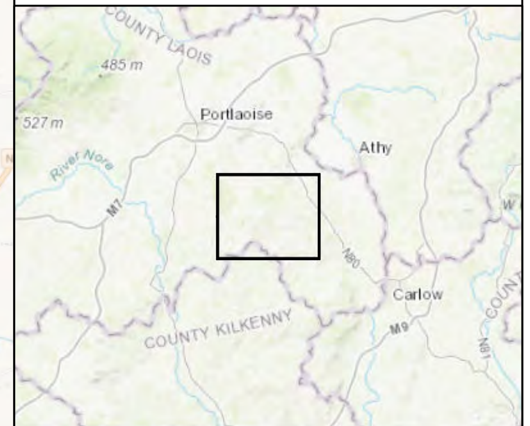
Raptor Species Flight Line

- Buzzard
- Kestrel
- Peregrine

Incidental Species Record

- Lapwing

BTO Code:
BZ - Buzzard
L. - Lapwing
K. - Kestrel
PE - Peregrine
SH - Sparrowhawk



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BIRD SURVEY REPORT
BREEDING SEASON 2022

BREEDING RAPTOR DRIVEN TRANSECT SURVEY RESULTS

FIGURE 4

Scale	Date
1:40,000 @ A3	JULY 2023

02036.00787.0127.0 Breeding Raptor Driven Transect Survey Results

Inset Map:© OpenStreetMap (and) contributors, CC-BY-SA
Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), (c) OpenStreetMap contributors, and the GIS User Community

APPENDIX 01

Survey dates, times and observers[9]

[9] Surveyor initials are listed in Section 2.2.1

Table A1-1
Details of VP surveys undertaken from Coolglass Wind Farm Vantage Point 1

Date	Surveyor	Start	End	Survey Duration
16/05/22	DN	10:05	13:05	03:00
20/05/22	DN	13:25	16:25	03:00
30/05/22	MMW	13:30	16:30	03:00
31/05/22	MMW	10:00	13:00	03:00
20/06/22	MMW	18:45	21:45	03:00
22/06/22	MMW	10:00	13:00	03:00
04/07/22	MMW	15:10	18:10	03:00
05/07/22	MMW	06:45	09:45	03:00
28/07/22	MMW	18:30	21:30	03:00
28/07/22	MMW	11:15	14:15	03:00
15/08/22	MMW	14:30	17:30	03:00
17/08/22	MMW	14:00	17:00	03:00
Total Hours				**36**

Table A1-2
Details of VP surveys undertaken from Coolglass Wind Farm Vantage Point 2

Date	Surveyor	Start	End	Survey Duration
16/05/22	DN	13:20	16:20	03:00
20/05/22	DN	10:15	13:15	03:00
27/05/22	MMW	10:45	13:45	03:00
31/05/22	MMW	13:45	16:45	03:00
21/06/22	MMW	14:30	17:30	03:00
22/06/22	MMW	06:20	09:20	03:00
05/07/22	MMW	18:45	21:45	03:00
06/07/22	MMW	11:40	14:40	03:00
26/07/22	MMW	06:35	09:35	03:00
27/07/22	MMW	10:10	13:10	03:00
15/08/22	MMW	18:00	19:25	01:25
16/08/22	MMW	19:30	21:05	01:35
16/08/22	MMW	10:30	13:30	03:00
Total Hours				**36**

Table A1-3

Details of VP surveys undertaken from Coolglass Wind Farm Vantage Point 3

Date	Surveyor	Start	End	Survey Duration
18/05/22	FL	12:00	15:00	03:00
19/05/22	FL	14:35	17:35	03:00
27/05/22	MMW	14:20	17:20	03:00
30/05/22	MMW	09:40	12:40	03:00
20/06/22	MMW	15:00	18:00	03:00
21/06/22	MMW	19:20	22:20	03:00
04/07/22	MMW	18:40	21:40	03:00
05/07/22	MMW	10:45	13:45	03:00
26/07/22	MMW	10:10	13:10	03:00
27/07/22	MMW	06:40	09:40	03:00
16/08/22	MMW	07:00	10:00	03:00
17/08/22	MMW	10:15	13:15	03:00
Total Hours				**36**

Table A1-4

Details of VP surveys undertaken from Coolglass Wind Farm Vantage Point 4

Date	Surveyor	Start	End	Survey Duration
13/05/22	DN	10:30	13:30	03:00
20/06/22	DN	10:07	13:07	03:00
24/06/22	AM	10:45	13:45	03:00
24/06/22	AM	14:20	17:20	03:00
14/07/22	DN	09:40	12:40	03:00
15/07/22	DN	12:35	15:35	03:00
21/07/22	DN	09:30	12:30	03:00
22/07/22	DN	11:45	14:45	03:00
08/08/22	JD	11:00	14:00	03:00
12/08/22	JD	18:30	21:30	03:00
29/08/22	DN	13:40	16:40	03:00
30/08/22	DN	11:15	14:15	03:00
Total Hours				**36**

Table A1-5
Details of VP surveys undertaken from Coolglass Wind Farm Vantage Point 7

Date	Surveyor	Start	End	Survey Duration
13/05/22	DN	13:40	16:40	03:00
18/05/22	FL	15:30	18:30	03:00
19/05/22	FL	11:15	14:15	03:00
20/06/22	DN	13:17	16:17	03:00
14/07/22	DN	12:50	15:50	03:00
15/07/22	DN	09:25	12:25	03:00
21/07/22	DN	12:41	15:41	03:00
22/07/22	DN	08:34	11:34	03:00
08/08/22	JD	14:30	17:40	03:00
12/08/22	JD	15:00	18:00	03:00
29/08/22	DN	10:30	13:30	03:00
30/08/22	DN	08:00	11:00	03:00
Total Hours				**36**

Table A1-6
Details of breeding raptor surveys undertaken at Coolglass Wind Farm

Date	Surveyor	Start	End	Survey Duration
06/05/22	JD	12:00	18:00	06:00
23/05/22	JD	14:30	18:30	04:00
22/06/22	MMW	18:00	21:00	03:00
23/06/22	MMW	07:20	12:30	05:10
25/07/22	MMW	14:00	22:00	08:00
Total Hours				**26:10**

Table A1-7
Details of breeding wader surveys undertaken at Coolglass Wind Farm

Date	Surveyor	Start	End	Survey Duration
06/05/22	JD	18:06	18:40	00:34
23/05/22	JD	18:33	20:33	02:00
23/06/22	MMW	06:00	06:50	00:50
Total Hours				**03:24**

APPENDIX 02

Weather Data

Table A2-1
Weather data collected during flight activity surveys undertaken at VP1

Date	Surveyor	Start	End	Survey Hour	Wind Speed	Wind Direction	Rain	Cloud Cover	Cloud Height	Visibility	Snow	Frost	Temp (°c)
16/05/2022	DN	10:05	13:05	1	3	S	0	5	2	2	0	0	14
16/05/2022	DN	10:05	13:05	2	3	S	0	6	2	2	0	0	14
16/05/2022	DN	10:05	13:05	3	3	S	0	5	2	2	0	0	16
20/05/2022	DN	13:25	16:25	1	2	SW	0	7	2	2	0	0	12
20/05/2022	DN	13:25	16:25	2	2	SW	0	5	2	2	0	0	12
20/05/2022	DN	13:25	16:25	3	2	SW	0	5	2	2	0	0	12
30/05/2022	MMW	13:30	16:30	1	3	W	2	8	1	2	0	0	11
30/05/2022	MMW	13:30	16:30	2	3	W	2	8	1	2	0	0	12
30/05/2022	MMW	13:30	16:30	3	2	W	0	8	1	2	0	0	12
31/05/2022	MMW	10:00	13:00	1	2	SW	0	5	2	2	0	0	13
31/05/2022	MMW	10:00	13:00	2	1	SW	0	5	2	2	0	0	14
31/05/2022	MMW	10:00	13:00	3	2	SW	0	8	1	2	0	0	14
20/06/2022	MMW	18:45	21:45	1	1	W	0	0	2	2	0	0	22
20/06/2022	MMW	18:45	21:45	2	0	W	0	0	2	2	0	0	22
20/06/2022	MMW	18:45	21:45	3	1	W	0	1	2	2	0	0	22
22/06/2022	MMW	10:00	13:00	1	1	NW	0	8	1	2	0	0	17
22/06/2022	MMW	10:00	13:00	2	1	NW	0	8	1	2	0	0	19
22/06/2022	MMW	10:00	13:00	3	0	NW	0	8	1	2	0	0	18
04/07/2022	MMW	15:10	18:10	1	2	SW	0	7	1	2	0	0	16

Date	Surveyor	Start	End	Survey Hour	Wind Speed	Wind Direction	Rain	Cloud Cover	Cloud Height	Visibility	Snow	Frost	Temp (°c)
04/07/2022	MMW	15:10	18:10	2	2	SW	0	5	2	2	0	0	17
04/07/2022	MMW	15:10	18:10	3	3	SW	0	5	2	2	0	0	16
05/07/2022	MMW	06:45	09:45	1	3	SW	1	8	1	1	0	0	14
05/07/2022	MMW	06:45	09:45	2	2	SW	0	7	1	1	0	0	14
05/07/2022	MMW	06:45	09:45	3	2	SW	0	7	1	1	0	0	15
28/07/2022	MMW	18:30	21:30	1	1	SW	0	7	2	2	0	0	17
28/07/2022	MMW	18:30	21:30	2	1	SW	0	7	2	2	0	0	17
28/07/2022	MMW	18:30	21:30	3	0	SW	0	7	2	2	0	0	16
28/07/2022	MMW	11:15	14:15	1	4	SW	1	7	1	2	0	0	17
28/07/2022	MMW	11:15	14:15	2	3	SW	1	7	1	2	0	0	17
28/07/2022	MMW	11:15	14:15	3	2	SW	1	7	1	2	0	0	18
15/08/2022	MMW	14:30	17:30	1	0	NA	0	6	2	2	0	0	22
15/08/2022	MMW	14:30	17:30	2	1	N	0	5	2	2	0	0	23
15/08/2022	MMW	14:30	17:30	3	2	N	0	7	1	2	0	0	21
17/08/2022	MMW	14:00	17:00	1	3	NW	0	6	1	2	0	0	19
17/08/2022	MMW	14:00	17:00	2	4	NW	0	8	2	2	0	0	17
17/08/2022	MMW	14:00	17:00	3	3	NW	0	8	2	2	0	0	17

Date	Surveyor	Start	End	Survey Hour	Wind Speed	Wind Direction	Rain	Cloud Cover	Cloud Height	Visibility	Snow	Frost	Temp (°c)

Rain/ Precipitation None 0 Drizzle 1 Light showers/snow 2 Heavy showers/snow 3 Heavy rain/snow 4	**Cloud Cover** Expressed in oktas (n/8) **Cloud Height** Height of cloud above average height of viewshed <150m 0 150-500m 1 >500m 2	**Visibility** Poor (<1km) 0 Moderate (1-3km) 1 Good (>3km) 2	**Lying Snow** None 0 On site 1 On higher ground 2	**Frost** None 0 Ground 1 All day 2

Table A2-2
Weather data collected during flight activity surveys undertaken at VP2

Date	Surveyor	Start	End	Survey Hour	Wind Speed	Wind Direction	Rain	Cloud Cover	Cloud Height	Visibility	Snow	Frost	Temp (°c)
16/05/2022	DN	13:20	16:20	1	2	S	0	7	2	2	0	0	16
16/05/2022	DN	13:20	16:20	2	2	S	0	7	2	2	0	0	16
16/05/2022	DN	13:20	16:20	3	2	S	0	5	2	2	0	0	16
20/05/2022	DN	10:15	13:15	1	2	S	2	8	1	1	0	0	11
20/05/2022	DN	10:15	13:15	2	1	S	2	8	1	1	0	0	11
20/05/2022	DN	10:15	13:15	3	3	S	2	7	1	1	0	0	11
27/05/2022	MMW	10:45	13:45	1	3	SW	0	4	2	2	0	0	12
27/05/2022	MMW	10:45	13:45	2	3	SW	0	5	2	2	0	0	14
27/05/2022	MMW	10:45	13:45	3	2	SW	0	3	2	2	0	0	14
31/05/2022	MMW	13:45	16:45	1	3	SW	0	7	2	2	0	0	12
31/05/2022	MMW	13:45	16:45	2	3	SW	0	5	2	2	0	0	12
31/05/2022	MMW	13:45	16:45	3	3	SW	0	6	2	2	0	0	11
21/06/2022	MMW	14:30	17:30	1	2	SW	0	5	1	2	0	0	18
21/06/2022	MMW	14:30	17:30	2	1	SW	0	7	1	2	0	0	18
21/06/2022	MMW	14:30	17:30	3	1	SW	0	7	1	2	0	0	18
22/06/2022	MMW	06:20	09:20	1	0	NW	0	8	1	2	0	0	15
22/06/2022	MMW	06:20	09:20	2	1	NW	0	8	1	2	0	0	16
22/06/2022	MMW	06:20	09:20	3	1	NW	0	8	1	2	0	0	16
05/07/2022	MMW	18:45	21:45	1	3	W	3	7	1	2	0	0	17
05/07/2022	MMW	18:45	21:45	2	2	SW	0	8	1	2	0	0	16

Date	Surveyor	Start	End	Survey Hour	Wind Speed	Wind Direction	Rain	Cloud Cover	Cloud Height	Visibility	Snow	Frost	Temp (°c)
05/07/2022	MMW	18:45	21:45	3	2	SW	0	8	1	2	0	0	16
06/07/2022	MMW	11:40	14:40	1	2	SW	1	8	1	2	0	0	14
06/07/2022	MMW	11:40	14:40	2	3	SW	0	8	1	2	0	0	14
06/07/2022	MMW	11:40	14:40	3	2	SW	0	7	1	2	0	0	14
26/07/2022	MMW	06:35	09:35	1	3	SW	0	7	2	2	0	0	12
26/07/2022	MMW	06:35	09:35	2	2	SW	1	8	1	2	0	0	11
26/07/2022	MMW	06:35	09:35	3	2	SW	0	7	1	2	0	0	13
27/07/2022	MMW	10:10	13:10	1	1	S	0	8	2	2	0	0	14
27/07/2022	MMW	10:10	13:10	2	1	S	0	8	2	2	0	0	15
27/07/2022	MMW	10:10	13:10	3	1	S	0	7	2	2	0	0	17
15/08/2022	MMW	18:00	19:25	1	3	NE	3	8	1	1	0	0	18
16/08/2022	MMW	19:30	21:05	2	3	NW	0	7	2	2	0	0	17
16/08/2022	MMW	19:30	21:05	3	3	NW	0	7	2	2	0	0	15
16/08/2022	MMW	10:30	13:30	1	4	NW	0	5	1	2	0	0	15
16/08/2022	MMW	10:30	13:30	2	3	NW	0	4	2	2	0	0	17
16/08/2022	MMW	10:30	13:30	3	3	NW	0	5	2	2	0	0	18

Rain/ Precipitation
None 0
Drizzle 1
Light showers/snow 2
Heavy showers/snow 3
Heavy rain/snow 4

Cloud Cover
Expressed in oktas (n/8)
Cloud Height
Height of cloud above average height of viewshed
<150m 0

Visibility
Poor (<1km) 0
Moderate (1-3km) 1
Good (>3km) 2

Lying Snow
None 0
On site 1
On higher ground 2

Frost
None 0
Ground 1
All day 2

Date	Surveyor	Start	End	Survey Hour	Wind Speed	Wind Direction	Rain	Cloud Cover	Cloud Height	Visibility	Snow	Frost	Temp (°c)
			150-500m	1									
			>500m	2									

Table A2-3
Weather data collected during flight activity surveys undertaken at VP3

Date	Surveyor	Start	End	Survey Hour	Wind Speed	Wind Direction	Rain	Cloud Cover	Cloud Height	Visibility	Snow	Frost	Temp (°c)
18/05/2022	FL	12:00	15:00	1	4	N	0	7	2	2	0	0	15
18/05/2022	FL	12:00	15:00	2	5	N	0	8	2	2	0	0	15
18/05/2022	FL	12:00	15:00	3	4	N	0	8	2	2	0	0	15
19/05/2022	FL	14:35	17:35	1	3	N	0	6	2	2	0	0	16
19/05/2022	FL	14:35	17:35	2	3	N	0	6	2	2	0	0	16
19/05/2022	FL	14:35	17:35	3	3	N	0	7	2	2	0	0	16
27/05/2022	MMW	14:20	17:20	1	2	W	0	3	2	2	0	0	16
27/05/2022	MMW	14:20	17:20	2	3	W	0	2	2	2	0	0	16
27/05/2022	MMW	14:20	17:20	3	2	W	0	2	2	2	0	0	15
30/05/2022	MMW	09:40	12:40	1	4	W	0	7	2	2	0	0	12
30/05/2022	MMW	09:40	12:40	2	4	W	0	8	2	2	0	0	11
30/05/2022	MMW	09:40	12:40	3	3	W	2	7	1	2	0	0	11
20/06/2022	MMW	15:00	18:00	1	2	W	0	1	2	2	0	0	23
20/06/2022	MMW	15:00	18:00	2	1	NW	0	1	2	2	0	0	23
20/06/2022	MMW	15:00	18:00	3	2	NW	0	1	2	2	0	0	23
21/06/2022	MMW	19:20	22:20	1	1	W	0	7	1	2	0	0	18
21/06/2022	MMW	19:20	22:20	2	2	W	0	8	1	2	0	0	17
21/06/2022	MMW	19:20	22:20	3	1	W	0	8	1	2	0	0	17
04/07/2022	MMW	18:40	21:40	1	4	W	0	4	2	2	0	0	15
04/07/2022	MMW	18:40	21:40	2	4	W	0	3	2	2	0	0	14

Date	Surveyor	Start	End	Survey Hour	Wind Speed	Wind Direction	Rain	Cloud Cover	Cloud Height	Visibility	Snow	Frost	Temp (°c)
04/07/2022	MMW	18:40	21:40	3	4	W	0	2	2	2	0	0	14
05/07/2022	MMW	10:45	13:45	1	4	W	1	8	1	2	0	0	15
05/07/2022	MMW	10:45	13:45	2	3	SW	0	8	1	2	0	0	15
05/07/2022	MMW	10:45	13:45	3	3	SW	0	8	1	2	0	0	15
26/07/2022	MMW	10:10	13:10	1	2	SW	0	8	2	2	0	0	14
26/07/2022	MMW	10:10	13:10	2	2	SW	0	7	2	2	0	0	16
26/07/2022	MMW	10:10	13:10	3	2	SW	0	7	2	2	0	0	16
27/07/2022	MMW	06:40	09:40	1	2	E	0	8	2	2	0	0	12
27/07/2022	MMW	06:40	09:40	2	2	SE	0	8	2	2	0	0	12
27/07/2022	MMW	06:40	09:40	3	2	SE	0	8	2	2	0	0	14
16/08/2022	MMW	07:00	10:00	1	4	N	0	3	2	2	0	0	10
16/08/2022	MMW	07:00	10:00	2	4	N	0	2	2	2	0	0	12
16/08/2022	MMW	07:00	10:00	3	3	N	0	3	2	2	0	0	15
17/08/2022	MMW	10:15	13:15	1	1	NW	0	6	1	2	0	0	19
17/08/2022	MMW	10:15	13:15	2	1	NW	0	5	2	2	0	0	20
17/08/2022	MMW	10:15	13:15	3	1	NW	0	4	2	2	0	0	20

Rain/ Precipitation	Cloud Cover	Visibility	Lying Snow	Frost
None 0 Drizzle 1 Light showers/snow 2 Heavy showers/snow 3 Heavy rain/snow 4	Expressed in oktas (n/8) **Cloud Height** Height of cloud above average height of viewshed <150m 0	Poor (<1km) 0 Moderate (1-3km) 1 Good (>3km) 2	None 0 On site 1 On higher ground 2	None 0 Ground 1 All day 2

Date	Surveyor	Start	End	Survey Hour	Wind Speed	Wind Direction	Rain	Cloud Cover	Cloud Height	Visibility	Snow	Frost	Temp (°c)
			150-500m	1									
			>500m	2									

Table A2-4
Weather data collected during flight activity surveys undertaken at VP4

Date	Surveyor	Start	End	Survey Hour	Wind Speed	Wind Direction	Rain	Cloud Cover	Cloud Height	Visibility	Snow	Frost	Temp (°c)
13/05/2022	DN	10:30	13:30	1	4	W	0	4	2	2	0	0	13
13/05/2022	DN	10:30	13:30	2	4	W	0	5	2	2	0	0	14
13/05/2022	DN	10:30	13:30	3	3	W	0	6	2	2	0	0	16
20/06/2022	DN	10:07	13:07	1	1	NW	0	1	2	2	0	0	16
20/06/2022	DN	10:07	13:07	2	2	NW	0	1	2	2	0	0	17
20/06/2022	DN	10:07	13:07	3	2	NW	0	2	2	2	0	0	17
24/06/2022	AM	10:45	13:45	1	4	S	2	8	1	2	0	0	15
24/06/2022	AM	10:45	13:45	2	4	S	2	8	1	1	0	0	16
24/06/2022	AM	10:45	13:45	3	4	S	2	8	1	1	0	0	16
24/06/2022	AM	14:20	17:20	1	4	S	1	8	1	2	0	0	16
24/06/2022	AM	14:20	17:20	2	4	SE	0	8	1	2	0	0	16
24/06/2022	AM	14:20	17:20	3	4	SE	0	8	1	2	0	0	16
14/07/2022	DN	09:40	12:40	1	3	W	0	4	2	2	0	0	16
14/07/2022	DN	09:40	12:40	2	3	W	0	6	2	2	0	0	16
14/07/2022	DN	09:40	12:40	3	3	W	0	7	2	2	0	0	17
15/07/2022	DN	12:35	15:35	1	3	NW	0	6	2	2	0	0	18
15/07/2022	DN	12:35	15:35	2	3	NW	0	7	2	2	0	0	18
15/07/2022	DN	12:35	15:35	3	3	NW	0	6	2	2	0	0	18
21/07/2022	DN	09:30	12:30	1	2	N	0	8	2	2	0	0	16
21/07/2022	DN	09:30	12:30	2	2	N	0	8	2	2	0	0	16

Date	Surveyor	Start	End	Survey Hour	Wind Speed	Wind Direction	Rain	Cloud Cover	Cloud Height	Visibility	Snow	Frost	Temp (°c)
21/07/2022	DN	09:30	12:30	3	3	N	0	8	2	2	0	0	17
22/07/2022	DN	11:45	14:45	1	3	W	0	5	2	2	0	0	18
22/07/2022	DN	11:45	14:45	2	2	W	0	6	2	2	0	0	19
22/07/2022	DN	11:45	14:45	3	2	W	0	6	2	2	0	0	19
08/08/2022	JD	11:00	14:00	1	1	NW	0	3	1	2	0	0	17
08/08/2022	JD	11:00	14:00	2	1	NW	0	3	1	2	0	0	19
08/08/2022	JD	11:00	14:00	3	1	NW	0	4	1	2	0	0	20
12/08/2022	JD	18:30	21:30	1	1	NE	0	6	1	2	0	0	20
12/08/2022	JD	18:30	21:30	2	1	NE	0	6	1	2	0	0	18
12/08/2022	JD	18:30	21:30	3	1	NE	0	7	1	2	0	0	16
29/08/2022	DN	13:40	16:40	1	2	SE	0	5	2	2	0	0	24
29/08/2022	DN	13:40	16:40	2	3	SE	0	5	2	2	0	0	24
29/08/2022	DN	13:40	16:40	3	3	SE	0	5	2	2	0	0	22
30/08/2022	DN	11:15	14:15	1	2	E	0	3	2	2	0	0	19
30/08/2022	DN	11:15	14:15	2	2	E	0	3	2	2	0	0	21
30/08/2022	DN	11:15	14:15	3	3	E	0	3	2	2	0	0	21

Rain/ Precipitation
None 0
Drizzle 1
Light showers/snow 2
Heavy showers/snow 3
Heavy rain/snow 4

Cloud Cover
Expressed in oktas (n/8)
Cloud Height
Height of cloud above average height of viewshed
<150m 0

Visibility
Poor (<1km) 0
Moderate (1-3km) 1
Good (>3km) 2

Lying Snow
None 0
On site 1
On higher ground 2

Frost
None 0
Ground 1
All day 2

Date	Surveyor	Start	End	Survey Hour	Wind Speed	Wind Direction	Rain	Cloud Cover	Cloud Height	Visibility	Snow	Frost	Temp (°c)
			150-500m >500m	1 2									

Table A2-5
Weather data collected during flight activity surveys undertaken at VP7

Date	Surveyor	Start	End	Survey Hour	Wind Speed	Wind Direction	Rain	Cloud Cover	Cloud Height	Visibility	Snow	Frost	Temp (°c)
13/05/2022	DN	13:40	16:40	1	4	W	0	3	2	2	0	0	16
13/05/2022	DN	13:40	16:40	2	4	W	0	3	2	2	0	0	16
13/05/2022	DN	13:40	16:40	3	5	W	0	4	2	2	0	0	16
18/05/2022	FL	15:30	18:30	1	5	N	0	6	2	2	0	0	14
18/05/2022	FL	15:30	18:30	2	5	N	0	5	2	2	0	0	14
18/05/2022	FL	15:30	18:30	3	4	N	2	8	2	2	0	0	13
19/05/2022	FL	11:15	14:15	1	3	N	0	4	2	2	0	0	15
19/05/2022	FL	11:15	14:15	2	3	N	0	4	2	2	0	0	15
19/05/2022	FL	11:15	14:15	3	3	N	0	4	2	2	0	0	15
20/06/2022	DN	13:17	16:17	1	2	N	0	2	2	2	0	0	19
20/06/2022	DN	13:17	16:17	2	1	N	0	3	2	2	0	0	19
20/06/2022	DN	13:17	16:17	3	1	N	0	3	2	2	0	0	19
14/07/2022	DN	12:50	15:50	1	2	NW	0	7	2	2	0	0	18
14/07/2022	DN	12:50	15:50	2	2	NW	0	7	2	2	0	0	18

Date	Surveyor	Start	End	Survey Hour	Wind Speed	Wind Direction	Rain	Cloud Cover	Cloud Height	Visibility	Snow	Frost	Temp (°c)
14/07/2022	DN	12:50	15:50	3	2	NW	0	7	2	2	0	0	18
15/07/2022	DN	09:25	12:25	1	3	W	0	7	2	2	0	0	17
15/07/2022	DN	09:25	12:25	2	3	W	0	8	2	2	0	0	17
15/07/2022	DN	09:25	12:25	3	3	W	0	8	2	2	0	0	17
21/07/2022	DN	12:41	15:41	1	2	N	0	8	2	2	0	0	16
21/07/2022	DN	12:41	15:41	2	2	N	0	8	2	2	0	0	16
21/07/2022	DN	12:41	15:41	3	2	N	0	8	2	2	0	0	16
22/07/2022	DN	08:34	11:34	1	2	N	0	4	2	2	0	0	16
22/07/2022	DN	08:34	11:34	2	2	N	0	5	2	2	0	0	18
22/07/2022	DN	08:34	11:34	3	2	N	0	6	2	2	0	0	18
08/08/2022	JD	14:30	17:30	1	1	NW	0	4	1	2	0	0	20
08/08/2022	JD	14:30	17:30	2	1	NW	0	3	1	2	0	0	21
08/08/2022	JD	14:30	17:30	3	1	NW	0	3	1	2	0	0	22
12/08/2022	JD	15:00	18:00	1	1	NE	0	6	1	2	0	0	24
12/08/2022	JD	15:00	18:00	2	1	NE	0	6	1	2	0	0	23
12/08/2022	JD	15:00	18:00	3	1	NE	0	6	1	2	0	0	22
29/08/2022	DN	10:30	13:30	1	3	SE	0	2	2	2	0	0	23
29/08/2022	DN	10:30	13:30	2	3	SE	0	4	2	2	0	0	22
29/08/2022	DN	10:30	13:30	3	4	SE	0	5	2	2	0	0	23
30/08/2022	DN	08:00	11:00	1	2	E	0	3	2	2	0	0	15
30/08/2022	DN	08:00	11:00	2	2	E	0	4	2	2	0	0	17

Date	Surveyor	Start	End	Survey Hour	Wind Speed	Wind Direction	Rain	Cloud Cover	Cloud Height	Visibility	Snow	Frost	Temp (°c)
30/08/2022	DN	08:00	11:00	3	2	E	0	3	2	2	0	0	18

Rain/ Precipitation None 0 Drizzle 1 Light showers/snow 2 Heavy showers/snow 3 Heavy rain/snow 4	**Cloud Cover** Expressed in oktas (n/8) **Cloud Height** Height of cloud above average height of viewshed <150m 0 150-500m 1 >500m 2	**Visibility** Poor (<1km) 0 Moderate (1-3km) 1 Good (>3km) 2	**Lying Snow** None 0 On site 1 On higher ground 2	**Frost** None 0 Ground 1 All day 2

APPENDIX 03

Flight activity survey data[10]

[10] Species codes are given in Section 5.0. Age categories: U = unidentified, Ad = adult and Juv = juvenile. Sex categories: M = male, F = female and U = unidentified.

Table A3-1
Primary target species recorded during flight activity surveys undertaken at VP1

Date	Surveyor	Flight ID	Species	Num. Birds	Age	Sex	Obs. Time	Flight Duration (s)
20/05/2022	DN	1	K.	1	U	U	14:40	85
20/06/2022	MMW	1	K.	1	Ad	U	19:19	242
20/06/2022	MMW	2	K.	1	Ad	U	19:24	12
20/06/2022	MMW	3	K.	1	Ad	U	19:56	168
20/06/2022	MMW	4	K.	1	Ad	U	20:11	91
20/06/2022	MMW	5	K.	1	Ad	U	20:15	86
20/06/2022	MMW	6	L.	2	Ad	U	20:31	72
20/06/2022	MMW	7	K.	1	Ad	U	20:57	61
20/06/2022	MMW	8	K.	1	Ad	U	20:59	35
20/06/2022	MMW	9	K.	1	Ad	U	21:01	218
22/06/2022	MMW	1	L.	1	Ad	U	10:41	8
22/06/2022	MMW	2	K.	1	Ad	U	11:13	55
22/06/2022	MMW	3	K.	1	Ad	M	11:19	846
22/06/2022	MMW	4	K.	1	Ad	U	12:42	250
04/07/2022	MMW	1	K.	1	Ad	U	15:17	34
04/07/2022	MMW	2	K.	1	Ad	U	15:21	331
04/07/2022	MMW	3	K.	1	Ad	U	15:36	50
04/07/2022	MMW	4	K.	1	Ad	U	15:57	67
04/07/2022	MMW	5	K.	1	Ad	U	15:53	4
04/07/2022	MMW	6	K.	1	Ad	U	15:58	8
04/07/2022	MMW	7	K.	1	Ad	U	16:08	241
04/07/2022	MMW	8	K.	1	Ad	U	16:12	185
04/07/2022	MMW	9	K.	1	Ad	U	16:13	16
04/07/2022	MMW	10	K.	1	Ad	U	16:14	49
04/07/2022	MMW	11	K.	1	Ad	U	16:21	32
04/07/2022	MMW	12	K.	1	Ad	U	16:22	66
04/07/2022	MMW	13	K.	1	Ad	U	16:26	128
04/07/2022	MMW	14	K.	1	Ad	U	16:30	347
04/07/2022	MMW	16	K.	1	Ad	U	17:24	31
04/07/2022	MMW	1	K.	1	Ad	U	17:50	137
05/07/2022	MMW	1	K.	1	U	U	08:47	155
05/07/2022	MMW	2	K.	1	U	U	08:52	9
05/07/2022	MMW	3	K.	3	U	U	09:05	79
05/07/2022	MMW	4	K.	1	U	U	09:04	16

Date	Surveyor	Flight ID	Species	Num. Birds	Age	Sex	Obs. Time	Flight Duration (s)
05/07/2022	MMW	5	K.	1	U	U	09:18	31
05/07/2022	MMW	6	K.	1	U	U	09:26	197
05/07/2022	MMW	7	K.	1	U	U	09:29	315
05/07/2022	MMW	8	K.	1	U	U	09:42	229
28/07/2022	MMW	1	K.	1	Ad	U	19:02	7
28/07/2022	MMW	2	K.	1	Ad	U	19:04	5
28/07/2022	MMW	3	K.	1	Ad	U	19:56	20
28/07/2022	MMW	4	K.	1	Ad	U	19:39	16
28/07/2022	MMW	5	K.	1	Ad	U	19:55	6
28/07/2022	MMW	6	K.	1	Ad	U	19:44	8
28/07/2022	MMW	1	K.	1	U	U	11:48	289
28/07/2022	MMW	2	K.	1	Ad	U	12:26	207
28/07/2022	MMW	3	K.	1	Ad	U	12:37	96
28/07/2022	MMW	4	K.	1	Ad	U	12:49	357
28/07/2022	MMW	5	K.	1	U	U	13:21	344
28/07/2022	MMW	6	K.	1	U	U	13:23	126
28/07/2022	MMW	7	K.	1	U	U	13:31	41
28/07/2022	MMW	8	K.	1	U	U	13:39	178
28/07/2022	MMW	9	K.	1	U	U	13:45	102
28/07/2022	MMW	10	K.	1	U	U	13:56	66
28/07/2022	MMW	11	K.	1	U	U	14:01	39
28/07/2022	MMW	12	K.	1	U	U	14:08	322
15/08/2022	MMW	1	PE	1	Ad	U	15:30	324
17/08/2022	MMW	1	K.	1	Ad	U	15:17	698
17/08/2022	MMW	2	PE	1	Ad	U	16:42	181

Table A3-2
Primary target species recorded during flight activity surveys undertaken at VP2

Date	Surveyor	Flight ID	Species	Num. Birds	Age	Sex	Obs. Time	Flight Duration (s)
20/05/2022	DN	1	K.	1	U	U	10:40	25
20/05/2022	DN	2	K.	1	U	U	12:30	55
21/06/2022	MMW	1	K.	1	U	U	15:44	64
05/07/2022	MMW	1	SN	1	Ad	M	19:11	5309
06/07/2022	MMW	1	SN	1	Ad	U	11:57	937
06/07/2022	MMW	2	SN	1	Ad	U	13:46	1523
27/07/2022	MMW	1	K.	1	Ad	U	11:43	152
27/07/2022	MMW	2	K.	1	Ad	U	12:02	188
27/07/2022	MMW	3	PE	1	Ad	U	12:56	314

Table A3-3
Primary target species recorded during flight activity surveys undertaken at VP3

Date	Surveyor	Flight ID	Species	Num. Birds	Age	Sex	Obs. Time	Flight Duration (s)
30/05/2022	MMW	1	K.	1	Ad	F	10:19	312
30/05/2022	MMW	2	K.	1	Ad	F	11:20	67
30/05/2022	MMW	3	K.	1	Ad	F	12:04	41
30/05/2022	MMW	4	K.	1	Ad	U	12:12	4
21/06/2022	MMW	1	K.	1	Ad	M	19:40	63
21/06/2022	MMW	2	K.	1	Ad	M	19:54	132
21/06/2022	MMW	3	WK	1	Ad	U	21:39	48
04/07/2022	MMW	1	K.	1	Ad	M	19:31	180
04/07/2022	MMW	2	K.	1	Ad	M	19:45	73
04/07/2022	MMW	3	K.	1	Ad	M	19:47	57
04/07/2022	MMW	4	K.	1	Ad	F	20:15	39
05/07/2022	MMW	1	K.	1	Ad	F	10:46	136
05/07/2022	MMW	2	K.	1	Ad	F	11:22	108
05/07/2022	MMW	3	K.	1	Ad	F	11:43	206
05/07/2022	MMW	4	K.	1	Ad	F	11:50	3
05/07/2022	MMW	5	K.	1	Ad	F	12:04	87
05/07/2022	MMW	6	K.	1	Ad	U	12:31	14
05/07/2022	MMW	7	K.	1	Ad	U	12:59	63
05/07/2022	MMW	8	K.	1	Ad	U	13:05	355
05/07/2022	MMW	9	K.	1	Ad	F	13:33	52

Date	Surveyor	Flight ID	Species	Num. Birds	Age	Sex	Obs. Time	Flight Duration (s)
26/07/2022	MMW	1	K.	1	Ad	U	10:46	59
26/07/2022	MMW	2	K.	2	Ad	U + F	11:12	111
26/07/2022	MMW	3	K.	1	Ad	U	11:14	63
26/07/2022	MMW	4	K.	1	Ad	U	11:52	92
26/07/2022	MMW	5	K.	1	Ad	U	12:57	87
26/07/2022	MMW	6	PE	1	Ad	U	13:02	14
16/08/2022	MMW	1	K.	1	Ad	F	08:54	166
16/08/2022	MMW	2	K.	1	Ad	F	09:26	81
16/08/2022	MMW	3	K.	1	Ad	F	09:35	78
16/08/2022	MMW	4	K.	1	Ad	F	09:39	49
16/08/2022	MMW	5	K.	1	Ad	F	09:50	93
17/08/2022	MMW	1	PE	1	Ad	U	12:03	89
17/08/2022	MMW	2	PE	1	Ad	U	12:42	372

Table A3-4
Primary target species recorded during flight activity surveys undertaken at VP4

Date	Surveyor	Flight ID	Species	Num. Birds	Age	Sex	Obs. Time	Flight Duration (s)
13/05/2022	DN	1	K.	1	U	U	11:50	60
13/05/2022	DN	2	K.	1	U	U	12:30	85
13/05/2022	DN	3	K.	1	U	U	13:10	20
14/07/2022	DN	1	K.	1	Ad	U	12:05	35
22/07/2022	DN	1	K.	1	Ad	U	12:40	85

Table A3-5
Primary target species recorded during flight activity surveys undertaken at VP7

Date	Surveyor	Flight ID	Species	Num. Birds	Age	Sex	Obs. Time	Flight Duration (s)
13/05/2022	DN	1	K.	1	U	U	15:07	18
18/05/2022	FL	1	K.	1	U	U	13:55	130
18/05/2022	FL	2	K.	1	U	U	14:20	60
18/05/2022	FL	3	K.	1	U	U	15:00	190
18/05/2022	FL	4	K.	1	U	U	15:20	40

Table A3-6
Secondary target species recorded during flight activity surveys undertaken at VP1

Date	Survey Start	Survey End	Species	Max Count	5 Min Period Start
16/05/2022	10:05	13:05	BZ	1	12:50
20/05/2022	13:25	16:25	BZ	1	14:50
30/05/2022	13:30	16:30	BZ	3	13:20
30/05/2022	13:30	16:30	BZ	2	13:30
30/05/2022	13:30	16:30	BZ	3	13:30
30/05/2022	13:30	16:30	BZ	3	13:35
30/05/2022	13:30	16:30	BZ	2	13:35
30/05/2022	13:30	16:30	BZ	3	13:40
30/05/2022	13:30	16:30	BZ	2	14:10
30/05/2022	13:30	16:30	BZ	2	14:15
30/05/2022	13:30	16:30	BZ	3	14:30
30/05/2022	13:30	16:30	BZ	3	14:35
30/05/2022	13:30	16:30	BZ	2	14:50
30/05/2022	13:30	16:30	BZ	2	14:55
30/05/2022	13:30	16:30	BZ	2	15:00

Date	Survey Start	Survey End	Species	Max Count	5 Min Period Start
30/05/2022	13:30	16:30	BZ	3	15:05
30/05/2022	13:30	16:30	SH	2	15:05
30/05/2022	13:30	16:30	BZ	2	15:10
30/05/2022	13:30	16:30	BZ	3	15:10
30/05/2022	13:30	16:30	BZ	3	15:15
30/05/2022	13:30	16:30	BZ	3	15:15
30/05/2022	13:30	16:30	BZ	2	15:20
30/05/2022	13:30	16:30	BZ	3	15:25
30/05/2022	13:30	16:30	BZ	2	15:25
30/05/2022	13:30	16:30	BZ	3	15:30
30/05/2022	13:30	16:30	SH	3	15:30
30/05/2022	13:30	16:30	BZ	3	15:35
30/05/2022	13:30	16:30	SH	3	15:45
30/05/2022	13:30	16:30	BZ	2	15:45
30/05/2022	13:30	16:30	BZ	3	15:50
30/05/2022	13:30	16:30	BZ	3	15:50
30/05/2022	13:30	16:30	BZ	2	15:55
30/05/2022	13:30	16:30	BZ	2	15:55
30/05/2022	13:30	16:30	BZ	2	16:00
30/05/2022	13:30	16:30	BZ	2	16:00
30/05/2022	13:30	16:30	SH	1	16:00
30/05/2022	13:30	16:30	BZ	2	16:05
30/05/2022	13:30	16:30	BZ	2	16:05
30/05/2022	13:30	16:30	SH	1	16:10
30/05/2022	13:30	16:30	BZ	2	16:10
30/05/2022	13:30	16:30	BZ	2	16:10
30/05/2022	13:30	16:30	BZ	2	16:15
30/05/2022	13:30	16:30	BZ	2	16:15
30/05/2022	13:30	16:30	SH	1	16:15
31/05/2022	10:00	13:00	BZ	2	10:00
31/05/2022	10:00	13:00	BZ	2	10:00
31/05/2022	10:00	13:00	BZ	2	10:05
31/05/2022	10:00	13:00	BZ	2	10:05
31/05/2022	10:00	13:00	BZ	3	10:10
31/05/2022	10:00	13:00	BZ	3	10:10
31/05/2022	10:00	13:00	BZ	2	10:15

Date	Survey Start	Survey End	Species	Max Count	5 Min Period Start
31/05/2022	10:00	13:00	BZ	2	10:20
31/05/2022	10:00	13:00	BZ	4	10:25
31/05/2022	10:00	13:00	BZ	4	10:25
31/05/2022	10:00	13:00	BZ	3	10:30
31/05/2022	10:00	13:00	BZ	1	10:35
31/05/2022	10:00	13:00	BZ	3	10:40
31/05/2022	10:00	13:00	BZ	3	10:40
31/05/2022	10:00	13:00	BZ	2	10:45
31/05/2022	10:00	13:00	BZ	5	10:50
31/05/2022	10:00	13:00	BZ	5	10:50
31/05/2022	10:00	13:00	BZ	5	10:50
31/05/2022	10:00	13:00	BZ	1	11:00
31/05/2022	10:00	13:00	BZ	1	11:05
31/05/2022	10:00	13:00	BZ	2	11:10
31/05/2022	10:00	13:00	BZ	2	11:10
31/05/2022	10:00	13:00	LB	1	11:10
31/05/2022	10:00	13:00	BZ	2	11:15
31/05/2022	10:00	13:00	BZ	1	11:20
31/05/2022	10:00	13:00	BZ	2	11:25
31/05/2022	10:00	13:00	BZ	2	11:30
31/05/2022	10:00	13:00	BZ	2	11:35
31/05/2022	10:00	13:00	BZ	3	11:40
31/05/2022	10:00	13:00	BZ	2	11:45
31/05/2022	10:00	13:00	BZ	2	11:45
31/05/2022	10:00	13:00	BZ	2	11:50
31/05/2022	10:00	13:00	BZ	2	11:55
31/05/2022	10:00	13:00	BZ	2	11:55
31/05/2022	10:00	13:00	BZ	2	12:00
31/05/2022	10:00	13:00	BZ	3	12:00
31/05/2022	10:00	13:00	BZ	2	12:05
31/05/2022	10:00	13:00	BZ	2	12:05
31/05/2022	10:00	13:00	BZ	2	12:05
31/05/2022	10:00	13:00	BZ	2	12:10
31/05/2022	10:00	13:00	BZ	2	12:15
31/05/2022	10:00	13:00	BZ	2	12:15
31/05/2022	10:00	13:00	BZ	2	12:20

Date	Survey Start	Survey End	Species	Max Count	5 Min Period Start
31/05/2022	10:00	13:00	BZ	4	12:20
31/05/2022	10:00	13:00	BZ	4	12:25
31/05/2022	10:00	13:00	BZ	4	12:25
31/05/2022	10:00	13:00	BZ	2	12:30
31/05/2022	10:00	13:00	BZ	3	12:30
31/05/2022	10:00	13:00	HG	3	12:30
31/05/2022	10:00	13:00	BZ	2	12:35
31/05/2022	10:00	13:00	BZ	2	12:40
31/05/2022	10:00	13:00	BZ	2	12:40
31/05/2022	10:00	13:00	BZ	2	12:45
31/05/2022	10:00	13:00	BZ	2	12:45
31/05/2022	10:00	13:00	BZ	2	12:50
31/05/2022	10:00	13:00	BZ	1	12:50
31/05/2022	10:00	13:00	BZ	1	12:55
20/06/2022	18:45	21:45	RN	5	18:45
20/06/2022	18:45	21:45	RN	5	18:50
20/06/2022	18:45	21:45	RN	3	19:05
20/06/2022	18:45	21:45	RN	3	19:05
20/06/2022	18:45	21:45	LB	1	19:05
20/06/2022	18:45	21:45	BZ	1	19:15
20/06/2022	18:45	21:45	BZ	1	19:25
20/06/2022	18:45	21:45	RN	1	19:25
20/06/2022	18:45	21:45	BZ	1	19:30
20/06/2022	18:45	21:45	LB	1	19:45
20/06/2022	18:45	21:45	BZ	1	21:25
22/06/2022	10:00	13:00	SH	1	10:10
22/06/2022	10:00	13:00	BZ	2	10:15
22/06/2022	10:00	13:00	RN	4	10:15
22/06/2022	10:00	13:00	BZ	2	10:15
22/06/2022	10:00	13:00	LB	2	10:20
22/06/2022	10:00	13:00	RN	4	10:20
22/06/2022	10:00	13:00	BZ	1	10:25
22/06/2022	10:00	13:00	HG	2	10:35
22/06/2022	10:00	13:00	HG	2	10:55
22/06/2022	10:00	13:00	BZ	1	11:15
22/06/2022	10:00	13:00	RN	4	11:20

Date	Survey Start	Survey End	Species	Max Count	5 Min Period Start
22/06/2022	10:00	13:00	BZ	1	11:25
22/06/2022	10:00	13:00	BZ	1	11:30
22/06/2022	10:00	13:00	BZ	2	11:30
22/06/2022	10:00	13:00	HG	3	11:35
22/06/2022	10:00	13:00	LB	1	11:45
22/06/2022	10:00	13:00	BZ	3	11:50
22/06/2022	10:00	13:00	BZ	3	11:50
22/06/2022	10:00	13:00	BZ	3	11:50
22/06/2022	10:00	13:00	RN	2	11:50
22/06/2022	10:00	13:00	BZ	1	11:55
22/06/2022	10:00	13:00	RN	1	11:55
22/06/2022	10:00	13:00	BZ	1	12:10
22/06/2022	10:00	13:00	BZ	2	12:25
22/06/2022	10:00	13:00	BZ	2	12:30
22/06/2022	10:00	13:00	BZ	2	12:40
22/06/2022	10:00	13:00	BZ	2	12:40
22/06/2022	10:00	13:00	BZ	1	12:45
22/06/2022	10:00	13:00	BZ	1	12:55
04/07/2022	15:10	18:10	HG	1	15:10
04/07/2022	15:10	18:10	BZ	1	15:15
04/07/2022	15:10	18:10	BZ	2	15:20
04/07/2022	15:10	18:10	BZ	1	15:25
04/07/2022	15:10	18:10	SH	1	15:30
04/07/2022	15:10	18:10	BZ	1	15:30
04/07/2022	15:10	18:10	BZ	1	15:35
04/07/2022	15:10	18:10	BZ	1	15:45
04/07/2022	15:10	18:10	RN	3	15:50
04/07/2022	15:10	18:10	BZ	1	15:55
04/07/2022	15:10	18:10	BZ	3	16:00
04/07/2022	15:10	18:10	BZ	3	16:00
04/07/2022	15:10	18:10	BZ	3	16:00
04/07/2022	15:10	18:10	BZ	2	16:05
04/07/2022	15:10	18:10	BZ	1	16:25
04/07/2022	15:10	18:10	BZ	1	16:35
04/07/2022	15:10	18:10	BZ	2	16:40
04/07/2022	15:10	18:10	BZ	2	16:45

Date	Survey Start	Survey End	Species	Max Count	5 Min Period Start
04/07/2022	15:10	18:10	BZ	3	16:50
04/07/2022	15:10	18:10	BZ	3	16:50
04/07/2022	15:10	18:10	SH	1	17:00
04/07/2022	15:10	18:10	LB	1	17:05
04/07/2022	15:10	18:10	BZ	1	17:05
04/07/2022	15:10	18:10	BZ	3	17:10
04/07/2022	15:10	18:10	BZ	3	17:10
04/07/2022	15:10	18:10	BZ	3	17:10
04/07/2022	15:10	18:10	BZ	2	17:15
04/07/2022	15:10	18:10	BZ	3	17:20
04/07/2022	15:10	18:10	BZ	3	17:20
04/07/2022	15:10	18:10	BH	1	14:25
04/07/2022	15:10	18:10	BZ	2	17:30
04/07/2022	15:10	18:10	BZ	2	17:30
04/07/2022	15:10	18:10	LB	2	17:30
04/07/2022	15:10	18:10	BZ	1	17:40
04/07/2022	15:10	18:10	HG	9	17:40
04/07/2022	15:10	18:10	BZ	3	17:45
04/07/2022	15:10	18:10	BZ	3	17:45
04/07/2022	15:10	18:10	BZ	3	17:45
04/07/2022	15:10	18:10	LB	5	17:45
04/07/2022	15:10	18:10	BZ	3	17:55
04/07/2022	15:10	18:10	BZ	3	17:55
04/07/2022	15:10	18:10	BZ	2	18:00
04/07/2022	15:10	18:10	BZ	3	18:05
04/07/2022	15:10	18:10	BZ	3	18:05
04/07/2022	15:10	18:10	BZ	3	18:05
05/07/2022	06:45	09:45	LB	2	07:30
05/07/2022	06:45	09:45	SH	1	08:30
05/07/2022	06:45	09:45	BZ	1	08:55
05/07/2022	06:45	09:45	RN	7	08:55
05/07/2022	06:45	09:45	HG	8	09:10
05/07/2022	06:45	09:45	HG	8	09:15
05/07/2022	06:45	09:45	BZ	2	09:15
05/07/2022	06:45	09:45	BZ	2	09:15
05/07/2022	06:45	09:45	HG	13	09:20

Date	Survey Start	Survey End	Species	Max Count	5 Min Period Start
05/07/2022	06:45	09:45	HG	17	09:40
28/07/2022	18:30	21:30	BZ	1	18:35
28/07/2022	18:30	21:30	BZ	1	18:45
28/07/2022	18:30	21:30	RN	2	18:45
28/07/2022	18:30	21:30	BZ	1	18:55
28/07/2022	18:30	21:30	SH	1	19:20
28/07/2022	18:30	21:30	BZ	1	19:50
28/07/2022	11:15	14:15	BZ	2	11:25
28/07/2022	11:15	14:15	BZ	2	11:30
28/07/2022	11:15	14:15	BZ	2	11:35
28/07/2022	11:15	14:15	BZ	3	11:35
28/07/2022	11:15	14:15	BZ	2	11:40
28/07/2022	11:15	14:15	BZ	2	11:40
28/07/2022	11:15	14:15	RN	2	12:00
28/07/2022	11:15	14:15	BZ	1	12:05
28/07/2022	11:15	14:15	BZ	1	12:10
28/07/2022	11:15	14:15	LB	4	12:10
28/07/2022	11:15	14:15	HG	7	12:15
28/07/2022	11:15	14:15	BZ	1	12:15
28/07/2022	11:15	14:15	RN	1	12:15
28/07/2022	11:15	14:15	BZ	1	12:20
28/07/2022	11:15	14:15	BZ	1	12:30
28/07/2022	11:15	14:15	BZ	1	12:35
28/07/2022	11:15	14:15	BZ	2	12:40
28/07/2022	11:15	14:15	BZ	2	12:40
28/07/2022	11:15	14:15	BZ	2	12:45
28/07/2022	11:15	14:15	BZ	2	12:45
28/07/2022	11:15	14:15	BZ	1	12:55
28/07/2022	11:15	14:15	BZ	1	13:00
28/07/2022	11:15	14:15	BZ	3	13:10
28/07/2022	11:15	14:15	BZ	3	13:10
28/07/2022	11:15	14:15	BZ	3	13:10
28/07/2022	11:15	14:15	BZ	2	13:15
28/07/2022	11:15	14:15	BZ	2	13:15
28/07/2022	11:15	14:15	BZ	1	13:20
28/07/2022	11:15	14:15	BZ	1	13:25

Date	Survey Start	Survey End	Species	Max Count	5 Min Period Start
28/07/2022	11:15	14:15	BZ	1	13:30
28/07/2022	11:15	14:15	BZ	2	13:35
28/07/2022	11:15	14:15	RN	2	13:35
28/07/2022	11:15	14:15	BZ	1	13:40
28/07/2022	11:15	14:15	BZ	1	13:45
28/07/2022	11:15	14:15	BZ	1	13:55
28/07/2022	11:15	14:15	BZ	2	14:05
28/07/2022	11:15	14:15	BZ	2	14:05
28/07/2022	11:15	14:15	BZ	2	14:10
28/07/2022	11:15	14:15	BZ	2	14:10
15/08/2022	14:30	17:30	BZ	1	14:55
15/08/2022	14:30	17:30	BZ	1	15:35
15/08/2022	14:30	17:30	BZ	1	15:50
15/08/2022	14:30	17:30	BZ	1	15:55
15/08/2022	14:30	17:30	LB	3	16:00
15/08/2022	14:30	17:30	BZ	1	16:15
15/08/2022	14:30	17:30	LB	4	16:20
15/08/2022	14:30	17:30	LB	7	16:25
15/08/2022	14:30	17:30	LB	10	16:55
15/08/2022	14:30	17:30	LB	10	16:55
15/08/2022	14:30	17:30	GB	1	17:05
15/08/2022	14:30	17:30	BZ	1	17:20
17/08/2022	14:00	17:00	BZ	1	14:25
17/08/2022	14:00	17:00	LB	3	14:35
17/08/2022	14:00	17:00	LB	1	14:40
17/08/2022	14:00	17:00	SH	1	14:50
17/08/2022	14:00	17:00	BZ	1	15:05
17/08/2022	14:00	17:00	BZ	1	15:10
17/08/2022	14:00	17:00	BZ	1	15:35
17/08/2022	14:00	17:00	BZ	1	15:40
17/08/2022	14:00	17:00	BZ	1	15:45
17/08/2022	14:00	17:00	BZ	2	15:50
17/08/2022	14:00	17:00	BZ	2	15:50
17/08/2022	14:00	17:00	BZ	1	15:55
17/08/2022	14:00	17:00	RN	1	16:15
17/08/2022	14:00	17:00	HG	5	16:20

Date	Survey Start	Survey End	Species	Max Count	5 Min Period Start
17/08/2022	14:00	17:00	BZ	1	16:30
17/08/2022	14:00	17:00	RN	2	16:35
17/08/2022	14:00	17:00	BZ	3	16:40
17/08/2022	14:00	17:00	RN	2	16:50

Table A3-7
Secondary target species recorded during flight activity surveys undertaken at VP2

Date	Survey Start	Survey End	Species	Max Count	5 Min Period Start
16/05/2022	13:20	16:20	SH	1	15:00
16/05/2022	13:20	16:20	BZ	2	15:25
27/05/2022	10:45	13:45	BZ	1	10:45
27/05/2022	10:45	13:45	BZ	2	11:00
27/05/2022	10:45	13:45	BZ	2	11:05
27/05/2022	10:45	13:45	BZ	1	11:05
27/05/2022	10:45	13:45	BZ	1	11:15
27/05/2022	10:45	13:45	BZ	2	11:20
27/05/2022	10:45	13:45	BZ	1	11:35
27/05/2022	10:45	13:45	BZ	2	11:45
27/05/2022	10:45	13:45	BZ	1	11:50
27/05/2022	10:45	13:45	BZ	1	11:55
27/05/2022	10:45	13:45	BZ	2	12:00
27/05/2022	10:45	13:45	BZ	1	12:10
27/05/2022	10:45	13:45	BZ	1	12:15
27/05/2022	10:45	13:45	BZ	2	12:20
27/05/2022	10:45	13:45	BZ	1	12:40
27/05/2022	10:45	13:45	BZ	1	13:05
27/05/2022	10:45	13:45	RN	1	13:25
27/05/2022	10:45	13:45	RN	2	13:35
31/05/2022	13:45	16:45	BZ	1	14:30
31/05/2022	13:45	16:45	BZ	2	14:55
31/05/2022	13:45	16:45	BZ	1	15:45
31/05/2022	13:45	16:45	BZ	1	15:50
31/05/2022	13:45	16:45	BZ	1	16:15
31/05/2022	13:45	16:45	BZ	1	16:20
31/05/2022	13:45	16:45	BZ	1	16:25

Date	Survey Start	Survey End	Species	Max Count	5 Min Period Start
31/05/2022	13:45	16:45	H.	1	16:25
21/06/2022	14:30	17:30	BZ	1	14:45
21/06/2022	14:30	17:30	BZ	1	15:00
21/06/2022	14:30	17:30	LB	1	15:20
21/06/2022	14:30	17:30	LB	1	16:25
21/06/2022	14:30	17:30	BZ	1	16:50
21/06/2022	14:30	17:30	RN	1	17:15
05/07/2022	18:45	21:45	BZ	1	19:50
05/07/2022	18:45	21:45	BZ	1	20:55
05/07/2022	18:45	21:45	BZ	1	21:05
06/07/2022	11:40	14:40	RN	3	11:40
06/07/2022	11:40	14:40	BZ	1	12:30
06/07/2022	11:40	14:40	BZ	1	12:35
06/07/2022	11:40	14:40	RN	2	12:50
06/07/2022	11:40	14:40	BZ	1	13:05
06/07/2022	11:40	14:40	BZ	1	13:25
06/07/2022	11:40	14:40	BZ	2	13:40
06/07/2022	11:40	14:40	BZ	2	13:45
06/07/2022	11:40	14:40	BZ	3	14:25
06/07/2022	11:40	14:40	BZ	3	14:25
06/07/2022	11:40	14:40	BZ	1	14:35
26/07/2022	06:35	09:35	LB	2	07:55
26/07/2022	06:35	09:35	RN	1	08:45
26/07/2022	06:35	09:35	BZ	1	08:55
26/07/2022	06:35	09:35	RN	1	09:05
26/07/2022	06:35	09:35	RN	1	09:10
26/07/2022	06:35	09:35	SH	1	09:30
27/07/2022	10:10	13:10	BZ	1	10:10
27/07/2022	10:10	13:10	H.	1	10:25
27/07/2022	10:10	13:10	BZ	1	10:35
27/07/2022	10:10	13:10	BZ	1	10:40
27/07/2022	10:10	13:10	BZ	1	11:05
27/07/2022	10:10	13:10	BZ	1	11:15
27/07/2022	10:10	13:10	BZ	2	12:10
27/07/2022	10:10	13:10	BZ	2	12:15
15/08/2022	18:00	19:25	BZ	1	18:25

Date	Survey Start	Survey End	Species	Max Count	5 Min Period Start
15/08/2022	18:00	19:25	BZ	1	18:50
16/08/2022	19:30	21:05	BZ	1	19:20
16/08/2022	19:30	21:05	BZ	1	19:25
16/08/2022	19:30	21:05	BZ	1	19:30
16/08/2022	19:30	21:05	BZ	1	19:55
16/08/2022	19:30	21:05	LB	2	20:10
16/08/2022	10:30	13:30	BZ	1	10:30
16/08/2022	10:30	13:30	BZ	1	10:50
16/08/2022	10:30	13:30	RN	2	11:05
16/08/2022	10:30	13:30	BZ	1	11:10
16/08/2022	10:30	13:30	BZ	1	11:15
16/08/2022	10:30	13:30	RN	2	11:35
16/08/2022	10:30	13:30	LB	3	12:05
16/08/2022	10:30	13:30	BZ	1	12:20
16/08/2022	10:30	13:30	RN	2	12:30
16/08/2022	10:30	13:30	RN	2	12:40
16/08/2022	10:30	13:30	BZ	2	13:20
16/08/2022	10:30	13:30	BZ	2	13:20

Table A3-8
Secondary target species recorded during flight activity surveys undertaken at VP3

Date	Survey Start	Survey End	Species	Max Count	5 Min Period Start
18/05/2022	12:00	15:00	BZ	1	12:00
18/05/2022	12:00	15:00	BZ	1	12:05
18/05/2022	12:00	15:00	BZ	1	13:25
18/05/2022	12:00	15:00	BZ	1	14:40
19/05/2022	14:35	17:35	BZ	1	15:25
19/05/2022	14:35	17:35	BZ	1	15:45
19/05/2022	14:35	17:35	BZ	1	16:15
19/05/2022	14:35	17:35	BZ	1	16:30
19/05/2022	14:35	17:35	BZ	2	16:40
27/05/2022	14:20	17:20	BZ	1	14:25
27/05/2022	14:20	17:20	BZ	3	14:50
27/05/2022	14:20	17:20	BZ	3	14:50
27/05/2022	14:20	17:20	RN	2	15:05
27/05/2022	14:20	17:20	BZ	1	15:10
27/05/2022	14:20	17:20	RN	2	15:10
27/05/2022	14:20	17:20	BZ	2	15:20
27/05/2022	14:20	17:20	BZ	1	15:25
27/05/2022	14:20	17:20	BZ	2	15:30
27/05/2022	14:20	17:20	BZ	2	15:35
27/05/2022	14:20	17:20	BZ	1	15:40
27/05/2022	14:20	17:20	BZ	1	16:40
27/05/2022	14:20	17:20	BZ	1	16:45
27/05/2022	14:20	17:20	BZ	1	16:55
27/05/2022	14:20	17:20	BZ	3	17:05
27/05/2022	14:20	17:20	BZ	1	17:15
30/05/2022	09:40	12:40	BZ	1	09:50
30/05/2022	09:40	12:40	BZ	1	10:05
30/05/2022	09:40	12:40	BZ	1	10:30
30/05/2022	09:40	12:40	RN	2	10:55
30/05/2022	09:40	12:40	BZ	1	10:55
30/05/2022	09:40	12:40	BZ	3	11:00
30/05/2022	09:40	12:40	BZ	2	11:05
30/05/2022	09:40	12:40	BZ	1	11:10
30/05/2022	09:40	12:40	BZ	1	11:20

Date	Survey Start	Survey End	Species	Max Count	5 Min Period Start
30/05/2022	09:40	12:40	BZ	2	11:25
30/05/2022	09:40	12:40	BZ	4	11:25
30/05/2022	09:40	12:40	BZ	1	11:45
30/05/2022	09:40	12:40	BZ	1	11:50
30/05/2022	09:40	12:40	BZ	2	11:55
30/05/2022	09:40	12:40	BZ	3	12:10
30/05/2022	09:40	12:40	BZ	1	12:30
30/05/2022	09:40	12:40	RN	1	12:30
30/05/2022	09:40	12:40	BZ	2	12:35
30/05/2022	09:40	12:40	BZ	2	12:35
20/06/2022	15:00	18:00	BZ	1	15:00
20/06/2022	15:00	18:00	BZ	1	15:05
20/06/2022	15:00	18:00	BZ	1	15:35
20/06/2022	15:00	18:00	BZ	1	15:40
20/06/2022	15:00	18:00	BZ	1	15:45
20/06/2022	15:00	18:00	BZ	1	15:50
20/06/2022	15:00	18:00	BZ	2	15:55
20/06/2022	15:00	18:00	BZ	2	15:55
20/06/2022	15:00	18:00	BZ	2	16:00
20/06/2022	15:00	18:00	BZ	1	16:05
20/06/2022	15:00	18:00	BZ	1	16:20
20/06/2022	15:00	18:00	BZ	1	16:25
20/06/2022	15:00	18:00	BZ	1	16:35
20/06/2022	15:00	18:00	RN	5	16:35
20/06/2022	15:00	18:00	RN	6	16:40
20/06/2022	15:00	18:00	BZ	1	16:55
20/06/2022	15:00	18:00	BZ	1	17:00
20/06/2022	15:00	18:00	LB	1	17:10
20/06/2022	15:00	18:00	LB	1	17:15
20/06/2022	15:00	18:00	BZ	1	17:20
20/06/2022	15:00	18:00	BZ	2	17:40
20/06/2022	15:00	18:00	BZ	2	17:45
20/06/2022	15:00	18:00	BZ	3	17:50
20/06/2022	15:00	18:00	BZ	3	17:50
20/06/2022	15:00	18:00	BZ	1	17:55
21/06/2022	19:20	22:20	RN	2	20:35

Date	Survey Start	Survey End	Species	Max Count	5 Min Period Start
04/07/2022	18:40	21:40	BZ	1	18:40
04/07/2022	18:40	21:40	BZ	1	18:50
04/07/2022	18:40	21:40	BZ	2	18:55
04/07/2022	18:40	21:40	BZ	1	19:00
04/07/2022	18:40	21:40	BZ	1	19:05
04/07/2022	18:40	21:40	BZ	1	20:50
05/07/2022	10:45	13:45	LB	1	11:10
05/07/2022	10:45	13:45	BZ	1	11:40
05/07/2022	10:45	13:45	HG	1	11:40
05/07/2022	10:45	13:45	LB	1	11:45
05/07/2022	10:45	13:45	BZ	1	11:50
05/07/2022	10:45	13:45	BZ	1	12:00
05/07/2022	10:45	13:45	BZ	1	12:05
05/07/2022	10:45	13:45	BZ	1	12:15
05/07/2022	10:45	13:45	BZ	1	12:40
05/07/2022	10:45	13:45	RN	8	13:10
05/07/2022	10:45	13:45	BZ	1	13:25
05/07/2022	10:45	13:45	RN	5	13:35
26/07/2022	10:10	13:10	BZ	1	10:25
26/07/2022	10:10	13:10	SH	1	11:10
26/07/2022	10:10	13:10	RN	3	11:50
26/07/2022	10:10	13:10	BZ	1	12:00
26/07/2022	10:10	13:10	BZ	3	12:05
26/07/2022	10:10	13:10	GB	1	12:05
26/07/2022	10:10	13:10	BZ	1	12:35
26/07/2022	10:10	13:10	BZ	1	12:40
26/07/2022	10:10	13:10	BZ	2	12:45
26/07/2022	10:10	13:10	BZ	2	12:45
26/07/2022	10:10	13:10	BZ	1	13:00
27/07/2022	06:40	09:40	BZ	1	08:35
16/08/2022	07:00	10:00	RN	1	07:20
16/08/2022	07:00	10:00	BZ	1	07:35
16/08/2022	07:00	10:00	RN	1	07:55
16/08/2022	07:00	10:00	RN	3	09:00
16/08/2022	07:00	10:00	BZ	1	09:50
17/08/2022	10:15	13:15	RN	1	10:30

Date	Survey Start	Survey End	Species	Max Count	5 Min Period Start
17/08/2022	10:15	13:15	RN	1	10:50
17/08/2022	10:15	13:15	RN	2	10:55
17/08/2022	10:15	13:15	BZ	1	11:45
17/08/2022	10:15	13:15	RN	1	11:45
17/08/2022	10:15	13:15	SH	1	11:55
17/08/2022	10:15	13:15	RN	2	12:00
17/08/2022	10:15	13:15	RN	5	12:05
17/08/2022	10:15	13:15	BZ	1	12:15
17/08/2022	10:15	13:15	BZ	1	12:25
17/08/2022	10:15	13:15	RN	2	12:30
17/08/2022	10:15	13:15	BZ	1	12:30
17/08/2022	10:15	13:15	RN	2	12:35
17/08/2022	10:15	13:15	HG	17	12:55

Table A3-9
Secondary target species recorded during flight activity surveys undertaken at VP4

Date	Survey Start	Survey End	Species	Max Count	5 Min Period Start
13/05/2022	10:30	13:30	BZ	2	12:10
20/06/2022	10:07	13:07	BZ	1	12:15
24/06/2022	10:45	13:45	BZ	1	10:45
24/06/2022	10:45	13:45	LB	23	11:05
24/06/2022	10:45	13:45	BZ	1	11:05
24/06/2022	10:45	13:45	LB	1	11:25
24/06/2022	10:45	13:45	LB	1	12:00
24/06/2022	10:45	13:45	LB	2	12:20
24/06/2022	10:45	13:45	BZ	1	12:25
24/06/2022	10:45	13:45	BZ	1	12:30
24/06/2022	10:45	13:45	BZ	1	12:50
24/06/2022	10:45	13:45	LB	2	13:00
24/06/2022	10:45	13:45	LB	9	13:20
24/06/2022	10:45	13:45	BZ	1	13:25
24/06/2022	14:20	17:20	LB	1	14:35
24/06/2022	14:20	17:20	SI	1	14:50
24/06/2022	14:20	17:20	BZ	2	14:55
24/06/2022	14:20	17:20	BZ	2	15:00

Date	Survey Start	Survey End	Species	Max Count	5 Min Period Start
24/06/2022	14:20	17:20	BZ	2	15:05
24/06/2022	14:20	17:20	BZ	1	15:15
24/06/2022	14:20	17:20	BZ	1	15:20
24/06/2022	14:20	17:20	BZ	1	15:25
24/06/2022	14:20	17:20	BZ	2	15:30
24/06/2022	14:20	17:20	BZ	2	15:35
24/06/2022	14:20	17:20	BZ	4	15:40
24/06/2022	14:20	17:20	BZ	2	16:10
24/06/2022	14:20	17:20	BZ	1	16:15
24/06/2022	14:20	17:20	BZ	3	16:20
24/06/2022	14:20	17:20	BZ	4	16:25
24/06/2022	14:20	17:20	BZ	1	16:30
24/06/2022	14:20	17:20	LB	13	16:30
24/06/2022	14:20	17:20	LB	5	16:35
24/06/2022	14:20	17:20	BZ	1	16:50
24/06/2022	14:20	17:20	BZ	2	16:55
24/06/2022	14:20	17:20	LB	2	16:55
24/06/2022	14:20	17:20	BZ	1	17:00
24/06/2022	14:20	17:20	BZ	1	17:05
24/06/2022	14:20	17:20	BZ	2	17:10
24/06/2022	14:20	17:20	BZ	1	17:15
14/07/2022	09:40	12:40	BZ	1	11:20
14/07/2022	09:40	12:40	BZ	1	11:35
15/07/2022	12:35	15:35	BZ	1	13:35
21/07/2022	09:30	12:30	BZ	2	13:45
21/07/2022	09:30	12:30	BZ	1	14:10
21/07/2022	09:30	12:30	BZ	1	15:05
22/07/2022	11:45	14:45	BZ	1	13:25
08/08/2022	11:00	14:00	BZ	1	12:05
08/08/2022	11:00	14:00	BZ	1	13:40
29/08/2022	13:40	16:40	BZ	1	14:00
29/08/2022	13:40	16:40	BZ	1	14:50
30/08/2022	11:15	14:15	SH	1	11:35
30/08/2022	11:15	14:15	BZ	1	12:05
30/08/2022	11:15	14:15	RN	1	12:40

Table A3-10
Secondary target species recorded during flight activity surveys undertaken at VP7

Date	Survey Start	Survey End	Species	Max Count	5 Min Period Start
13/05/2022	13:40	16:40	BZ	1	14:15
13/05/2022	13:40	16:40	BZ	1	14:30
13/05/2022	13:40	16:40	BZ	1	15:00
18/05/2022	15:30	18:30	BZ	1	15:50
18/05/2022	15:30	18:30	BZ	1	15:55
18/05/2022	15:30	18:30	BZ	1	16:15
18/05/2022	15:30	18:30	RN	2	17:30
18/05/2022	15:30	18:30	BZ	1	17:50
18/05/2022	15:30	18:30	BZ	1	18:15
19/05/2022	11:15	14:15	BZ	1	12:25
19/05/2022	11:15	14:15	BZ	1	12:45
19/05/2022	11:15	14:15	BZ	1	12:50
19/05/2022	11:15	14:15	BZ	2	13:00
19/05/2022	11:15	14:15	BZ	1	13:05
19/05/2022	11:15	14:15	BZ	1	13:55
19/05/2022	11:15	14:15	BZ	1	14:05
20/06/2022	13:17	16:17	BZ	1	13:45
20/06/2022	13:17	16:17	BZ	1	14:20
20/06/2022	13:17	16:17	RN	1	14:40
20/06/2022	13:17	16:17	BZ	1	15:25
14/07/2022	12:50	15:50	BZ	1	13:35
14/07/2022	12:50	15:50	BZ	1	13:50
14/07/2022	12:50	15:50	BZ	1	14:10
15/07/2022	09:25	12:25	BZ	1	09:55
15/07/2022	09:25	12:25	BZ	2	10:05
15/07/2022	09:25	12:25	BZ	1	10:15
15/07/2022	09:25	12:25	BZ	1	11:40
15/07/2022	09:25	12:25	BZ	1	12:05
22/07/2022	08:34	11:34	BZ	1	10:30
22/07/2022	08:34	11:34	RN	1	10:50
22/07/2022	08:34	11:34	BZ	1	11:10
08/08/2022	14:30	17:30	BZ	1	15:10
08/08/2022	14:30	17:30	BZ	1	15:15
08/08/2022	14:30	17:30	BH	3	17:05

Date	Survey Start	Survey End	Species	Max Count	5 Min Period Start
12/08/2022	15:00	18:00	BZ	1	16:00
29/08/2022	10:30	13:30	BZ	1	11:00
29/08/2022	10:30	13:30	BZ	2	11:05
29/08/2022	10:30	13:30	LB	3	11:25
29/08/2022	10:30	13:30	BZ	4	12:30
30/08/2022	08:00	11:00	BZ	1	09:00
30/08/2022	08:00	11:00	BZ	1	09:55
30/08/2022	08:00	11:00	BZ	1	10:05
30/08/2022	08:00	11:00	BZ	1	10:10
30/08/2022	08:00	11:00	BZ	1	10:35
30/08/2022	08:00	11:00	BZ	4	10:40

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COOLGLASS WIND FARM

Avian Collision Risk Assessment

Coolglass Wind Farm Ltd

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05/07/2023	3	Dr Jonathon Dunn		Dr Jonathon Dunn	Issue02	Updated with alternative avoidance rate for golden plover

BASIS OF REPORT

CONTENTS

DOCUMENT REFERENCES

TABLES

APPENDICES

1.0 Introduction

This report presents the results of Collision Risk Modelling (CRM) undertaken for five bird species to inform an assessment of potential ornithological impacts relating to the proposed Coolglass Wind Farm, which has a layout comprising a North Cluster of seven turbines, and a South Cluster of six turbines.

As requested by Coolglass Wind Farm Ltd, modelling was based on the use of two turbine options:

- Siemens Gamesa 155 6.6 MW, each with a rotor diameter of 155m, tip height of 180 m and hub height of 102.5 m.
- Vestas V162-7.2 MW turbines, each with a rotor diameter of 162m, tip height of 180m and hub height of 99 m.

The CRM was undertaken in accordance with current NatureScot (NS) (formerly Scottish Natural Heritage (SNH)) guidance, which is recognised as standard best practice guidance through the UK and Ireland to inform impact assessment for onshore wind farms. Further details regarding the methodology used, including details of assumptions used and any corrections applied, are provided in Section 2. The monitoring results are presented in Section 3 and copies of the modelling calculations for each species modelled are included in Appendices 01-02.

1.1 Primary Target Species

Target species for the surveys were defined by legal and/ or conservation status and vulnerability to impacts caused by wind turbines, as defined in NS Guidance (SNH 2017[1]).

There are no nearby Special Protection Areas (SPAs) which are potentially within the core foraging range of any qualifying features which may occur on the Site (e.g., as defined by SNH 2016[2]). Therefore, bird species of high conservation importance in this case are those which are Annex I species and other species of high conservation importance which are considered to be vulnerable to impacts from wind farm developments. The following species are therefore considered relevant as primary target species:

- Annex I raptor and owl species;
- Qualifying interest species for nearby SPAs; and
- Other raptors, waders or wildfowl red-listed on the latest Birds of Conservation Concern in Ireland (BoCCI) scheme[3].

[1] Scottish Natural Heritage (SNH) (2017). *Recommended Bird Survey Methods to Inform Impact Assessment of Onshore Wind Farms. Version 2*.
[2] Scottish Natural Heritage (SNH) (2016). *Assessing Connectivity with Special Protection Areas (SPAs). Version 3 – June 2016*. Scottish Natural Heritage, Inverness.
[3] Gilbert, G., Stanbury, A. and Lewis, L. (2021). Birds of Conservation Concern in Ireland 2020–2026. Irish Birds 43: 1–22

2.0 Methods

The standard Band CRM (Band *et. al.* 2007[4]) was used to estimate collision risk based on recorded target species activity levels and flight behaviour, proposed turbine numbers and specifications, and the relevant species biometrics and flight characteristics. Modelling collision risk under the Band CRM is a two-stage process. Stage 1 estimates the number of birds that fly through the rotor swept area. Stage 2 predicts the proportion of these birds that have the potential to be hit by a rotor blade. Combining both stages produces an estimate of collision mortality in the absence of any avoidance action/behaviour by birds. Avoidance rates are then applied to generate predicted rates of collision mortality.

2.1 Prediction of Rotor Transits from Vantage Point Survey Data

2.1.1 Survey Data 2017 to 2018

The number of birds that fly through the rotor swept area was estimated using flight data gathered during baseline surveys carried out during September 2017 to March 2018. These data were collected by Fehily Timoney and Company and were provided to SLR in raw format only.

Table 2-1
VP Surveys undertaken at Coolglass, Sept 2017 – Mar 2018

VP Number	WF Cluster	ITM Coordinates (x,y)	Hours of Survey Completed (hrs:mins)
1	North	654394, 690098	51:00
2	North	656489, 687433	43:04
3	North	654863, 687925	40:00
4	South	657247, 685790	32:30
5	South	658446, 683332	30:00
7	South	655853, 683304	36:00

2.1.2 Survey Data 2020 to 2022

The number of birds that fly through the rotor swept area was estimated using flight data gathered during baseline surveys carried out during May 2020 to March 2022, which equates to two breeding seasons and two non-breeding seasons. These data were collected by SLR.

The surveys gathered data from two vantage points (VPs). The total number of hours are as shown in **Table 2-2**.

[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. and Ferrer, M., Eds., Birds and Wind Power, Quercus Editions, Madrid, 259-275.

Table 2-2
VP Surveys undertaken at Coolglass, Apr 2021 – Aug 2022

VP Number	WF Cluster	ITM Coordinates (x,y)	Hours of Survey Completed (hrs:mins)			
			Apr 2021-Aug 2021	Sep 2021-Mar 2022	Apr 2022-Aug 2022	Total
1	North	654394, 690098	30:00	36:00	42:00	108:00
2	North	656489, 687433	30:00	35:00	42:00	107:00
3	North	654863, 687925	30:00	36:00	42:00	108:00
4	South	657247, 685790	30:00	36:00	42:00	108:00
5	South	658446, 683332	30:00	42:00	00:00	72:00
7	South	655853, 683304	30:00	39:00	36:00	105:00

2.1.3 Viewshed Data

Viewshed data, i.e., the area visible from each VP within each wind farm polygon (WP)[5], are summarised in **Table 2-3** and **Table 2-5**. Separate analyses were undertaken for each turbine model as follows.

North Cluster

Siemens Gamesa 155 Turbine

Using a surface offset of 25.0m, the combined viewshed area (minus overlap) from VP1, VP2 & VP3 (3,948,319m²) represents 77.6% of the survey WP (i.e., turbines buffered by 577.5m) (5,087,989m²). Viewshed data are presented in **Table 2-3**.

Table 2-3
Coolglass VP Viewshed Data - North Cluster (SG155)

VP/ Viewshed Number	Area of visibility (m²)*
VP 1 viewshed	700,356
VP 2 viewshed	2,497,213
VP 3 viewshed	1,870,676
VP 1-3 viewshed combined (minus overlap)	3,948,319

[5] The survey wind farm polygon (WP) includes the area within 500m of the outermost turbine blades.

Vestas 162 Turbine

Using a surface offset of 17.0m, the combined viewshed area (minus overlap) from VP1, VP2 & VP3 (3,660,514m²) represents 71.5% of the survey WP (i.e., turbines buffered by 582m) (5,118,214m²). Viewshed data are presented in **Table 2-4**.

Table 2-4
Coolglass VP Viewshed Data - North Cluster (V162)

VP/ Viewshed Number	Area of visibility (m²)*
VP 1 viewshed	661,483
VP 2 viewshed	2,130,074
VP 3 viewshed	1,644,556
VP 1-3 viewshed combined (minus overlap)	3,660,514

South Cluster

The viewshed coverage of the survey WP from VP5 is very small (c.16ha) and lies completely within the survey WP coverage from VP7. For this reason, surveys from VP5 were discontinued in 2022 once the layout design was known.

Siemens Gamesa 155 Turbine

Using a surface offset of 25.0m, the combined viewshed area (minus overlap) from VP4, VP5 & VP7 (3,261,764m²) represents 89.3% of the survey WP (i.e., turbines buffered by 577.5m) (3,649,139m²). Viewshed data are presented in **Table 2-5**.

Table 2-5
Coolglass VP Viewshed Data - South Cluster (SG155)

VP/ Viewshed Number	Area of visibility (m²)*
VP 4 viewshed	2,141,875
VP 5 viewshed	161,473
VP 7 viewshed	2,551,864
VP 4,5,7 viewshed combined (minus overlap)	3,261,764

Vestas 162 Turbine

Using a surface offset of 17.0m, the combined viewshed area (minus overlap) from VP4, VP5 & VP7 (3,272,030m²) represents 89.1% of the survey WP (i.e., turbines buffered by 582m) (3,673,529m²). Viewshed data are presented in **Table 2-6**.

Table 2-6
Coolglass VP Viewshed Data - South Cluster (V162)

VP/ Viewshed Number	Area of visibility (m^2)*
VP 4 viewshed	2,093,582
VP 5 viewshed	165,069
VP 7 viewshed	2,453,118
VP 4,5,7 viewshed combined (minus overlap)	3,272,030

2.1.4 Flight Selection for CRM

In order to select flights liable to incur a potential risk of collision, i.e., within the areas occupied by proposed turbines, the CRM used only observations collected within the WP – defined by a 500 m buffer around the proposed outermost turbine locations. The size of buffer takes into account rotor blade length and potential spatial errors in flight recording accuracy. It is known that bird detection rates vary between species. To ensure the CRM used robust measures of flight activity, a 2 km distance truncation was used in the viewshed from each VP, i.e., only flights within 2 km of each VP were included (as per NS guidance).

Analysis in MS Excel and GIS identified those flights that were at Potential Collision Height (PCH) and within the WP. Flight times that were used in the CRM were derived from field data for each flight. Time spent at different flight heights was estimated in a database from interval data for flights that entered the WP. Flying time estimated to occur within the survey recording height bands (see following section) was used to determine the period that target species were at risk of collision with the rotors.

2.1.5 Correcting Survey PCH to Actual PCH

September 2017 to March 2018 Surveys

Baseline VP surveys were initiated before the current candidate turbine details were known. The baseline surveys during September 2017 to March 2018 utilised the following height bands:

- 1 = <30m
- 2 = 30-40m
- 3 = 40-50m
- 4 = 50-170m
- 5 = >170m

Siemens Gamesa 155 Turbine

The height bands used to record flight activity do not correspond precisely to PCH for the Siemens Gamesa 155 turbine (25-180m), i.e., height band 1 overlaps with the lower limit of the actual PCH (25-30m of the 0-30m band) and height band 5 overlaps with the upper limit of the actual PCH (170-180m of the >170m band). Assuming flight heights are equally distributed it is likely that a proportion of height band 1 will be below PCHs.

For height band 5 (>170m), it is not possible to make assumptions on the proportion of flights that were above risk height. Therefore, all flights in height band 5 were included in the CRM.

Overall, the proportion of flights included within the CRM for the SG 155 turbine in all height bands was 155/170 (91%).

Vestas 162 Turbine

Similarly, for the Vestas 162 turbine, the actual PCH is 17-180m. It is therefore assumed that a proportion of height band 1 will be below PCHs. All flights in height band 5 were included in the CRM. Overall, the proportion of flights included within the CRM in all height bands was 163/170 (96%).

April 2021 to August 2022 Surveys

On resumption of surveys in 2021, survey height bands were reviewed. Baseline surveys during this period utilised the following height bands:

- 1 = <15m
- 2 = 15-30m
- 3 = 30-150m
- 4 = 150-200m
- 5 = >200m

Siemens Gamesa 155 Turbine

It is assumed that a proportion of flights in height band 1 will be below PCH and a proportion of flights in height band 4 will be above PCH. Height band 5 was above the upper limit of PCH, so any flights in this height band were excluded from the CRM. Overall, the proportion of flights included within the CRM for the SG 155 turbine in all height bands was (180-25)/200 (77.5%).

Vestas 162 Turbine

It is assumed that a proportion of flights in height band 1 will be below PCH and a proportion of flights in height band 4 will be above PCH. Height band 5 was above the upper limit of PCH, so any flights in this height band were excluded from the CRM. Overall, the proportion of flights included within the CRM for the Vestas 162 turbine in all height bands was (180-17)/200 (81.5%).

2.1.6 Seasonal Definitions

CRMs were constructed using data from the relevant breeding and non-breeding season periods, assumed to be April – August (breeding season) and September – March (non-breeding season)[6].

The theoretical time that birds could be active with potential for turbine collisions was assumed to be the period between sunrise and sunset within each survey period using the latitude of the Site[7].

For waders and wildfowl, which could be active nocturnally, an additional 25% of nocturnal hours were added to the daylight hours to give a more accurate representation of the available hours for these species (as per Band *et al.*, 2007).

2.1.7 Undertaking CRM

Collision risk modelling employs an estimated three-dimensional risk volume[8], in keeping with the assumption that flight directions are random in space. For species with non-directional (e.g., random, circling and foraging)

[6] Note that in the 2021 breeding season and 2021/22 non-breeding baseline reports, the breeding season was defined as April – September and non-breeding season as October – March. This difference has no effect on the CRM.
[7] https://www.timeanddate.com [Accessed in September 2022].
[8] Calculated by multiplying the area of the wind farm by the diameter of the rotors.

flights, the occupancy data are derived by multiplying the numbers of a particular species flying through the survey risk area (i.e., the WP) by the total time spent.

The following parameters were entered into a bespoke modelling spreadsheet:-

- The total observation effort within the risk volume (V_w) visible from each VP;
- The occupancy total: the total time spent by a particular species flying within the risk volume (V_w) visible from each VP;
- The size of the risk volume Vw in m^3 visible from each VP (this is area covered by the outermost turbines with the 500m buffer);
- An estimation of average daylight hours within the season of analysis;
- Species-specific bird parameters (**Table 2-7**); and
- Wind farm and turbine parameters (**Table 2-8, Table 2-9, Table 2-10** and **Table 2-11**).

Maps showing VP locations and viewsheds along with the 500 m buffer around the outermost turbine blades are shown in associated baseline bird reports.

The NS CRM spreadsheet[9] calculates the probability of collision for each species. The model then combines this probability of collision with the observed flight activity per unit area (hours per hectare) weighted for observation effort from each VP to produce an estimate of the number of transits through the rotor blades. Mortality estimates are then derived by applying species-specific avoidance rates.

2.1.8 Bird Biometrics and Avoidance Rates

Measurements and flight speeds of the species for which CRM was undertaken were derived from British Trust for Ornithology (BTO)[10], Provan & Whitfield (2007[11]), Bruderer & Boldt (2001[12]) and Alerstram *et al.* (2007[13]). The avoidance rates for these species are taken from NS (2018[14]).

Table 2-7
Bird biometrics and avoidance rates used in CRM

Species name	Bird length (m)	Wingspan (m)	Flight speed (m/s)	Avoidance rate (%)
Common kestrel	0.34	0.8	12.7	95

[9] https://www.nature.scot/wind-farm-impacts-birds-calculating-probability-collision [Accessed in September 2022].
[10] https://www.bto.org/understanding-birds/birdfacts [Accessed in September 2022].
[11] Provan, S. and Whitfield, D.P. (2007) Avian flight speeds and biometrics for use in collision risk modelling. Report to Scottish Natural Heritage.
[12] Bruderer, B. and Bolt, A. (2001) Flight characteristics of birds: 1. Radar measurements of speeds, *Ibis*, **143**. 178 – 204.
[13] Alerstam T, Rosén M, Bäckman J, Ericson PG, Hellgren O. (2007). Flight speeds among bird species: allometric and phylogenetic effects. PLoS Biol.
[14] SNH (2018) Avoidance rates for the onshore SNH wind farm collision risk model. https://www.nature.scot/doc/wind-farm-impacts-birds-use-avoidance-rates-naturescot-wind-farm-collision-risk-model#:~:text=2.%20Recommended%20avoidance%20rates%20%20%20Species%20,%20SNH%20%282013%29%20%207%20more%20rows%20. [Accessed in September 2022].

Species name	Bird length (m)	Wingspan (m)	Flight speed (m/s)	Avoidance rate (%)
Peregrine falcon	0.45	1.1	14.0	98
European golden plover	0.28	0.72	17.5	98 / 99.8
Northern lapwing	0.30	0.84	12.3	98
Common snipe	0.26	0.455	16.0	98

In addition to the NS 98% default avoidance rate, there has been recent research that shows that for European golden plover, an avoidance rate of 99.8% may be more appropriate. This is based on empirical evidence collected during post-construction monitoring surveys for operational wind farms in England[15]. Consequently, we have presented the results using the two avoidance rates to show the range of possible collision estimates.

2.1.9 Wind Farm and Turbine Parameters

The wind turbine parameters used in the CRM are detailed in **Table 2-8 Table 2-9, Table 2-10** and **Table 2-11** based on the use of 1) Siemens Gamesa 155 Turbine, and 2) Vestas V162-7.2 MW turbines.

Table 2-8
Wind farm & turbine parameters – North Cluster (SG155)

Parameter	Value
Size of survey wind farm polygon (WP)	508.8 ha
Number of turbines	7
Rotor radius/ diameter	77.5m/ 157.0m
Hub height	102.5m
Max. chord	4.5m
Pitch	6°
Rotation period	5.4s (max 11.1rpm)
Turbine operation time	85%

Table 2-9
Wind farm & turbine parameters – North Cluster (V162)

Parameter	Value
Size of survey wind farm polygon (WP)	511.8 ha
Number of turbines	7
Rotor radius/ diameter	81.0m/ 162.0m
Hub height	99.0m

15 https://www.ballivorwindfarmplanning.ie/wp-content/uploads/sites/38/2023/04/Appendix_7-6_Collision_Risk_Assessment.pdf . Accessed 05/07/2023

Parameter	Value
Max. chord	4.3m
Pitch	6°
Rotation period	4.96s (max 12.1rpm)
Turbine operation time	85%

Table 2-10
Wind farm & turbine parameters – South Cluster (SG155)

Parameter	Value
Size of survey wind farm polygon (WP)	364.9 ha
Number of turbines	6
Rotor radius/ diameter	77.5m/ 157.0m
Hub height	102.5m
Max. chord	4.5m
Pitch	6°
Rotation period	5.4s (max 11.1rpm)
Turbine operation time	85%

Table 2-11
Wind farm & turbine parameters – South Cluster (V162)

Parameter	Value
Size of survey wind farm polygon (WP)	367.4 ha
Number of turbines	6
Rotor radius/ diameter	81.0m/ 162.0m
Hub height	99.0m
Max. chord	4.3m
Pitch	6°
Rotation period	4.96s (max 12.1rpm)
Turbine operation time	85%

2.2 Coolglass Flightline Data

Table 2-12 and **Table 2-19** summarise the primary target species flightline[16] data from VP surveys conducted, presented for each cluster and season. **Table 2-13** to **Table 2-18** (inclusive) and **Table 2-20** to **Table 2-26** (inclusive) present the seasonal primary target species occupancy data within each height band, and the total at-risk occupancy data used in the CRM.

2.2.1 North Cluster

Table 2-12
Number of target species flights and individuals observed passing through the Coolglass North Cluster WP during VP surveys (2017/18 and 2021/ 2022)

Species name	Period of analysis	Cumulative number of birds recorded in flight	Flights through WP		Flights through WP at Potential Collision Height (PCH[17])	
			Flights	Individuals	Flights	Individuals
Hen harrier	Non-breeding season 2017/18 (01 Sep-31 Mar)	3	2	2	2	2
Common kestrel	Non-breeding season 2017/18 (01 Sep-31 Mar)	18	11	11	11	11
	Breeding season 2021 (01 Apr-31 Aug)	29	14	14	14	14
	Non-breeding season 2021/22 (01 Sep-31 Mar)	14	4	4	4	4
	Breeding season 2022 (01 Apr-31 Aug)	92	40	43	38	41
Peregrine falcon	Breeding season 2021 (01 Apr-31 Aug)	6	5	5	3	3
	Non-breeding season 2021/22 (01 Sep-31 Mar)	2	2	2	1	1
	Breeding season 2022 (01 Apr-31 Aug)	9	3	3	3	3

[16] A flight line refers to the line drawn to record avian movement during a VP survey. A single flight line may be used indicate the collective movement of a flock of birds. In Table 2-12 'Individuals' refers to the cumulative number of birds within these flight lines.
[17] In this table, PCH is assumed to be within the 0-170m survey height bands (2017/2018 data) or within the 15-200m survey height bands (2021/2022 data)

Species name	Period of analysis	Cumulative number of birds recorded in flight	Flights through WP		Flights through WP at Potential Collision Height (PCH[17])	
			Flights	Individuals	Flights	Individuals
European golden plover	Non-breeding season 2017/18 (01 Sep-31 Mar)	2	1	2	1	2
	Non-breeding season 2021/22 (01 Sep-31 Mar)	2,039	1	9	0	0
Northern lapwing	Non-breeding season 2017/18 (01 Sep-31 Mar)	1	1	1	1	1
	Breeding season 2022 (01 Apr-31 Aug)	3	0	0	0	0
Common snipe	Non-breeding season 2017/18 (01 Sep-31 Mar)	2	2	2	2	2
	Non-breeding season 2021/22 (01 Sep-31 Mar)	1	0	0	0	0
	Breeding season 2022 (01 Apr-31 Aug)	4	4	4	4	4
Eurasian woodcock	Breeding season 2022 (01 Apr-31 Aug)	1	1	1	1	1

Table 2-13
Details of Common Kestrel Flights Recorded within 500m Buffer of North Cluster Turbines

Period	VP No.	No. of flights	No. of birds	Total flying time (s)	Time in height category (s)					
					<30m	**30-40m**	**40-50m**	**50-170m**	**>170m**	**At risk**
Sep-17 to Mar-18	VP1	0	0	0	0	0	0	0	0	0
	VP2	2	2	152	40	0	18	94	0	112
	VP3	9	9	889	249	18	112	510	0	640
Total		11	11	1041	289	18	130	604	0	752
					<15m	**15-30m**	**30-150m**	**150-200m**	**>200m**	**At risk**
Apr-21 to Aug-21	VP1	1	1	270	15	90	165	0	0	165
	VP2	4	4	480	30	420	30	0	0	30
	VP3	7	7	435	180	180	75	0	0	75
Sep-21 to Mar-22	VP1	1	1	60	15	45	0	0	0	0
	VP2	0	0	0	0	0	0	0	0	0
	VP3	5	5	315	165	150	0	0	0	0
Apr-22 to Aug-22	VP1	12	14	1950	45	1710	195	0	0	195
	VP2	4	4	495	45	435	15	0	0	15
	VP3	24	25	2145	195	1650	300	0	0	300
Total		58	61	6150	690	4680	780	0	0	780

Table 2-14
Details of Peregrine Falcon Flights Recorded within 500m Buffer of North Cluster Turbines

Period	VP No.	No. of flights	No. of birds	Total flying time (s)	Time in height category (s)					
					<15m	**15-30m**	**30-150m**	**150-200m**	**>200m**	**At risk**
Apr-21 to Aug-21	VP1	3	3	630	30	30	45	30	495	75
	VP2	2	2	255	0	30	120	105	0	225
	VP3	0	0	0	0	0	0	0	0	0
Sep-21 to Mar-22	VP1	1	1	150	45	30	75	0	0	75
	VP2	1	1	45	45	0	0	0	0	0
	VP3	0	0	0	0	0	0	0	0	0
	VP1	0	0	0	0	0	0	0	0	0

Period	VP No.	No. of flights	No. of birds	Total flying time (s)	Time in height category (s)					
					<15m	**15-30m**	**30-150m**	**150-200m**	**>200m**	**At risk**
Apr-22 to Aug-22	VP2	1	1	315	0	180	135	0	0	135
	VP3	2	2	105	0	105	0	0	0	0
Total		10	10	1500	120	375	375	135	495	510

Table 2-15
Details of European Golden Plover Flights Recorded within 500m Buffer of North Cluster Turbines

Period	VP No.	No. of flights	No. of birds	Total flying time (s)	Time in height category (s)					
					<30m	**30-40m**	**40-50m**	**50-170m**	**>170m**	**At risk**
Sep-17 to Mar-18	VP1	0	0	0	0	0	0	0	0	0
	VP2	0	0	0	0	0	0	0	0	0
	VP3	1	2	84	44	20	20	0	0	40
Total		1	2	84	44	20	20	0	0	40
					<15m	**15-30m**	**30-150m**	**150-200m**	**>200m**	**At risk**
Sep-21 to Mar-22	VP1	0	0	0	0	0	0	0	0	0
	VP2	0	0	0	0	0	0	0	0	0
	VP3	1	9	405	405	0	0	0	0	0
Total		1	9	405	405	0	0	0	0	0

Table 2-16
Details of Northern Lapwing Flights Recorded within 500m Buffer of North Cluster Turbines

Period	VP No.	No. of flights	No. of birds	Total flying time (s)	Time in height category (s)					
					<30m	**30-40m**	**40-50m**	**50-170m**	**>170m**	**At risk**
Sep-17 to Mar-18	VP1	0	0	0	0	0	0	0	0	0
	VP2	0	0	0	0	0	0	0	0	0
	VP3	1	1	93	0	0	0	93	0	93
Total		1	1	93	0	0	0	93	0	93

Table 2-17
Details of Common Snipe Flights Recorded within 500m Buffer of North Cluster Turbines

Period	VP No.	No. of flights	No. of birds	Total flying time (s)	Time in height category (s)					
					<30m	**30-40m**	**40-50m**	**50-170m**	**>170m**	**At risk**
Sep-17 to Mar-18	VP1	0	0	0	0	0	0	0	0	0
	VP2	0	0	0	0	0	0	0	0	0
	VP3	3	3	31	7	1	23	0	0	0
Total		3	3	31	7	1	23	0	0	0
					<15m	**15-30m**	**30-150m**	**150-200m**	**>200m**	**At risk**
Sep-21 to Mar-22	VP1	0	0	0	0	0	0	0	0	0
	VP2	1	1	45	30	15	0	0	0	0
	VP3	0	0	0	0	0	0	0	0	0
Apr-22 to Aug-22	VP1	2	2	6240	630	5610	0	0	0	0
	VP2	1	1	1575	975	600	0	0	0	0
	VP3	0	0	0	0	0	0	0	0	0
Total		4	4	7860	1635	6225	0	0	0	0

Table 2-18
Details of Woodcock Flights Recorded within 500m Buffer of North Cluster Turbines

Period	VP No.	No. of flights	No. of birds	Total flying time (s)	Time in height category (s)					
					<15m	**15-30m**	**30-150m**	**150-200m**	**>200m**	**At risk**
Apr-22 to Aug-22	VP1	0	0	0	0	0	0	0	0	0
	VP2	0	0	0	0	0	0	0	0	0
	VP3	1	1	45	0	45	0	0	0	0
Total		1	1	45	0	45	0	0	0	0

2.2.2 South Cluster

Table 2-19
Number of target species flights and individuals observed passing through the Coolglass South Cluster WP during VP surveys (2017/18 and 2021/ 2022)

Species name	Period of analysis	Total number of birds recorded in flight	Flights through WP		Flights through WP at Potential Collision Height (PCH)	
			Flights	Individuals	Flights	Individuals
Common kestrel	Non-breeding season 2017/18 (01 Sep-31 Mar)	61	10	10	10	10
	Breeding season 2021 (01 Apr-31 Aug)	29	18	19	15	16
	Non-breeding season 2021/22 (01 Sep-31 Mar)	27	12	12	1	1
	Breeding season 2022 (01 Apr-31 Aug)	10	3	3	3	3
Peregrine falcon	Non-breeding season 2017/18 (01 Sep-31 Mar)	2	1	1	1	1
	Breeding season 2021 (01 Apr-31 Aug)	4	1	1	1	1
	Non-breeding season 2021/22 (01 Sep-31 Mar)	3	2	2	2	2
	Breeding season 2022 (01 Apr-31 Aug)	0	0	0	0	0

Species name	Period of analysis	Total number of birds recorded in flight	Flights through WP		Flights through WP at Potential Collision Height (PCH)	
			Flights	Individuals	Flights	Individuals
European golden plover	Non-breeding season 2017/18 (01 Sep-31 Mar)	39	2	7	2	7
	Non-breeding season 2021/22 (01 Sep-31 Mar)	330	2	39	2	39
Northern lapwing	Non-breeding season 2021/22 (01 Sep-31 Mar)	10	1	10	1	10
Common snipe	Breeding season 2021 (01 Apr-31 Aug)	2	1	2	1	2
	Non-breeding season 2021/22 (01 Sep-31 Mar)	13	5	7	3	4
Woodcock	Breeding season 2021 (01 Apr-31 Aug)	1	1	1	0	0

Table 2-20
Details of Common Kestrel Flights Recorded within 500m Buffer of South Cluster Turbines

Period	VP No.	No. of flights	No. of birds	Total flying time (s)	Time in height category (s)					
					<30m	**30-40m**	**40-50m**	**50-170m**	**>170m**	**At risk**
Sep-17 to Mar-18	VP4	0	0	0	0	0	0	0	0	0
	VP5	0	0	0	0	0	0	0	0	0
	VP7	10	10	1322	800	130	149	88	155	522
Total		10	10	1322	800	130	149	88	155	522
					<15m	**15-30m**	**30-150m**	**150-200m**	**>200m**	**At risk**
Apr-21 to Aug-21	VP4	4	5	255	0	255	0	0	0	0
	VP5	0	0	0	0	0	0	0	0	0
	VP7	14	14	1230	930	300	0	0	0	0
Sep-21 to Mar-22	VP4	1	1	60	60	0	0	0	0	0
	VP5	0	0	0	0	0	0	0	0	0
	VP7	11	11	1170	555	585	30	0	0	30
Apr-22 to Aug-22	VP4	3	3	240	0	45	195	0	0	195
	VP5	0	0	0	0	0	0	0	0	0
	VP7	0	0	0	0	0	0	0	0	0
Total		33	34	2955	1545	1185	225	0	0	225

Table 2-21
Details of Peregrine Falcon Flights Recorded within 500m Buffer of South Cluster Turbines

Period	VP No.	No. of flights	No. of birds	Total flying time (s)	Time in height category (s)					
					<30m	**30-40m**	**40-50m**	**50-170m**	**>170m**	**At risk**
Sep-17 to Mar-18	VP4	0	0	0	0	0	0	0	0	0
	VP5	0	0	0	0	0	0	0	0	0
	VP7	1	1	106	45	22	28	11	0	61
Total		1	1	106	45	22	28	11	0	61
					<15m	**15-30m**	**30-150m**	**150-200m**	**>200m**	**At risk**
Apr-21 to Aug-21	VP4	0	0	0	0	0	0	0	0	0
	VP5	0	0	0	0	0	0	0	0	0
	VP7	1	1	165	0	30	135	0	0	135
Sep-21 to Mar-22	VP4	1	1	30	0	30	0	0	0	0
	VP5	0	0	0	0	0	0	0	0	0
	VP7	1	1	90	0	0	90	0	0	90
Total		3	3	285	0	60	225	0	0	225

Table 2-22
Details of European Golden plover Flights Recorded within 500m Buffer of South Cluster Turbines

Period	VP No.	No. of flights	No. of birds	Total flying time (s)	Time in height category (s)					
					<30m	**30-40m**	**40-50m**	**50-170m**	**>170m**	**At risk**
Sep-17 to Mar-18	VP4	0	0	0	0	0	0	0	0	0
	VP5	0	0	0	0	0	0	0	0	0
	VP7	2	7	141	105	36	0	0	0	36
Total		2	7	141	105	36	0	0	0	36
					<15m	**15-30m**	**30-150m**	**150-200m**	**>200m**	**At risk**
Sep-21 to Mar-22	VP4	1	23	1035	0	1035	0	0	0	0
	VP5	1	16	2400	0	0	2400	0	0	2400
	VP7	0	0	0	0	0	0	0	0	0
Total		2	39	3435	0	1035	2400	0	0	2400

Table 2-23
Details of Northern Lapwing Flights Recorded within 500m Buffer of South Cluster Turbines

Period	VP No.	No. of flights	No. of birds	Total flying time (s)	Time in height category (s)					
					<15m	**15-30m**	**30-150m**	**150-200m**	**>200m**	**At risk**
Sep-21 to Mar-22	VP4	0	0	0	0	0	0	0	0	0
	VP5	0	0	0	0	0	0	0	0	0
	VP7	1	10	2250	0	300	1950	0	0	1950
Total		1	10	2250	0	300	1950	0	0	1950

Table 2-24
Details of Common Snipe Flights Recorded within 500m Buffer of South Cluster Turbines

Period	VP No.	No. of flights	No. of birds	Total flying time (s)	Time in height category (s)					
					<15m	**15-30m**	**30-150m**	**150-200m**	**>200m**	**At risk**
Apr-21 to Aug-21	VP4	0	0	0	0	0	0	0	0	0
	VP5	0	0	0	0	0	0	0	0	0
	VP7	1	2	30	30	0	0	0	0	0
Sep-21 to Mar-22	VP4	1	1	15	15	0	0	0	0	0
	VP5	0	0	0	0	0	0	0	0	0
	VP7	4	6	255	150	105	0	0	0	0
Total		6	9	300	195	105	0	0	0	0

Table 2-25
Details of Woodcock Flights Recorded within 500m Buffer of South Cluster Turbines

Period	VP No.	No. of flights	No. of birds	Total flying time (s)	Time in height category (s)					
					<15m	**15-30m**	**30-150m**	**150-200m**	**>200m**	**At risk**
Apr-21 to Aug-21	VP4	0	0	0	0	0	0	0	0	0
	VP5	0	0	0	0	0	0	0	0	0
	VP7	1	1	75	75	0	0	0	0	0
Total		1	1	75	75	0	0	0	0	0

3.0 Collision Risk Modelling Results

Table 3-1 (Siemens Gamesa 155 Turbine Model) and **Table 3-2** (Vestas V162-7.2 MW Turbine Model) summarise the predicted collision rates for the five species under consideration. Copies of the modelling calculations for each species are included in Appendices 01-02. Note that the results for the two avoidance rates used for European golden plover are supplied.

Table 3-1
Summary of CRM Output (SG155)

Species name	Wind farm cluster	Period of analysis	Modelled collisions per Season	Years per collision
Common kestrel	North	Breeding season 2021+2022	0.6094	1.64
		Non-breeding season 2017/18	0.2104	4.75
		Non-breeding season 2021/22	0.0406	24.65
		Annual	0.6791	1.47
	South	Breeding season 2021+2022	0.0879	11.38
		Non-breeding season 2017/18	0.3001	3.33
		Non-breeding season 2021/22	0.1076	9.29
		Annual	0.2755	3.63
	North + South	**Annual**	**0.9546**	**1.05**
Peregrine falcon	North	Breeding season 2021+2022	0.0423	23.63
		Non-breeding season 2017/18	0	-
		Non-breeding season 2021/22	0.0102	97.65
		Annual	0.0433	23.08
	South	Breeding season 2021+2022	0.0086	116.95
		Non-breeding season 2017/18	0.0113	88.66
		Non-breeding season 2021/22	0.0098	101.60

Species name	Wind farm cluster	Period of analysis	Modelled collisions per Season	Years per collision
		Annual	0.0185	54.10
	North + South	**Annual**	**0.0618**	**16.2**
European golden plover	North	Breeding season 2021+2022	0 / 0	-
		Non-breeding season 2017/18	0.0119 / 0.0012	84.15 / 841.54
		Non-breeding season 2021/22	0 /	-
		Annual	0.0056 / 0.0006	178.23 / 1,782.29
	South	Breeding season 2021+2022	0 / 0	-
		Non-breeding season 2017/18	0.0224 / 0.0022	44.64 / 446.4
		Non-breeding season 2021/22	0.4207 / 0.0421	2.38 / 23.88
		Annual	0.2306 / 0.0231	4.34 / 43.36
	North + South	**Annual**	**0.2362 / 0.0236**	**4.23 / 42.3**
Northern lapwing	North	Breeding season 2021+2022	0	-
		Non-breeding season 2017/18	0.0099	100.82
		Non-breeding season 2021/22	0	-
		Annual	0.0047	213.52
	South	Breeding season 2021+2022	0	-
		Non-breeding season 2017/18	0	-
		Non-breeding season 2021/22	0.2077	4.81
		Annual	0.1094	9.14
	North + South	**Annual**	**0.1141**	**8.76**

Species name	Wind farm cluster	Period of analysis	Modelled collisions per Season	Years per collision
Common snipe	North	Breeding season 2021+2022	0.4324	2.31
		Non-breeding season 2017/18	0.0046	215.16
		Non-breeding season 2021/22	0.0022	445.88
		Annual	0.4291	2.33
	South	Breeding season 2021+2022	0	-
		Non-breeding season 2017/18	0	-
		Non-breeding season 2021/22	0.0083	120.95
		Annual	0.0048	209.84
	North + South	**Annual**	**0.4339**	**2.30**

Table 3-2
Summary of CRM Output (V162)

Species name	Wind farm cluster	Period of analysis	Modelled collisions per Season	Years per collision
Common kestrel	North	Breeding season 2021+2022	0.7349	1.36
		Non-breeding season 2017/18	0.1829	5.47
		Non-breeding season 2021/22	0.489	20.45
		Annual	0.7820	1.28
	South	Breeding season 2021+2022	0.957	10.45
		Non-breeding season 2017/18	0.3266	3.06
		Non-breeding season 2021/22	0.1170	8.54
		Annual	0.2998	3.34

Species name	Wind farm cluster	Period of analysis	Modelled collisions per Season	Years per collision
	North + South	**Annual**	**0.9244**	**0.92**
Peregrine falcon	North	Breeding season 2021+2022	0.0513	19.47
		Non-breeding season 2017/18	0	-
		Non-breeding season 2021/22	0.0124	80.51
		Annual	0.0525	19.03
	South	Breeding season 2021+2022	0.0094	106.80
		Non-breeding season 2017/18	0.0124	80.96
		Non-breeding season 2021/22	0.0108	92.83
		Annual	0.0202	49.41
	North + South	**Annual**	**0.0727**	**13.76**
European golden plover	North	Breeding season 2021+2022	0 / 0	-
		Non-breeding season 2017/18	0.140 / 0.0014	71.58 / 715.83
		Non-breeding season 2021/22	0 / 0	-
		Annual	0.066 / 0.0007	151.41 / 1,514.09
	South	Breeding season 2021+2022	0 / 0	-
		Non-breeding season 2017/18	0.238 / 0.0024	41.99 / 419.93
		Non-breeding season 2021/22	0.4469 / 0.0447	2.24 / 22.37
		Annual	0.2451 / 0.0245	4.08 / 40.8
	North + South	**Annual**	**0.3111 / 0.0311**	**3.21 / 31.1**
Northern lapwing	North	Breeding season 2021+2022	0	-

Species name	Wind farm cluster	Period of analysis	Modelled collisions per Season	Years per collision
		Non-breeding season 2017/18	0.118	84.45
		Non-breeding season 2021/22	0	-
		Annual	0.0056	178.63
	South	Breeding season 2021+2022	0	-
		Non-breeding season 2017/18	0	-
		Non-breeding season 2021/22	0.2241	4.46
		Annual	0.1181	8.47
	North + South	**Annual**	**0.1237**	**8.08**
Common snipe	North	Breeding season 2021+2022	0.3327	3.01
		Non-breeding season 2017/18	0.0034	290.33
		Non-breeding season 2021/22	0.0017	578.42
		Annual	0.3297	3.03
	South	Breeding season 2021+2022	0	-
		Non-breeding season 2017/18	0	-
		Non-breeding season 2021/22	0.0088	113.33
		Annual	0.0051	196.56
	North + South	**Annual**	**0.3348**	**2.99**

3.1 Species Summary

The annual mortality rates for the north and south clusters combined for each species modelled (including the two avoidance rates for European golden plover) are summarised in as follows:

Table 3-3
Summary of CRM Output (Annual Rates)

Species name	Wind farm cluster	Turbine Model	Annual collisions	Years per collision
Common kestrel	North	SG155	0.6791	1.47
	North	V162	0.7820	1.28
	South	SG155	0.2755	3.63
	South	V162	0.2998	3.34
	North + South	**SG155**	**0.9546**	**1.05**
	North + South	**V162**	**0.9244**	**0.92**
Peregrine falcon	North	SG155	0.0433	23.08
	North	V162	0.0525	19.03
	South	SG155	0.0185	54.10
	South	V162	0.0202	49.41
	North + South	**SG155**	**0.0618**	**16.2**
	North + South	**V162**	**0.0727**	**13.76**
European golden plover	North	SG155	0.0056 / 0.0006	178.23 / 1,782.3
	North	V162	0.066 / 0.0007	151.41 / 1,514.1
	South	SG155	0.2306 / 0.0231	4.34 / 43.4
	South	V162	0.2451 / 0.0245	4.08 / 40.8
	North + South	**SG155**	**0.2362 / 0.0236**	**4.23 / 42.30**
	North + South	**V162**	**0.3111 / 0.0311**	**3.21 / 32.10**
Northern lapwing	North	SG155	0.0047	213.52
	North	V162	0.0056	178.63
	South	SG155	0.1094	9.14
	South	V162	0.1181	8.47
	North + South	**SG155**	**0.1141**	**8.76**

Species name	Wind farm cluster	Turbine Model	Annual collisions	Years per collision
	North + South	**V162**	**0.1237**	**8.08**
Common snipe	North	SG155	0.4291	2.33
	North	V162	0.3297	3.03
	South	SG155	0.0048	209.84
	South	V162	0.0051	196.56
	North + South	**SG155**	**0.4339**	**2.30**
	North + South	**V162**	**0.3348**	**2.99**

APPENDIX 01

CRM Probability Calculations

Siemens Gamesa 155

Common Kestrel

K: [1D or [3D] (0 or 1)	1		**Calculation of alpha and p(collision) as a function of radius**								
NoBlades	3						Upwind:			Downwind:	
MaxChord	4.5	m	r/R	c/C	α	collide		contribution	collide		contribution
Pitch (degrees)	6		radius	chord	alpha	length	p(collision)	from radius r	length	p(collision)	from radius r
BirdLength	0.34	m	0.025	0.575	5.63	17.64	0.77	0.00096	17.10	0.75	0.00093
Wingspan	0.8	m	0.075	0.575	1.88	6.06	0.27	0.00199	5.52	0.24	0.00181
F: Flapping (0) or gliding (-	1		0.125	0.702	1.13	4.44	0.19	0.00243	3.78	0.17	0.00207
			0.175	0.860	0.80	3.91	0.17	0.00299	3.10	0.14	0.00238
Bird speed	12.7	m/sec	0.225	0.994	0.63	3.57	0.16	0.00352	2.64	0.12	0.00260
RotorDiam	155	m	0.275	0.947	0.51	2.88	0.13	0.00346	1.99	0.09	0.00239
RotationPeriod	5.40	sec	0.325	0.899	0.43	2.39	0.10	0.00339	1.54	0.07	0.00219
			0.375	0.851	0.38	2.17	0.09	0.00356	1.37	0.06	0.00225
			0.425	0.804	0.33	1.91	0.08	0.00355	1.15	0.05	0.00214
			0.475	0.756	0.30	1.70	0.07	0.00353	0.99	0.04	0.00205
Bird aspect ratioo: β	0.43		0.525	0.708	0.27	1.52	0.07	0.00350	0.86	0.04	0.00197
			0.575	0.660	0.24	1.37	0.06	0.00346	0.75	0.03	0.00189
			0.625	0.613	0.23	1.25	0.05	0.00341	0.67	0.03	0.00183
			0.675	0.565	0.21	1.13	0.05	0.00335	0.60	0.03	0.00178
			0.725	0.517	0.19	1.03	0.05	0.00328	0.55	0.02	0.00173
			0.775	0.470	0.18	0.94	0.04	0.00320	0.50	0.02	0.00170
			0.825	0.422	0.17	0.86	0.04	0.00311	0.46	0.02	0.00167
			0.875	0.374	0.16	0.79	0.03	0.00301	0.43	0.02	0.00166
			0.925	0.327	0.15	0.72	0.03	0.00290	0.41	0.02	0.00165
			0.975	0.279	0.14	0.65	0.03	0.00278	0.39	0.02	0.00166
				Overall p(collision) =			**Upwind**	**6.1%**		**Downwind**	**3.8%**
								Average	**5.0%**		

Peregrine Falcon

K: [1D or [3D] (0 or 1)	1		**Calculation of alpha and p(collision) as a function of radius**								
NoBlades	3					Upwind:			Downwind:		
MaxChord	4.5	m	r/R	c/C	α	collide		contribution	collide		contribution
Pitch (degrees)	6		radius	chord	alpha	length	p(collision)	from radius r	length	p(collision)	from radius r
BirdLength	0.45	m	0.025	0.575	6.21	20.60	0.82	0.00102	20.06	0.80	0.00099
Wingspan	1.1	m	0.075	0.575	2.07	7.05	0.28	0.00210	6.51	0.26	0.00194
F: Flapping (0) or gliding (·	1		0.125	0.702	1.24	5.10	0.20	0.00253	4.44	0.18	0.00220
			0.175	0.860	0.89	4.44	0.18	0.00308	3.63	0.14	0.00252
Bird speed	14	m/sec	0.225	0.994	0.69	4.02	0.16	0.00359	3.09	0.12	0.00276
RotorDiam	155	m	0.275	0.947	0.56	3.23	0.13	0.00353	2.34	0.09	0.00256
RotationPeriod	5.40	sec	0.325	0.899	0.48	2.68	0.11	0.00346	1.83	0.07	0.00236
			0.375	0.851	0.41	2.27	0.09	0.00337	1.47	0.06	0.00218
			0.425	0.804	0.37	2.14	0.08	0.00361	1.39	0.05	0.00234
			0.475	0.756	0.33	1.91	0.08	0.00360	1.20	0.05	0.00226
Bird aspect ratioo: β	0.41		0.525	0.708	0.30	1.72	0.07	0.00358	1.05	0.04	0.00220
			0.575	0.660	0.27	1.56	0.06	0.00356	0.94	0.04	0.00214
			0.625	0.613	0.25	1.42	0.06	0.00352	0.84	0.03	0.00209
			0.675	0.565	0.23	1.30	0.05	0.00348	0.77	0.03	0.00205
			0.725	0.517	0.21	1.19	0.05	0.00342	0.70	0.03	0.00202
			0.775	0.470	0.20	1.09	0.04	0.00336	0.65	0.03	0.00200
			0.825	0.422	0.19	1.00	0.04	0.00329	0.61	0.02	0.00199
			0.875	0.374	0.18	0.92	0.04	0.00321	0.57	0.02	0.00198
			0.925	0.327	0.17	0.85	0.03	0.00312	0.54	0.02	0.00199
			0.975	0.279	0.16	0.78	0.03	0.00302	0.52	0.02	0.00200
				Overall p(collision) =			**Upwind**	**6.3%**		**Downwind**	**4.3%**
								Average	**5.3%**		

European Golden Plover

K: [1D or [3D] (0 or 1)	1		**Calculation of alpha and p(collision) as a function of radius**								
NoBlades	3					Upwind:			Downwind:		
MaxChord	4.5	m	r/R	c/C	α	collide		contribution	collide		contribution
Pitch (degrees)	6		radius	chord	alpha	length	p(collision)	from radius r	length	p(collision)	from radius r
BirdLength	0.28	m	0.025	0.575	7.98	26.41	0.82	0.00102	25.87	0.80	0.00100
Wingspan	0.7	m	0.075	0.575	2.66	8.98	0.28	0.00208	8.44	0.26	0.00195
F: Flapping (0) or gliding (-	0		0.125	0.702	1.60	6.46	0.20	0.00249	5.80	0.18	0.00224
			0.175	0.860	1.14	5.59	0.17	0.00302	4.78	0.15	0.00258
Bird speed	18	m/sec	0.225	0.994	0.89	5.04	0.16	0.00350	4.10	0.13	0.00285
RotorDiam	155	m	0.275	0.947	0.73	4.03	0.12	0.00342	3.14	0.10	0.00266
RotationPeriod	5.40	sec	0.325	0.899	0.61	3.32	0.10	0.00333	2.48	0.08	0.00249
			0.375	0.851	0.53	2.80	0.09	0.00324	2.00	0.06	0.00231
			0.425	0.804	0.47	2.40	0.07	0.00314	1.64	0.05	0.00215
			0.475	0.756	0.42	2.07	0.06	0.00304	1.36	0.04	0.00199
Bird aspect ratioo: β	0.40		0.525	0.708	0.38	1.82	0.06	0.00295	1.15	0.04	0.00187
			0.575	0.660	0.35	1.62	0.05	0.00287	1.00	0.03	0.00177
			0.625	0.613	0.32	1.44	0.04	0.00279	0.87	0.03	0.00167
			0.675	0.565	0.30	1.29	0.04	0.00270	0.76	0.02	0.00159
			0.725	0.517	0.28	1.16	0.04	0.00260	0.67	0.02	0.00151
			0.775	0.470	0.26	1.04	0.03	0.00249	0.60	0.02	0.00144
			0.825	0.422	0.24	0.94	0.03	0.00238	0.54	0.02	0.00137
			0.875	0.374	0.23	0.84	0.03	0.00226	0.49	0.02	0.00131
			0.925	0.327	0.22	0.75	0.02	0.00214	0.44	0.01	0.00126
			0.975	0.279	0.20	0.67	0.02	0.00201	0.40	0.01	0.00122
				Overall p(collision) =			**Upwind**	**5.3%**		**Downwind**	**3.7%**
								Average	**4.5%**		

Northern Lapwing

K: [1D or [3D] (0 or 1)	1		**Calculation of alpha and p(collision) as a function of radius**								
NoBlades	3						Upwind:			Downwind:	
MaxChord	4.5	m	r/R	c/C	α	collide		contribution	collide		contribution
Pitch (degrees)	6		radius	chord	alpha	length	p(collision)	from radius r	length	p(collision)	from radius r
BirdLength	0.3	m	0.025	0.575	5.46	18.89	0.85	0.00107	18.35	0.83	0.00104
Wingspan	0.84	m	0.075	0.575	1.82	6.48	0.29	0.00219	5.94	0.27	0.00201
F: Flapping (0) or gliding (-	0		0.125	0.702	1.09	4.67	0.21	0.00264	4.01	0.18	0.00227
			0.175	0.860	0.78	4.06	0.18	0.00321	3.25	0.15	0.00257
Bird speed	12.3	m/sec	0.225	0.994	0.61	3.67	0.17	0.00373	2.74	0.12	0.00278
RotorDiam	155	m	0.275	0.947	0.50	2.96	0.13	0.00368	2.07	0.09	0.00257
RotationPeriod	5.40	sec	0.325	0.899	0.42	2.46	0.11	0.00362	1.62	0.07	0.00238
			0.375	0.851	0.36	2.09	0.09	0.00354	1.29	0.06	0.00219
			0.425	0.804	0.32	1.83	0.08	0.00352	1.08	0.05	0.00207
			0.475	0.756	0.29	1.63	0.07	0.00349	0.92	0.04	0.00196
Bird aspect ratioo: β	0.36		0.525	0.708	0.26	1.46	0.07	0.00345	0.79	0.04	0.00187
			0.575	0.660	0.24	1.31	0.06	0.00341	0.69	0.03	0.00179
			0.625	0.613	0.22	1.19	0.05	0.00335	0.61	0.03	0.00172
			0.675	0.565	0.20	1.08	0.05	0.00328	0.55	0.02	0.00166
			0.725	0.517	0.19	0.98	0.04	0.00321	0.49	0.02	0.00161
			0.775	0.470	0.18	0.89	0.04	0.00312	0.45	0.02	0.00157
			0.825	0.422	0.17	0.81	0.04	0.00302	0.41	0.02	0.00154
			0.875	0.374	0.16	0.74	0.03	0.00291	0.39	0.02	0.00152
			0.925	0.327	0.15	0.67	0.03	0.00280	0.36	0.02	0.00151
			0.975	0.279	0.14	0.61	0.03	0.00267	0.34	0.02	0.00151
				Overall p(collision) =			**Upwind**	**6.2%**		**Downwind**	**3.8%**
								Average	**5.0%**		

Common Snipe

K: [1D or [3D] (0 or 1)	1		**Calculation of alpha and p(collision) as a function of radius**								
NoBlades	3					Upwind:			Downwind:		
MaxChord	4.5	m	r/R	c/C	α	collide		contribution	collide		contribution
Pitch (degrees)	6		radius	chord	alpha	length	p(collision)	from radius r	length	p(collision)	from radius r
BirdLength	0.26	m	0.025	0.575	7.10	21.76	0.76	0.00094	21.22	0.74	0.00092
Wingspan	0.455	m	0.075	0.575	2.37	7.43	0.26	0.00194	6.89	0.24	0.00180
F: Flapping (0) or gliding (·	0		0.125	0.702	1.42	5.43	0.19	0.00236	4.77	0.17	0.00207
			0.175	0.860	1.01	4.77	0.17	0.00290	3.96	0.14	0.00241
Bird speed	16	m/sec	0.225	0.994	0.79	4.34	0.15	0.00339	3.40	0.12	0.00266
RotorDiam	155	m	0.275	0.947	0.65	3.47	0.12	0.00332	2.58	0.09	0.00247
RotationPeriod	5.40	sec	0.325	0.899	0.55	2.88	0.10	0.00325	2.03	0.07	0.00229
			0.375	0.851	0.47	2.46	0.09	0.00321	1.66	0.06	0.00216
			0.425	0.804	0.42	2.14	0.07	0.00316	1.38	0.05	0.00204
			0.475	0.756	0.37	1.88	0.07	0.00310	1.17	0.04	0.00193
Bird aspect ratioo: β	0.57		0.525	0.708	0.34	1.66	0.06	0.00303	1.00	0.03	0.00182
			0.575	0.660	0.31	1.48	0.05	0.00296	0.86	0.03	0.00172
			0.625	0.613	0.28	1.33	0.05	0.00288	0.75	0.03	0.00163
			0.675	0.565	0.26	1.19	0.04	0.00279	0.66	0.02	0.00154
			0.725	0.517	0.24	1.07	0.04	0.00269	0.58	0.02	0.00147
			0.775	0.470	0.23	0.96	0.03	0.00259	0.52	0.02	0.00140
			0.825	0.422	0.22	0.86	0.03	0.00248	0.47	0.02	0.00134
			0.875	0.374	0.20	0.78	0.03	0.00236	0.42	0.01	0.00129
			0.925	0.327	0.19	0.69	0.02	0.00223	0.39	0.01	0.00124
			0.975	0.279	0.18	0.62	0.02	0.00209	0.36	0.01	0.00121
				Overall p(collision) =			**Upwind**	**5.4%**		**Downwind**	**3.5%**
								Average	**4.5%**		

APPENDIX 02

CRM Probability Calculations

Vestas 162

Common Kestrel

K: [1D or [3D] (0 or 1)	1		**Calculation of alpha and p(collision) as a function of radius**								
NoBlades	3						Upwind:			Downwind:	
MaxChord	4.3	m	r/R	c/C	α	collide		contribution	collide		contribution
Pitch (degrees)	6		radius	chord	alpha	length	p(collision)	from radius r	length	p(collision)	from radius r
BirdLength	0.34	m	0.025	0.575	4.95	14.95	0.71	0.00089	14.44	0.69	0.00086
Wingspan	0.8	m	0.075	0.575	1.65	5.16	0.25	0.00184	4.64	0.22	0.00166
F: Flapping (0) or gliding (·	1		0.125	0.702	0.99	3.79	0.18	0.00226	3.16	0.15	0.00188
			0.175	0.860	0.71	3.35	0.16	0.00279	2.58	0.12	0.00215
Bird speed	12.7	m/sec	0.225	0.994	0.55	3.07	0.15	0.00329	2.17	0.10	0.00233
RotorDiam	162	m	0.275	0.947	0.45	2.48	0.12	0.00324	1.63	0.08	0.00213
RotationPeriod	4.96	sec	0.325	0.899	0.38	2.21	0.11	0.00342	1.40	0.07	0.00217
			0.375	0.851	0.33	1.92	0.09	0.00344	1.16	0.06	0.00207
			0.425	0.804	0.29	1.70	0.08	0.00344	0.98	0.05	0.00198
			0.475	0.756	0.26	1.52	0.07	0.00344	0.84	0.04	0.00191
Bird aspect ratioo: β	0.43		0.525	0.708	0.24	1.37	0.07	0.00343	0.74	0.04	0.00184
			0.575	0.660	0.22	1.24	0.06	0.00341	0.65	0.03	0.00178
			0.625	0.613	0.20	1.13	0.05	0.00338	0.58	0.03	0.00174
			0.675	0.565	0.18	1.04	0.05	0.00333	0.53	0.03	0.00170
			0.725	0.517	0.17	0.95	0.05	0.00328	0.49	0.02	0.00168
			0.775	0.470	0.16	0.87	0.04	0.00322	0.45	0.02	0.00166
			0.825	0.422	0.15	0.80	0.04	0.00314	0.42	0.02	0.00165
			0.875	0.374	0.14	0.73	0.03	0.00306	0.40	0.02	0.00166
			0.925	0.327	0.13	0.67	0.03	0.00297	0.38	0.02	0.00167
			0.975	0.279	0.13	0.62	0.03	0.00286	0.37	0.02	0.00170
				Overall p(collision) =			**Upwind**	**6.0%**		**Downwind**	**3.6%**
								Average	**4.8%**		

Peregrine Falcon

K: [1D or [3D] (0 or 1)	1		**Calculation of alpha and p(collision) as a function of radius**								
NoBlades	3					Upwind:			Downwind:		
MaxChord	4.3	m	r/R	c/C	α	collide		contribution	collide		contribution
Pitch (degrees)	6		radius	chord	alpha	length	p(collision)	from radius r	length	p(collision)	from radius r
BirdLength	0.45	m	0.025	0.575	5.46	17.50	0.76	0.00095	16.98	0.73	0.00092
Wingspan	1.1	m	0.075	0.575	1.82	6.01	0.26	0.00195	5.49	0.24	0.00178
F: Flapping (0) or gliding (-	1		0.125	0.702	1.09	4.35	0.19	0.00235	3.72	0.16	0.00201
			0.175	0.860	0.78	3.80	0.16	0.00287	3.03	0.13	0.00229
Bird speed	14	m/sec	0.225	0.994	0.61	3.45	0.15	0.00335	2.56	0.11	0.00248
RotorDiam	162	m	0.275	0.947	0.50	2.78	0.12	0.00330	1.93	0.08	0.00229
RotationPeriod	4.96	sec	0.325	0.899	0.42	2.31	0.10	0.00325	1.50	0.06	0.00211
			0.375	0.851	0.36	2.16	0.09	0.00349	1.39	0.06	0.00226
			0.425	0.804	0.32	1.91	0.08	0.00352	1.19	0.05	0.00219
			0.475	0.756	0.29	1.72	0.07	0.00353	1.04	0.04	0.00213
Bird aspect ratioo: β	0.41		0.525	0.708	0.26	1.56	0.07	0.00353	0.92	0.04	0.00208
			0.575	0.660	0.24	1.42	0.06	0.00352	0.82	0.04	0.00205
			0.625	0.613	0.22	1.30	0.06	0.00350	0.75	0.03	0.00202
			0.675	0.565	0.20	1.19	0.05	0.00348	0.68	0.03	0.00200
			0.725	0.517	0.19	1.10	0.05	0.00344	0.63	0.03	0.00199
			0.775	0.470	0.18	1.01	0.04	0.00340	0.59	0.03	0.00198
			0.825	0.422	0.17	0.94	0.04	0.00334	0.56	0.02	0.00199
			0.875	0.374	0.16	0.87	0.04	0.00328	0.53	0.02	0.00201
			0.925	0.327	0.15	0.80	0.03	0.00321	0.51	0.02	0.00203
			0.975	0.279	0.14	0.74	0.03	0.00313	0.49	0.02	0.00207
				Overall p(collision) =			**Upwind**	**6.2%**		**Downwind**	**4.1%**
								Average	**5.2%**		

European Golden Plover

K: [1D or [3D] (0 or 1)	1		**Calculation of alpha and p(collision) as a function of radius**								
NoBlades	3					Upwind:			Downwind:		
MaxChord	4.3	m	r/R	c/C	α	collide		contribution	collide		contribution
Pitch (degrees)	6		radius	chord	alpha	length	p(collision)	from radius r	length	p(collision)	from radius r
BirdLength	0.28	m	0.025	0.575	7.02	22.42	0.75	0.00094	21.91	0.74	0.00092
Wingspan	0.7	m	0.075	0.575	2.34	7.65	0.26	0.00193	7.13	0.24	0.00180
F: Flapping (0) or gliding (+	0		0.125	0.702	1.40	5.51	0.19	0.00231	4.88	0.16	0.00205
			0.175	0.860	1.00	4.78	0.16	0.00281	4.00	0.13	0.00235
Bird speed	18	m/sec	0.225	0.994	0.78	4.31	0.14	0.00326	3.41	0.11	0.00258
RotorDiam	162	m	0.275	0.947	0.64	3.45	0.12	0.00319	2.60	0.09	0.00241
RotationPeriod	4.96	sec	0.325	0.899	0.54	2.86	0.10	0.00312	2.05	0.07	0.00224
			0.375	0.851	0.47	2.41	0.08	0.00304	1.65	0.06	0.00208
			0.425	0.804	0.41	2.07	0.07	0.00295	1.35	0.05	0.00192
			0.475	0.756	0.37	1.81	0.06	0.00289	1.13	0.04	0.00181
Bird aspect ratioo: β	0.40		0.525	0.708	0.33	1.61	0.05	0.00284	0.97	0.03	0.00172
			0.575	0.660	0.31	1.44	0.05	0.00278	0.84	0.03	0.00163
			0.625	0.613	0.28	1.29	0.04	0.00271	0.74	0.02	0.00155
			0.675	0.565	0.26	1.16	0.04	0.00264	0.65	0.02	0.00148
			0.725	0.517	0.24	1.05	0.04	0.00255	0.58	0.02	0.00142
			0.775	0.470	0.23	0.95	0.03	0.00246	0.52	0.02	0.00136
			0.825	0.422	0.21	0.85	0.03	0.00237	0.47	0.02	0.00131
			0.875	0.374	0.20	0.77	0.03	0.00226	0.43	0.01	0.00127
			0.925	0.327	0.19	0.69	0.02	0.00215	0.40	0.01	0.00124
			0.975	0.279	0.18	0.62	0.02	0.00203	0.37	0.01	0.00121
				Overall p(collision) =			**Upwind**	**5.1%**		**Downwind**	**3.4%**
								Average	**4.3%**		

Northern Lapwing

K: [1D or [3D] (0 or 1)	1		**Calculation of alpha and p(collision) as a function of radius**								
NoBlades	3					Upwind:			Downwind:		
MaxChord	4.3	m	r/R	c/C	α	collide		contribution	collide		contribution
Pitch (degrees)	6		radius	chord	alpha	length	p(collision)	from radius r	length	p(collision)	from radius r
BirdLength	0.3	m	0.025	0.575	4.79	16.08	0.79	0.00099	15.56	0.77	0.00096
Wingspan	0.84	m	0.075	0.575	1.60	5.53	0.27	0.00204	5.01	0.25	0.00185
F: Flapping (0) or gliding (-	0		0.125	0.702	0.96	4.00	0.20	0.00246	3.37	0.17	0.00207
			0.175	0.860	0.68	3.48	0.17	0.00300	2.71	0.13	0.00233
Bird speed	12.3	m/sec	0.225	0.994	0.53	3.16	0.16	0.00350	2.27	0.11	0.00251
RotorDiam	162	m	0.275	0.947	0.44	2.56	0.13	0.00346	1.71	0.08	0.00231
RotationPeriod	4.96	sec	0.325	0.899	0.37	2.13	0.10	0.00341	1.32	0.07	0.00212
			0.375	0.851	0.32	1.85	0.09	0.00340	1.08	0.05	0.00199
			0.425	0.804	0.28	1.63	0.08	0.00341	0.91	0.04	0.00190
			0.475	0.756	0.25	1.46	0.07	0.00340	0.78	0.04	0.00181
Bird aspect ratioo: β	0.36		0.525	0.708	0.23	1.31	0.06	0.00338	0.67	0.03	0.00174
			0.575	0.660	0.21	1.19	0.06	0.00335	0.59	0.03	0.00167
			0.625	0.613	0.19	1.08	0.05	0.00331	0.53	0.03	0.00162
			0.675	0.565	0.18	0.98	0.05	0.00326	0.48	0.02	0.00158
			0.725	0.517	0.17	0.90	0.04	0.00320	0.43	0.02	0.00154
			0.775	0.470	0.15	0.82	0.04	0.00313	0.40	0.02	0.00152
			0.825	0.422	0.15	0.75	0.04	0.00305	0.37	0.02	0.00151
			0.875	0.374	0.14	0.69	0.03	0.00296	0.35	0.02	0.00151
			0.925	0.327	0.13	0.63	0.03	0.00286	0.33	0.02	0.00152
			0.975	0.279	0.12	0.57	0.03	0.00274	0.32	0.02	0.00154
				Overall p(collision) =			**Upwind**	**6.0%**		**Downwind**	**3.6%**
								Average	**4.8%**		

Common Snipe

K: [1D or [3D] (0 or 1)	1		**Calculation of alpha and p(collision) as a function of radius**								
NoBlades	3						Upwind:			Downwind:	
MaxChord	4.3	m	r/R	c/C	α	collide		contribution	collide		contribution
Pitch (degrees)	6		radius	chord	alpha	length	p(collision)	from radius r	length	p(collision)	from radius r
BirdLength	0.26	m	0.025	0.575	6.24	18.43	0.70	0.00087	17.92	0.68	0.00085
Wingspan	0.455	m	0.075	0.575	2.08	6.32	0.24	0.00179	5.80	0.22	0.00164
F: Flapping (0) or gliding (-	0		0.125	0.702	1.25	4.63	0.17	0.00219	3.99	0.15	0.00189
			0.175	0.860	0.89	4.07	0.15	0.00269	3.30	0.12	0.00218
Bird speed	16	m/sec	0.225	0.994	0.69	3.71	0.14	0.00315	2.82	0.11	0.00239
RotorDiam	162	m	0.275	0.947	0.57	2.98	0.11	0.00310	2.13	0.08	0.00221
RotationPeriod	4.96	sec	0.325	0.899	0.48	2.51	0.09	0.00308	1.70	0.06	0.00209
			0.375	0.851	0.42	2.16	0.08	0.00306	1.39	0.05	0.00197
			0.425	0.804	0.37	1.88	0.07	0.00302	1.16	0.04	0.00186
			0.475	0.756	0.33	1.66	0.06	0.00298	0.98	0.04	0.00176
Bird aspect ratioo: β	0.57		0.525	0.708	0.30	1.48	0.06	0.00293	0.84	0.03	0.00167
			0.575	0.660	0.27	1.32	0.05	0.00288	0.73	0.03	0.00158
			0.625	0.613	0.25	1.19	0.04	0.00281	0.64	0.02	0.00151
			0.675	0.565	0.23	1.07	0.04	0.00274	0.56	0.02	0.00144
			0.725	0.517	0.22	0.97	0.04	0.00265	0.50	0.02	0.00138
			0.775	0.470	0.20	0.88	0.03	0.00256	0.45	0.02	0.00133
			0.825	0.422	0.19	0.79	0.03	0.00247	0.41	0.02	0.00128
			0.875	0.374	0.18	0.71	0.03	0.00236	0.38	0.01	0.00125
			0.925	0.327	0.17	0.64	0.02	0.00225	0.35	0.01	0.00122
			0.975	0.279	0.16	0.58	0.02	0.00212	0.33	0.01	0.00120
				Overall p(collision) =			**Upwind**	**5.2%**		**Downwind**	**3.3%**
								Average	**4.2%**		

APPENDIX 03

CRM Calculations

Siemens Gamesa 155

Common Kestrel North Cluster Breeding Season SG 155

	Viewsheds								
	1	2	3						
STAGE 1: Estimation of rotor transits									
Step 1.1: Seconds occupancy of the survey risk volume (T_w)[1] recorded within each viewshed (T_wV)	2160	900	2,205						
Step 1.2: Unweighted occupancy rate each viewshed (T_wVrate)									
Hours of survey effort (*e*)	72	72	72						
Windfarm area (ha) visible within viewshed (*v*)[1]	70.04	249.72	187.0676						
Observation effort (*e*v*)	5042.56	17979.93	13468.87						
T_wV rate=$T_wV/e*v$	1.19E-04	1.39E-05	4.55E-05						
Step 1.3: Weighted occupancy rate *(weighted T_wV rate)*[1]									
Weight: proportion of total survey effort made at the VP	0.138	0.493	0.369	0.000	0.000	0.000	0.000		
Weighted T_wV rate (T_wV rate * weight)	1.64E-05	6.85E-06	1.68E-05						
Total weighted occupancy rate	0.000040				birds seconds per ha/hour				
Mean % activity hr^-1 in wind farm at risk height	2.039%								
Mean % activity hr^-1 in wind farm at rotor height (z)	1.580%								

Step 1.4: Total occupancy of risk volume during surveys (T_w)		
Hours potentially active: breeding season (a) (footnote 2)	2,377	hours
Tw=z*a	37.56	hours
Step 1.6: Flight risk volume (V_w)		
Risk volume: $V_w=A*h$ (footnote 3)	788,638,295	m^3
Step 1.7: Volume swept by windfarm rotors (V_r)		
Bird length (L)	0.34	m
Rotor-swept volume: $V_r=N*\pi*r^2*(d+L)$ footnote 4	639,288.19	m^3
Step 1.8: Bird occupancy of rotor-swept volume (Tr)		
$T_r=T_w*(V_r/Vw)$	109.6067	seconds
Step 1.9: Time taken to transit rotor *(t)*		
Flight speed *(s)*	12.7	m/sec
$t=(d+L)/s$	0.38	seconds
Step 1.10: Number of rotor transits (N)		
$N=T_r/t$	288	rotor transits
STAGE 2: Probability of Collision for a bird flying through rotors (*p*(collision)) from SNH spreadsheet[5]	0.050	
STAGE 3: Predicted mortality (birds per year)		
Step 3.1: With no avoidance, turbines operational 85% of the time N*p(collision)*0.85	12.188	collisions

Step 3.2: Adjusted using a range of avoidance rates:				
95.00%	**0.6094**	**approx one collision every**	**1.64**	**years**

[1] The survey risk volume was derived from the windfarm polygon including a precautionary 500m buffer around the turbine rotors.

[2] The total number of daylight hours during the period

[3] A= size of windfarm polygon(ha) h= rotor diameter (m)

[4] N= number of turbines, r= rotor radius (m), d= max depth of rotors (m)

[5]Assumes bird length=0.34m, wingspan 0.8m, flight speed= 12.7m/sec

Common Kestrel North Cluster Non-Breeding Season 2017/18 SG 155

	Viewsheds								
	1	**2**	**3**						
STAGE 1: Estimation of rotor transits									
Step 1.1: Seconds occupancy of the survey risk volume (T_w)[1] recorded within each viewshed (T_wV)	0	152	889						
Step 1.2: Unweighted occupancy rate each viewshed ($T_wV$rate)									
Hours of survey effort (*e*)	51	43	40						
Windfarm area (ha) visible within viewshed (*v*)[1]	70.04	249.72	187.0676						
Observation effort (*e*v*)	3571.81	10738.01	7482.70						
T_wV rate=$T_wV/e*v$	0.00E+00	3.93E-06	3.30E-05						
Step 1.3: Weighted occupancy rate *(weighted T_wV rate)*[1]									
Weight: proportion of total survey effort made at the VP	0.164	0.493	0.343						
Weighted T_wV rate (T_wV rate * weight)	0.00E+00	1.94E-06	1.13E-05						
Total weighted occupancy rate	0.000013					birds seconds per ha/hour			
Mean % activity hr^-1 in wind farm at risk height	0.675%								

Mean % activity hr^-1 in wind farm at rotor height (z)	0.616%	
Step 1.4: Total occupancy of risk volume during surveys (T_w)		
Hours potentially active: breeding season (a) (footnote 2)	2,107	hours
Tw=z*a	12.97	hours
Step 1.6: Flight risk volume (V_w)		
Risk volume: $V_w=A*h$ (footnote 3)	788,638,295	m^3
Step 1.7: Volume swept by windfarm rotors (V_r)		
Bird length (L)	0.34	m
Rotor-swept volume: $V_r=N*\pi*r^2*(d+L)$ footnote 4	639,288.19	m^3
Step 1.8: Bird occupancy of rotor-swept volume (Tr)		
$T_r=T_w*(V_r/Vw)$	37.84	seconds
Step 1.9: Time taken to transit rotor *(t)*		
Flight speed *(s)*	12.7	m/sec
t=(d+L)/s	0.38	seconds
Step 1.10: Number of rotor transits (N)		
$N=T_r/t$	99	rotor transits
STAGE 2: Probability of Collision for a bird flying through rotors (*p*(collision)) from SNH spreadsheet[5]	0.050	

STAGE 3: Predicted mortality (birds per year)				
Step 3.1: With no avoidance, turbines operational 85% of the time N*p(collision)*0.85	4.208	collisions		
Step 3.2: Adjusted using a range of avoidance rates:				
95.00%	**0.2104**	**approx one collision every**	**4.75**	**years**

[1] The survey risk volume was derived from the windfarm polygon including a precautionary 500m buffer around the turbine rotors.

[2] The total number of daylight hours during the period

[3] A= size of windfarm polygon(ha) h= rotor diameter (m)

[4] N= number of turbines, r= rotor radius (m), d= max depth of rotors (m)

[5]Assumes bird length=0.34m, wingspan 0.8m, flight speed= 12.7m/sec

Common Kestrel Non-Breeding Season 2021/22 SG 155

	Viewsheds								
	1	**2**	**3**						
STAGE 1: Estimation of rotor transits									
Step 1.1: Seconds occupancy of the survey risk volume (T_w)[1] recorded within each viewshed (T_wV)	45	0	150						
Step 1.2: Unweighted occupancy rate each viewshed ($T_wV$rate)									
Hours of survey effort (*e*)	36	35	36						
Windfarm area (ha) visible within viewshed (*v*)[1]	70.04	249.72	187.0676						
Observation effort (*e*v*)	2521.28	8740.24	6734.43						
T_wV rate=$T_wV/e*v$	4.96E-06	0.00E+00	6.19E-06						
Step 1.3: Weighted occupancy rate *(weighted T_wV rate)*[1]									
Weight: proportion of total survey effort made at the VP	0.140	0.486	0.374						
Weighted T_wV rate (T_wV rate * weight)	6.95E-07	0.00E+00	2.32E-06						
Total weighted occupancy rate	0.000003					birds seconds per ha/hour			
Mean % activity hr^-1 in wind farm at risk height	0.153%								

Mean % activity hr^-1 in wind farm at rotor height (z)	0.119%	
Step 1.4: Total occupancy of risk volume during surveys (T_w)		
Hours potentially active: breeding season (a) (footnote 2)	2,107	hours
Tw=z*a	2.50	hours
Step 1.6: Flight risk volume (V_w)		
Risk volume: $V_w=A*h$ (footnote 3)	788,638,295	m^3
Step 1.7: Volume swept by windfarm rotors (V_r)		
Bird length (L)	0.34	m
Rotor-swept volume: $V_r=N*\pi*r^2*(d+L)$ footnote 4	639,288.19	m^3
Step 1.8: Bird occupancy of rotor-swept volume (Tr)		
$T_r=T_w*(V_r/Vw)$	7.30	seconds
Step 1.9: Time taken to transit rotor *(t)*		
Flight speed *(s)*	12.7	m/sec
$t=(d+L)/s$	0.38	seconds
Step 1.10: Number of rotor transits (N)		
$N=T_r/t$	19	rotor transits
STAGE 2: Probability of Collision for a bird flying through rotors (*p*(collision)) from SNH spreadsheet[5]	0.050	
STAGE 3: Predicted mortality (birds per year)		

Step 3.1: With no avoidance, turbines operational 85% of the time N*p(collision)*0.85	0.811	collisions		
Step 3.2: Adjusted using a range of avoidance rates:				
95.00%	**0.0406**	**approx one collision every**	**24.65**	**years**

[1] The survey risk volume was derived from the windfarm polygon including a precautionary 500m buffer around the turbine rotors.

[2] The total number of daylight hours during the period

[3] A= size of windfarm polygon(ha) h= rotor diameter (m)

[4] N= number of turbines, r= rotor radius (m), d= max depth of rotors (m)

[5]Assumes bird length=0.34m, wingspan 0.8m, flight speed= 12.7m/sec

Common Kestrel North Cluster Annual SG 155

	Viewsheds								
	1	**2**	**3**						
STAGE 1: Estimation of rotor transits									
Step 1.1: Seconds occupancy of the survey risk volume (T_w)[1] recorded within each viewshed (T_wV)	2205	1,052	3,244						
Step 1.2: Unweighted occupancy rate each viewshed ($T_wV$rate)									
Hours of survey effort (*e*)	159	150	148						
Windfarm area (ha) visible within viewshed (*v*)[1]	70.04	249.72	187.07						
Observation effort (*e*v*)	11135.65	37458.19	27686.01						
T_wV rate=$T_wV/e*v$	5.50E-05	7.80E-06	3.25E-05						
Step 1.3: Weighted occupancy rate *(weighted T_wV rate)*[1]									
Weight: proportion of total survey effort made at the VP	0.146	0.491	0.363						
Weighted T_wV rate (T_wV rate * weight)	8.03E-06	3.83E-06	1.18E-05						
Total weighted occupancy rate	0.000024				birds seconds per ha/hour				
Mean % activity hr^-1 in wind farm at risk height	1.205%								

SLR

Mean % activity hr^-1 in wind farm at rotor height (z)	0.934%	
Step 1.4: Total occupancy of risk volume during surveys (T_w)		
Hours potentially active: breeding season (a) (footnote 2)	4,483	hours
Tw=z*a	41.85	hours
Step 1.6: Flight risk volume (V_w)		
Risk volume: $V_w=A*h$ (footnote 3)	788,638,295	m^3
Step 1.7: Volume swept by windfarm rotors (V_r)		
Bird length (L)	0.34	m
Rotor-swept volume: $V_r=N*\pi*r^2*(d+L)$ footnote 4	639,288.19	m^3
Step 1.8: Bird occupancy of rotor-swept volume (Tr)		
$T_r=T_w*(V_r/Vw)$	122.1340	seconds
Step 1.9: Time taken to transit rotor *(t)*		
Flight speed *(s)*	12.7	m/sec
t=(d+L)/s	0.38	seconds
Step 1.10: Number of rotor transits (N)		
$N=T_r/t$	320	rotor transits
STAGE 2: Probability of Collision for a bird flying through rotors (*p*(collision)) from SNH spreadsheet[5]	0.050	
STAGE 3: Predicted mortality (birds per year)		

Step 3.1: With no avoidance, turbines operational 85% of the time N*p(collision)*0.85	13.582	collisions		
Step 3.2: Adjusted using a range of avoidance rates:				
95.00%	**0.6791**	**approx one collision every**	**1.47**	**years**

[1] The survey risk volume was derived from the windfarm polygon including a precautionary 500m buffer around the turbine rotors.

[2] The total number of daylight hours during the period

[3] A= size of windfarm polygon(ha) h= rotor diameter (m)

[4] N= number of turbines, r= rotor radius (m), d= max depth of rotors (m)

[5]Assumes bird length=0.34m, wingspan 0.8m, flight speed= 12.7m/sec

Common Kestrel South Cluster Breeding Season SG 155

	Viewsheds								
	4	5	7						
STAGE 1: Estimation of rotor transits									
Step 1.1: Seconds occupancy of the survey risk volume (T_w)[1] recorded within each viewshed (T_wV)	495	0	300						
Step 1.2: Unweighted occupancy rate each viewshed (T_wVrate)									
Hours of survey effort (*e*)	72	30	66						
Windfarm area (ha) visible within viewshed (*v*)[1]	214.19	16.15	255.1864						
Observation effort (*e*v*)	15421.50	484.42	16842.31						
T_wV rate=$T_wV/e*v$	8.92E-06	0.00E+00	4.95E-06						
Step 1.3: Weighted occupancy rate *(weighted T_wV rate)*[1]									
Weight: proportion of total survey effort made at the VP	0.471	0.015	0.514	0.000	0.000	0.000	0.000		
Weighted T_wV rate (T_wV rate * weight)	4.20E-06	0.00E+00	2.54E-06						
Total weighted occupancy rate	0.000007					birds seconds per ha/hour			
Mean % activity hr^-1 in wind farm at risk height	0.246%								
Mean % activity hr^-1 in wind farm at rotor height (z)	0.191%								

Step 1.4: Total occupancy of risk volume during surveys (T_w)		
Hours potentially active: breeding season (a) (footnote 2)	2,377	hours
Tw=z*a	4.53	hours
Step 1.6: Flight risk volume (V_w)		
Risk volume: $V_w=A*h$ (footnote 3)	565,616,700	m^3
Step 1.7: Volume swept by windfarm rotors (V_r)		
Bird length (L)	0.34	m
Rotor-swept volume: $V_r=N*\pi*r^2*(d+L)$ footnote 4	547,961.30	m^3
Step 1.8: Bird occupancy of rotor-swept volume (Tr)		
$T_r=T_w*(V_r/Vw)$	15.8074	seconds
Step 1.9: Time taken to transit rotor *(t)*		
Flight speed *(s)*	12.7	m/sec
$t=(d+L)/s$	0.38	seconds
Step 1.10: Number of rotor transits (N)		
$N=T_r/t$	41	rotor transits
STAGE 2: Probability of Collision for a bird flying through rotors (*p*(collision)) from SNH spreadsheet[5]	0.050	
STAGE 3: Predicted mortality (birds per year)		

Step 3.1: With no avoidance, turbines operational 85% of the time N*p(collision)*0.85	1.758	collisions			
Step 3.2: Adjusted using a range of avoidance rates:					
95.00%	**0.0879**	**approx one collision every**	**11.38**	**years**	

[1] The survey risk volume was derived from the windfarm polygon including a precautionary 500m buffer around the turbine rotors.

[2] The total number of daylight hours during the period

[3] A= size of windfarm polygon(ha) h= rotor diameter (m)

[4] N= number of turbines, r= rotor radius (m), d= max depth of rotors (m)

[5]Assumes bird length=0.34m, wingspan 0.8m, flight speed= 12.7m/sec

Common Kestrel South Cluster Non-Breeding Season 2017/18 SG 155

	Viewsheds								
	4	5	7						
STAGE 1: Estimation of rotor transits									
Step 1.1: Seconds occupancy of the survey risk volume (T_w)[1] recorded within each viewshed (T_wV)	0	0	1,322						
Step 1.2: Unweighted occupancy rate each viewshed ($T_wV$rate)									
Hours of survey effort (*e*)	33	30	36						
Windfarm area (ha) visible within viewshed (*v*)[1]	214.19	16.15	255.18644						
Observation effort (*e**v*)	6961.09	484.42	9186.71						
T_wV rate=$T_wV/e*v$	0.00E+00	0.00E+00	4.00E-05						
Step 1.3: Weighted occupancy rate *(weighted T_wV rate)*[1]									
Weight: proportion of total survey effort made at the VP	0.419	0.029	0.552						
Weighted T_wV rate (T_wV rate * weight)	0.00E+00	0.00E+00	2.21E-05						
Total weighted occupancy rate	0.000022				birds seconds per ha/hour				
Mean % activity hr^-1 in wind farm at risk height	0.806%								

Mean % activity hr^-1 in wind farm at rotor height (z)	0.735%	
Step 1.4: Total occupancy of risk volume during surveys (T_w)		
Hours potentially active: breeding season (a) (footnote 2)	2,107	hours
Tw=z*a	15.48	hours
Step 1.6: Flight risk volume (V_w)		
Risk volume: $V_w=A*h$ (footnote 3)	565,616,700	m^3
Step 1.7: Volume swept by windfarm rotors (V_r)		
Bird length (L)	0.34	m
Rotor-swept volume: $V_r=N*\pi*r^2*(d+L)$ footnote 4	547,961.30	m^3
Step 1.8: Bird occupancy of rotor-swept volume (Tr)		
$T_r=T_w*(V_r/Vw)$	53.97	seconds
Step 1.9: Time taken to transit rotor *(t)*		
Flight speed *(s)*	12.7	m/sec
$t=(d+L)/s$	0.38	seconds
Step 1.10: Number of rotor transits (N)		
$N=T_r/t$	142	rotor transits
STAGE 2: Probability of Collision for a bird flying through rotors (*p*(collision)) from SNH spreadsheet[5]	0.050	

STAGE 3: Predicted mortality (birds per year)					
Step 3.1: With no avoidance, turbines operational 85% of the time N*p(collision)*0.85	6.002	collisions			
Step 3.2: Adjusted using a range of avoidance rates:					
95.00%	**0.3001**	**approx one collision every**	**3.33**	**years**	

[1] The survey risk volume was derived from the windfarm polygon including a precautionary 500m buffer around the turbine rotors.

[2] The total number of daylight hours during the period

[3] A= size of windfarm polygon(ha) h= rotor diameter (m)

[4] N= number of turbines, r= rotor radius (m), d= max depth of rotors (m)

[5]Assumes bird length=0.34m, wingspan 0.8m, flight speed= 12.7m/sec

Common Kestrel South Cluster Non-Breeding Season 2021/22 SG 155

	Viewsheds								
	4	**5**	**7**						
STAGE 1: Estimation of rotor transits									
Step 1.1: Seconds occupancy of the survey risk volume (T_w)[1] recorded within each viewshed (T_wV)	0	0	615						
Step 1.2: Unweighted occupancy rate each viewshed ($T_wV$rate)									
Hours of survey effort (*e*)	36	42	39						
Windfarm area (ha) visible within viewshed (*v*)[1]	214.19	16.15	255.18644						
Observation effort (*e*v*)	7710.75	678.19	9952.27						
T_wV rate=$T_wV/e*v$	0.00E+00	0.00E+00	1.72E-05						
Step 1.3: Weighted occupancy rate *(weighted T_wV rate)*[1]									
Weight: proportion of total survey effort made at the VP	0.420	0.037	0.543						
Weighted T_wV rate (T_wV rate * weight)	0.00E+00	0.00E+00	9.31E-06						
Total weighted occupancy rate	0.000009					birds seconds per ha/hour			
Mean % activity hr^-1 in wind farm at risk height	0.340%								

Mean % activity hr^-1 in wind farm at rotor height (z)	0.263%	
Step 1.4: Total occupancy of risk volume during surveys (T_w)		
Hours potentially active: breeding season (a) (footnote 2)	2,107	hours
Tw=z*a	5.55	hours
Step 1.6: Flight risk volume (V_w)		
Risk volume: $V_w=A*h$ (footnote 3)	565,616,700	m^3
Step 1.7: Volume swept by windfarm rotors (V_r)		
Bird length (L)	0.34	m
Rotor-swept volume: $V_r=N*\pi*r^2*(d+L)$ footnote 4	547,961.30	m^3
Step 1.8: Bird occupancy of rotor-swept volume (Tr)		
$T_r=T_w*(V_r/Vw)$	19.35	seconds
Step 1.9: Time taken to transit rotor *(t)*		
Flight speed *(s)*	12.7	m/sec
$t=(d+L)/s$	0.38	seconds
Step 1.10: Number of rotor transits (N)		
$N=T_r/t$	51	rotor transits
STAGE 2: Probability of Collision for a bird flying through rotors (*p*(collision)) from SNH spreadsheet[5]	0.050	

STAGE 3: Predicted mortality (birds per year)				
Step 3.1: With no avoidance, turbines operational 85% of the time N*p(collision)*0.85	2.152	collisions		
Step 3.2: Adjusted using a range of avoidance rates:				
95.00%	**0.1076**	**approx one collision every**	**9.29**	**years**

[1] The survey risk volume was derived from the windfarm polygon including a precautionary 500m buffer around the turbine rotors.

[2] The total number of daylight hours during the period

[3] A= size of windfarm polygon(ha) h= rotor diameter (m)

[4] N= number of turbines, r= rotor radius (m), d= max depth of rotors (m)

[5]Assumes bird length=0.34m, wingspan 0.8m, flight speed= 12.7m/sec

Common Kestrel South Cluster Annual SG 155

	Viewsheds								
	4	5	7						
STAGE 1: Estimation of rotor transits									
Step 1.1: Seconds occupancy of the survey risk volume (T_w)[1] recorded within each viewshed (T_wV)	495	0	2,237						
Step 1.2: Unweighted occupancy rate each viewshed ($T_wV$rate)									
Hours of survey effort (*e*)	141	102	141						
Windfarm area (ha) visible within viewshed (*v*)[1]	214.19	16.15	255.19						
Observation effort (*e*v*)	30093.34	1647.03	35981.29						
T_wV rate=$T_wV/e*v$	4.57E-06	0.00E+00	1.73E-05						
Step 1.3: Weighted occupancy rate *(weighted T_wV rate)*[1]									
Weight: proportion of total survey effort made at the VP	0.444	0.024	0.531						
Weighted T_wV rate (T_wV rate * weight)	2.03E-06	0.00E+00	9.18E-06						
Total weighted occupancy rate	0.000011				birds seconds per ha/hour				
Mean % activity hr^-1 in wind farm at risk height	0.409%								

Mean % activity hr^-1 in wind farm at rotor height (z)	0.317%	
Step 1.4: Total occupancy of risk volume during surveys (T_w)		
Hours potentially active: breeding season (a) (footnote 2)	4,483	hours
Tw=z*a	14.21	hours
Step 1.6: Flight risk volume (V_w)		
Risk volume: $V_w=A*h$ (footnote 3)	565,616,700	m^3
Step 1.7: Volume swept by windfarm rotors (V_r)		
Bird length (L)	0.34	m
Rotor-swept volume: $V_r=N*\pi*r^2*(d+L)$ footnote 4	547,961.30	m^3
Step 1.8: Bird occupancy of rotor-swept volume (Tr)		
$T_r=T_w*(V_r/Vw)$	49.5533	seconds
Step 1.9: Time taken to transit rotor *(t)*		
Flight speed *(s)*	12.7	m/sec
$t=(d+L)/s$	0.38	seconds
Step 1.10: Number of rotor transits (N)		
$N=T_r/t$	130	rotor transits
STAGE 2: Probability of Collision for a bird flying through rotors (*p*(collision)) from SNH spreadsheet[5]	0.050	

STAGE 3: Predicted mortality (birds per year)				
Step 3.1: With no avoidance, turbines operational 85% of the time N*p(collision)*0.85	5.510	collisions		
Step 3.2: Adjusted using a range of avoidance rates:				
95.00%	**0.2755**	**approx one collision every**	**3.63**	**years**

[1] The survey risk volume was derived from the windfarm polygon including a precautionary 500m buffer around the turbine rotors.

[2] The total number of daylight hours during the period

[3] A= size of windfarm polygon(ha) h= rotor diameter (m)

[4] N= number of turbines, r= rotor radius (m), d= max depth of rotors (m)

[5]Assumes bird length=0.34m, wingspan 0.8m, flight speed= 12.7m/sec

Peregrine Falcon North Cluster Breeding Season SG 155

	Viewsheds								
	1	2	3						
STAGE 1: Estimation of rotor transits									
Step 1.1: Seconds occupancy of the survey risk volume (T_w)[1] recorded within each viewshed (T_wV)	105	570	105						
Step 1.2: Unweighted occupancy rate each viewshed ($T_wV$rate)									
Hours of survey effort (*e*)	72	72	72						
Windfarm area (ha) visible within viewshed (*v*)[1]	70.04	249.72	187.0676						
Observation effort (*e***v*)	5042.56	17979.93	13468.87						
T_wV rate=$T_wV/e*v$	5.78E-06	8.81E-06	2.17E-06						
Step 1.3: Weighted occupancy rate *(weighted T_wV rate)*[1]									
Weight: proportion of total survey effort made at the VP	0.138	0.493	0.369	0.000	0.000	0.000	0.000		
Weighted T_wV rate (T_wV rate * weight)	7.99E-07	4.34E-06	7.99E-07						
Total weighted occupancy rate	0.000006				birds seconds per ha/hour				
Mean % activity hr^-1 in wind farm at risk height	0.302%								
Mean % activity hr^-1 in wind farm at rotor height (z)	0.234%								

Step 1.4: Total occupancy of risk volume during surveys (T_w)		
Hours potentially active: breeding season (a) (footnote 2)	2,377	hours
Tw=z*a	5.56	hours
Step 1.6: Flight risk volume (V_w)		
Risk volume: $V_w=A*h$ (footnote 3)	788,638,295	m^3
Step 1.7: Volume swept by windfarm rotors (V_r)		
Bird length (L)	0.45	m
Rotor-swept volume: $V_r=N*\pi*r^2*(d+L)$ footnote 4	653,817.46	m^3
Step 1.8: Bird occupancy of rotor-swept volume (Tr)		
$T_r=T_w*(V_r/Vw)$	16.6071	seconds
Step 1.9: Time taken to transit rotor *(t)*		
Flight speed *(s)*	14	m/sec
$t=(d+L)/s$	0.35	seconds
Step 1.10: Number of rotor transits (N)		
$N=T_r/t$	47	rotor transits
STAGE 2: Probability of Collision for a bird flying through rotors (*p*(collision)) from SNH spreadsheet[5]	0.053	
STAGE 3: Predicted mortality (birds per year)		
Step 3.1: With no avoidance, turbines operational 85% of the time N*p(collision)*0.85	2.116	collisions

Step 3.2: Adjusted using a range of avoidance rates:				
98.00%	**0.0423**	**approx one collision every**	**23.63**	**years**

[1] The survey risk volume was derived from the windfarm polygon including a precautionary 500m buffer around the turbine rotors.

[2] The total number of daylight hours during the period

[3] A= size of windfarm polygon(ha) h= rotor diameter (m)

[4] N= number of turbines, r= rotor radius (m), d= max depth of rotors (m)

[5]Assumes bird length=0.45m, wingspan 1.1m, flight speed= 14.0m/sec

Peregrine Falcon North Cluster Non-Breeding Season 2021/22 SG 155

	Viewsheds								
	1	**2**	**3**						
STAGE 1: Estimation of rotor transits									
Step 1.1: Seconds occupancy of the survey risk volume (T_w)[1] recorded within each viewshed (T_wV)	105	0	0						
Step 1.2: Unweighted occupancy rate each viewshed ($T_wV$rate)									
Hours of survey effort (*e*)	36	35	36						
Windfarm area (ha) visible within viewshed (*v*)[1]	70.04	249.72	187.0676						
Observation effort (*e*v*)	2521.28	8740.24	6734.43						
T_wV rate=$T_wV/e*v$	1.16E-05	0.00E+00	0.00E+00						
Step 1.3: Weighted occupancy rate *(weighted T_wV rate)*[1]									
Weight: proportion of total survey effort made at the VP	0.140	0.486	0.374						
Weighted T_wV rate (T_wV rate * weight)	1.62E-06	0.00E+00	0.00E+00						
Total weighted occupancy rate	0.000002					birds seconds per ha/hour			
Mean % activity hr^-1 in wind farm at risk height	0.082%								

Mean % activity hr^-1 in wind farm at rotor height (z)	0.064%	
Step 1.4: Total occupancy of risk volume during surveys (T_w)		
Hours potentially active: breeding season (a) (footnote 2)	2,107	hours
Tw=z*a	1.35	hours
Step 1.6: Flight risk volume (V_w)		
Risk volume: $V_w=A*h$ (footnote 3)	788,638,295	m^3
Step 1.7: Volume swept by windfarm rotors (V_r)		
Bird length (L)	0.45	m
Rotor-swept volume: $V_r=N*\pi*r^2*(d+L)$ footnote 4	653,817.46	m^3
Step 1.8: Bird occupancy of rotor-swept volume (Tr)		
$T_r=T_w*(V_r/Vw)$	4.02	seconds
Step 1.9: Time taken to transit rotor *(t)*		
Flight speed *(s)*	14	m/sec
$t=(d+L)/s$	0.35	seconds
Step 1.10: Number of rotor transits (N)		
$N=T_r/t$	11	rotor transits
STAGE 2: Probability of Collision for a bird flying through rotors (*p*(collision)) from SNH spreadsheet[5]	0.053	

STAGE 3: Predicted mortality (birds per year)					
Step 3.1: With no avoidance, turbines operational 85% of the time N*p(collision)*0.85	0.512	collisions			
Step 3.2: Adjusted using a range of avoidance rates:					
98.00%	**0.0102**	**approx one collision every**	**97.65**	**years**	

[1] The survey risk volume was derived from the windfarm polygon including a precautionary 500m buffer around the turbine rotors.

[2] The total number of daylight hours during the period

[3] A= size of windfarm polygon(ha) h= rotor diameter (m)

[4] N= number of turbines, r= rotor radius (m), d= max depth of rotors (m)

[5]Assumes bird length=0.45m, wingspan 1.1m, flight speed= 14.0m/sec

Peregrine Falcon North Cluster Annual SG 155

	Viewsheds								
	1	**2**	**3**						
STAGE 1: Estimation of rotor transits									
Step 1.1: Seconds occupancy of the survey risk volume (T_w)[1] recorded within each viewshed (T_wV)	210	570	105						
Step 1.2: Unweighted occupancy rate each viewshed ($T_wV$rate)									
Hours of survey effort (*e*)	159	150	148						
Windfarm area (ha) visible within viewshed (*v*)[1]	70.04	249.72	187.07						
Observation effort (*e***v*)	11135.65	37458.19	27686.01						
T_wV rate=$T_wV/e*v$	5.24E-06	4.23E-06	1.05E-06						
Step 1.3: Weighted occupancy rate *(weighted T_wV rate)*[1]									
Weight: proportion of total survey effort made at the VP	0.146	0.491	0.363						
Weighted T_wV rate (T_wV rate * weight)	7.65E-07	2.08E-06	3.82E-07						
Total weighted occupancy rate			0.000003				birds seconds per ha/hour		
Mean % activity hr^-1 in wind farm at risk height			0.164%						

Mean % activity hr^-1 in wind farm at rotor height (z)	0.127%	
Step 1.4: Total occupancy of risk volume during surveys (T_w)		
Hours potentially active: breeding season (a) (footnote 2)	4,483	hours
Tw=z*a	5.70	hours
Step 1.6: Flight risk volume (V_w)		
Risk volume: $V_w=A*h$ (footnote 3)	788,638,295	m^3
Step 1.7: Volume swept by windfarm rotors (V_r)		
Bird length (L)	0.45	m
Rotor-swept volume: $V_r=N*\pi*r^2*(d+L)$ footnote 4	653,817.46	m^3
Step 1.8: Bird occupancy of rotor-swept volume (Tr)		
$T_r=T_w*(V_r/Vw)$	17.0043	seconds
Step 1.9: Time taken to transit rotor *(t)*		
Flight speed *(s)*	14	m/sec
$t=(d+L)/s$	0.35	seconds
Step 1.10: Number of rotor transits (N)		
$N=T_r/t$	48	rotor transits
STAGE 2: Probability of Collision for a bird flying through rotors (*p*(collision)) from SNH spreadsheet[5]	0.053	
STAGE 3: Predicted mortality (birds per year)		

Step 3.1: With no avoidance, turbines operational 85% of the time N*p(collision)*0.85	2.167	collisions		
Step 3.2: Adjusted using a range of avoidance rates:				
98.00%	**0.0433**	**approx one collision every**	**23.08**	**years**

[1] The survey risk volume was derived from the windfarm polygon including a precautionary 500m buffer around the turbine rotors.

[2] The total number of daylight hours during the period

[3] A= size of windfarm polygon(ha) h= rotor diameter (m)

[4] N= number of turbines, r= rotor radius (m), d= max depth of rotors (m)

[5]Assumes bird length=0.45m, wingspan 1.1m, flight speed= 14.0m/sec

Peregrine Falcon South Cluster Breeding Season SG 155

	Viewsheds								
	4	**5**	**7**						
STAGE 1: Estimation of rotor transits									
Step 1.1: Seconds occupancy of the survey risk volume (T_w)[1] recorded within each viewshed (T_wV)	0	0	165						
Step 1.2: Unweighted occupancy rate each viewshed ($T_wV$rate)									
Hours of survey effort (*e*)	72	30	66						
Windfarm area (ha) visible within viewshed (*v*)[1]	214.19	16.15	255.1864						
Observation effort (*e*v*)	15421.50	484.42	16842.31						
T_wV rate=$T_wV/e*v$	0.00E+00	0.00E+00	2.72E-06						
Step 1.3: Weighted occupancy rate *(weighted T_wV rate)*[1]									
Weight: proportion of total survey effort made at the VP	0.471	0.015	0.514	0.000	0.000	0.000	0.000		
Weighted T_wV rate (T_wV rate * weight)	0.00E+00	0.00E+00	1.40E-06						
Total weighted occupancy rate	0.000001					birds seconds per ha/hour			
Mean % activity hr^-1 in wind farm at risk height	0.051%								
Mean % activity hr^-1 in wind farm at rotor height (z)	0.040%								

Step 1.4: Total occupancy of risk volume during surveys (T_w)		
Hours potentially active: breeding season (a) (footnote 2)	2,377	hours
Tw=z*a	0.94	hours
Step 1.6: Flight risk volume (V_w)		
Risk volume: $V_w=A*h$ (footnote 3)	565,616,700	m^3
Step 1.7: Volume swept by windfarm rotors (V_r)		
Bird length (L)	0.45	m
Rotor-swept volume: $V_r=N*\pi*r^2*(d+L)$ footnote 4	560,414.97	m^3
Step 1.8: Bird occupancy of rotor-swept volume (Tr)		
$T_r=T_w*(V_r/Vw)$	3.3554	seconds
Step 1.9: Time taken to transit rotor *(t)*		
Flight speed *(s)*	14	m/sec
$t=(d+L)/s$	0.35	seconds
Step 1.10: Number of rotor transits (N)		
$N=T_r/t$	9	rotor transits
STAGE 2: Probability of Collision for a bird flying through rotors (*p*(collision)) from SNH spreadsheet[5]	0.053	
STAGE 3: Predicted mortality (birds per year)		
Step 3.1: With no avoidance, turbines operational 97% of the time N*p(collision)*0.97	0.428	collisions

Step 3.2: Adjusted using a range of avoidance rates:				
98.00%	**0.0086**	**approx one collision every**	**116.95**	**years**

[1] The survey risk volume was derived from the windfarm polygon including a precautionary 500m buffer around the turbine rotors.

[2] The total number of daylight hours during the period

[3] A= size of windfarm polygon(ha) h= rotor diameter (m)

[4] N= number of turbines, r= rotor radius (m), d= max depth of rotors (m)

[5]Assumes bird length=0.45m, wingspan 1.1m, flight speed= 14.0m/sec

Peregrine Falcon South Cluster Non-Breeding Season 2017/18 SG 155

	Viewsheds								
	4	5	7						
STAGE 1: Estimation of rotor transits									
Step 1.1: Seconds occupancy of the survey risk volume (T_w)[1] recorded within each viewshed (T_wV)	0	0	106						
Step 1.2: Unweighted occupancy rate each viewshed ($T_wV$rate)									
Hours of survey effort (*e*)	33	30	36						
Windfarm area (ha) visible within viewshed (*v*)[1]	214.19	16.15	255.18644						
Observation effort (*e*v*)	6961.09	484.42	9186.71						
T_wV rate=$T_wV/e*v$	0.00E+00	0.00E+00	3.21E-06						
Step 1.3: Weighted occupancy rate *(weighted T_wV rate)*[1]									
Weight: proportion of total survey effort made at the VP	0.419	0.029	0.552						
Weighted T_wV rate (T_wV rate * weight)	0.00E+00	0.00E+00	1.77E-06						
Total weighted occupancy rate	0.000002				birds seconds per ha/hour				
Mean % activity hr^-1 in wind farm at risk height	0.065%								

Mean % activity hr^-1 in wind farm at rotor height (z)	0.059%	
Step 1.4: Total occupancy of risk volume during surveys (T_w)		
Hours potentially active: breeding season (a) (footnote 2)	2,107	hours
Tw=z*a	1.24	hours
Step 1.6: Flight risk volume (V_w)		
Risk volume: $V_w=A*h$ (footnote 3)	565,616,700	m^3
Step 1.7: Volume swept by windfarm rotors (V_r)		
Bird length (L)	0.45	m
Rotor-swept volume: $V_r=N*\pi*r^2*(d+L)$ footnote 4	560,414.97	m^3
Step 1.8: Bird occupancy of rotor-swept volume (Tr)		
$T_r=T_w*(V_r/Vw)$	4.43	seconds
Step 1.9: Time taken to transit rotor *(t)*		
Flight speed *(s)*	14	m/sec
$t=(d+L)/s$	0.35	seconds
Step 1.10: Number of rotor transits (N)		
$N=T_r/t$	13	rotor transits
STAGE 2: Probability of Collision for a bird flying through rotors (*p*(collision)) from SNH spreadsheet[5]	0.053	

STAGE 3: Predicted mortality (birds per year)				
Step 3.1: With no avoidance, turbines operational 97% of the time N*p(collision)*0.97	0.564	collisions		
Step 3.2: Adjusted using a range of avoidance rates:				
98.00%	**0.0113**	**approx one collision every**	**88.66**	**years**

[1] The survey risk volume was derived from the windfarm polygon including a precautionary 500m buffer around the turbine rotors.

[2] The total number of daylight hours during the period

[3] A= size of windfarm polygon(ha) h= rotor diameter (m)

[4] N= number of turbines, r= rotor radius (m), d= max depth of rotors (m)

[5]Assumes bird length=0.45m, wingspan 1.1m, flight speed= 14.0m/sec

Peregrine Falcon South Cluster Non-Breeding Season 2021/22 SG 155

	Viewsheds								
	4	5	7						
STAGE 1: Estimation of rotor transits									
Step 1.1: Seconds occupancy of the survey risk volume (T_w)[1] recorded within each viewshed (T_wV)	30	0	90						
Step 1.2: Unweighted occupancy rate each viewshed ($T_wV$rate)									
Hours of survey effort (*e*)	36	42	39						
Windfarm area (ha) visible within viewshed (*v*)[1]	214.19	16.15	255.18644						
Observation effort (*e**v*)	7710.75	678.19	9952.27						
T_wV rate=$T_wV/e*v$	1.08E-06	0.00E+00	2.51E-06						
Step 1.3: Weighted occupancy rate *(weighted T_wV rate)*[1]									
Weight: proportion of total survey effort made at the VP	0.420	0.037	0.543						
Weighted T_wV rate (T_wV rate * weight)	4.54E-07	0.00E+00	1.36E-06						
Total weighted occupancy rate	0.000002					birds seconds per ha/hour			
Mean % activity hr^-1 in wind farm at risk height	0.066%								

Mean % activity hr^-1 in wind farm at rotor height (z)	0.051%	
Step 1.4: Total occupancy of risk volume during surveys (T_w)		
Hours potentially active: breeding season (a) (footnote 2)	2,107	hours
Tw=z*a	1.08	hours
Step 1.6: Flight risk volume (V_w)		
Risk volume: $V_w=A*h$ (footnote 3)	565,616,700	m^3
Step 1.7: Volume swept by windfarm rotors (V_r)		
Bird length (L)	0.45	m
Rotor-swept volume: $V_r=N*\pi*r^2*(d+L)$ footnote 4	560,414.97	m^3
Step 1.8: Bird occupancy of rotor-swept volume (Tr)		
$T_r=T_w*(V_r/Vw)$	3.86	seconds
Step 1.9: Time taken to transit rotor *(t)*		
Flight speed *(s)*	14	m/sec
$t=(d+L)/s$	0.35	seconds
Step 1.10: Number of rotor transits (N)		
$N=T_r/t$	11	rotor transits
STAGE 2: Probability of Collision for a bird flying through rotors (*p*(collision)) from SNH spreadsheet[5]	0.053	

STAGE 3: Predicted mortality (birds per year)				
Step 3.1: With no avoidance, turbines operational 97% of the time N*p(collision)*0.97	0.492	collisions		
Step 3.2: Adjusted using a range of avoidance rates:				
98.00%	**0.0098**	**approx one collision every**	**101.60**	**years**

[1] The survey risk volume was derived from the windfarm polygon including a precautionary 500m buffer around the turbine rotors.

[2] The total number of daylight hours during the period

[3] A= size of windfarm polygon(ha) h= rotor diameter (m)

[4] N= number of turbines, r= rotor radius (m), d= max depth of rotors (m)

[5]Assumes bird length=0.45m, wingspan 1.1m, flight speed= 14.0m/sec

Peregrine Falcon South Cluster Annual SG 155

	Viewsheds								
	4	5	7						
STAGE 1: Estimation of rotor transits									
Step 1.1: Seconds occupancy of the survey risk volume (T_w)[1] recorded within each viewshed (T_wV)	30	0	361						
Step 1.2: Unweighted occupancy rate each viewshed ($T_wV$rate)									
Hours of survey effort (*e*)	141	102	141						
Windfarm area (ha) visible within viewshed (*v*)[1]	214.19	16.15	255.19						
Observation effort (*e*v*)	30093.34	1647.03	35981.29						
T_wV rate=$T_wV/e*v$	2.77E-07	0.00E+00	2.79E-06						
Step 1.3: Weighted occupancy rate *(weighted T_wV rate)*[1]									
Weight: proportion of total survey effort made at the VP	0.444	0.024	0.531						
Weighted T_wV rate (T_wV rate * weight)	1.23E-07	0.00E+00	1.48E-06						
Total weighted occupancy rate	0.000002					birds seconds per ha/hour			
Mean % activity hr^-1 in wind farm at risk height	0.059%								

Mean % activity hr^-1 in wind farm at rotor height (z)	0.045%	
Step 1.4: Total occupancy of risk volume during surveys (T_w)		
Hours potentially active: breeding season (a) (footnote 2)	4,483	hours
Tw=z*a	2.03	hours
Step 1.6: Flight risk volume (V_w)		
Risk volume: $V_w=A*h$ (footnote 3)	565,616,700	m^3
Step 1.7: Volume swept by windfarm rotors (V_r)		
Bird length (L)	0.45	m
Rotor-swept volume: $V_r=N*\pi*r^2*(d+L)$ footnote 4	560,414.97	m^3
Step 1.8: Bird occupancy of rotor-swept volume (Tr)		
$T_r=T_w*(V_r/Vw)$	7.2532	seconds
Step 1.9: Time taken to transit rotor *(t)*		
Flight speed *(s)*	14	m/sec
$t=(d+L)/s$	0.35	seconds
Step 1.10: Number of rotor transits (N)		
$N=T_r/t$	21	rotor transits
STAGE 2: Probability of Collision for a bird flying through rotors (*p*(collision)) from SNH spreadsheet[5]	0.053	

STAGE 3: Predicted mortality (birds per year)				
Step 3.1: With no avoidance, turbines operational 97% of the time N*p(collision)*0.97	0.924	collisions		
Step 3.2: Adjusted using a range of avoidance rates:				
98.00%	**0.0185**	**approx one collision every**	**54.10**	**years**

[1] The survey risk volume was derived from the windfarm polygon including a precautionary 500m buffer around the turbine rotors.

[2] The total number of daylight hours during the period

[3] A= size of windfarm polygon(ha) h= rotor diameter (m)

[4] N= number of turbines, r= rotor radius (m), d= max depth of rotors (m)

[5]Assumes bird length=0.45m, wingspan 1.1m, flight speed= 14.0m/sec

European Golden Plover North Cluster Non-Breeding Season 2017/18 SG 155

	Viewsheds								
	1	**2**	**3**						
STAGE 1: Estimation of rotor transits									
Step 1.1: Seconds occupancy of the survey risk volume (T_w)[1] recorded within each viewshed (T_wV)	0	0	84						
Step 1.2: Unweighted occupancy rate each viewshed ($T_wV$rate)									
Hours of survey effort (*e*)	51	43	40						
Windfarm area (ha) visible within viewshed (*v*)[1]	70.04	249.72	187.0676						
Observation effort (*e***v*)	3571.81	10738.01	7482.70						
T_wV rate=$T_wV/e*v$	0.00E+00	0.00E+00	3.12E-06						
Step 1.3: Weighted occupancy rate *(weighted T_wV rate)*[1]									
Weight: proportion of total survey effort made at the VP	0.164	0.493	0.343						
Weighted T_wV rate (T_wV rate * weight)	0.00E+00	0.00E+00	1.07E-06						
Total weighted occupancy rate	0.000001				birds seconds per ha/hour				
Mean % activity hr^-1 in wind farm at risk height	0.054%								

Mean % activity hr^-1 in wind farm at rotor height (z)	0.050%	
Step 1.4: Total occupancy of risk volume during surveys (T_w)		
Hours potentially active: breeding season (a) (footnote 2)	2,860	hours
Tw=z*a	1.42	hours
Step 1.6: Flight risk volume (V_w)		
Risk volume: $V_w=A*h$ (footnote 3)	788,638,295	m^3
Step 1.7: Volume swept by windfarm rotors (V_r)		
Bird length (L)	0.28	m
Rotor-swept volume: $V_r=N*\pi*r^2*(d+L)$ footnote 4	631,363.13	m^3
Step 1.8: Bird occupancy of rotor-swept volume (Tr)		
$T_r=T_w*(V_r/Vw)$	4.09	seconds
Step 1.9: Time taken to transit rotor *(t)*		
Flight speed *(s)*	18	m/sec
$t=(d+L)/s$	0.27	seconds
Step 1.10: Number of rotor transits (N)		
$N=T_r/t$	15	rotor transits
STAGE 2: Probability of Collision for a bird flying through rotors (*p*(collision)) from SNH spreadsheet[5]	0.045	

STAGE 3: Predicted mortality (birds per year)					
Step 3.1: With no avoidance, turbines operational 85% of the time N*p(collision)*0.85	0.594	collisions			
Step 3.2: Adjusted using a range of avoidance rates:					
98.00%	**0.0119**	**approx one collision every**	**84.15**	**years**	
99.8%	**0.0012**		**841.54**		

[1] The survey risk volume was derived from the windfarm polygon including a precautionary 500m buffer around the turbine rotors.

[2] The total number of daylight hours during the period

[3] A= size of windfarm polygon(ha) h= rotor diameter (m)

[4] N= number of turbines, r= rotor radius (m), d= max depth of rotors (m)

[5]Assumes bird length=0.28m, wingspan 0.7m, flight speed= 18m/sec

European Golden Plover North Cluster Annual SG 155

	Viewsheds									
	1	2	3							
STAGE 1: Estimation of rotor transits										
Step 1.1: Seconds occupancy of the survey risk volume (T_w)[1] recorded within each viewshed (T_wV)	0	0	84							
Step 1.2: Unweighted occupancy rate each viewshed ($T_wV$rate)										
Hours of survey effort (*e*)	159	150	148							
Windfarm area (ha) visible within viewshed (*v*)[1]	70.04	249.72	187.07							
Observation effort (*e***v*)	11135.65	37458.19	27686.01							
T_wV rate=$T_wV/e*v$	0.00E+00	0.00E+00	8.43E-07							
Step 1.3: Weighted occupancy rate *(weighted T_wV rate)*[1]										
Weight: proportion of total survey effort made at the VP	0.146	0.491	0.363							
Weighted T_wV rate (T_wV rate * weight)	0.00E+00	0.00E+00	3.06E-07							
Total weighted occupancy rate	0.000000					birds seconds per ha/hour				
Mean % activity hr^-1 in wind farm at risk height	0.016%									

Mean % activity hr^-1 in wind farm at rotor height (z)	0.012%	
Step 1.4: Total occupancy of risk volume during surveys (T_w)		
Hours potentially active: breeding season (a) (footnote 2)	5,560	hours
Tw=z*a	0.67	hours
Step 1.6: Flight risk volume (V_w)		
Risk volume: $V_w=A*h$ (footnote 3)	788,638,295	m^3
Step 1.7: Volume swept by windfarm rotors (V_r)		
Bird length (L)	0.28	m
Rotor-swept volume: $V_r=N*\pi*r^2*(d+L)$ footnote 4	631,363.13	m^3
Step 1.8: Bird occupancy of rotor-swept volume (Tr)		
$T_r=T_w*(V_r/Vw)$	1.9328	seconds
Step 1.9: Time taken to transit rotor *(t)*		
Flight speed *(s)*	18	m/sec
$t=(d+L)/s$	0.27	seconds
Step 1.10: Number of rotor transits (N)		
$N=T_r/t$	7	rotor transits
STAGE 2: Probability of Collision for a bird flying through rotors (*p*(collision)) from SNH spreadsheet[5]	0.045	

STAGE 3: Predicted mortality (birds per year)				
Step 3.1: With no avoidance, turbines operational 85% of the time N*p(collision)*0.85	0.281	collisions		
Step 3.2: Adjusted using a range of avoidance rates:				
98.00%	**0.0056**	**approx one collision every**	**178.23**	**years**
99.8%	**0.0006**		**1,782.29**	

[1] The survey risk volume was derived from the windfarm polygon including a precautionary 500m buffer around the turbine rotors.

[2] The total number of daylight hours during the period

[3] A= size of windfarm polygon(ha) h= rotor diameter (m)

[4] N= number of turbines, r= rotor radius (m), d= max depth of rotors (m)

[5]Assumes bird length=0.28m, wingspan 0.7m, flight speed= 18m/sec

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	Viewsheds								
	4	5	7						
STAGE 1: Estimation of rotor transits									
Step 1.1: Seconds occupancy of the survey risk volume (T_w)[1] recorded within each viewshed (T_wV)	0	0	141						
Step 1.2: Unweighted occupancy rate each viewshed ($T_wV$rate)									
Hours of survey effort (*e*)	33	30	36						
Windfarm area (ha) visible within viewshed (*v*)[1]	214.19	16.15	255.18644						
Observation effort (*e*v*)	6961.09	484.42	9186.71						
T_wV rate=$T_wV/e*v$	0.00E+00	0.00E+00	4.26E-06						
Step 1.3: Weighted occupancy rate *(weighted T_wV rate)*[1]									
Weight: proportion of total survey effort made at the VP	0.419	0.029	0.552						
Weighted T_wV rate (T_wV rate * weight)	0.00E+00	0.00E+00	2.35E-06						
Total weighted occupancy rate	0.000002				birds seconds per ha/hour				
Mean % activity hr^-1 in wind farm at risk height	0.086%								

Mean % activity hr^-1 in wind farm at rotor height (z)	0.078%	
Step 1.4: Total occupancy of risk volume during surveys (T_w)		
Hours potentially active: breeding season (a) (footnote 2)	2,860	hours
Tw=z*a	2.24	hours
Step 1.6: Flight risk volume (V_w)		
Risk volume: $V_w=A*h$ (footnote 3)	565,616,700	m^3
Step 1.7: Volume swept by windfarm rotors (V_r)		
Bird length (L)	0.28	m
Rotor-swept volume: $V_r=N*\pi*r^2*(d+L)$ footnote 4	541,168.39	m^3
Step 1.8: Bird occupancy of rotor-swept volume (Tr)		
$T_r=T_w*(V_r/Vw)$	7.72	seconds
Step 1.9: Time taken to transit rotor *(t)*		
Flight speed *(s)*	18	m/sec
$t=(d+L)/s$	0.27	seconds
Step 1.10: Number of rotor transits (N)		
$N=T_r/t$	29	rotor transits
STAGE 2: Probability of Collision for a bird flying through rotors (*p*(collision)) from SNH spreadsheet[5]	0.045	

STAGE 3: Predicted mortality (birds per year)					
Step 3.1: With no avoidance, turbines operational 85% of the time N*p(collision)*0.85	1.120	collisions			
Step 3.2: Adjusted using a range of avoidance rates:					
98.00%	**0.0224**	**approx one collision every**	**44.64**	**years**	
99.8%	**0.0022**		**446.4**		

[1] The survey risk volume was derived from the windfarm polygon including a precautionary 500m buffer around the turbine rotors.

[2] The total number of daylight hours during the period

[3] A= size of windfarm polygon(ha) h= rotor diameter (m)

[4] N= number of turbines, r= rotor radius (m), d= max depth of rotors (m)

[5]Assumes bird length=0.28m, wingspan 0.72m, flight speed= 17.5m/sec

European Golden Plover South Cluster Non-Breeding Season 2021/22 SG 155

	Viewsheds								
	4	**5**	**7**						
STAGE 1: Estimation of rotor transits									
Step 1.1: Seconds occupancy of the survey risk volume (T_w)[1] recorded within each viewshed (T_wV)	1035	2,400	0						
Step 1.2: Unweighted occupancy rate each viewshed ($T_wV$rate)									
Hours of survey effort (*e*)	36	42	39						
Windfarm area (ha) visible within viewshed (*v*)[1]	214.19	16.15	255.18644						
Observation effort (*e**v*)	7710.75	678.19	9952.27						
T_wV rate=$T_wV/e*v$	3.73E-05	9.83E-04	0.00E+00						
Step 1.3: Weighted occupancy rate *(weighted T_wV rate)*[1]									
Weight: proportion of total survey effort made at the VP	0.420	0.037	0.543						
Weighted T_wV rate (T_wV rate * weight)	1.57E-05	3.63E-05	0.00E+00						
Total weighted occupancy rate	0.000052				birds seconds per ha/hour				
Mean % activity hr^-1 in wind farm at risk height	1.898%								

Mean % activity hr^-1 in wind farm at rotor height (z)	1.471%	
Step 1.4: Total occupancy of risk volume during surveys (T_w)		
Hours potentially active: breeding season (a) (footnote 2)	2,860	hours
Tw=z*a	42.07	hours
Step 1.6: Flight risk volume (V_w)		
Risk volume: $V_w=A*h$ (footnote 3)	565,616,700	m^3
Step 1.7: Volume swept by windfarm rotors (V_r)		
Bird length (L)	0.28	m
Rotor-swept volume: $V_r=N*\pi*r^2*(d+L)$ footnote 4	541,168.39	m^3
Step 1.8: Bird occupancy of rotor-swept volume (Tr)		
$T_r=T_w*(V_r/Vw)$	144.91	seconds
Step 1.9: Time taken to transit rotor *(t)*		
Flight speed *(s)*	18	m/sec
$t=(d+L)/s$	0.27	seconds
Step 1.10: Number of rotor transits (N)		
$N=T_r/t$	546	rotor transits
STAGE 2: Probability of Collision for a bird flying through rotors (*p*(collision)) from SNH spreadsheet[5]	0.045	
STAGE 3: Predicted mortality (birds per year)		

Step 3.1: With no avoidance, turbines operational 85% of the time N*p(collision)*0.85	21.033	collisions		
Step 3.2: Adjusted using a range of avoidance rates:				
98.00%	**0.4207**	**approx one collision every**	**2.38**	**years**
99.8%	**0.0421**		**23.77**	

[1] The survey risk volume was derived from the windfarm polygon including a precautionary 500m buffer around the turbine rotors.

[2] The total number of daylight hours during the period

[3] A= size of windfarm polygon(ha) h= rotor diameter (m)

[4] N= number of turbines, r= rotor radius (m), d= max depth of rotors (m)

[5]Assumes bird length=0.28m, wingspan 0.72m, flight speed= 17.5m/sec

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	Viewsheds								
	4	**5**	**7**						
STAGE 1: Estimation of rotor transits									
Step 1.1: Seconds occupancy of the survey risk volume (T_w)[1] recorded within each viewshed (T_wV)	1035	2,400	141						
Step 1.2: Unweighted occupancy rate each viewshed ($T_wV$rate)									
Hours of survey effort (*e*)	141	102	141						
Windfarm area (ha) visible within viewshed (*v*)[1]	214.19	16.15	255.19						
Observation effort (*e*v*)	30093.34	1647.03	35981.29						
T_wV rate=$T_wV/e*v$	9.55E-06	4.05E-04	1.09E-06						
Step 1.3: Weighted occupancy rate *(weighted T_wV rate)*[1]									
Weight: proportion of total survey effort made at the VP	0.444	0.024	0.531						
Weighted T_wV rate (T_wV rate * weight)	4.25E-06	9.84E-06	5.78E-07						
Total weighted occupancy rate	0.000015				birds seconds per ha/hour				
Mean % activity hr^-1 in wind farm at risk height	0.535%								

Mean % activity hr^-1 in wind farm at rotor height (z)	0.415%	
Step 1.4: Total occupancy of risk volume during surveys (T_w)		
Hours potentially active: breeding season (a) (footnote 2)	5,560	hours
Tw=z*a	23.06	hours
Step 1.6: Flight risk volume (V_w)		
Risk volume: $V_w=A*h$ (footnote 3)	565,616,700	m^3
Step 1.7: Volume swept by windfarm rotors (V_r)		
Bird length (L)	0.28	m
Rotor-swept volume: $V_r=N*\pi*r^2*(d+L)$ footnote 4	541,168.39	m^3
Step 1.8: Bird occupancy of rotor-swept volume (Tr)		
$T_r=T_w*(V_r/Vw)$	79.4413	seconds
Step 1.9: Time taken to transit rotor *(t)*		
Flight speed *(s)*	18	m/sec
$t=(d+L)/s$	0.27	seconds
Step 1.10: Number of rotor transits (N)		
$N=T_r/t$	299	rotor transits
STAGE 2: Probability of Collision for a bird flying through rotors (*p*(collision)) from SNH spreadsheet[5]	0.045	
STAGE 3: Predicted mortality (birds per year)		

Step 3.1: With no avoidance, turbines operational 85% of the time N*p(collision)*0.85	11.530	collisions		
Step 3.2: Adjusted using a range of avoidance rates:				
98.00%	**0.2306**	**approx one collision every**	**4.34**	**years**
99.8%	**0.0231**		**43.36**	

[1] The survey risk volume was derived from the windfarm polygon including a precautionary 500m buffer around the turbine rotors.

[2] The total number of daylight hours during the period

[3] A= size of windfarm polygon(ha) h= rotor diameter (m)

[4] N= number of turbines, r= rotor radius (m), d= max depth of rotors (m)

[5]Assumes bird length=0.28m, wingspan 0.72m, flight speed= 17.5m/sec

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	Viewsheds								
	1	2	3						
STAGE 1: Estimation of rotor transits									
Step 1.1: Seconds occupancy of the survey risk volume (T_w)[1] recorded within each viewshed (T_wV)	0	0	93						
Step 1.2: Unweighted occupancy rate each viewshed ($T_wV$rate)									
Hours of survey effort (*e*)	51	43	40						
Windfarm area (ha) visible within viewshed (*v*)[1]	70.04	249.72	187.0676						
Observation effort (*e*v*)	3571.81	10738.01	7482.70						
T_wV rate=$T_wV/e*v$	0.00E+00	0.00E+00	3.45E-06						
Step 1.3: Weighted occupancy rate *(weighted T_wV rate)*[1]									
Weight: proportion of total survey effort made at the VP	0.164	0.493	0.343						
Weighted T_wV rate (T_wV rate * weight)	0.00E+00	0.00E+00	1.19E-06						
Total weighted occupancy rate	0.000001				birds seconds per ha/hour				
Mean % activity hr^-1 in wind farm at risk height	0.060%								

Mean % activity hr^-1 in wind farm at rotor height (z)	0.055%	
Step 1.4: Total occupancy of risk volume during surveys (T_w)		
Hours potentially active: breeding season (a) (footnote 2)	2,860	hours
Tw=z*a	1.57	hours
Step 1.6: Flight risk volume (V_w)		
Risk volume: $V_w=A*h$ (footnote 3)	788,638,295	m^3
Step 1.7: Volume swept by windfarm rotors (V_r)		
Bird length (L)	0.3	m
Rotor-swept volume: $V_r=N*\pi*r^2*(d+L)$ footnote 4	634,004.81	m^3
Step 1.8: Bird occupancy of rotor-swept volume (Tr)		
$T_r=T_w*(V_r/Vw)$	4.55	seconds
Step 1.9: Time taken to transit rotor *(t)*		
Flight speed *(s)*	12.3	m/sec
$t=(d+L)/s$	0.39	seconds
Step 1.10: Number of rotor transits (N)		
$N=T_r/t$	12	rotor transits
STAGE 2: Probability of Collision for a bird flying through rotors (*p*(collision)) from SNH spreadsheet[5]	0.050	

STAGE 3: Predicted mortality (birds per year)				
Step 3.1: With no avoidance, turbines operational 85% of the time N*p(collision)*0.85	0.496	collisions		
Step 3.2: Adjusted using a range of avoidance rates:				
98.00%	**0.0099**	**approx one collision every**	**100.82**	**years**

[1] The survey risk volume was derived from the windfarm polygon including a precautionary 500m buffer around the turbine rotors.

[2] The total number of daylight hours during the period

[3] A= size of windfarm polygon(ha) h= rotor diameter (m)

[4] N= number of turbines, r= rotor radius (m), d= max depth of rotors (m)

[5]Assumes bird length=0.34m, wingspan 0.8m, flight speed= 12.7m/sec

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	Viewsheds								
	1	**2**	**3**						
STAGE 1: Estimation of rotor transits									
Step 1.1: Seconds occupancy of the survey risk volume (T_w)[1] recorded within each viewshed (T_wV)	0	0	93						
Step 1.2: Unweighted occupancy rate each viewshed ($T_wV$rate)									
Hours of survey effort (*e*)	159	150	148						
Windfarm area (ha) visible within viewshed (*v*)[1]	70.04	249.72	187.07						
Observation effort (*e*v*)	11135.65	37458.19	27686.01						
T_wV rate=$T_wV/e*v$	0.00E+00	0.00E+00	9.33E-07						
Step 1.3: Weighted occupancy rate *(weighted T_wV rate)*[1]									
Weight: proportion of total survey effort made at the VP	0.146	0.491	0.363						
Weighted T_wV rate (T_wV rate * weight)	0.00E+00	0.00E+00	3.39E-07						
Total weighted occupancy rate	0.000000				birds seconds per ha/hour				
Mean % activity hr^-1 in wind farm at risk height	0.017%								

Mean % activity hr^-1 in wind farm at rotor height (z)	0.013%	
Step 1.4: Total occupancy of risk volume during surveys (T_w)		
Hours potentially active: breeding season (a) (footnote 2)	5,560	hours
Tw=z*a	0.74	hours
Step 1.6: Flight risk volume (V_w)		
Risk volume: $V_w=A*h$ (footnote 3)	788,638,295	m^3
Step 1.7: Volume swept by windfarm rotors (V_r)		
Bird length (L)	0.3	m
Rotor-swept volume: $V_r=N*\pi*r^2*(d+L)$ footnote 4	634,004.81	m^3
Step 1.8: Bird occupancy of rotor-swept volume (Tr)		
$T_r=T_w*(V_r/Vw)$	2.1489	seconds
Step 1.9: Time taken to transit rotor *(t)*		
Flight speed *(s)*	12.3	m/sec
$t=(d+L)/s$	0.39	seconds
Step 1.10: Number of rotor transits (N)		
$N=T_r/t$	6	rotor transits
STAGE 2: Probability of Collision for a bird flying through rotors (*p*(collision)) from SNH spreadsheet[5]	0.050	

STAGE 3: Predicted mortality (birds per year)				
Step 3.1: With no avoidance, turbines operational 85% of the time N*p(collision)*0.85	0.234	collisions		
Step 3.2: Adjusted using a range of avoidance rates:				
98.00%	**0.0047**	**approx one collision every**	**213.52**	**years**

[1] The survey risk volume was derived from the windfarm polygon including a precautionary 500m buffer around the turbine rotors.

[2] The total number of daylight hours during the period

[3] A= size of windfarm polygon(ha) h= rotor diameter (m)

[4] N= number of turbines, r= rotor radius (m), d= max depth of rotors (m)

[5]Assumes bird length=0.34m, wingspan 0.8m, flight speed= 12.7m/sec

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	Viewsheds								
	4	5	7						
STAGE 1: Estimation of rotor transits									
Step 1.1: Seconds occupancy of the survey risk volume (T_w)[1] recorded within each viewshed (T_wV)	0	0	2,250						
Step 1.2: Unweighted occupancy rate each viewshed ($T_wV$rate)									
Hours of survey effort (*e*)	36	42	39						
Windfarm area (ha) visible within viewshed (*v*)[1]	214.19	16.15	255.18644						
Observation effort (*e*v*)	7710.75	678.19	9952.27						
T_wV rate=$T_wV/e*v$	0.00E+00	0.00E+00	6.28E-05						
Step 1.3: Weighted occupancy rate *(weighted T_wV rate)*[1]									
Weight: proportion of total survey effort made at the VP	0.420	0.037	0.543						
Weighted T_wV rate (T_wV rate * weight)	0.00E+00	0.00E+00	3.41E-05						
Total weighted occupancy rate	0.000034				birds seconds per ha/hour				
Mean % activity hr^-1 in wind farm at risk height	1.243%								

Mean % activity hr^-1 in wind farm at rotor height (z)	0.964%	
Step 1.4: Total occupancy of risk volume during surveys (T_w)		
Hours potentially active: breeding season (a) (footnote 2)	2,860	hours
Tw=z*a	27.56	hours
Step 1.6: Flight risk volume (V_w)		
Risk volume: $V_w=A*h$ (footnote 3)	565,616,700	m^3
Step 1.7: Volume swept by windfarm rotors (V_r)		
Bird length (L)	0.3	m
Rotor-swept volume: $V_r=N*\pi*r^2*(d+L)$ footnote 4	543,432.70	m^3
Step 1.8: Bird occupancy of rotor-swept volume (Tr)		
$T_r=T_w*(V_r/Vw)$	95.32	seconds
Step 1.9: Time taken to transit rotor *(t)*		
Flight speed *(s)*	12.3	m/sec
$t=(d+L)/s$	0.39	seconds
Step 1.10: Number of rotor transits (N)		
$N=T_r/t$	244	rotor transits
STAGE 2: Probability of Collision for a bird flying through rotors (*p*(collision)) from SNH spreadsheet[5]	0.050	

STAGE 3: Predicted mortality (birds per year)					
Step 3.1: With no avoidance, turbines operational 85% of the time N*p(collision)*0.85	10.387	collisions			
Step 3.2: Adjusted using a range of avoidance rates:					
98.00%	**0.2077**	**approx one collision every**	**4.81**	**years**	

[1] The survey risk volume was derived from the windfarm polygon including a precautionary 500m buffer around the turbine rotors.

[2] The total number of daylight hours during the period

[3] A= size of windfarm polygon(ha) h= rotor diameter (m)

[4] N= number of turbines, r= rotor radius (m), d= max depth of rotors (m)

[5]Assumes bird length=0.30m, wingspan 0.84m, flight speed= 12.3m/sec

Northern Lapwing South Cluster Annual SG 155

	Viewsheds								
	4	5	7						
STAGE 1: Estimation of rotor transits									
Step 1.1: Seconds occupancy of the survey risk volume (T_w)[1] recorded within each viewshed (T_wV)	0	0	2,250						
Step 1.2: Unweighted occupancy rate each viewshed ($T_wV$rate)									
Hours of survey effort (*e*)	141	102	141						
Windfarm area (ha) visible within viewshed (*v*)[1]	214.19	16.15	255.19						
Observation effort (*e*v*)	30093.34	1647.03	35981.29						
T_wV rate=$T_wV/e*v$	0.00E+00	0.00E+00	1.74E-05						
Step 1.3: Weighted occupancy rate *(weighted T_wV rate)*[1]									
Weight: proportion of total survey effort made at the VP	0.444	0.024	0.531						
Weighted T_wV rate (T_wV rate * weight)	0.00E+00	0.00E+00	9.23E-06						
Total weighted occupancy rate	0.000009				birds seconds per ha/hour				
Mean % activity hr^-1 in wind farm at risk height	0.337%								

Mean % activity hr^-1 in wind farm at rotor height (z)	0.261%	
Step 1.4: Total occupancy of risk volume during surveys (T_w)		
Hours potentially active: breeding season (a) (footnote 2)	5,560	hours
Tw=z*a	14.51	hours
Step 1.6: Flight risk volume (V_w)		
Risk volume: $V_w=A*h$ (footnote 3)	565,616,700	m^3
Step 1.7: Volume swept by windfarm rotors (V_r)		
Bird length (L)	0.3	m
Rotor-swept volume: $V_r=N*\pi*r^2*(d+L)$ footnote 4	543,432.70	m^3
Step 1.8: Bird occupancy of rotor-swept volume (Tr)		
$T_r=T_w*(V_r/Vw)$	50.1932	seconds
Step 1.9: Time taken to transit rotor *(t)*		
Flight speed *(s)*	12.3	m/sec
$t=(d+L)/s$	0.39	seconds
Step 1.10: Number of rotor transits (N)		
$N=T_r/t$	129	rotor transits
STAGE 2: Probability of Collision for a bird flying through rotors (*p*(collision)) from SNH spreadsheet[5]	0.050	

STAGE 3: Predicted mortality (birds per year)					
Step 3.1: With no avoidance, turbines operational 85% of the time N*p(collision)*0.85	5.470	collisions			
Step 3.2: Adjusted using a range of avoidance rates:					
98.00%	**0.1094**	**approx one collision every**	**9.14**	**years**	

[1] The survey risk volume was derived from the windfarm polygon including a precautionary 500m buffer around the turbine rotors.

[2] The total number of daylight hours during the period

[3] A= size of windfarm polygon(ha) h= rotor diameter (m)

[4] N= number of turbines, r= rotor radius (m), d= max depth of rotors (m)

[5]Assumes bird length=0.30m, wingspan 0.84m, flight speed= 12.3m/sec

Common Snipe North Cluster Breeding Season SG 155

	Viewsheds								
	1	**2**	**3**						
STAGE 1: Estimation of rotor transits									
Step 1.1: Seconds occupancy of the survey risk volume (T_w)[1] recorded within each viewshed (T_wV)	5610	600	0						
Step 1.2: Unweighted occupancy rate each viewshed ($T_wV$rate)									
Hours of survey effort (*e*)	72	72	72						
Windfarm area (ha) visible within viewshed (*v*)[1]	70.04	249.72	187.0676						
Observation effort (*e*v*)	5042.56	17979.93	13468.87						
T_wV rate=$T_wV/e*v$	3.09E-04	9.27E-06	0.00E+00						
Step 1.3: Weighted occupancy rate *(weighted T_wV rate)*[1]									
Weight: proportion of total survey effort made at the VP	0.138	0.493	0.369	0.000	0.000	0.000	0.000		
Weighted T_wV rate (T_wV rate * weight)	4.27E-05	4.57E-06	0.00E+00						
Total weighted occupancy rate			0.000047				birds seconds per ha/hour		
Mean % activity hr^-1 in wind farm at risk height			2.405%						
Mean % activity hr^-1 in wind farm at rotor height (z)			2.193%						

Step 1.4: Total occupancy of risk volume during surveys (T_w)		
Hours potentially active: breeding season (a) (footnote 2)	2,700	hours
Tw=z*a	59.22	hours
Step 1.6: Flight risk volume (V_w)		
Risk volume: $V_w=A*h$ (footnote 3)	788,638,295	m^3
Step 1.7: Volume swept by windfarm rotors (V_r)		
Bird length (L)	0.26	m
Rotor-swept volume: $V_r=N*\pi*r^2*(d+L)$ footnote 4	628,721.44	m^3
Step 1.8: Bird occupancy of rotor-swept volume (Tr)		
$T_r=T_w*(V_r/Vw)$	169.9617	seconds
Step 1.9: Time taken to transit rotor *(t)*		
Flight speed *(s)*	16	m/sec
$t=(d+L)/s$	0.30	seconds
Step 1.10: Number of rotor transits (N)		
$N=T_r/t$	571	rotor transits
STAGE 2: Probability of Collision for a bird flying through rotors (*p*(collision)) from SNH spreadsheet[5]	0.045	
STAGE 3: Predicted mortality (birds per year)		
Step 3.1: With no avoidance, turbines operational 85% of the time N*p(collision)*0.85	21.621	collisions

Step 3.2: Adjusted using a range of avoidance rates:				
98.00%	**0.4324**	**approx one collision every**	**2.31**	**years**

[1] The survey risk volume was derived from the windfarm polygon including a precautionary 500m buffer around the turbine rotors.

[2] The total number of daylight hours during the period

[3] A= size of windfarm polygon(ha) h= rotor diameter (m)

[4] N= number of turbines, r= rotor radius (m), d= max depth of rotors (m)

[5]Assumes bird length=0.26m, wingspan 0.455m, flight speed= 16.0m/sec

Common Snipe North Cluster Non-Breeding Season 2017/18 SG 155

	Viewsheds								
	1	**2**	**3**						
STAGE 1: Estimation of rotor transits									
Step 1.1: Seconds occupancy of the survey risk volume (T_w)[1] recorded within each viewshed (T_wV)	0	0	31						
Step 1.2: Unweighted occupancy rate each viewshed ($T_wV$rate)									
Hours of survey effort (*e*)	51	43	40						
Windfarm area (ha) visible within viewshed (*v*)[1]	70.04	249.72	187.0676						
Observation effort (*e**v*)	3571.81	10738.01	7482.70						
T_wV rate=$T_wV/e*v$	0.00E+00	0.00E+00	1.15E-06						
Step 1.3: Weighted occupancy rate *(weighted T_wV rate)*[1]									
Weight: proportion of total survey effort made at the VP	0.164	0.493	0.343						
Weighted T_wV rate (T_wV rate * weight)	0.00E+00	0.00E+00	3.95E-07						
Total weighted occupancy rate	0.000000				birds seconds per ha/hour				
Mean % activity hr^-1 in wind farm at risk height	0.020%								

Mean % activity hr^-1 in wind farm at rotor height (z)	0.022%	
Step 1.4: Total occupancy of risk volume during surveys (T_w)		
Hours potentially active: breeding season (a) (footnote 2)	2,860	hours
Tw=z*a	0.64	hours
Step 1.6: Flight risk volume (V_w)		
Risk volume: $V_w=A*h$ (footnote 3)	788,638,295	m^3
Step 1.7: Volume swept by windfarm rotors (V_r)		
Bird length (L)	0.26	m
Rotor-swept volume: $V_r=N*\pi*r^2*(d+L)$ footnote 4	628,721.44	m^3
Step 1.8: Bird occupancy of rotor-swept volume (Tr)		
$T_r=T_w*(V_r/Vw)$	1.83	seconds
Step 1.9: Time taken to transit rotor *(t)*		
Flight speed *(s)*	16	m/sec
$t=(d+L)/s$	0.30	seconds
Step 1.10: Number of rotor transits (N)		
$N=T_r/t$	6	rotor transits
STAGE 2: Probability of Collision for a bird flying through rotors (*p*(collision)) from SNH spreadsheet[5]	0.045	

STAGE 3: Predicted mortality (birds per year)				
Step 3.1: With no avoidance, turbines operational 85% of the time N*p(collision)*0.85	0.232	collisions		
Step 3.2: Adjusted using a range of avoidance rates:				
98.00%	**0.0046**	**approx one collision every**	**215.16**	**years**

[1] The survey risk volume was derived from the windfarm polygon including a precautionary 500m buffer around the turbine rotors.

[2] The total number of daylight hours during the period

[3] A= size of windfarm polygon(ha) h= rotor diameter (m)

[4] N= number of turbines, r= rotor radius (m), d= max depth of rotors (m)

[5]Assumes bird length=0.26m, wingspan 0.455m, flight speed= 16.0m/sec

Common Snipe North Cluster Non-Breeding Season 2020/21 SG 155

	Viewsheds								
	1	**2**	**3**						
STAGE 1: Estimation of rotor transits									
Step 1.1: Seconds occupancy of the survey risk volume (T_w)[1] recorded within each viewshed (T_wV)	0	15	0						
Step 1.2: Unweighted occupancy rate each viewshed ($T_wV$rate)									
Hours of survey effort (*e*)	36	35	36						
Windfarm area (ha) visible within viewshed (*v*)[1]	70.04	249.72	187.0676						
Observation effort (*e*v*)	2521.28	8740.24	6734.43						
T_wV rate=$T_wV/e*v$	0.00E+00	4.77E-07	0.00E+00						
Step 1.3: Weighted occupancy rate *(weighted T_wV rate)*[1]									
Weight: proportion of total survey effort made at the VP	0.140	0.486	0.374						
Weighted T_wV rate (T_wV rate * weight)	0.00E+00	2.32E-07	0.00E+00						
Total weighted occupancy rate	0.000000				birds seconds per ha/hour				
Mean % activity hr^-1 in wind farm at risk height	0.012%								

Mean % activity hr^-1 in wind farm at rotor height (z)	0.011%	
Step 1.4: Total occupancy of risk volume during surveys (T_w)		
Hours potentially active: breeding season (a) (footnote 2)	2,860	hours
Tw=z*a	0.31	hours
Step 1.6: Flight risk volume (V_w)		
Risk volume: $V_w=A*h$ (footnote 3)	788,638,295	m^3
Step 1.7: Volume swept by windfarm rotors (V_r)		
Bird length (L)	0.26	m
Rotor-swept volume: $V_r=N*\pi*r^2*(d+L)$ footnote 4	628,721.44	m^3
Step 1.8: Bird occupancy of rotor-swept volume (Tr)		
$T_r=T_w*(V_r/Vw)$	0.88	seconds
Step 1.9: Time taken to transit rotor *(t)*		
Flight speed *(s)*	16	m/sec
$t=(d+L)/s$	0.30	seconds
Step 1.10: Number of rotor transits (N)		
$N=T_r/t$	3	rotor transits
STAGE 2: Probability of Collision for a bird flying through rotors (*p*(collision)) from SNH spreadsheet[5]	0.045	

STAGE 3: Predicted mortality (birds per year)				
Step 3.1: With no avoidance, turbines operational 85% of the time N*p(collision)*0.85	0.112	collisions		
Step 3.2: Adjusted using a range of avoidance rates:				
98.00%	**0.0022**	**approx one collision every**	**445.88**	**years**

[1] The survey risk volume was derived from the windfarm polygon including a precautionary 500m buffer around the turbine rotors.

[2] The total number of daylight hours during the period

[3] A= size of windfarm polygon(ha) h= rotor diameter (m)

[4] N= number of turbines, r= rotor radius (m), d= max depth of rotors (m)

[5]Assumes bird length=0.26m, wingspan 0.455m, flight speed= 16.0m/sec

Common Snipe North Cluster Annual SG 155

	Viewsheds								
	1	2	3						
STAGE 1: Estimation of rotor transits									
Step 1.1: Seconds occupancy of the survey risk volume (T_w)[1] recorded within each viewshed (T_wV)	5610	615	31						
Step 1.2: Unweighted occupancy rate each viewshed ($T_wV$rate)									
Hours of survey effort (*e*)	159	150	148						
Windfarm area (ha) visible within viewshed (*v*)[1]	70.04	249.72	187.07						
Observation effort (*e***v*)	11135.65	37458.19	27686.01						
T_wV rate=$T_wV/e*v$	1.40E-04	4.56E-06	3.11E-07						
Step 1.3: Weighted occupancy rate *(weighted T_wV rate)*[1]									
Weight: proportion of total survey effort made at the VP	0.146	0.491	0.363						
Weighted T_wV rate (T_wV rate * weight)	2.04E-05	2.24E-06	1.13E-07						
Total weighted occupancy rate	0.000023					birds seconds per ha/hour			
Mean % activity hr^-1 in wind farm at risk height	1.159%								

Mean % activity hr^-1 in wind farm at rotor height (z)	1.057%	
Step 1.4: Total occupancy of risk volume during surveys (T_w)		
Hours potentially active: breeding season (a) (footnote 2)	5,560	hours
Tw=z*a	58.76	hours
Step 1.6: Flight risk volume (V_w)		
Risk volume: $V_w=A*h$ (footnote 3)	788,638,295	m^3
Step 1.7: Volume swept by windfarm rotors (V_r)		
Bird length (L)	0.26	m
Rotor-swept volume: $V_r=N*\pi*r^2*(d+L)$ footnote 4	628,721.44	m^3
Step 1.8: Bird occupancy of rotor-swept volume (Tr)		
$T_r=T_w*(V_r/Vw)$	168.6437	seconds
Step 1.9: Time taken to transit rotor *(t)*		
Flight speed *(s)*	16	m/sec
$t=(d+L)/s$	0.30	seconds
Step 1.10: Number of rotor transits (N)		
$N=T_r/t$	567	rotor transits
STAGE 2: Probability of Collision for a bird flying through rotors (*p*(collision)) from SNH spreadsheet[5]	0.045	
STAGE 3: Predicted mortality (birds per year)		

Step 3.1: With no avoidance, turbines operational 85% of the time N*p(collision)*0.85	21.454	collisions			
Step 3.2: Adjusted using a range of avoidance rates:					
98.00%	**0.4291**	**approx one collision every**	**2.33**	**years**	

[1] The survey risk volume was derived from the windfarm polygon including a precautionary 500m buffer around the turbine rotors.

[2] The total number of daylight hours during the period

[3] A= size of windfarm polygon(ha) h= rotor diameter (m)

[4] N= number of turbines, r= rotor radius (m), d= max depth of rotors (m)

[5]Assumes bird length=0.26m, wingspan 0.455m, flight speed= 16.0m/sec

APPENDIX 04

CRM Calculations

Vestas 162

Common Kestrel North Cluster Breeding Season Vestas 162

	Viewsheds								
	1	2	3						
STAGE 1: Estimation of rotor transits									
Step 1.1: Seconds occupancy of the survey risk volume (T_w)[1] recorded within each viewshed (T_wV)	2160	900	2,205						
Step 1.2: Unweighted occupancy rate each viewshed ($T_wV$rate)									
Hours of survey effort (*e*)	72	72	72						
Windfarm area (ha) visible within viewshed (*v*)[1]	66.15	213.01	164.456						
Observation effort (*e*v*)	4762.80	15336.50	11840.83						
T_wV rate=$T_wV/e*v$	1.26E-04	1.63E-05	5.17E-05						
Step 1.3: Weighted occupancy rate *(weighted T_wV rate)*[1]									
Weight: proportion of total survey effort made at the VP	0.149	0.480	0.371	0.000	0.000	0.000	0.000		
Weighted T_wV rate (T_wV rate * weight)	1.88E-05	7.83E-06	1.92E-05						
Total weighted occupancy rate	0.000046					birds seconds per ha/hour			
Mean % activity hr^-1 in wind farm at risk height	2.344%								
Mean % activity hr^-1 in wind farm at rotor height (z)	1.898%								

Step 1.4: Total occupancy of risk volume during surveys (T_w)		
Hours potentially active: breeding season (a) (footnote 2)	2,377	hours
Tw=z*a	45.12	hours
Step 1.6: Flight risk volume (V_w)		
Risk volume: $V_w=A*h$ (footnote 3)	829,150,668	m^3
Step 1.7: Volume swept by windfarm rotors (V_r)		
Bird length (L)	0.34	m
Rotor-swept volume: $V_r=N*\pi*r^2*(d+L)$ footnote 4	669,477.42	m^3
Step 1.8: Bird occupancy of rotor-swept volume (Tr)		
$T_r=T_w*(V_r/Vw)$	131.1384	seconds
Step 1.9: Time taken to transit rotor *(t)*		
Flight speed *(s)*	12.7	m/sec
$t=(d+L)/s$	0.37	seconds
Step 1.10: Number of rotor transits (N)		
$N=T_r/t$	359	rotor transits
STAGE 2: Probability of Collision for a bird flying through rotors (*p*(collision)) from SNH spreadsheet[5]	0.048	
STAGE 3: Predicted mortality (birds per year)		
Step 3.1: With no avoidance, turbines operational 85% of the time N*p(collision)*0.85	14.697	collisions

Step 3.2: Adjusted using a range of avoidance rates:				
95.00%	**0.7349**	**approx one collision every**	**1.36**	**years**

[1] The survey risk volume was derived from the windfarm polygon including a precautionary 500m buffer around the turbine rotors.

[2] The total number of daylight hours during the period

[3] A= size of windfarm polygon(ha) h= rotor diameter (m)

[4] N= number of turbines, r= rotor radius (m), d= max depth of rotors (m)

[5]Assumes bird length=0.34m, wingspan 0.8m, flight speed= 12.7m/sec

Common Kestrel North Cluster Non-Breeding Season 2017/18 Vestas 162

	Viewsheds								
	1	**2**	**3**						
STAGE 1: Estimation of rotor transits									
Step 1.1: Seconds occupancy of the survey risk volume (T_w)[1] recorded within each viewshed (T_wV)	0	112	640						
Step 1.2: Unweighted occupancy rate each viewshed ($T_wV$rate)									
Hours of survey effort (*e*)	51	43	40						
Windfarm area (ha) visible within viewshed (*v*)[1]	66.15	213.01	164.456						
Observation effort (*e*v*)	3373.65	9159.30	6578.24						
T_wV rate=$T_wV/e*v$	0.00E+00	3.40E-06	2.70E-05						
Step 1.3: Weighted occupancy rate *(weighted T_wV rate)*[1]									
Weight: proportion of total survey effort made at the VP	0.177	0.479	0.344						
Weighted T_wV rate (T_wV rate * weight)	0.00E+00	1.63E-06	9.30E-06						
Total weighted occupancy rate	0.000011				birds seconds per ha/hour				
Mean % activity hr^-1 in wind farm at risk height	0.559%								

Mean % activity hr^-1 in wind farm at rotor height (z)	0.533%	
Step 1.4: Total occupancy of risk volume during surveys (T_w)		
Hours potentially active: breeding season (a) (footnote 2)	2,107	hours
Tw=z*a	11.23	hours
Step 1.6: Flight risk volume (V_w)		
Risk volume: $V_w=A*h$ (footnote 3)	829,150,668	m^3
Step 1.7: Volume swept by windfarm rotors (V_r)		
Bird length (L)	0.34	m
Rotor-swept volume: $V_r=N*\pi*r^2*(d+L)$ footnote 4	669,477.42	m^3
Step 1.8: Bird occupancy of rotor-swept volume (Tr)		
$T_r=T_w*(V_r/Vw)$	32.64	seconds
Step 1.9: Time taken to transit rotor *(t)*		
Flight speed *(s)*	12.7	m/sec
$t=(d+L)/s$	0.37	seconds
Step 1.10: Number of rotor transits (N)		
$N=T_r/t$	89	rotor transits
STAGE 2: Probability of Collision for a bird flying through rotors (*p*(collision)) from SNH spreadsheet[5]	0.048	
STAGE 3: Predicted mortality (birds per year)		

Step 3.1: With no avoidance, turbines operational 85% of the time N*p(collision)*0.85	3.659	collisions		
Step 3.2: Adjusted using a range of avoidance rates:				
95.00%	**0.1829**	**approx one collision every**	**5.47**	**years**

[1] The survey risk volume was derived from the windfarm polygon including a precautionary 500m buffer around the turbine rotors.

[2] The total number of daylight hours during the period

[3] A= size of windfarm polygon(ha) h= rotor diameter (m)

[4] N= number of turbines, r= rotor radius (m), d= max depth of rotors (m)

[5]Assumes bird length=0.34m, wingspan 0.8m, flight speed= 12.7m/sec

Common Kestrel Non-Breeding Season 2021/22 Vestas 162

	Viewsheds								
	1	2	3						
STAGE 1: Estimation of rotor transits									
Step 1.1: Seconds occupancy of the survey risk volume (T_w)[1] recorded within each viewshed (T_wV)	45	0	150						
Step 1.2: Unweighted occupancy rate each viewshed ($T_wV$rate)									
Hours of survey effort (*e*)	36	35	36						
Windfarm area (ha) visible within viewshed (*v*)[1]	66.15	213.01	164.456						
Observation effort (*e**v*)	2381.40	7455.25	5920.42						
T_wV rate=$T_wV/e*v$	5.25E-06	0.00E+00	7.04E-06						
Step 1.3: Weighted occupancy rate *(weighted T_wV rate)*[1]									
Weight: proportion of total survey effort made at the VP	0.151	0.473	0.376						
Weighted T_wV rate (T_wV rate * weight)	7.93E-07	0.00E+00	2.64E-06						
Total weighted occupancy rate	0.000003				birds seconds per ha/hour				
Mean % activity hr^-1 in wind farm at risk height	0.176%								

Mean % activity hr^-1 in wind farm at rotor height (z)	0.143%	
Step 1.4: Total occupancy of risk volume during surveys (T_w)		
Hours potentially active: breeding season (a) (footnote 2)	2,107	hours
Tw=z*a	3.00	hours
Step 1.6: Flight risk volume (V_w)		
Risk volume: $V_w=A*h$ (footnote 3)	829,150,668	m^3
Step 1.7: Volume swept by windfarm rotors (V_r)		
Bird length (L)	0.34	m
Rotor-swept volume: $V_r=N*\pi*r^2*(d+L)$ footnote 4	669,477.42	m^3
Step 1.8: Bird occupancy of rotor-swept volume (Tr)		
$T_r=T_w*(V_r/Vw)$	8.73	seconds
Step 1.9: Time taken to transit rotor *(t)*		
Flight speed *(s)*	12.7	m/sec
$t=(d+L)/s$	0.37	seconds
Step 1.10: Number of rotor transits (N)		
$N=T_r/t$	24	rotor transits
STAGE 2: Probability of Collision for a bird flying through rotors (*p*(collision)) from SNH spreadsheet[5]	0.048	
STAGE 3: Predicted mortality (birds per year)		

Step 3.1: With no avoidance, turbines operational 85% of the time N*p(collision)*0.85	0.978	collisions		
Step 3.2: Adjusted using a range of avoidance rates:				
95.00%	**0.0489**	**approx one collision every**	**20.45**	**years**

[1] The survey risk volume was derived from the windfarm polygon including a precautionary 500m buffer around the turbine rotors.

[2] The total number of daylight hours during the period

[3] A= size of windfarm polygon(ha) h= rotor diameter (m)

[4] N= number of turbines, r= rotor radius (m), d= max depth of rotors (m)

[5]Assumes bird length=0.34m, wingspan 0.8m, flight speed= 12.7m/sec

Common Kestrel North Cluster Annual Vestas 162

	Viewsheds								
	1	**2**	**3**						
STAGE 1: Estimation of rotor transits									
Step 1.1: Seconds occupancy of the survey risk volume (T_w)[1] recorded within each viewshed (T_wV)	2205	1,012	2,995						
Step 1.2: Unweighted occupancy rate each viewshed ($T_wV$rate)									
Hours of survey effort (*e*)	159	150	148						
Windfarm area (ha) visible within viewshed (*v*)[1]	66.15	213.01	164.46						
Observation effort (*e*v*)	10517.85	31951.05	24339.49						
T_wV rate=$T_wV/e*v$	5.82E-05	8.80E-06	3.42E-05						
Step 1.3: Weighted occupancy rate *(weighted T_wV rate)*[1]									
Weight: proportion of total survey effort made at the VP	0.157	0.478	0.364						
Weighted T_wV rate (T_wV rate * weight)	9.17E-06	4.21E-06	1.25E-05						
Total weighted occupancy rate	0.000026					birds seconds per ha/hour			
Mean % activity hr^-1 in wind farm at risk height	1.322%								

Mean % activity hr^-1 in wind farm at rotor height (z)	1.071%	
Step 1.4: Total occupancy of risk volume during surveys (T_w)		
Hours potentially active: breeding season (a) (footnote 2)	4,483	hours
Tw=z*a	48.01	hours
Step 1.6: Flight risk volume (V_w)		
Risk volume: $V_w=A*h$ (footnote 3)	829,150,668	m^3
Step 1.7: Volume swept by windfarm rotors (V_r)		
Bird length (L)	0.34	m
Rotor-swept volume: $V_r=N*\pi*r^2*(d+L)$ footnote 4	669,477.42	m^3
Step 1.8: Bird occupancy of rotor-swept volume (Tr)		
$T_r=T_w*(V_r/Vw)$	139.5423	seconds
Step 1.9: Time taken to transit rotor *(t)*		
Flight speed *(s)*	12.7	m/sec
$t=(d+L)/s$	0.37	seconds
Step 1.10: Number of rotor transits (N)		
$N=T_r/t$	382	rotor transits
STAGE 2: Probability of Collision for a bird flying through rotors (*p*(collision)) from SNH spreadsheet[5]	0.048	
STAGE 3: Predicted mortality (birds per year)		

Step 3.1: With no avoidance, turbines operational 85% of the time N*p(collision)*0.85	15.639	collisions		
Step 3.2: Adjusted using a range of avoidance rates:				
95.00%	**0.7820**	**approx one collision every**	**1.28**	**years**

[1] The survey risk volume was derived from the windfarm polygon including a precautionary 500m buffer around the turbine rotors.

[2] The total number of daylight hours during the period

[3] A= size of windfarm polygon(ha) h= rotor diameter (m)

[4] N= number of turbines, r= rotor radius (m), d= max depth of rotors (m)

[5]Assumes bird length=0.34m, wingspan 0.8m, flight speed= 12.7m/sec

Common Kestrel South Cluster Breeding Season Vestas 162

	Viewsheds								
	4	**5**	**7**						
STAGE 1: Estimation of rotor transits									
Step 1.1: Seconds occupancy of the survey risk volume (T_w)[1] recorded within each viewshed (T_wV)	495	0	300						
Step 1.2: Unweighted occupancy rate each viewshed ($T_wV$rate)									
Hours of survey effort (*e*)	72	30	66						
Windfarm area (ha) visible within viewshed (*v*)[1]	209.36	16.51	245.3118						
Observation effort (*e*v*)	15073.79	495.21	16190.58						
T_wV rate=$T_wV/e*v$	9.12E-06	0.00E+00	5.15E-06						
Step 1.3: Weighted occupancy rate *(weighted T_wV rate)*[1]									
Weight: proportion of total survey effort made at the VP	0.475	0.016	0.510	0.000	0.000	0.000	0.000		
Weighted T_wV rate (T_wV rate * weight)	4.33E-06	0.00E+00	2.62E-06						
Total weighted occupancy rate	0.000007					birds seconds per ha/hour			
Mean % activity hr^-1 in wind farm at risk height	0.255%								
Mean % activity hr^-1 in wind farm at rotor height (z)	0.207%								

Step 1.4: Total occupancy of risk volume during surveys (T_w)		
Hours potentially active: breeding season (a) (footnote 2)	2,377	hours
Tw=z*a	4.92	hours
Step 1.6: Flight risk volume (V_w)		
Risk volume: $V_w=A*h$ (footnote 3)	595,111,814	m^3
Step 1.7: Volume swept by windfarm rotors (V_r)		
Bird length (L)	0.34	m
Rotor-swept volume: $V_r=N*\pi*r^2*(d+L)$ footnote 4	573,837.78	m^3
Step 1.8: Bird occupancy of rotor-swept volume (Tr)		
$T_r=T_w*(V_r/Vw)$	17.0692	seconds
Step 1.9: Time taken to transit rotor *(t)*		
Flight speed *(s)*	12.7	m/sec
$t=(d+L)/s$	0.37	seconds
Step 1.10: Number of rotor transits (N)		
$N=T_r/t$	47	rotor transits
STAGE 2: Probability of Collision for a bird flying through rotors (*p*(collision)) from SNH spreadsheet[5]	0.048	
STAGE 3: Predicted mortality (birds per year)		
Step 3.1: With no avoidance, turbines operational 85% of the time N*p(collision)*0.85	1.913	collisions

Step 3.2: Adjusted using a range of avoidance rates:				
95.00%	**0.0957**	**approx one collision every**	**10.45**	**years**

[1] The survey risk volume was derived from the windfarm polygon including a precautionary 500m buffer around the turbine rotors.

[2] The total number of daylight hours during the period

[3] A= size of windfarm polygon(ha) h= rotor diameter (m)

[4] N= number of turbines, r= rotor radius (m), d= max depth of rotors (m)

[5]Assumes bird length=0.34m, wingspan 0.8m, flight speed= 12.7m/sec

Common Kestrel South Cluster Non-Breeding Season 2017/18 Vestas

	Viewsheds								
	4	**5**	**7**						
STAGE 1: Estimation of rotor transits									
Step 1.1: Seconds occupancy of the survey risk volume (T_w)[1] recorded within each viewshed (T_wV)	0	0	1,322						
Step 1.2: Unweighted occupancy rate each viewshed ($T_wV$rate)									
Hours of survey effort (*e*)	33	30	36						
Windfarm area (ha) visible within viewshed (*v*)[1]	209.36	16.51	245.31184						
Observation effort (*e***v*)	6804.14	495.21	8831.23						
T_wV rate=$T_wV/e*v$	0.00E+00	0.00E+00	4.16E-05						
Step 1.3: Weighted occupancy rate *(weighted T_wV rate)*[1]									
Weight: proportion of total survey effort made at the VP	0.422	0.031	0.547						
Weighted T_wV rate (T_wV rate * weight)	0.00E+00	0.00E+00	2.28E-05						
Total weighted occupancy rate	0.000023				birds seconds per ha/hour				
Mean % activity hr^-1 in wind farm at risk height	0.836%								

Mean % activity hr^-1 in wind farm at rotor height (z)	0.797%	
Step 1.4: Total occupancy of risk volume during surveys (T_w)		
Hours potentially active: breeding season (a) (footnote 2)	2,107	hours
Tw=z*a	16.79	hours
Step 1.6: Flight risk volume (V_w)		
Risk volume: $V_w=A*h$ (footnote 3)	595,111,814	m^3
Step 1.7: Volume swept by windfarm rotors (V_r)		
Bird length (L)	0.34	m
Rotor-swept volume: $V_r=N*\pi*r^2*(d+L)$ footnote 4	573,837.78	m^3
Step 1.8: Bird occupancy of rotor-swept volume (Tr)		
$T_r=T_w*(V_r/Vw)$	58.28	seconds
Step 1.9: Time taken to transit rotor *(t)*		
Flight speed *(s)*	12.7	m/sec
$t=(d+L)/s$	0.37	seconds
Step 1.10: Number of rotor transits (N)		
$N=T_r/t$	160	rotor transits
STAGE 2: Probability of Collision for a bird flying through rotors (*p*(collision)) from SNH spreadsheet[5]	0.048	

STAGE 3: Predicted mortality (birds per year)					
Step 3.1: With no avoidance, turbines operational 85% of the time N*p(collision)*0.85	6.532	collisions			
Step 3.2: Adjusted using a range of avoidance rates:					
95.00%	**0.3266**	**approx one collision every**	**3.06**	**years**	

[1] The survey risk volume was derived from the windfarm polygon including a precautionary 500m buffer around the turbine rotors.

[2] The total number of daylight hours during the period

[3] A= size of windfarm polygon(ha) h= rotor diameter (m)

[4] N= number of turbines, r= rotor radius (m), d= max depth of rotors (m)

[5]Assumes bird length=0.34m, wingspan 0.8m, flight speed= 12.7m/sec

Common Kestrel South Cluster Non-Breeding Season 2021/22 Vestas 162

	Viewsheds								
	4	**5**	**7**						
STAGE 1: Estimation of rotor transits									
Step 1.1: Seconds occupancy of the survey risk volume (T_w)[1] recorded within each viewshed (T_wV)	0	0	615						
Step 1.2: Unweighted occupancy rate each viewshed ($T_wV$rate)									
Hours of survey effort (*e*)	36	42	39						
Windfarm area (ha) visible within viewshed (*v*)[1]	209.36	16.51	245.31184						
Observation effort (*e*v*)	7536.90	693.29	9567.16						
T_wV rate=$T_wV/e*v$	0.00E+00	0.00E+00	1.79E-05						
Step 1.3: Weighted occupancy rate *(weighted T_wV rate)*[1]									
Weight: proportion of total survey effort made at the VP	0.423	0.039	0.538						
Weighted T_wV rate (T_wV rate * weight)	0.00E+00	0.00E+00	9.60E-06						
Total weighted occupancy rate	0.000010				birds seconds per ha/hour				
Mean % activity hr^-1 in wind farm at risk height	0.353%								

Mean % activity hr^-1 in wind farm at rotor height (z)	0.286%	
Step 1.4: Total occupancy of risk volume during surveys (T_w)		
Hours potentially active: breeding season (a) (footnote 2)	2,107	hours
Tw=z*a	6.02	hours
Step 1.6: Flight risk volume (V_w)		
Risk volume: $V_w=A*h$ (footnote 3)	595,111,814	m^3
Step 1.7: Volume swept by windfarm rotors (V_r)		
Bird length (L)	0.34	m
Rotor-swept volume: $V_r=N*\pi*r^2*(d+L)$ footnote 4	573,837.78	m^3
Step 1.8: Bird occupancy of rotor-swept volume (Tr)		
$T_r=T_w*(V_r/Vw)$	20.89	seconds
Step 1.9: Time taken to transit rotor *(t)*		
Flight speed *(s)*	12.7	m/sec
$t=(d+L)/s$	0.37	seconds
Step 1.10: Number of rotor transits (N)		
$N=T_r/t$	57	rotor transits
STAGE 2: Probability of Collision for a bird flying through rotors (*p*(collision)) from SNH spreadsheet[5]	0.048	

STAGE 3: Predicted mortality (birds per year)				
Step 3.1: With no avoidance, turbines operational 85% of the time N*p(collision)*0.85	2.341	collisions		
Step 3.2: Adjusted using a range of avoidance rates:				
95.00%	**0.1170**	**approx one collision every**	**8.54**	**years**

[1] The survey risk volume was derived from the windfarm polygon including a precautionary 500m buffer around the turbine rotors.

[2] The total number of daylight hours during the period

[3] A= size of windfarm polygon(ha) h= rotor diameter (m)

[4] N= number of turbines, r= rotor radius (m), d= max depth of rotors (m)

[5]Assumes bird length=0.34m, wingspan 0.8m, flight speed= 12.7m/sec

Common Kestrel South Cluster Annual Vestas 162

	Viewsheds								
	4	**5**	**7**						
STAGE 1: Estimation of rotor transits									
Step 1.1: Seconds occupancy of the survey risk volume (T_w)[1] recorded within each viewshed (T_wV)	495	0	2,237						
Step 1.2: Unweighted occupancy rate each viewshed ($T_wV$rate)									
Hours of survey effort (*e*)	141	102	141						
Windfarm area (ha) visible within viewshed (*v*)[1]	209.36	16.51	245.31						
Observation effort (*e*v*)	29414.83	1683.71	34588.97						
T_wV rate=$T_wV/e*v$	4.67E-06	0.00E+00	1.80E-05						
Step 1.3: Weighted occupancy rate *(weighted T_wV rate)*[1]									
Weight: proportion of total survey effort made at the VP	0.448	0.026	0.527						
Weighted T_wV rate (T_wV rate * weight)	2.09E-06	0.00E+00	9.46E-06						
Total weighted occupancy rate	0.000012					birds seconds per ha/hour			
Mean % activity hr^-1 in wind farm at risk height	0.424%								

Mean % activity hr^-1 in wind farm at rotor height (z)	0.344%	
Step 1.4: Total occupancy of risk volume during surveys (T_w)		
Hours potentially active: breeding season (a) (footnote 2)	4,483	hours
Tw=z*a	15.41	hours
Step 1.6: Flight risk volume (V_w)		
Risk volume: $V_w=A*h$ (footnote 3)	595,111,814	m^3
Step 1.7: Volume swept by windfarm rotors (V_r)		
Bird length (L)	0.34	m
Rotor-swept volume: $V_r=N*\pi*r^2*(d+L)$ footnote 4	573,837.78	m^3
Step 1.8: Bird occupancy of rotor-swept volume (Tr)		
$T_r=T_w*(V_r/Vw)$	53.5003	seconds
Step 1.9: Time taken to transit rotor *(t)*		
Flight speed *(s)*	12.7	m/sec
$t=(d+L)/s$	0.37	seconds
Step 1.10: Number of rotor transits (N)		
$N=T_r/t$	146	rotor transits
STAGE 2: Probability of Collision for a bird flying through rotors (*p*(collision)) from SNH spreadsheet[5]	0.048	

STAGE 3: Predicted mortality (birds per year)				
Step 3.1: With no avoidance, turbines operational 85% of the time N*p(collision)*0.85	5.996	collisions		
Step 3.2: Adjusted using a range of avoidance rates:				
95.00%	**0.2998**	**approx one collision every**	**3.34**	**years**

[1] The survey risk volume was derived from the windfarm polygon including a precautionary 500m buffer around the turbine rotors.

[2] The total number of daylight hours during the period

[3] A= size of windfarm polygon(ha) h= rotor diameter (m)

[4] N= number of turbines, r= rotor radius (m), d= max depth of rotors (m)

[5]Assumes bird length=0.34m, wingspan 0.8m, flight speed= 12.7m/sec

Peregrine Falcon North Cluster Breeding Season Vestas 162

	Viewsheds								
	1	2	3						
STAGE 1: Estimation of rotor transits									
Step 1.1: Seconds occupancy of the survey risk volume (T_w)[1] recorded within each viewshed (T_wV)	105	570	105						
Step 1.2: Unweighted occupancy rate each viewshed ($T_wV$rate)									
Hours of survey effort (*e*)	72	72	72						
Windfarm area (ha) visible within viewshed (*v*)[1]	66.15	213.01	164.456						
Observation effort (*e**v*)	4762.80	15336.50	11840.83						
T_wV rate=$T_wV/e*v$	6.12E-06	1.03E-05	2.46E-06						
Step 1.3: Weighted occupancy rate *(weighted T_wV rate)*[1]									
Weight: proportion of total survey effort made at the VP	0.149	0.480	0.371						
Weighted T_wV rate (T_wV rate * weight)	9.13E-07	4.96E-06	9.13E-07						
Total weighted occupancy rate	0.000007				birds seconds per ha/hour				
Mean % activity hr^-1 in wind farm at risk height	0.347%								
Mean % activity hr^-1 in wind farm at rotor height (z)	0.281%								

Step 1.4: Total occupancy of risk volume during surveys (T_w)		
Hours potentially active: breeding season (a) (footnote 2)	2,377	hours
Tw=z*a	6.68	hours
Step 1.6: Flight risk volume (V_w)		
Risk volume: $V_w=A*h$ (footnote 3)	829,150,668	m^3
Step 1.7: Volume swept by windfarm rotors (V_r)		
Bird length (L)	0.45	m
Rotor-swept volume: $V_r=N*\pi*r^2*(d+L)$ footnote 4	685,348.65	m^3
Step 1.8: Bird occupancy of rotor-swept volume (Tr)		
$T_r=T_w*(V_r/Vw)$	19.8885	seconds
Step 1.9: Time taken to transit rotor *(t)*		
Flight speed *(s)*	14	m/sec
$t=(d+L)/s$	0.34	seconds
Step 1.10: Number of rotor transits (N)		
$N=T_r/t$	59	rotor transits
STAGE 2: Probability of Collision for a bird flying through rotors (*p*(collision)) from SNH spreadsheet[5]	0.052	
STAGE 3: Predicted mortality (birds per year)		
Step 3.1: With no avoidance, turbines operational 85% of the time N*p(collision)*0.85	2.567	collisions

Step 3.2: Adjusted using a range of avoidance rates:				
98.00%	**0.0513**	**approx one collision every**	**19.47**	**years**

[1] The survey risk volume was derived from the windfarm polygon including a precautionary 500m buffer around the turbine rotors.

[2] The total number of daylight hours during the period

[3] A= size of windfarm polygon(ha) h= rotor diameter (m)

[4] N= number of turbines, r= rotor radius (m), d= max depth of rotors (m)

[5]Assumes bird length=0.45m, wingspan 1.1m, flight speed= 14.0m/sec

Peregrine Falcon North Cluster Non-Breeding Season 2021/22 Vestas 162

	Viewsheds								
	1	2	3						
STAGE 1: Estimation of rotor transits									
Step 1.1: Seconds occupancy of the survey risk volume (T_w)[1] recorded within each viewshed (T_wV)	105	0	0						
Step 1.2: Unweighted occupancy rate each viewshed ($T_wV$rate)									
Hours of survey effort (*e*)	36	35	36						
Windfarm area (ha) visible within viewshed (*v*)[1]	66.15	213.01	164.456						
Observation effort (*e*v*)	2381.40	7455.25	5920.42						
T_wV rate=$T_wV/e*v$	1.22E-05	0.00E+00	0.00E+00						
Step 1.3: Weighted occupancy rate *(weighted T_wV rate)*[1]									
Weight: proportion of total survey effort made at the VP	0.151	0.473	0.376						
Weighted T_wV rate (T_wV rate * weight)	1.85E-06	0.00E+00	0.00E+00						
Total weighted occupancy rate	0.000002				birds seconds per ha/hour				
Mean % activity hr^-1 in wind farm at risk height	0.095%								

Mean % activity hr^-1 in wind farm at rotor height (z)	0.077%	
Step 1.4: Total occupancy of risk volume during surveys (T_w)		
Hours potentially active: breeding season (a) (footnote 2)	2,107	hours
Tw=z*a	1.62	hours
Step 1.6: Flight risk volume (V_w)		
Risk volume: $V_w=A*h$ (footnote 3)	829,150,668	m^3
Step 1.7: Volume swept by windfarm rotors (V_r)		
Bird length (L)	0.45	m
Rotor-swept volume: $V_r=N*\pi*r^2*(d+L)$ footnote 4	685,348.65	m^3
Step 1.8: Bird occupancy of rotor-swept volume (Tr)		
$T_r=T_w*(V_r/Vw)$	4.81	seconds
Step 1.9: Time taken to transit rotor *(t)*		
Flight speed *(s)*	14	m/sec
$t=(d+L)/s$	0.34	seconds
Step 1.10: Number of rotor transits (N)		
$N=T_r/t$	14	rotor transits
STAGE 2: Probability of Collision for a bird flying through rotors (*p*(collision)) from SNH spreadsheet[5]	0.052	

STAGE 3: Predicted mortality (birds per year)					
Step 3.1: With no avoidance, turbines operational 85% of the time N*p(collision)*0.85	0.621	collisions			
Step 3.2: Adjusted using a range of avoidance rates:					
98.00%	**0.0124**	**approx one collision every**	**80.51**	**years**	

[1] The survey risk volume was derived from the windfarm polygon including a precautionary 500m buffer around the turbine rotors.

[2] The total number of daylight hours during the period

[3] A= size of windfarm polygon(ha) h= rotor diameter (m)

[4] N= number of turbines, r= rotor radius (m), d= max depth of rotors (m)

[5]Assumes bird length=0.45m, wingspan 1.1m, flight speed= 14.0m/sec

Peregrine Falcon North Cluster Annual Vestas 162

	Viewsheds								
	1	**2**	**3**						
STAGE 1: Estimation of rotor transits									
Step 1.1: Seconds occupancy of the survey risk volume (T_w)[1] recorded within each viewshed (T_wV)	210	570	105						
Step 1.2: Unweighted occupancy rate each viewshed ($T_wV$rate)									
Hours of survey effort (*e*)	159	150	148						
Windfarm area (ha) visible within viewshed (*v*)[1]	66.15	213.01	164.46						
Observation effort (*e*v*)	10517.85	31951.05	24339.49						
T_wV rate=$T_wV/e*v$	5.55E-06	4.96E-06	1.20E-06						
Step 1.3: Weighted occupancy rate *(weighted T_wV rate)*[1]									
Weight: proportion of total survey effort made at the VP	0.157	0.478	0.364						
Weighted T_wV rate (T_wV rate * weight)	8.73E-07	2.37E-06	4.37E-07						
Total weighted occupancy rate	0.000004				birds seconds per ha/hour				
Mean % activity hr^-1 in wind farm at risk height	0.188%								

Mean % activity hr^-1 in wind farm at rotor height (z)	0.153%	
Step 1.4: Total occupancy of risk volume during surveys (T_w)		
Hours potentially active: breeding season (a) (footnote 2)	4,483	hours
Tw=z*a	6.84	hours
Step 1.6: Flight risk volume (V_w)		
Risk volume: $V_w=A*h$ (footnote 3)	829,150,668	m^3
Step 1.7: Volume swept by windfarm rotors (V_r)		
Bird length (L)	0.45	m
Rotor-swept volume: $V_r=N*\pi*r^2*(d+L)$ footnote 4	685,348.65	m^3
Step 1.8: Bird occupancy of rotor-swept volume (Tr)		
$T_r=T_w*(V_r/Vw)$	20.3514	seconds
Step 1.9: Time taken to transit rotor *(t)*		
Flight speed *(s)*	14	m/sec
$t=(d+L)/s$	0.34	seconds
Step 1.10: Number of rotor transits (N)		
$N=T_r/t$	60	rotor transits
STAGE 2: Probability of Collision for a bird flying through rotors (*p*(collision)) from SNH spreadsheet[5]	0.052	
STAGE 3: Predicted mortality (birds per year)		

Step 3.1: With no avoidance, turbines operational 85% of the time N*p(collision)*0.85	2.627	collisions		
Step 3.2: Adjusted using a range of avoidance rates:				
98.00%	**0.0525**	**approx one collision every**	**19.03**	**years**

[1] The survey risk volume was derived from the windfarm polygon including a precautionary 500m buffer around the turbine rotors.

[2] The total number of daylight hours during the period

[3] A= size of windfarm polygon(ha) h= rotor diameter (m)

[4] N= number of turbines, r= rotor radius (m), d= max depth of rotors (m)

[5]Assumes bird length=0.45m, wingspan 1.1m, flight speed= 14.0m/sec

Peregrine Falcon South Cluster Breeding Season Vestas 162

	Viewsheds								
	4	**5**	**7**						
STAGE 1: Estimation of rotor transits									
Step 1.1: Seconds occupancy of the survey risk volume (T_w)[1] recorded within each viewshed (T_wV)	0	0	165						
Step 1.2: Unweighted occupancy rate each viewshed ($T_wV$rate)									
Hours of survey effort (*e*)	72	30	66						
Windfarm area (ha) visible within viewshed (*v*)[1]	209.36	16.51	245.3118						
Observation effort (*e*v*)	15073.79	495.21	16190.58						
T_wV rate=$T_wV/e*v$	0.00E+00	0.00E+00	2.83E-06						
Step 1.3: Weighted occupancy rate *(weighted T_wV rate)*[1]									
Weight: proportion of total survey effort made at the VP	0.475	0.016	0.510						
Weighted T_wV rate (T_wV rate * weight)	0.00E+00	0.00E+00	1.44E-06						
Total weighted occupancy rate	0.000001				birds seconds per ha/hour				
Mean % activity hr^-1 in wind farm at risk height	0.053%								
Mean % activity hr^-1 in wind farm at rotor height (z)	0.043%								

Step 1.4: Total occupancy of risk volume during surveys (T_w)		
Hours potentially active: breeding season (a) (footnote 2)	2,377	hours
Tw=z*a	1.02	hours
Step 1.6: Flight risk volume (V_w)		
Risk volume: $V_w=A*h$ (footnote 3)	595,111,814	m^3
Step 1.7: Volume swept by windfarm rotors (V_r)		
Bird length (L)	0.45	m
Rotor-swept volume: $V_r=N*\pi*r^2*(d+L)$ footnote 4	587,441.70	m^3
Step 1.8: Bird occupancy of rotor-swept volume (Tr)		
$T_r=T_w*(V_r/Vw)$	3.6267	seconds
Step 1.9: Time taken to transit rotor *(t)*		
Flight speed *(s)*	14	m/sec
$t=(d+L)/s$	0.34	seconds
Step 1.10: Number of rotor transits (N)		
$N=T_r/t$	11	rotor transits
STAGE 2: Probability of Collision for a bird flying through rotors (*p*(collision)) from SNH spreadsheet[5]	0.052	
STAGE 3: Predicted mortality (birds per year)		
Step 3.1: With no avoidance, turbines operational 97% of the time N*p(collision)*0.97	0.468	collisions

Step 3.2: Adjusted using a range of avoidance rates:				
98.00%	**0.0094**	**approx one collision every**	**106.80**	**years**

[1] The survey risk volume was derived from the windfarm polygon including a precautionary 500m buffer around the turbine rotors.

[2] The total number of daylight hours during the period

[3] A= size of windfarm polygon(ha) h= rotor diameter (m)

[4] N= number of turbines, r= rotor radius (m), d= max depth of rotors (m)

[5]Assumes bird length=0.45m, wingspan 1.1m, flight speed= 14.0m/sec

Peregrine Falcon South Cluster Non-Breeding Season 2017/18 Vestas 162

	Viewsheds								
	4	5	7						
STAGE 1: Estimation of rotor transits									
Step 1.1: Seconds occupancy of the survey risk volume (T_w)[1] recorded within each viewshed (T_wV)	0	0	106						
Step 1.2: Unweighted occupancy rate each viewshed ($T_wV$rate)									
Hours of survey effort (*e*)	33	30	36						
Windfarm area (ha) visible within viewshed (*v*)[1]	209.36	16.51	245.31184						
Observation effort (*e*v*)	6804.14	495.21	8831.23						
T_wV rate=$T_wV/e*v$	0.00E+00	0.00E+00	3.33E-06						
Step 1.3: Weighted occupancy rate *(weighted T_wV rate)*[1]									
Weight: proportion of total survey effort made at the VP	0.422	0.031	0.547						
Weighted T_wV rate (T_wV rate * weight)	0.00E+00	0.00E+00	1.83E-06						
Total weighted occupancy rate	0.000002				birds seconds per ha/hour				
Mean % activity hr^-1 in wind farm at risk height	0.067%								

Mean % activity hr^-1 in wind farm at rotor height (z)	0.064%	
Step 1.4: Total occupancy of risk volume during surveys (T_w)		
Hours potentially active: breeding season (a) (footnote 2)	2,107	hours
Tw=z*a	1.35	hours
Step 1.6: Flight risk volume (V_w)		
Risk volume: $V_w=A*h$ (footnote 3)	595,111,814	m^3
Step 1.7: Volume swept by windfarm rotors (V_r)		
Bird length (L)	0.45	m
Rotor-swept volume: $V_r=N*\pi*r^2*(d+L)$ footnote 4	587,441.70	m^3
Step 1.8: Bird occupancy of rotor-swept volume (Tr)		
$T_r=T_w*(V_r/Vw)$	4.78	seconds
Step 1.9: Time taken to transit rotor *(t)*		
Flight speed *(s)*	14	m/sec
$t=(d+L)/s$	0.34	seconds
Step 1.10: Number of rotor transits (N)		
$N=T_r/t$	14	rotor transits
STAGE 2: Probability of Collision for a bird flying through rotors (*p*(collision)) from SNH spreadsheet[5]	0.052	

STAGE 3: Predicted mortality (birds per year)				
Step 3.1: With no avoidance, turbines operational 97% of the time N*p(collision)*0.97	0.618	collisions		
Step 3.2: Adjusted using a range of avoidance rates:				
98.00%	**0.0124**	**approx one collision every**	**80.96**	**years**

[1] The survey risk volume was derived from the windfarm polygon including a precautionary 500m buffer around the turbine rotors.

[2] The total number of daylight hours during the period

[3] A= size of windfarm polygon(ha) h= rotor diameter (m)

[4] N= number of turbines, r= rotor radius (m), d= max depth of rotors (m)

[5]Assumes bird length=0.45m, wingspan 1.1m, flight speed= 14.0m/sec

Peregrine Falcon South Cluster Non-Breeding Season 2021/22 Vestas 162

	Viewsheds								
	4	**5**	**7**						
STAGE 1: Estimation of rotor transits									
Step 1.1: Seconds occupancy of the survey risk volume (T_w)[1] recorded within each viewshed (T_wV)	30	0	90						
Step 1.2: Unweighted occupancy rate each viewshed ($T_wV$rate)									
Hours of survey effort (*e*)	36	42	39						
Windfarm area (ha) visible within viewshed (*v*)[1]	209.36	16.51	245.31184						
Observation effort (*e*v*)	7536.90	693.29	9567.16						
T_wV rate=$T_wV/e*v$	1.11E-06	0.00E+00	2.61E-06						
Step 1.3: Weighted occupancy rate *(weighted T_wV rate)*[1]									
Weight: proportion of total survey effort made at the VP	0.423	0.039	0.538						
Weighted T_wV rate (T_wV rate * weight)	4.68E-07	0.00E+00	1.40E-06						
Total weighted occupancy rate	0.000002				birds seconds per ha/hour				
Mean % activity hr^-1 in wind farm at risk height	0.069%								

Mean % activity hr^-1 in wind farm at rotor height (z)	0.056%	
Step 1.4: Total occupancy of risk volume during surveys (T_w)		
Hours potentially active: breeding season (a) (footnote 2)	2,107	hours
Tw=z*a	1.17	hours
Step 1.6: Flight risk volume (V_w)		
Risk volume: $V_w=A*h$ (footnote 3)	595,111,814	m^3
Step 1.7: Volume swept by windfarm rotors (V_r)		
Bird length (L)	0.45	m
Rotor-swept volume: $V_r=N*\pi*r^2*(d+L)$ footnote 4	587,441.70	m^3
Step 1.8: Bird occupancy of rotor-swept volume (Tr)		
$T_r=T_w*(V_r/Vw)$	4.17	seconds
Step 1.9: Time taken to transit rotor *(t)*		
Flight speed *(s)*	14	m/sec
$t=(d+L)/s$	0.34	seconds
Step 1.10: Number of rotor transits (N)		
$N=T_r/t$	12	rotor transits
STAGE 2: Probability of Collision for a bird flying through rotors (*p*(collision)) from SNH spreadsheet[5]	0.052	

STAGE 3: Predicted mortality (birds per year)				
Step 3.1: With no avoidance, turbines operational 97% of the time N*p(collision)*0.97	0.539	collisions		
Step 3.2: Adjusted using a range of avoidance rates:				
98.00%	**0.0108**	**approx one collision every**	**92.83**	**years**

[1] The survey risk volume was derived from the windfarm polygon including a precautionary 500m buffer around the turbine rotors.

[2] The total number of daylight hours during the period

[3] A= size of windfarm polygon(ha) h= rotor diameter (m)

[4] N= number of turbines, r= rotor radius (m), d= max depth of rotors (m)

[5]Assumes bird length=0.45m, wingspan 1.1m, flight speed= 14.0m/sec

Peregrine Falcon South Cluster Annual Vestas 162

	Viewsheds								
	4	5	7						
STAGE 1: Estimation of rotor transits									
Step 1.1: Seconds occupancy of the survey risk volume (T_w)[1] recorded within each viewshed (T_wV)	30	0	361						
Step 1.2: Unweighted occupancy rate each viewshed ($T_wV$rate)									
Hours of survey effort (*e*)	141	102	141						
Windfarm area (ha) visible within viewshed (*v*)[1]	209.36	16.51	245.31						
Observation effort (*e***v*)	29414.83	1683.71	34588.97						
T_wV rate=$T_wV/e*v$	2.83E-07	0.00E+00	2.90E-06						
Step 1.3: Weighted occupancy rate *(weighted T_wV rate)*[1]									
Weight: proportion of total survey effort made at the VP	0.448	0.026	0.527						
Weighted T_wV rate (T_wV rate * weight)	1.27E-07	0.00E+00	1.53E-06						
Total weighted occupancy rate	0.000002				birds seconds per ha/hour				
Mean % activity hr^-1 in wind farm at risk height	0.061%								

Mean % activity hr^-1 in wind farm at rotor height (z)	0.049%	
Step 1.4: Total occupancy of risk volume during surveys (T_w)		
Hours potentially active: breeding season (a) (footnote 2)	4,483	hours
Tw=z*a	2.21	hours
Step 1.6: Flight risk volume (V_w)		
Risk volume: $V_w=A*h$ (footnote 3)	595,111,814	m^3
Step 1.7: Volume swept by windfarm rotors (V_r)		
Bird length (L)	0.45	m
Rotor-swept volume: $V_r=N*\pi*r^2*(d+L)$ footnote 4	587,441.70	m^3
Step 1.8: Bird occupancy of rotor-swept volume (Tr)		
$T_r=T_w*(V_r/Vw)$	7.8384	seconds
Step 1.9: Time taken to transit rotor *(t)*		
Flight speed *(s)*	14	m/sec
$t=(d+L)/s$	0.34	seconds
Step 1.10: Number of rotor transits (N)		
$N=T_r/t$	23	rotor transits
STAGE 2: Probability of Collision for a bird flying through rotors (*p*(collision)) from SNH spreadsheet[5]	0.052	

STAGE 3: Predicted mortality (birds per year)					
Step 3.1: With no avoidance, turbines operational 97% of the time N*p(collision)*0.97	1.012	collisions			
Step 3.2: Adjusted using a range of avoidance rates:					
98.00%	**0.0202**	**approx one collision every**	**49.41**	**years**	

[1] The survey risk volume was derived from the windfarm polygon including a precautionary 500m buffer around the turbine rotors.

[2] The total number of daylight hours during the period

[3] A= size of windfarm polygon(ha) h= rotor diameter (m)

[4] N= number of turbines, r= rotor radius (m), d= max depth of rotors (m)

[5]Assumes bird length=0.45m, wingspan 1.1m, flight speed= 14.0m/sec

European Golden Plover North Cluster Non-Breeding Season 2017/18 Vestas 162

	Viewsheds								
	1	**2**	**3**						
STAGE 1: Estimation of rotor transits									
Step 1.1: Seconds occupancy of the survey risk volume (T_w)[1] recorded within each viewshed (T_wV)	0	0	84						
Step 1.2: Unweighted occupancy rate each viewshed ($T_wV$rate)									
Hours of survey effort (*e*)	51	43	40						
Windfarm area (ha) visible within viewshed (*v*)[1]	66.15	213.01	164.456						
Observation effort (*e*v*)	3373.65	9159.30	6578.24						
T_wV rate=$T_wV/e*v$	0.00E+00	0.00E+00	3.55E-06						
Step 1.3: Weighted occupancy rate *(weighted T_wV rate)*[1]									
Weight: proportion of total survey effort made at the VP	0.177	0.479	0.344						
Weighted T_wV rate (T_wV rate * weight)	0.00E+00	0.00E+00	1.22E-06						
Total weighted occupancy rate			0.000001				birds seconds per ha/hour		
Mean % activity hr^-1 in wind farm at risk height			0.062%						

Mean % activity hr^-1 in wind farm at rotor height (z)	0.060%	
Step 1.4: Total occupancy of risk volume during surveys (T_w)		
Hours potentially active: breeding season (a) (footnote 2)	2,860	hours
Tw=z*a	1.70	hours
Step 1.6: Flight risk volume (V_w)		
Risk volume: $V_w=A*h$ (footnote 3)	829,150,668	m^3
Step 1.7: Volume swept by windfarm rotors (V_r)		
Bird length (L)	0.28	m
Rotor-swept volume: $V_r=N*\pi*r^2*(d+L)$ footnote 4	660,820.38	m^3
Step 1.8: Bird occupancy of rotor-swept volume (Tr)		
$T_r=T_w*(V_r/Vw)$	4.89	seconds
Step 1.9: Time taken to transit rotor *(t)*		
Flight speed *(s)*	18	m/sec
$t=(d+L)/s$	0.25	seconds
Step 1.10: Number of rotor transits (N)		
$N=T_r/t$	19	rotor transits
STAGE 2: Probability of Collision for a bird flying through rotors (*p*(collision)) from SNH spreadsheet[5]	0.043	

STAGE 3: Predicted mortality (birds per year)				
Step 3.1: With no avoidance, turbines operational 85% of the time N*p(collision)*0.85	0.698	collisions		
Step 3.2: Adjusted using a range of avoidance rates:				
98.00%	**0.0140**	**approx one collision every**	**71.58**	**years**

[1] The survey risk volume was derived from the windfarm polygon including a precautionary 500m buffer around the turbine rotors.

[2] The total number of daylight hours during the period

[3] A= size of windfarm polygon(ha) h= rotor diameter (m)

[4] N= number of turbines, r= rotor radius (m), d= max depth of rotors (m)

[5]Assumes bird length=0.28m, wingspan 0.7m, flight speed= 18m/sec

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	Viewsheds								
	1	**2**	**3**						
STAGE 1: Estimation of rotor transits									
Step 1.1: Seconds occupancy of the survey risk volume (T_w)[1] recorded within each viewshed (T_wV)	0	0	84						
Step 1.2: Unweighted occupancy rate each viewshed (T_wVrate)									
Hours of survey effort (*e*)	159	150	148						
Windfarm area (ha) visible within viewshed (*v*)[1]	66.15	213.01	164.46						
Observation effort (*e***v*)	10517.85	31951.05	24339.49						
T_wV rate=$T_wV/e*v$	0.00E+00	0.00E+00	9.59E-07						
Step 1.3: Weighted occupancy rate *(weighted T_wV rate)*[1]									
Weight: proportion of total survey effort made at the VP	0.157	0.478	0.364						
Weighted T_wV rate (T_wV rate * weight)	0.00E+00	0.00E+00	3.49E-07						
Total weighted occupancy rate			0.000000			birds seconds per ha/hour			
Mean % activity hr^-1 in wind farm at risk height			0.018%						

Mean % activity hr^-1 in wind farm at rotor height (z)	0.014%	
Step 1.4: Total occupancy of risk volume during surveys (T_w)		
Hours potentially active: breeding season (a) (footnote 2)	5,560	hours
Tw=z*a	0.81	hours
Step 1.6: Flight risk volume (V_w)		
Risk volume: $V_w=A*h$ (footnote 3)	829,150,668	m^3
Step 1.7: Volume swept by windfarm rotors (V_r)		
Bird length (L)	0.28	m
Rotor-swept volume: $V_r=N*\pi*r^2*(d+L)$ footnote 4	660,820.38	m^3
Step 1.8: Bird occupancy of rotor-swept volume (Tr)		
$T_r=T_w*(V_r/Vw)$	2.3098	seconds
Step 1.9: Time taken to transit rotor *(t)*		
Flight speed *(s)*	18	m/sec
$t=(d+L)/s$	0.25	seconds
Step 1.10: Number of rotor transits (N)		
$N=T_r/t$	9	rotor transits
STAGE 2: Probability of Collision for a bird flying through rotors (*p*(collision)) from SNH spreadsheet[5]	0.043	

STAGE 3: Predicted mortality (birds per year)				
Step 3.1: With no avoidance, turbines operational 85% of the time N*p(collision)*0.85	0.330	collisions		
Step 3.2: Adjusted using a range of avoidance rates:				
98.00%	**0.0066**	**approx one collision every**	**151.41**	**years**

[1] The survey risk volume was derived from the windfarm polygon including a precautionary 500m buffer around the turbine rotors.

[2] The total number of daylight hours during the period

[3] A= size of windfarm polygon(ha) h= rotor diameter (m)

[4] N= number of turbines, r= rotor radius (m), d= max depth of rotors (m)

[5]Assumes bird length=0.28m, wingspan 0.7m, flight speed= 18m/sec

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	Viewsheds								
	4	5	7						
STAGE 1: Estimation of rotor transits									
Step 1.1: Seconds occupancy of the survey risk volume (T_w)[1] recorded within each viewshed (T_wV)	0	0	141						
Step 1.2: Unweighted occupancy rate each viewshed ($T_wV$rate)									
Hours of survey effort (*e*)	33	30	36						
Windfarm area (ha) visible within viewshed (*v*)[1]	209.36	16.51	245.31184						
Observation effort (*e*v*)	6804.14	495.21	8831.23						
T_wV rate=$T_wV/e*v$	0.00E+00	0.00E+00	4.44E-06						
Step 1.3: Weighted occupancy rate *(weighted T_wV rate)*[1]									
Weight: proportion of total survey effort made at the VP	0.422	0.031	0.547						
Weighted T_wV rate (T_wV rate * weight)	0.00E+00	0.00E+00	2.43E-06						
Total weighted occupancy rate	0.000002				birds seconds per ha/hour				
Mean % activity hr^-1 in wind farm at risk height	0.089%								

Mean % activity hr^-1 in wind farm at rotor height (z)	0.085%	
Step 1.4: Total occupancy of risk volume during surveys (T_w)		
Hours potentially active: breeding season (a) (footnote 2)	2,860	hours
Tw=z*a	2.43	hours
Step 1.6: Flight risk volume (V_w)		
Risk volume: $V_w=A*h$ (footnote 3)	595,111,814	m^3
Step 1.7: Volume swept by windfarm rotors (V_r)		
Bird length (L)	0.28	m
Rotor-swept volume: $V_r=N*\pi*r^2*(d+L)$ footnote 4	566,417.47	m^3
Step 1.8: Bird occupancy of rotor-swept volume (Tr)		
$T_r=T_w*(V_r/Vw)$	8.33	seconds
Step 1.9: Time taken to transit rotor *(t)*		
Flight speed *(s)*	18	m/sec
$t=(d+L)/s$	0.25	seconds
Step 1.10: Number of rotor transits (N)		
$N=T_r/t$	33	rotor transits
STAGE 2: Probability of Collision for a bird flying through rotors (*p*(collision)) from SNH spreadsheet[5]	0.043	

STAGE 3: Predicted mortality (birds per year)				
Step 3.1: With no avoidance, turbines operational 85% of the time N*p(collision)*0.85	1.191	collisions		
Step 3.2: Adjusted using a range of avoidance rates:				
98.00%	**0.0238**	**approx one collision every**	**41.99**	**years**

[1] The survey risk volume was derived from the windfarm polygon including a precautionary 500m buffer around the turbine rotors.

[2] The total number of daylight hours during the period

[3] A= size of windfarm polygon(ha) h= rotor diameter (m)

[4] N= number of turbines, r= rotor radius (m), d= max depth of rotors (m)

[5]Assumes bird length=0.28m, wingspan 0.72m, flight speed= 17.5m/sec

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	Viewsheds								
	4	**5**	**7**						
STAGE 1: Estimation of rotor transits									
Step 1.1: Seconds occupancy of the survey risk volume (T_w)[1] recorded within each viewshed (T_wV)	1035	2,400	0						
Step 1.2: Unweighted occupancy rate each viewshed ($T_wV$rate)									
Hours of survey effort (*e*)	36	42	39						
Windfarm area (ha) visible within viewshed (*v*)[1]	209.36	16.51	245.31184						
Observation effort (*e*v*)	7536.90	693.29	9567.16						
T_wV rate=$T_wV/e*v$	3.81E-05	9.62E-04	0.00E+00						
Step 1.3: Weighted occupancy rate *(weighted T_wV rate)*[1]									
Weight: proportion of total survey effort made at the VP	0.423	0.039	0.538						
Weighted T_wV rate (T_wV rate * weight)	1.62E-05	3.75E-05	0.00E+00						
Total weighted occupancy rate	0.000054					birds seconds per ha/hour			
Mean % activity hr^-1 in wind farm at risk height	1.969%								

Mean % activity hr^-1 in wind farm at rotor height (z)	1.595%	
Step 1.4: Total occupancy of risk volume during surveys (T_w)		
Hours potentially active: breeding season (a) (footnote 2)	2,860	hours
Tw=z*a	45.62	hours
Step 1.6: Flight risk volume (V_w)		
Risk volume: $V_w=A*h$ (footnote 3)	595,111,814	m^3
Step 1.7: Volume swept by windfarm rotors (V_r)		
Bird length (L)	0.28	m
Rotor-swept volume: $V_r=N*\pi*r^2*(d+L)$ footnote 4	566,417.47	m^3
Step 1.8: Bird occupancy of rotor-swept volume (Tr)		
$T_r=T_w*(V_r/Vw)$	156.30	seconds
Step 1.9: Time taken to transit rotor *(t)*		
Flight speed *(s)*	18	m/sec
$t=(d+L)/s$	0.25	seconds
Step 1.10: Number of rotor transits (N)		
$N=T_r/t$	614	rotor transits
STAGE 2: Probability of Collision for a bird flying through rotors (*p*(collision)) from SNH spreadsheet[5]	0.043	

STAGE 3: Predicted mortality (birds per year)				
Step 3.1: With no avoidance, turbines operational 85% of the time N*p(collision)*0.85	22.347	collisions		
Step 3.2: Adjusted using a range of avoidance rates:				
98.00%	**0.4469**	**approx one collision every**	**2.24**	**years**

[1] The survey risk volume was derived from the windfarm polygon including a precautionary 500m buffer around the turbine rotors.

[2] The total number of daylight hours during the period

[3] A= size of windfarm polygon(ha) h= rotor diameter (m)

[4] N= number of turbines, r= rotor radius (m), d= max depth of rotors (m)

[5]Assumes bird length=0.28m, wingspan 0.72m, flight speed= 17.5m/sec

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	Viewsheds								
	4	5	7						
STAGE 1: Estimation of rotor transits									
Step 1.1: Seconds occupancy of the survey risk volume (T_w)[1] recorded within each viewshed (T_wV)	1035	2,400	141						
Step 1.2: Unweighted occupancy rate each viewshed ($T_wV$rate)									
Hours of survey effort (*e*)	141	102	141						
Windfarm area (ha) visible within viewshed (*v*)[1]	209.36	16.51	245.31						
Observation effort (*e***v*)	29414.83	1683.71	34588.97						
T_wV rate=$T_wV/e*v$	9.77E-06	3.96E-04	1.13E-06						
Step 1.3: Weighted occupancy rate *(weighted T_wV rate)*[1]									
Weight: proportion of total survey effort made at the VP	0.448	0.026	0.527						
Weighted T_wV rate (T_wV rate * weight)	4.38E-06	1.01E-05	5.96E-07						
Total weighted occupancy rate	0.000015				birds seconds per ha/hour				
Mean % activity hr^-1 in wind farm at risk height	0.556%								

Mean % activity hr^-1 in wind farm at rotor height (z)	0.450%	
Step 1.4: Total occupancy of risk volume during surveys (T_w)		
Hours potentially active: breeding season (a) (footnote 2)	5,560	hours
Tw=z*a	25.02	hours
Step 1.6: Flight risk volume (V_w)		
Risk volume: $V_w=A*h$ (footnote 3)	595,111,814	m^3
Step 1.7: Volume swept by windfarm rotors (V_r)		
Bird length (L)	0.28	m
Rotor-swept volume: $V_r=N*\pi*r^2*(d+L)$ footnote 4	566,417.47	m^3
Step 1.8: Bird occupancy of rotor-swept volume (Tr)		
$T_r=T_w*(V_r/Vw)$	85.7226	seconds
Step 1.9: Time taken to transit rotor *(t)*		
Flight speed *(s)*	18	m/sec
$t=(d+L)/s$	0.25	seconds
Step 1.10: Number of rotor transits (N)		
$N=T_r/t$	337	rotor transits
STAGE 2: Probability of Collision for a bird flying through rotors (*p*(collision)) from SNH spreadsheet[5]	0.043	

STAGE 3: Predicted mortality (birds per year)				
Step 3.1: With no avoidance, turbines operational 85% of the time N*p(collision)*0.85	12.256	collisions		
Step 3.2: Adjusted using a range of avoidance rates:				
98.00%	**0.2451**	**approx one collision every**	**4.08**	**years**

[1] The survey risk volume was derived from the windfarm polygon including a precautionary 500m buffer around the turbine rotors.

[2] The total number of daylight hours during the period

[3] A= size of windfarm polygon(ha) h= rotor diameter (m)

[4] N= number of turbines, r= rotor radius (m), d= max depth of rotors (m)

[5]Assumes bird length=0.28m, wingspan 0.72m, flight speed= 17.5m/sec

Northern Lapwing North Cluster Non-Breeding 2017/18 Vestas 162

	Viewsheds								
	1	**2**	**3**						
STAGE 1: Estimation of rotor transits									
Step 1.1: Seconds occupancy of the survey risk volume (T_w)[1] recorded within each viewshed (T_wV)	0	0	93						
Step 1.2: Unweighted occupancy rate each viewshed ($T_wV$rate)									
Hours of survey effort (*e*)	51	43	40						
Windfarm area (ha) visible within viewshed (*v*)[1]	66.15	213.01	164.456						
Observation effort (*e*v*)	3373.65	9159.30	6578.24						
T_wV rate=$T_wV/e*v$	0.00E+00	0.00E+00	3.93E-06						
Step 1.3: Weighted occupancy rate *(weighted T_wV rate)*[1]									
Weight: proportion of total survey effort made at the VP	0.177	0.479	0.344						
Weighted T_wV rate (T_wV rate * weight)	0.00E+00	0.00E+00	1.35E-06						
Total weighted occupancy rate	0.000001					birds seconds per ha/hour			
Mean % activity hr^-1 in wind farm at risk height	0.069%								

Mean % activity hr^-1 in wind farm at rotor height (z)	0.066%	
Step 1.4: Total occupancy of risk volume during surveys (T_w)		
Hours potentially active: breeding season (a) (footnote 2)	2,860	hours
Tw=z*a	1.89	hours
Step 1.6: Flight risk volume (V_w)		
Risk volume: $V_w=A*h$ (footnote 3)	829,150,668	m^3
Step 1.7: Volume swept by windfarm rotors (V_r)		
Bird length (L)	0.3	m
Rotor-swept volume: $V_r=N*\pi*r^2*(d+L)$ footnote 4	663,706.06	m^3
Step 1.8: Bird occupancy of rotor-swept volume (Tr)		
$T_r=T_w*(V_r/Vw)$	5.43	seconds
Step 1.9: Time taken to transit rotor *(t)*		
Flight speed *(s)*	12.3	m/sec
$t=(d+L)/s$	0.37	seconds
Step 1.10: Number of rotor transits (N)		
$N=T_r/t$	15	rotor transits
STAGE 2: Probability of Collision for a bird flying through rotors (*p*(collision)) from SNH spreadsheet[5]	0.048	

STAGE 3: Predicted mortality (birds per year)				
Step 3.1: With no avoidance, turbines operational 85% of the time N*p(collision)*0.85	0.592	collisions		
Step 3.2: Adjusted using a range of avoidance rates:				
98.00%	**0.0118**	**approx one collision every**	**84.45**	**years**

[1] The survey risk volume was derived from the windfarm polygon including a precautionary 500m buffer around the turbine rotors.

[2] The total number of daylight hours during the period

[3] A= size of windfarm polygon(ha) h= rotor diameter (m)

[4] N= number of turbines, r= rotor radius (m), d= max depth of rotors (m)

[5]Assumes bird length=0.34m, wingspan 0.8m, flight speed= 12.7m/sec

Northern Lapwing North Cluster Annual Vestas 162

	Viewsheds								
	1	**2**	**3**						
STAGE 1: Estimation of rotor transits									
Step 1.1: Seconds occupancy of the survey risk volume (T_w)[1] recorded within each viewshed (T_wV)	0	0	93						
Step 1.2: Unweighted occupancy rate each viewshed (T_wVrate)									
Hours of survey effort (*e*)	159	150	148						
Windfarm area (ha) visible within viewshed (*v*)[1]	66.15	213.01	164.46						
Observation effort (*e***v*)	10517.85	31951.05	24339.49						
T_wV rate=$T_wV/e*v$	0.00E+00	0.00E+00	1.06E-06						
Step 1.3: Weighted occupancy rate *(weighted T_wV rate)*[1]									
Weight: proportion of total survey effort made at the VP	0.157	0.478	0.364						
Weighted T_wV rate (T_wV rate * weight)	0.00E+00	0.00E+00	3.87E-07						
Total weighted occupancy rate	0.000000					birds seconds per ha/hour			
Mean % activity hr^-1 in wind farm at risk height	0.020%								

Mean % activity hr^-1 in wind farm at rotor height (z)	0.016%	
Step 1.4: Total occupancy of risk volume during surveys (T_w)		
Hours potentially active: breeding season (a) (footnote 2)	5,560	hours
Tw=z*a	0.89	hours
Step 1.6: Flight risk volume (V_w)		
Risk volume: $V_w=A*h$ (footnote 3)	829,150,668	m^3
Step 1.7: Volume swept by windfarm rotors (V_r)		
Bird length (L)	0.3	m
Rotor-swept volume: $V_r=N*\pi*r^2*(d+L)$ footnote 4	663,706.06	m^3
Step 1.8: Bird occupancy of rotor-swept volume (Tr)		
$T_r=T_w*(V_r/Vw)$	2.5685	seconds
Step 1.9: Time taken to transit rotor *(t)*		
Flight speed *(s)*	12.3	m/sec
$t=(d+L)/s$	0.37	seconds
Step 1.10: Number of rotor transits (N)		
$N=T_r/t$	7	rotor transits
STAGE 2: Probability of Collision for a bird flying through rotors (*p*(collision)) from SNH spreadsheet[5]	0.048	

STAGE 3: Predicted mortality (birds per year)				
Step 3.1: With no avoidance, turbines operational 85% of the time N*p(collision)*0.85	0.280	collisions		
Step 3.2: Adjusted using a range of avoidance rates:				
98.00%	**0.0056**	**approx one collision every**	**178.63**	**years**

[1] The survey risk volume was derived from the windfarm polygon including a precautionary 500m buffer around the turbine rotors.

[2] The total number of daylight hours during the period

[3] A= size of windfarm polygon(ha) h= rotor diameter (m)

[4] N= number of turbines, r= rotor radius (m), d= max depth of rotors (m)

[5]Assumes bird length=0.34m, wingspan 0.8m, flight speed= 12.7m/sec

Northern Lapwing South Cluster Non-Breeding 2021/22 Vestas 162

	Viewsheds								
	4	5	7						
STAGE 1: Estimation of rotor transits									
Step 1.1: Seconds occupancy of the survey risk volume (T_w)[1] recorded within each viewshed (T_wV)	0	0	2,250						
Step 1.2: Unweighted occupancy rate each viewshed ($T_wV$rate)									
Hours of survey effort (*e*)	36	42	39						
Windfarm area (ha) visible within viewshed (*v*)[1]	209.36	16.51	245.31184						
Observation effort (*e*v*)	7536.90	693.29	9567.16						
T_wV rate=$T_wV/e*v$	0.00E+00	0.00E+00	6.53E-05						
Step 1.3: Weighted occupancy rate *(weighted T_wV rate)*[1]									
Weight: proportion of total survey effort made at the VP	0.423	0.039	0.538						
Weighted T_wV rate (T_wV rate * weight)	0.00E+00	0.00E+00	3.51E-05						
Total weighted occupancy rate	0.000035				birds seconds per ha/hour				
Mean % activity hr^-1 in wind farm at risk height	1.290%								

Mean % activity hr^-1 in wind farm at rotor height (z)	1.045%	
Step 1.4: Total occupancy of risk volume during surveys (T_w)		
Hours potentially active: breeding season (a) (footnote 2)	2,860	hours
Tw=z*a	29.88	hours
Step 1.6: Flight risk volume (V_w)		
Risk volume: $V_w=A*h$ (footnote 3)	595,111,814	m^3
Step 1.7: Volume swept by windfarm rotors (V_r)		
Bird length (L)	0.3	m
Rotor-swept volume: $V_r=N*\pi*r^2*(d+L)$ footnote 4	568,890.91	m^3
Step 1.8: Bird occupancy of rotor-swept volume (Tr)		
$T_r=T_w*(V_r/Vw)$	102.83	seconds
Step 1.9: Time taken to transit rotor *(t)*		
Flight speed *(s)*	12.3	m/sec
$t=(d+L)/s$	0.37	seconds
Step 1.10: Number of rotor transits (N)		
$N=T_r/t$	275	rotor transits
STAGE 2: Probability of Collision for a bird flying through rotors (*p*(collision)) from SNH spreadsheet[5]	0.048	

STAGE 3: Predicted mortality (birds per year)				
Step 3.1: With no avoidance, turbines operational 85% of the time N*p(collision)*0.85	11.207	collisions		
Step 3.2: Adjusted using a range of avoidance rates:				
98.00%	**0.2241**	**approx one collision every**	**4.46**	**years**

[1] The survey risk volume was derived from the windfarm polygon including a precautionary 500m buffer around the turbine rotors.

[2] The total number of daylight hours during the period

[3] A= size of windfarm polygon(ha) h= rotor diameter (m)

[4] N= number of turbines, r= rotor radius (m), d= max depth of rotors (m)

[5]Assumes bird length=0.30m, wingspan 0.84m, flight speed= 12.3m/sec

Northern Lapwing South Cluster Annual Vestas 162

	Viewsheds								
	4	5	7						
STAGE 1: Estimation of rotor transits									
Step 1.1: Seconds occupancy of the survey risk volume (T_w)[1] recorded within each viewshed (T_wV)	0	0	2,250						
Step 1.2: Unweighted occupancy rate each viewshed ($T_wV$rate)									
Hours of survey effort (*e*)	141	102	141						
Windfarm area (ha) visible within viewshed (*v*)[1]	209.36	16.51	245.31						
Observation effort (*e*v*)	29414.83	1683.71	34588.97						
T_wV rate=$T_wV/e*v$	0.00E+00	0.00E+00	1.81E-05						
Step 1.3: Weighted occupancy rate *(weighted T_wV rate)*[1]									
Weight: proportion of total survey effort made at the VP	0.448	0.026	0.527						
Weighted T_wV rate (T_wV rate * weight)	0.00E+00	0.00E+00	9.51E-06						
Total weighted occupancy rate	0.000010				birds seconds per ha/hour				
Mean % activity hr^-1 in wind farm at risk height	0.350%								

Mean % activity hr^-1 in wind farm at rotor height (z)	0.283%	
Step 1.4: Total occupancy of risk volume during surveys (T_w)		
Hours potentially active: breeding season (a) (footnote 2)	5,560	hours
Tw=z*a	15.74	hours
Step 1.6: Flight risk volume (V_w)		
Risk volume: $V_w=A*h$ (footnote 3)	595,111,814	m^3
Step 1.7: Volume swept by windfarm rotors (V_r)		
Bird length (L)	0.3	m
Rotor-swept volume: $V_r=N*\pi*r^2*(d+L)$ footnote 4	568,890.91	m^3
Step 1.8: Bird occupancy of rotor-swept volume (Tr)		
$T_r=T_w*(V_r/Vw)$	54.1717	seconds
Step 1.9: Time taken to transit rotor *(t)*		
Flight speed *(s)*	12.3	m/sec
$t=(d+L)/s$	0.37	seconds
Step 1.10: Number of rotor transits (N)		
$N=T_r/t$	145	rotor transits
STAGE 2: Probability of Collision for a bird flying through rotors (*p*(collision)) from SNH spreadsheet[5]	0.048	

STAGE 3: Predicted mortality (birds per year)				
Step 3.1: With no avoidance, turbines operational 85% of the time N*p(collision)*0.85	5.904	collisions		
Step 3.2: Adjusted using a range of avoidance rates:				
98.00%	**0.1181**	**approx one collision every**	**8.47**	**years**

[1] The survey risk volume was derived from the windfarm polygon including a precautionary 500m buffer around the turbine rotors.

[2] The total number of daylight hours during the period

[3] A= size of windfarm polygon(ha) h= rotor diameter (m)

[4] N= number of turbines, r= rotor radius (m), d= max depth of rotors (m)

[5] Assumes bird length=0.30m, wingspan 0.84m, flight speed= 12.3m/sec

Common Snipe North Cluster Breeding Season Vestas 162

	Viewsheds								
	1	**2**	**3**						
STAGE 1: Estimation of rotor transits									
Step 1.1: Seconds occupancy of the survey risk volume (T_w)[1] recorded within each viewshed (T_wV)	5610	600	0						
Step 1.2: Unweighted occupancy rate each viewshed ($T_wV$rate)									
Hours of survey effort (*e*)	72	72	72						
Windfarm area (ha) visible within viewshed (*v*)[1]	82.35	325.82	171.6626						
Observation effort (*e*v*)	5929.45	23459.30	12359.71						
T_wV rate=$T_wV/e*v$	2.63E-04	7.10E-06	0.00E+00						
Step 1.3: Weighted occupancy rate *(weighted T_wV rate)*[1]									
Weight: proportion of total survey effort made at the VP	0.142	0.562	0.296						
Weighted T_wV rate (T_wV rate * weight)	3.73E-05	3.99E-06	0.00E+00						
Total weighted occupancy rate			0.000041			birds seconds per ha/hour			
Mean % activity hr^-1 in wind farm at risk height			2.115%						
Mean % activity hr^-1 in wind farm at rotor height (z)			1.713%						

Step 1.4: Total occupancy of risk volume during surveys (T_w)		
Hours potentially active: breeding season (a) (footnote 2)	2,700	hours
Tw=z*a	46.26	hours
Step 1.6: Flight risk volume (V_w)		
Risk volume: $V_w=A*h$ (footnote 3)	829,150,668	m^3
Step 1.7: Volume swept by windfarm rotors (V_r)		
Bird length (L)	0.26	m
Rotor-swept volume: $V_r=N*\pi*r^2*(d+L)$ footnote 4	657,934.70	m^3
Step 1.8: Bird occupancy of rotor-swept volume (Tr)		
$T_r=T_w*(V_r/Vw)$	132.1430	seconds
Step 1.9: Time taken to transit rotor *(t)*		
Flight speed *(s)*	16	m/sec
$t=(d+L)/s$	0.29	seconds
Step 1.10: Number of rotor transits (N)		
$N=T_r/t$	464	rotor transits
STAGE 2: Probability of Collision for a bird flying through rotors (*p*(collision)) from SNH spreadsheet[5]	0.042	
STAGE 3: Predicted mortality (birds per year)		
Step 3.1: With no avoidance, turbines operational 85% of the time N*p(collision)*0.85	16.635	collisions

Step 3.2: Adjusted using a range of avoidance rates:				
98.00%	**0.3327**	**approx one collision every**	**3.01**	**years**

[1] The survey risk volume was derived from the windfarm polygon including a precautionary 500m buffer around the turbine rotors.

[2] The total number of daylight hours during the period

[3] A= size of windfarm polygon(ha) h= rotor diameter (m)

[4] N= number of turbines, r= rotor radius (m), d= max depth of rotors (m)

[5]Assumes bird length=0.26m, wingspan 0.455m, flight speed= 16.0m/sec

Common Snipe North Cluster Non-Breeding Season 2017/18 Vestas 162

	Viewsheds								
	1	2	3						
STAGE 1: Estimation of rotor transits									
Step 1.1: Seconds occupancy of the survey risk volume (T_w)[1] recorded within each viewshed (T_wV)	0	0	31						
Step 1.2: Unweighted occupancy rate each viewshed ($T_wV$rate)									
Hours of survey effort (*e*)	51	43	40						
Windfarm area (ha) visible within viewshed (*v*)[1]	82.35	325.82	171.66259						
Observation effort (*e*v*)	4200.03	14010.41	6866.50						
T_wV rate=$T_wV/e*v$	0.00E+00	0.00E+00	1.25E-06						
Step 1.3: Weighted occupancy rate *(weighted T_wV rate)*[1]									
Weight: proportion of total survey effort made at the VP	0.167	0.559	0.274						
Weighted T_wV rate (T_wV rate * weight)	0.00E+00	0.00E+00	3.43E-07						
Total weighted occupancy rate	0.000000				birds seconds per ha/hour				
Mean % activity hr^-1 in wind farm at risk height	0.018%								

Mean % activity hr^-1 in wind farm at rotor height (z)	0.017%	
Step 1.4: Total occupancy of risk volume during surveys (T_w)		
Hours potentially active: breeding season (a) (footnote 2)	2,860	hours
Tw=z*a	0.48	hours
Step 1.6: Flight risk volume (V_w)		
Risk volume: $V_w=A*h$ (footnote 3)	829,150,668	m^3
Step 1.7: Volume swept by windfarm rotors (V_r)		
Bird length (L)	0.26	m
Rotor-swept volume: $V_r=N*\pi*r^2*(d+L)$ footnote 4	657,934.70	m^3
Step 1.8: Bird occupancy of rotor-swept volume (Tr)		
$T_r=T_w*(V_r/Vw)$	1.37	seconds
Step 1.9: Time taken to transit rotor *(t)*		
Flight speed *(s)*	16	m/sec
$t=(d+L)/s$	0.29	seconds
Step 1.10: Number of rotor transits (N)		
$N=T_r/t$	5	rotor transits
STAGE 2: Probability of Collision for a bird flying through rotors (*p*(collision)) from SNH spreadsheet[5]	0.042	

STAGE 3: Predicted mortality (birds per year)				
Step 3.1: With no avoidance, turbines operational 85% of the time N*p(collision)*0.85	0.172	collisions		
Step 3.2: Adjusted using a range of avoidance rates:				
98.00%	**0.0034**	**approx one collision every**	**290.33**	**years**

[1] The survey risk volume was derived from the windfarm polygon including a precautionary 500m buffer around the turbine rotors.

[2] The total number of daylight hours during the period

[3] A= size of windfarm polygon(ha) h= rotor diameter (m)

[4] N= number of turbines, r= rotor radius (m), d= max depth of rotors (m)

[5]Assumes bird length=0.26m, wingspan 0.455m, flight speed= 16.0m/sec

Common Snipe North Cluster Non-Breeding Season 2020/21 Vestas 162

	Viewsheds								
	1	**2**	**3**						
STAGE 1: Estimation of rotor transits									
Step 1.1: Seconds occupancy of the survey risk volume (T_w)[1] recorded within each viewshed (T_wV)	0	15	0						
Step 1.2: Unweighted occupancy rate each viewshed ($T_wV$rate)									
Hours of survey effort (*e*)	36	35	36						
Windfarm area (ha) visible within viewshed (*v*)[1]	82.35	325.82	171.66259						
Observation effort (*e*v*)	2964.73	11403.82	6179.85						
T_wV rate=$T_wV/e*v$	0.00E+00	3.65E-07	0.00E+00						
Step 1.3: Weighted occupancy rate *(weighted T_wV rate)*[1]									
Weight: proportion of total survey effort made at the VP	0.144	0.555	0.301						
Weighted T_wV rate (T_wV rate * weight)	0.00E+00	2.03E-07	0.00E+00						
Total weighted occupancy rate	0.000000				birds seconds per ha/hour				
Mean % activity hr^-1 in wind farm at risk height	0.010%								

Mean % activity hr^-1 in wind farm at rotor height (z)	0.008%	
Step 1.4: Total occupancy of risk volume during surveys (T_w)		
Hours potentially active: breeding season (a) (footnote 2)	2,860	hours
Tw=z*a	0.24	hours
Step 1.6: Flight risk volume (V_w)		
Risk volume: $V_w=A*h$ (footnote 3)	829,150,668	m^3
Step 1.7: Volume swept by windfarm rotors (V_r)		
Bird length (L)	0.26	m
Rotor-swept volume: $V_r=N*\pi*r^2*(d+L)$ footnote 4	657,934.70	m^3
Step 1.8: Bird occupancy of rotor-swept volume (Tr)		
$T_r=T_w*(V_r/Vw)$	0.69	seconds
Step 1.9: Time taken to transit rotor *(t)*		
Flight speed *(s)*	16	m/sec
$t=(d+L)/s$	0.29	seconds
Step 1.10: Number of rotor transits (N)		
$N=T_r/t$	2	rotor transits
STAGE 2: Probability of Collision for a bird flying through rotors (*p*(collision)) from SNH spreadsheet[5]	0.042	

STAGE 3: Predicted mortality (birds per year)				
Step 3.1: With no avoidance, turbines operational 85% of the time N*p(collision)*0.85	0.086	collisions		
Step 3.2: Adjusted using a range of avoidance rates:				
98.00%	**0.0017**	**approx one collision every**	**578.42**	**years**

[1] The survey risk volume was derived from the windfarm polygon including a precautionary 500m buffer around the turbine rotors.

[2] The total number of daylight hours during the period

[3] A= size of windfarm polygon(ha) h= rotor diameter (m)

[4] N= number of turbines, r= rotor radius (m), d= max depth of rotors (m)

[5]Assumes bird length=0.26m, wingspan 0.455m, flight speed= 16.0m/sec

Common Snipe North Cluster Annual Vestas 162

	Viewsheds								
	1	2	3						
STAGE 1: Estimation of rotor transits									
Step 1.1: Seconds occupancy of the survey risk volume (T_w)[1] recorded within each viewshed (T_wV)	5610	615	31						
Step 1.2: Unweighted occupancy rate each viewshed ($T_wV$rate)									
Hours of survey effort (*e*)	159	150	148						
Windfarm area (ha) visible within viewshed (*v*)[1]	82.35	325.82	171.66						
Observation effort (*e**v*)	13094.21	48873.53	25406.06						
T_wV rate=$T_wV/e*v$	1.19E-04	3.50E-06	3.39E-07						
Step 1.3: Weighted occupancy rate *(weighted T_wV rate)*[1]									
Weight: proportion of total survey effort made at the VP	0.150	0.559	0.291						
Weighted T_wV rate (T_wV rate * weight)	1.78E-05	1.96E-06	9.86E-08						
Total weighted occupancy rate	0.000020					birds seconds per ha/hour			
Mean % activity hr^-1 in wind farm at risk height	1.018%								

Mean % activity hr^-1 in wind farm at rotor height (z)	0.825%	
Step 1.4: Total occupancy of risk volume during surveys (T_w)		
Hours potentially active: breeding season (a) (footnote 2)	5,560	hours
Tw=z*a	45.84	hours
Step 1.6: Flight risk volume (V_w)		
Risk volume: $V_w=A*h$ (footnote 3)	829,150,668	m^3
Step 1.7: Volume swept by windfarm rotors (V_r)		
Bird length (L)	0.26	m
Rotor-swept volume: $V_r=N*\pi*r^2*(d+L)$ footnote 4	657,934.70	m^3
Step 1.8: Bird occupancy of rotor-swept volume (Tr)		
$T_r=T_w*(V_r/Vw)$	130.9610	seconds
Step 1.9: Time taken to transit rotor *(t)*		
Flight speed *(s)*	16	m/sec
$t=(d+L)/s$	0.29	seconds
Step 1.10: Number of rotor transits (N)		
$N=T_r/t$	460	rotor transits
STAGE 2: Probability of Collision for a bird flying through rotors (*p*(collision)) from SNH spreadsheet[5]	0.042	
STAGE 3: Predicted mortality (birds per year)		

Step 3.1: With no avoidance, turbines operational 85% of the time N*p(collision)*0.85	16.486	collisions			
Step 3.2: Adjusted using a range of avoidance rates:					
98.00%	**0.3297**	**approx one collision every**	**3.03**	**years**	

[1] The survey risk volume was derived from the windfarm polygon including a precautionary 500m buffer around the turbine rotors.

[2] The total number of daylight hours during the period

[3] A= size of windfarm polygon(ha) h= rotor diameter (m)

[4] N= number of turbines, r= rotor radius (m), d= max depth of rotors (m)

[5]Assumes bird length=0.26m, wingspan 0.455m, flight speed= 16.0m/sec

Common Snipe South Cluster Non-Breeding Season 2020/21 Vestas 162

	Viewsheds								
	4	5	7						
STAGE 1: Estimation of rotor transits									
Step 1.1: Seconds occupancy of the survey risk volume (T_w)[1] recorded within each viewshed (T_wV)	0	0	105						
Step 1.2: Unweighted occupancy rate each viewshed ($T_wV$rate)									
Hours of survey effort (*e*)	36	42	39						
Windfarm area (ha) visible within viewshed (*v*)[1]	209.36	16.51	245.31184						
Observation effort (*e***v*)	7536.90	693.29	9567.16						
T_wV rate=$T_wV/e*v$	0.00E+00	0.00E+00	3.05E-06						
Step 1.3: Weighted occupancy rate *(weighted T_wV rate)*[1]									
Weight: proportion of total survey effort made at the VP	0.423	0.039	0.538						
Weighted T_wV rate (T_wV rate * weight)	0.00E+00	0.00E+00	1.64E-06						
Total weighted occupancy rate	0.000002				birds seconds per ha/hour				
Mean % activity hr^-1 in wind farm at risk height	0.060%								

Mean % activity hr^-1 in wind farm at rotor height (z)	0.049%	
Step 1.4: Total occupancy of risk volume during surveys (T_w)		
Hours potentially active: breeding season (a) (footnote 2)	2,107	hours
Tw=z*a	1.03	hours
Step 1.6: Flight risk volume (V_w)		
Risk volume: $V_w=A*h$ (footnote 3)	595,111,814	m^3
Step 1.7: Volume swept by windfarm rotors (V_r)		
Bird length (L)	0.26	m
Rotor-swept volume: $V_r=N*\pi*r^2*(d+L)$ footnote 4	563,944.03	m^3
Step 1.8: Bird occupancy of rotor-swept volume (Tr)		
$T_r=T_w*(V_r/Vw)$	3.50	seconds
Step 1.9: Time taken to transit rotor *(t)*		
Flight speed *(s)*	16	m/sec
$t=(d+L)/s$	0.29	seconds
Step 1.10: Number of rotor transits (N)		
$N=T_r/t$	12	rotor transits
STAGE 2: Probability of Collision for a bird flying through rotors (*p*(collision)) from SNH spreadsheet[5]	0.042	

STAGE 3: Predicted mortality (birds per year)				
Step 3.1: With no avoidance, turbines operational 85% of the time N*p(collision)*0.85	0.441	collisions		
Step 3.2: Adjusted using a range of avoidance rates:				
98.00%	**0.0088**	**approx one collision every**	**113.33**	**years**

[1] The survey risk volume was derived from the windfarm polygon including a precautionary 500m buffer around the turbine rotors.

[2] The total number of daylight hours during the period

[3] A= size of windfarm polygon(ha) h= rotor diameter (m)

[4] N= number of turbines, r= rotor radius (m), d= max depth of rotors (m)

[5]Assumes bird length=0.26m, wingspan 0.455m, flight speed= 16.0m/sec

Common Snipe South Cluster Annual Vestas 162

	Viewsheds								
	4	5	7						
STAGE 1: Estimation of rotor transits									
Step 1.1: Seconds occupancy of the survey risk volume (T_w)[1] recorded within each viewshed (T_wV)	0	0	105						
Step 1.2: Unweighted occupancy rate each viewshed (T_wVrate)									
Hours of survey effort (*e*)	141	102	141						
Windfarm area (ha) visible within viewshed (*v*)[1]	209.36	16.51	245.31						
Observation effort (*e*v*)	29414.83	1683.71	34588.97						
T_wV rate=$T_wV/e*v$	0.00E+00	0.00E+00	8.43E-07						
Step 1.3: Weighted occupancy rate *(weighted T_wV rate)*[1]									
Weight: proportion of total survey effort made at the VP	0.448	0.026	0.527						
Weighted T_wV rate (T_wV rate * weight)	0.00E+00	0.00E+00	4.44E-07						
Total weighted occupancy rate	0.000000				birds seconds per ha/hour				
Mean % activity hr^-1 in wind farm at risk height	0.016%								

Mean % activity hr^-1 in wind farm at rotor height (z)	0.013%	
Step 1.4: Total occupancy of risk volume during surveys (T_w)		
Hours potentially active: breeding season (a) (footnote 2)	4,483	hours
Tw=z*a	0.59	hours
Step 1.6: Flight risk volume (V_w)		
Risk volume: $V_w=A*h$ (footnote 3)	595,111,814	m^3
Step 1.7: Volume swept by windfarm rotors (V_r)		
Bird length (L)	0.26	m
Rotor-swept volume: $V_r=N*\pi*r^2*(d+L)$ footnote 4	563,944.03	m^3
Step 1.8: Bird occupancy of rotor-swept volume (Tr)		
$T_r=T_w*(V_r/Vw)$	2.0207	seconds
Step 1.9: Time taken to transit rotor *(t)*		
Flight speed *(s)*	16	m/sec
$t=(d+L)/s$	0.29	seconds
Step 1.10: Number of rotor transits (N)		
$N=T_r/t$	7	rotor transits
STAGE 2: Probability of Collision for a bird flying through rotors (*p*(collision)) from SNH spreadsheet[5]	0.042	

STAGE 3: Predicted mortality (birds per year)					
Step 3.1: With no avoidance, turbines operational 85% of the time N*p(collision)*0.85	0.254	collisions			
Step 3.2: Adjusted using a range of avoidance rates:					
98.00%	**0.0051**	**approx one collision every**	**196.56**	**years**	

[1] The survey risk volume was derived from the windfarm polygon including a precautionary 500m buffer around the turbine rotors.

[2] The total number of daylight hours during the period

[3] A= size of windfarm polygon(ha) h= rotor diameter (m)

[4] N= number of turbines, r= rotor radius (m), d= max depth of rotors (m)

[5]Assumes bird length=0.26m, wingspan 0.455m, flight speed= 16.0m/sec

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SLR

Appendix 3

Aquatic Ecology Report

Coolglass Wind Farm NIS

Coolglass Wind Farm Limited

SLR Project No.: 501.V00727.00006

11 July 2023

SLR

Aquatic baseline report for Coolglass wind farm, Co. Laois

Prepared by Triturus Environmental Ltd. for SLR Consulting

December 2022

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Table of contents

1. Introduction

1.1 Background

Triturus Environmental Ltd. were commissioned by SLR Consulting to conduct baseline aquatic surveys to inform EIAR preparation for the proposed Coolglass (formerly Fossy) wind farm project (inclusive of potential grid connection routes). The following report provides a baseline assessment of the aquatic ecology including fisheries and biological water quality, as well as protected aquatic species and habitats in the vicinity of the proposed Coolglass wind farm, approximately 11km south-east of Portlaoise, Co. Laois.

Undertaken on a catchment-wide scale, the baseline surveys focused on the detection of freshwater habitats and species of high conservation value. These included surveys for white-clawed crayfish (*Austropotamobius pallipes*), freshwater pearl mussel (*Margaritifera margaritifera*) (eDNA only), macro-invertebrates (biological water quality) and fish of high conservation inclusive of supporting nursery and spawning habitat. The surveys also documented macrophyte and aquatic bryophyte communities including Annex I Habitat associations in the vicinity of the project (**Figure 2.1**). The surveys were undertaken in August and September 2022.

1.2 Project description

A full description of the proposed project is provided in the accompanying Environmental Impact Assessment Report (EIAR).

2. Methodology

2.1 Selection of watercourses for assessment

All freshwater watercourses which could be affected directly or indirectly by the proposed wind farm project were considered as part of the current assessment. A total of *n*=33 riverine sites were selected for detailed aquatic assessment (see **Table 2.1, Figure 2.1** below). The nomenclature for the watercourses surveyed is as per the Environmental Protection Agency (EPA). Aquatic survey sites were present on the Fallowbeg Upper Stream (EPA code: 14F06), Crooked River (14C02) an unnamed tributary, Honey Stream (14H01), Honey Stream North (14H21), Aghoney Stream (14A08), Fossy Lower Stream (14F10), Timahoe Stream (14T09) and Stradbally River (14S02) in the Barrow_SC_050 river sub-catchment. Sites were also surveyed on the Scotland Stream (15S06), Owveg River 915O01), Cleanagh Stream (15C58), Garrintaggart Stream (15G30), Graiguenahown Stream (15G29), Knocklead Stream (15K21), Clogh River (15C03), Brennanshill River (15B51), Moyadd Stream (15M22) and the Douglass River (15D03) in the Nore_SC_060, Dinin[North]_SC_10 and Barrow_SC_070 river sub-catchments (**Table 2.1**).

The proposed wind farm site was not located within a European site. However, there was potential downstream connectivity to the River Barrow and River Nore SAC (002162) via the Stradbally River (flowing north-east), Owveg River (flowing south-west) and Clogh River (flowing south) (**Figure 2.1**).

Please note this aquatic report should be read in conjunction with the final Environmental Impact Assessment Report (EIAR) prepared for the proposed project. More specific aquatic methodology is outlined below and in the appendices of this report.

2.2 Aquatic site surveys

Aquatic surveys of the watercourses within the vicinity of the proposed wind farm project were conducted on Wednesday 31st August to Saturday 3rd September 2022. Survey effort focused on both instream and riparian habitats at each aquatic sampling location (**Figure 2.1**). Surveys at each of these sites included a fisheries assessment (electro-fishing and or fisheries habitat appraisal), white-clawed crayfish survey, macrophyte and aquatic bryophyte survey and (where suitable) biological water quality sampling (Q-sampling) or macro-invertebrate sweep sampling. (**Figure 2.1**).

Suitability for freshwater pearl mussel (*Margaritifera margaritifera*) was assessed at each survey site with environmental DNA (eDNA) sampling undertaken for the species at *n*=4 strategically chosen riverine locations within the vicinity of the project. These water samples were also analysed for white-clawed crayfish (*Austropotamobius pallipes*) and crayfish plague (*Aphanomyces astaci*). This holistic approach informed the overall aquatic ecological evaluation of each site in context of the proposed project and ensured that any habitats and species of high conservation value would be detected to best inform mitigation for the wind farm project.

In addition to the ecological characteristics of the site, a broad aquatic and riparian habitat assessment was conducted utilising elements of the methodology given in the Environment Agency's 'River Habitat Survey in Britain and Ireland Field Survey Guidance Manual 2003' (EA, 2003) and the Irish Heritage Council's 'A Guide to Habitats in Ireland' (Fossitt, 2000). This broad characterisation helped define the watercourses' conformity or departure from naturalness. All sites were assessed in terms of:

- Physical watercourse/waterbody characteristics (i.e. width, depth etc.) including associated evidence of historical drainage
- Substrate type, listing substrate fractions in order of dominance (i.e. bedrock, boulder, cobble, gravel, sand, silt etc.)
- Flow type by proportion of riffle, glide and pool in the sampling area
- An appraisal of the macrophyte and aquatic bryophyte community at each site
- Riparian vegetation composition

2.3 Fish stock assessment (electro-fishing)

A single anode Smith-Root LR24 backpack (12V DC input; 300V, 100W DC output) was used to electro-fish sites on watercourses in the vicinity of the proposed Coolglass wind farm in August and September 2022, following notification to Inland Fisheries Ireland, under the conditions of a Department of the Environment, Climate and Communications (DECC) licence. Electro-fishing was proposed for all riverine survey sites. However, eight sites, A2 (Crooked River), A3 (unnamed stream), A7 (Aghoney Stream), A8 (Fossy Lower Stream), A10 (Timahoe Stream), A13 (unnamed stream), B7 (Owveg River) and C5 (Moyaddd Stream) were dry at the time of survey. Therefore, a total of *n*=25 sites were surveyed via electro-fishing (**Table 2.1, Figure 2.1; Appendix A**). The survey was undertaken in accordance with best practice (CEN, 2003; CFB, 2008) and Section 14 licencing requirements.

Furthermore, a fisheries habitat appraisal of the aquatic survey sites (**Figure 2.1**) (inclusive of ephemeral sites) was undertaken to establish their importance for salmonid, lamprey, European eel and other fish species. The baseline assessment also considered the quality of spawning, nursery and holding habitat for salmonids and lamprey within the vicinity of the survey sites. For detailed survey methodology, please refer to accompanying fisheries assessment report in **Appendix A.**

2.4 White-clawed crayfish survey

White-clawed crayfish (*Austropotamobius pallipes*) surveys were undertaken at the aquatic survey sites in August 2022 under a National Parks and Wildlife (NPWS) open licence (no. C31/2022), as prescribed by Sections 9, 23 and 34 of the Wildlife Act (1976-2021), to capture and release crayfish to their site of capture, under condition no. 6 of the licence. As per Inland Fisheries Ireland recommendations, the crayfish sampling started at the uppermost site(s) of the wind farm catchment/sub-catchments in the survey area to minimise the risk of transfer invasive propagules (including crayfish plague) in an upstream direction.

Hand-searching of instream refugia and sweep netting was undertaken according to Reynolds et al. (2010). An appraisal of white-clawed crayfish habitat at each site was conducted based on physical channel attributes, water chemistry and incidental records in mustelid spraint. Additionally, a desktop review of crayfish records within the wider Coolglass wind farm survey area was completed.

Table 2.1 Location of *n*=33 aquatic survey sites in the vicinity of Coolglass wind farm, Co. Laois (* indicates eDNA sampling)

Site no.	Watercourse	EPA code	Location	X (ITM)	Y (ITM)
A1	Fallowbeg Upper Stream	14F06	Fallowbeg Upper	[redacted]	
A2	Crooked River	14C02	Local road crossing, Luggacurreen		
A3	Unnamed stream	n/a	Fallowbeg Upper		
A4	Honey Stream	14H01	L38401 road crossing, Fossy Upper		
A5	Honey Stream North	14H21	Proposed GCR crossing, L3838		
A6	Crooked River	14C02	Timogue Bridge		
A7	Aghoney Stream	14A08	Proposed GCR crossing, R426		
A8	Fossy Lower Stream	14F10	Proposed GCR crossing, Fossy Upper		
A9	Fossy Lower Stream	14F10	Proposed GCR crossing, R426		
A10	Timahoe Stream	14T09	Proposed GCR crossing, Fossy Lower		
A11	Stradbally River	14S02	Proposed GCR crossing, R426		
A12	Cremorgan Stream	14C24	Proposed GCR crossing, R426		
A13	Unnamed stream	n/a	Proposed GCR crossing, L3838		
A14	Stradbally River	14S02	Bauteogue Bridge		
A15*	Stradbally River	14S02	Stradbally Bridge, N80		
B1	Scotland Stream	15S06	Proposed GCR crossing, L3851		
B2	Owveg River	15O01	Knocklead		
B3	Owveg River	15O01	L7792 road crossing		
B4	Cleanagh Stream	15C58	L7792 road crossing		
B5	Garrintaggart Stream	15G30	L7792 road crossing		
B6	Garrintaggart Stream	15G30	R430 road crossing		
B7	Owveg River	15O01	Spink Bridge		
B8	Owveg River	15O01	R430 road crossing, Garrintaggart		
B9	Graiguenahown Stream	15G29	Graiguenahown		
B10*	Owveg River	15O01	Graiguenasmuttan Bridge		
C1	Knocklead Stream	15K21	R426 road crossing		
C2	Clogh River	15C03	Coolglass		
C3	Brennanshill River	15B51	Coolglass		
C4	Clogh River	15C03	Moyadd		
C5	Moyadd Stream	15M22	Kylenabehy		
C6	Clogh River	15C03	Swan Bridge		
C7*	Clogh River	15C03	Clogh Bridge		
D1*	Douglas River	15D03	Shanragh Bridge		

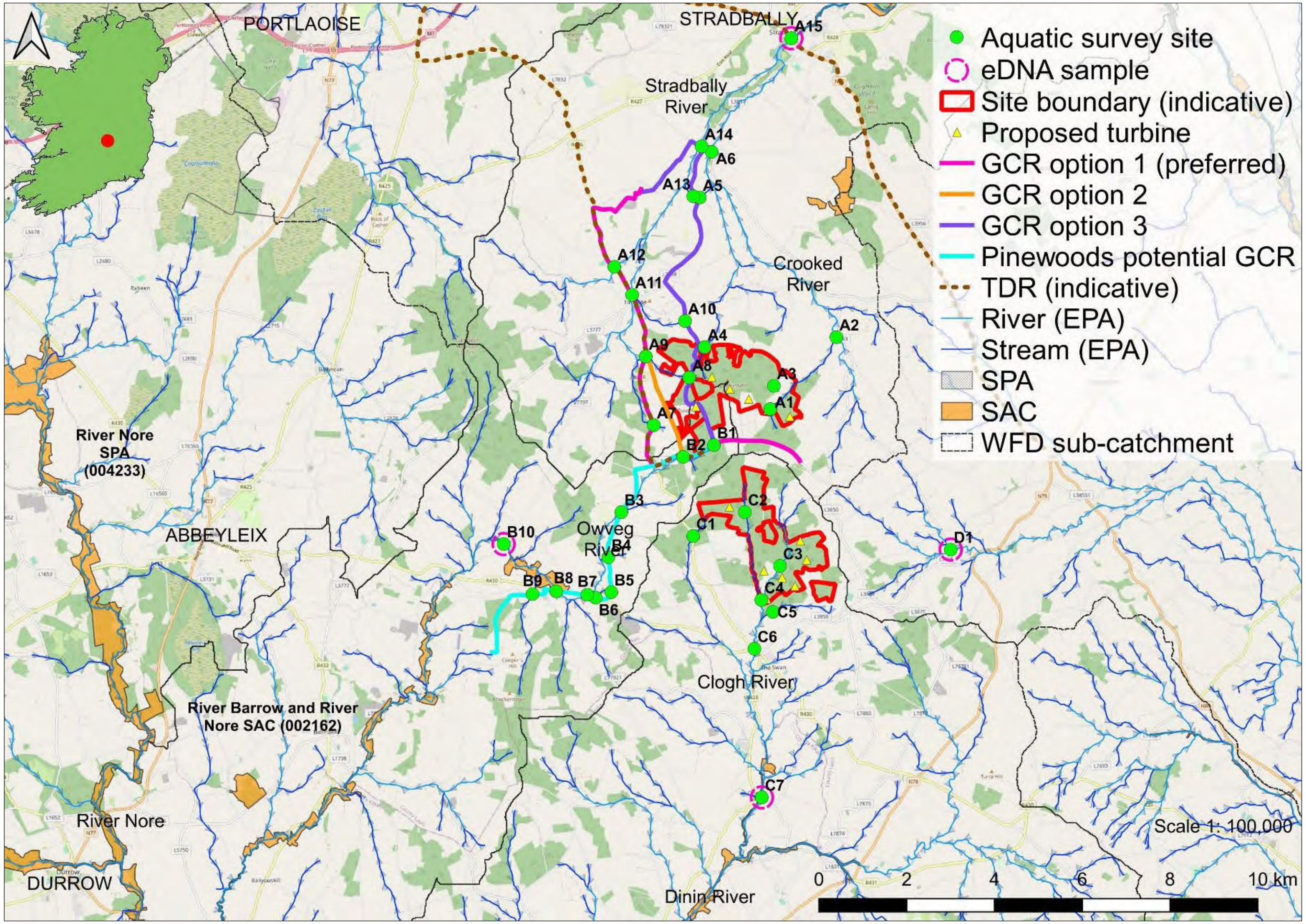

Figure 2.1 Overview of the *n*=33 aquatic survey site locations for Coolglass wind farm, Co. Laois

2.5 Freshwater pearl mussel survey (including eDNA)

There are no known freshwater pearl mussel (*Margaritifera margaritifera*) records in the Nore_SC_060, Dinin[North]_SC_10, Barrow_SC_050 and Barrow_SC_070 river sub-catchments. This was based on an extensive literature review and also examination of NPWS sensitive species data. However, records are known on the downstream-connecting River Nore in the vicinity of Ballyragget (see below). Following to the precautionary principle and to account for any lacunae in data for the species, environmental DNA (eDNA) samples were collected from the Stradbally River, Owveg River, Clogh River and Douglas River and analysed for freshwater pearl mussel eDNA to confirm the species' absence within vicinity of the proposed wind farm site. Please refer to section 2.6 (eDNA analysis) below for further detail.

Furthermore, a Stage 1 and 2 pearl mussel survey was undertaken on the 4th August by Sweeny Consultancy on 3.9km of the River Nore in the vicinity of the Owveg River confluence, ranging from Archer's Island (upstream of confluence) to Old Bridge, Ballyragget. The methodology and full survey report is provided in **Appendix D**.

2.6 eDNA analysis

To validate site surveys and to detect potentially cryptically-low populations of sensitive aquatic receptors within the study area, *n*=4 composite water samples were collected from the Stradbally River (site A15), Owveg River (B10), Clogh River (C7) and Douglas River (D1) and analysed for freshwater pearl mussel, white-clawed crayfish and crayfish plague environmental DNA (eDNA) (**Figure 2.1**). The water samples were collected on the 1st September 2022, with the sites strategically chosen to maximise longitudinal (instream) coverage within the catchment (i.e. facilitating a greater likelihood of species detection).

In accordance with best practice, a composite (500ml) water sample was collected from the sampling point, maximising the geographic spread at the site (20 x 25ml samples at each site), thus increasing the chance of detecting the target species' DNA. The composite sample was filtered on site using a sterile proprietary eDNA sampling kit. The fixed sample was stored at room temperature and sent to the laboratory for analysis with 48 hours of collection. A total of *n*=12 qPCR replicates were analysed for the site. Given the high sensitivity of eDNA analysis, a single positive qPCR replicate is considered as proof of the species' presence (termed qPCR No Threshold, or qPCR NT). Whilst an eDNA approach is not currently quantitative, the detection of the target species' DNA indicates the presence of the species at and or upstream of the sampling point. Please refer to **Appendix C** for full eDNA laboratory analysis methodology.

2.7 Otter signs

The presence of otter (*Lutra lutra*) within 150m of each aquatic survey site was determined through the recording of otter signs. Notes on the age and location (ITM coordinates) were made for each otter sign recorded, in addition to the quantity and visible constituents of spraint (i.e. remains of fish, molluscs etc.).

2.8 Biological water quality (Q-sampling)

All wetted riverine survey sites (*n*=25) were assessed for biological water quality through Q-sampling in August 2022 (sites A2, A3 , A7, A8, A10, A13, B7 & C5 were dry at the time of survey; **Figure 2.1).** All samples were taken with a standard kick sampling hand net (250mm width, 500µm mesh size) from areas of riffle/glide utilising a 2-minute kick sample, as per Environmental Protection Authority (EPA) methodology (Feeley et al., 2020). Large cobble was also washed at each site for 1-minute (where present) to collect attached macro-invertebrates (as per Feeley et al., 2020). Samples were elutriated and fixed in 70% ethanol for subsequent laboratory identification. Samples were converted to Q-ratings as per Toner et al. (2005) and assigned to WFD status classes. Any rare invertebrate species were identified from the NPWS Red List publications for beetles (Foster et al., 2009), mayflies (Kelly-Quinn & Regan, 2012), stoneflies (Feeley et al., 2020) and other relevant taxa (i.e. Byrne et al., 2009; Nelson et al., 2011).

Table 2.2 Reference categories for EPA Q-ratings (Q1 to Q5)

Q Value	WFD status	Pollution status	Condition
Q5 or Q4-5	High status	Unpolluted	Satisfactory
Q4	Good status	Unpolluted	Satisfactory
Q3-4	Moderate status	Slightly polluted	Unsatisfactory
Q3 or Q2-3	Poor status	Moderately polluted	Unsatisfactory
Q2, Q1-2 or Q1	Bad status	Seriously polluted	Unsatisfactory

2.9 Macrophytes and aquatic bryophytes

Surveys of the macrophyte and aquatic bryophyte community were conducted by instream wading at *n*=33 riverine, with specimens collected (by hand or via grapnel) for on-site identification. An assessment of the aquatic vegetation community helped to identify any rare macrophyte species or habitats corresponding to Annex I habitats, e.g. 'Water courses of plain to montane levels, with submerged or floating vegetation of the *Ranunculion fluitantis* and *Callitricho-Batrachion* (low water level during summer) or aquatic mosses [3260]' (more commonly referred to as 'floating river vegetation').

2.10 Aquatic ecological evaluation

The evaluation of aquatic ecological receptors contained within this report uses the geographic scale and criteria defined in the 'Guidelines for Assessment of Ecological Impacts of National Road Schemes' (NRA, 2009).

2.11 Biosecurity

A strict biosecurity protocol following IFI (2010) and the Check-Clean-Dry approach was adhered to during surveys for all equipment and PPE used. Disinfection of all equipment and PPE before and after use with Virkon™ was conducted to prevent the transfer of pathogens or invasive propagules between survey sites. Surveys were undertaken at sites in a downstream order to minimise the risk of upstream propagule mobilisation. Cognisance was given towards preventing the spread or introduction of crayfish plague (*Aphanomyces astaci*) given the known distribution of white-clawed crayfish (*Austropotamobius pallipes*) in the wider survey area. Furthermore, staff did not undertake any work in a known crayfish plague catchment for a period of <72hrs in advance of the survey. Where feasible, equipment was also thoroughly dried (through UV exposure) between survey areas. Any aquatic invasive species or pathogens recorded within or adjoining the survey areas were geo-referenced. All Triturus staff are certified in 'Good fieldwork practice: slowing the spread of invasive non-native species' by the University of Leeds.

3. Receiving environment

3.1 Coolglass wind farm catchment and survey area description

The proposed Coolglass wind farm is located in the vicinity of Fossy Mountain within the townlands of Scotland, Orchard Upper, Fallowbeg Upper, Aghoney, Clashboy, Fossy Upper, Fossy Lower, Knocklead, Moyadd, Aghadreen, Monamanry, Slatt Lower, Coolglass, Fallowbeg Lower, Gorreelagh, Kylenabehy, Brennanshill, Luggacurren, Fallowbeg Middle and Crissard, approximately 11km south-east of Portlaoise, Co. Laois (**Figure 2.1**). The proposed wind farm site is within the South Eastern River Basin District and within hydrometric areas 14 (Barrow) and 15 (Nore). The aquatic survey sites were located within Nore_SC_060, Dinin[North]_SC_10, Barrow_SC_050 and Barrow_SC_070 river sub-catchments (**Figure 2.1**). The proposed wind farm site is drained by the numerous watercourses, namely the Fallowbeg Upper Stream (14F06), Honey Stream (14H01), Fossy Lower Stream (14F10), Owveg River (15O01), Knocklead Stream (15K21), Clogh River (15C03) and Brennanshill River (15B51), with numerous other watercourses crossed by the proposed GCR alignments.

The watercourses and aquatic surveys sites in the vicinity of Coolglass wind farm are typically small, upland eroding (FW1; Fossitt, 2000) and, further down the catchment, small lowland depositing channels (FW2) which have been historically modified. Predominantly, the watercourses flow over upland areas of shale, sandstone, siltstone and coal, with Visean limestone and calcareous shale dominating in the adjoining lowlands (Geological Survey of Ireland data). Land use practices in the wider survey area comprise coniferous forests (CORINE 312), transitional woodland scrub (324) and land principally occupied by agriculture with significant areas of natural vegetation (243) in upland areas with pastures (CORINE 231) dominating in the adjoining lowlands.

3.2 Fisheries asset of the survey area

The Stradbally River is a valuable brown trout nursery and also supports stone loach, minnow and three-spined stickleback and, in the lower reaches, Atlantic salmon and invasive dace (*Leuciscus leuciscus*) (Gordon et al., 2021; IFI 2020 data[1]; Delanty et al., 2017).

The Crooked River, a tributary of the Stradbally River, is known to support brown trout and stone loach (Delanty et al., 2017). Lamprey (*Lampetra* sp.) are also present in both the Stradbally and Crooked Rivers (IFI 2020 data; Gallagher et al., 2019; King, 2006).

The Douglas River, a tributary of the River Barrow, is known to support Atlantic salmon, brown trout, lamprey (*Lampetra* sp.), minnow, stone loach and three-spined stickleback (Gordon et al., 2021a; Delanty et al., 2017). Lamprey are present in the lower catchment only, with none recorded in the vicinity of Shanragh Bridge (survey site D1) in 2017 (Gallagher et al., 2019).

The Owveg (syn. Owenbeg) River, a tributary of the River Nore, is known to support Atlantic salmon, brown trout, stone loach, lamprey (*Lampetra* sp.), three-spined stickleback and minnow (IFI 2021 data[1]; Galetech Energy Services, 2020). High densities of Atlantic salmon and brown trout, in addition

[1] Inland Fisheries Ireland data for Water Framework Directive Fish Ecological Status 2008-2021. Available at https://opendata-ifigis.hub.arcgis.com/datasets/IFIgis::water-framework-directive-fish-ecological-status-2008-2021/

to minnow and lamprey (*Lampetra* sp.), were recorded from the lower Owveg River (Loughill Bridge) in 2021 (Triturus, 2021).

A number of significant barriers to fish passage (mostly ramps but also weirs & culverts) have been identified on numerous watercourses in vicinity of the proposed project, namely the Crooked River, Stradbally River, Aghoney Stream, Douglas River, Owveh River and Clogh River (AMBER Barrier Tracker app data; AMBER Consortium, 2020; **Appendix A**).

Fisheries data for the other watercourses within the survey area was not available at the time of survey.

3.3 Protected aquatic species[2]

A comprehensive desktop review of available data (NPWS, NBDC & BSBI data) for 10km grid squares containing and adjoining the project (i.e. S47, S48, S49, S57, S58, S59, S68 & S78) identified records for a low number of rare and or protected aquatic species within the vicinity of the proposed project.

A high number (c.47) of contemporary records (year >2000) for white-clawed crayfish (*Austropotamobius pallipes*) were available for respective grid squares, including a low number of records for Owveg River (grid square [redacted]), Stradbally River [redacted]) and Douglas River [redacted]) (**Figure 3.1**). These records ranged from 2000-2011. Most records in the wider vicinity of the proposed project were available for the River Barrow catchment, with many historical only (1972-1998).

Records for otter (*Lutra lutra*) were widespread within the respective grid squares. However, most records were historical only (c.1980). More contemporary records (2000 onwards) were available for the Owveg River, Crooked River, Stradbally River, Clogh River and the Douglas River (**Figure 3.1**). These locations overlapped with several survey sites, including the Owveg River at site B8, the Clogh River at Clogh Bridge (site C7) and the Douglas River at Shanragh Bridge (site D1).

A high number of records were available for the Nore freshwater pearl mussel (*Margaritifera durrovensis*[3]) on the River Nore in grid squares [redacted]. However, the majority of these records were located upstream of the Owveg-Nore confluence (i.e. upstream of potential hydrological pathway from the proposed project) (**Figure 3.1**).

3.4 EPA water quality data (existing data)

The following outlines the available water quality data for the watercourses in context of the proposed wind farm project. Only recent water quality is summarised below. Apart from the below watercourses, there was no contemporary EPA biological monitoring data available for the survey area.

[2] **This report may not be made available to the public without redaction given the inclusion of sensitive species data (e.g. pearl mussel)**

[3] Nore freshwater pearl mussel is no longer considered a separate species based on genetic analysis, i.e. now included within the *Margaritifera margaritifera* taxon but still considered a separate conservation unit (central-eastern) (Geist et al., 2018)

Please note that biological water quality analysis (Q-sampling) was undertaken as part of this survey, with the results presented in the **section 4** and **Appendix B** of this report.

3.4.1 Crooked River

Three contemporary EPA biological monitoring stations were located on the Crooked River (14C02). Upstream of survey site A2, the river achieved **Q4 (good status)** at station RS14C020200 in 2020. The river also achieved **Q4 (good status)** at Timogue Bridge (survey site A6, station RS14C020600) and station RS14C020800, 3km downstream of survey site A6, in 2020.

The upper and middle reaches of the Crooked River (Crooked (Stradbally)_010 river water body) achieved good status in the 2016-2021 period and was considered 'not at risk' of achieving target good status water quality. The lower river, located within the Stradbally (Laois)_030 river water body, also achieved good status in the same period but was considered 'at risk' of not achieving good status.

3.4.2 Stradbally River

There were two contemporary EPA biological monitoring station located on the Stradbally River (14S02) in the vicinity of the proposed project. At Bauteoge Bridge (survey site A14, station RS14S020100) the river achieved **Q4 (good status)** in 2020. The river also achieved Q4 (good status) at station RS14S020350, c.3km downstream of Stradbally, in 2020.

The upper reaches of the Stradbally River (Stradbally (Laois)_010, Stradbally (Laois)_020 and Stradbally (Laois)_030 river water bodies) achieved good status in the 2016-2021, with only the Stradbally (Laois)_030 considered at risk of not achieving good ecological status. Forestry (felling) and urban waste water are the primary threats to water quality in these waterbodies (EPA, 2018a).

3.4.3 Owveg River

Two contemporary EPA biological monitoring stations were located on the Owveg River (15O01) in the vicinity of the project. The river achieved **Q4 (good status)** at station RS15O010050 (survey site B8) and station RS15O010080 in 2019. The Owveg achieved Q4 (good status) at a further 3 no. stations downstream (as far as the Nore confluence), also in 2019.

The upper reaches of Owveg (Owveg (Nore)_010 and Owveg (Nore)_020 river waterbodies) achieved good status in the 2016-2021 period, and were considered not at risk of failing to achieve good ecological status.

3.4.4 Clogh River

A single contemporary EPA biological monitoring station was located on the Clogh River (15C03). The river achieved **Q3-4 (moderate status)** at Clogh Bridge (survey site C7, station RS15C030300).

The upper and middle reaches of Clogh River (Clogh_010 river water body) achieved moderate status in the 2016-2021 period, and was 'at risk' of not achieving target good status water quality. Agriculture is the primary risk to water quality in the river water body (EPA, 2019). The lower reaches, part of the Dinin (North)_020 river water body, achieved good status in the same period and were not at risk.

3.4.5 Douglas River

A number of contemporary EPA biological monitoring stations were located on the lower reaches of the River Brosna. The river achieved **Q4-5 (high status)** at Shanragh Bridge (survey site D1, station RS14D03004) in 2020. The river retained its Q4-5 (high status) at Gale's Bridge (station RS14D030100) and station RS14D030200 in 2021 and 2020, respectively.

The upper reaches of Douglas River (Douglas (Laois)_010 river water body) achieved high status in the 2016-2021 period and was therefore 'not at risk' of failing to achieve target good status water quality. Water quality pressures increase moving downstream with agriculture and urban waste waters the most significant threats (EPA, 2018b).

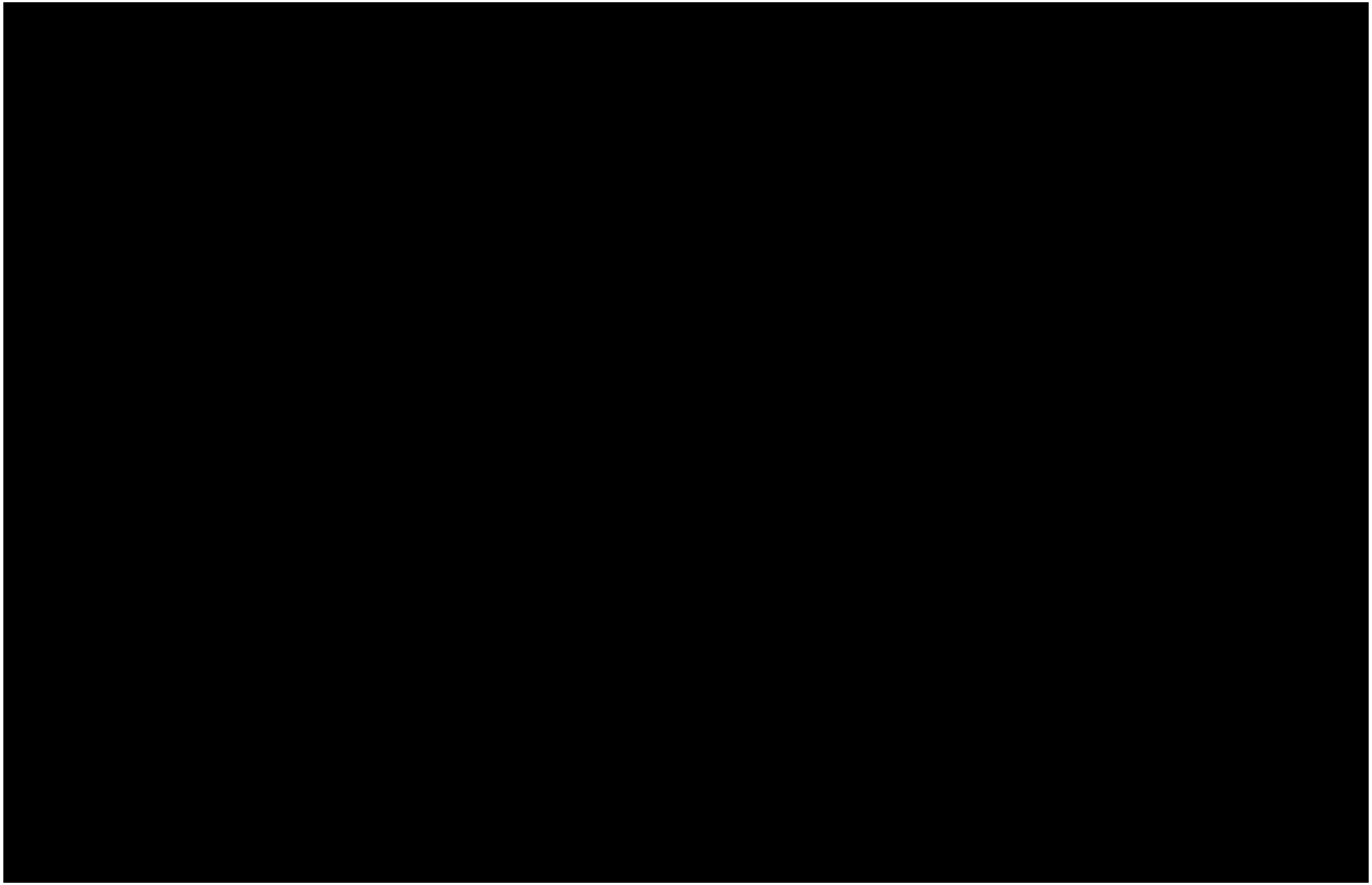

Figure 3.1 Distribution of selected protected aquatic species records in the vicinity of the proposed Coolglass wind farm (NPWS & NBDC data, 2000 onwards)

4. Results of aquatic surveys

The following section summarises each of the *n*=33 survey sites in terms of aquatic habitats, physical characteristics and overall value for fish, white-clawed crayfish and macrophyte/aquatic bryophyte communities. Biological water quality (Q-sample) results are also summarised for each (wetted) riverine sampling site (*n*=25) and in **Appendix B**. Habitat codes are according to Fossitt (2000). Scientific names are provided at first mention only. Sites were surveyed in August 2022. Please refer to **Appendix A** (fisheries assessment report) for more detailed fisheries results. A summary of the fish species recorded at each survey site is provided in **Table 4.2**. A summary of the aquatic species and habitats of high conservation concern recorded during the surveys is provided in **Table 4.3**. An evaluation of the aquatic ecological importance of each survey site based on these aquatic surveys is provided and summarised in **Table 4.4**.

4.1 Aquatic survey site results

4.1.1 Site A1 – Fallowbeg Upper Stream, Fallowbeg Upper

Site A1 was located on the Fallowbeg Upper Stream (14F06), a Crooked River tributary, adjacent to proposed turbine T2. The upland eroding watercourse (FW1) flowed over a relatively steep gradient in a natural, deeply incised valley, with bankfull heights of >10m. The small spate channel suffered from low flows at the time of survey and averaged 2m wide and 0.1-0.2m deep, with few deeper areas. The profile was of shallow glide over boulder cascades, with frequent small plunge pools. Typical of an upland stream, the substrata were dominated by angular boulder and cobble with frequent mixed interstitial gravels. Siltation was moderate (exacerbated by low flows). No soft sediment accumulations were present although beds of sand were occasional along the stream margins. Given the high-energy nature of the site and high shading, macrophyte growth was limited to only very occasional watercress (*Nasturtium officinale*). Aquatic bryophyte coverage was also low with occasional *Hygrohypnum* sp. and *Thamnobryum alopecurum* on larger boulder. *Chiloscyphus polyanthos* was present but rare overall. The steep valley escarpments supported hazel (Corylus avellana), rowan (*Sorbus aucuparia*), holly (*Ilex aquilinum*), bramble (*Rubus fruticosus* agg.), great wood rush (*Luzula sylvatica*), sedges (*Carex* spp.), ferns and a well-developed moss layer. The stream flowed through a coniferous plantation (WD4) and was adjoined to the north by heavily improved pasture (GA1).

No fish were recorded via electro-fishing at site A1 (**Appendix A**). Despite some physical suitability for salmonids and European eel, the did not support fish at the time of survey. This reflected low seasonal flows and high natural gradients which would reduce the inherent fisheries value of the stream at this location. The upland eroding site as unsuitable for lamprey or white-clawed crayfish. Incidentally, a series of small landlocked ponds/ruts on an old forestry track c.200m west of the site (ITM 656546, 688053) were found to support plentiful juvenile smooth newt (*Lissotriton vulgaris*) (i.e. efts) at the time of survey (**Plate 4.2**).

Biological water quality, based on Q-sampling, was calculated as **Q3-4 (moderate status)** (**Appendix B**). No macro-invertebrate species of conservation value greater than 'least concern', according to national red lists, were recorded via Q-sampling.

Given the absence of aquatic species or habitats of higher conservation value, in addition to less than good status water quality, the aquatic ecological evaluation of site A1 was of **local importance (lower value)** (**Table 4.4**).

Plate 4.1 Representative image of site A1 on the upper reaches of the Fallowbeg Upper Stream, September 2022

Plate 4.2 A series of small ponds on an old forestry track (used to access site A1) were found to support moderate densities of smooth newt efts in September 2022

4.1.2 Site A2 – Crooked River, Luggacurreen

Site A2 was located on the upper reaches of the Crooked River (14C02) at a local road crossing. The Stradbally River tributary at this location had been historically straightened and deepened in vicinity of the road crossing, with intermittent retaining walls on both banks. The river was dry at the time of survey, with no ponding of water present, featuring a dry, dusty mud base. The channel likely conveys water during wetter periods, i.e. an ephemeral channel. Livestock poaching was excessive in vicinity of the bridge.

Site A2 was not of fisheries value given its dry, ephemeral nature and absence of aquatic habitats. No otter signs were recorded in the vicinity of the site.

Given the dry nature of the site, it was not possible to collected a biological water quality sample at the time of survey.

Given the absence of aquatic habitats in the ephemeral channel, the aquatic ecological evaluation of site A2 was of **local importance (lower value) (Table 4.4).**

Plate 4.3 Representative image of site A2 on the upper reaches of the Crooked River, September 2022 (dry, ephemeral channel)

4.1.3 Site A3 – Unnamed stream, Fallowbeg Upper

Site A3 was located on the upper reaches of an unmapped (by EPA), unnamed Crooked River tributary adjacent to the proposed turbine T13. The stream at this location had been historically straightened and deepened as part of land drainage works, with a resulting steep trapezoidal profile and banks of up to 2.5m in height. The stream channel was 1.5-2m wide and dry at the time of survey, with no ponding of water present. The substrata comprised angular cobble and boulder with occasional mixed gravels, indicating the channel conveys water during wetter periods, i.e. an ephemeral channel. The channel was heavily tunnelled by scrub vegetation dominated by bramble with an intermittent treeline of alder (*Alnus glutinosa*), willow (*Salix cinerea*), sycamore (*Acer psuedoplatanus*) and holly. The site was located in heavily improved agricultural pasture (GA1).

Site A3 was not of fisheries value given its dry, ephemeral nature and absence of aquatic habitats. Its location in the upper reaches of the stream, with high natural gradients downstream, would likely prelude fish populations during wetted periods. No otter signs were recorded in the vicinity of the site.

Given the dry nature of the site, it was not possible to collect a biological water quality sample at the time of survey.

Given the absence of aquatic habitats in the ephemeral channel, the aquatic ecological evaluation of site A3 was of **local importance (lower value) (Table 4.4).**

Plate 4.4 Representative image of site A3 on an unnamed Crooked River tributary, September 2022 (dry, ephemeral channel)

4.1.4 Site A4 – Honey Stream, Fossy Upper

Site A4 was located on the upper reaches of the Honey Stream (14H01) at the L38401 road crossing, adjoining the proposed site boundary. The upland eroding watercourse (FW1) had been deepened historically. The stream flowed along a moderate gradient and under the road via a masonry box culvert. The channel was semi-dry with an imperceptible flow and frequent ponding of water. The small spate channel suffered from very low seasonal flows at the time of survey and averaged 1m wide and <0.05m deep, with a deep trapezoidal channel and bankfull heights of up to 2m. The profile of the semi-dry channel was of stagnant pool but would typically represent shallow glide and riffle at higher flows. Bank scouring was frequent and further indicative of the spate nature of the stream. The substrata were dominated by angular cobble and small boulder with frequent fine to medium gravels.

However, these were compacted and heavily bedded in silt. Livestock poaching was present at the road crossing. Given semi-dry conditions and heavy tunnelling (by scrub), macrophytes were limited to very occasional watercress and fool's watercress (*Apium nodiflorum*) along channel margins in more open areas. Aquatic bryophytes were limited to *Pellia* sp. liverwort on the cobbled culvert apron. The fenced-off riparian zones were heavily scrubbed with mature willow and hawthorn (*Crataegus monogyna*) and dense bramble, with scattered ash (*Fraxinus excelsior*) and hazel. The site was bordered by intensive agricultural pasture (GA1) and mixed broad-leaved woodland (WD1). Coniferous afforestation (WD4) was present upstream.

No fish were recorded via electro-fishing at site A4 (**Appendix A**). This reflected low seasonal flows, its likely ephemeral nature and poor connectivity with downstream habitats which would reduce the inherent fisheries value of the stream at this location. Suitability for white-clawed crayfish was poor and none were recorded. No otter signs were recorded in vicinity of the site.

Biological water quality, based on Q-sampling, was calculated as **Q3 (poor status)** (**Appendix B**). However, it should be noted that this is a tentative rating given poor flows and lack of suitable riffle areas for sampling (as per Toner et al., 2005). No macro-invertebrate species of conservation value greater than 'least concern', according to national red lists, were recorded via Q-sampling.

Given the absence of aquatic species or habitats of higher conservation value, in addition to less than good status water quality, the aquatic ecological evaluation of site A4 was of **local importance (lower value)** (**Table 4.4**).

Plate 4.5 Representative image of site A4 on the Honey Stream, September 2022

4.1.5 Site A5 – Honey Stream North, Timogue

Site A5 was located on the upper reaches of the Honey North Stream (14H21) adjacent to a proposed GCR (option 3) crossing of the L3838 road. The stream had been extensively straightened and deepened as far as its confluence with the Crooked River approx. 0.4km downstream and featured a steep trapezoidal channel with bank heights of up to 2m. The stream averaged 2-2.5m wide and <0.05m deep and was semi-dry at the time of survey, with an imperceptible flow and stagnant pools of water. The substrata of the ephemeral channel were dominated by mobile mixed gravels but these were heavily silted. Deep silt deposits were also present locally. The site was heavily vegetated with abundant watercress and fool's watercress covering >90% of the channel width. The stream was heavily shaded by scrub vegetation dominated by bramble and hedge bindweed (*Calystegia sepium*) with a mature treeline (WL2) of ash, elder (*Sambucus nigra*) and alder along the south bank. The site was bordered by intensive agricultural pasture (GA1).

No fish were recorded via electro-fishing at site A5 (**Appendix A**). This reflected low seasonal flows, its ephemeral nature and poor connectivity with downstream habitats which would reduce the inherent fisheries value of the stream at this location. The stream would have some improved (although still low) fisheries value during higher flow periods given the proximity of the Crooked River. Suitability for white-clawed crayfish was poor and none were recorded. No otter signs were recorded in vicinity of the site.

Biological water quality, based on Q-sampling, was calculated as **Q3 (poor status)** (**Appendix B**). However, it should be noted that this is a tentative rating given poor flows and lack of suitable riffle areas for sampling (as per Toner et al., 2005). No macro-invertebrate species of conservation value greater than 'least concern', according to national red lists, were recorded via Q-sampling.

Given the absence of aquatic species or habitats of higher conservation value, in addition to less than good status water quality, the aquatic ecological evaluation of site A5 was of **local importance (lower value)** (**Table 4.4**).

Plate 4.6 Representative image of site A5 on the Honey North Stream, September 2022 (semi-dry channel)

4.1.6 Site A6 – Crooked River, Timogue Bridge

Site A6 was located on the Crooked River (14C02) at Timogue Bridge, a proposed GCR crossing, approx. 6km downstream of site A2 (which was dry). The small lowland depositing watercourse (FW2) had been historically straightened and deepened in vicinity of the bridge. The river suffered from low seasonal flows at the time of survey and averaged 3m wide and 0.2-0.4m deep, with very few deeper areas present. The profile was of swift-flowing glide and riffle with occasional pool downstream of the bridge and associated apron. Upstream of the rendered bridge apron (0.15m fall) comprised depositional glide. The substrata were dominated by compacted cobble and frequent boulder, with mixed gravels in faster-flowing areas (increasing in frequency downstream). Siltation was high overall with frequent organic-rich silt deposits in depositional areas. Livestock poaching was evident throughout and excessively high upstream of the bridge. The site supported frequent water crowfoot (*Ranunculus* sp.) instream, with frequent fool's watercress and watercress beds along channel margins. Water starwort (*Callitriche* sp.) was also frequent. Common duckweed (*Lemna minor*) was present locally. Aquatic bryophyte coverage was high with abundant *Leptodictyum riparium*[4] and more occasional *Fontinalis antipyretica* on cobble and boulder. Given the poor quality of the habitat, the aquatic vegetation community did not correspond to the Annex I habitat 'floating river vegetation [3260]'. Filamentous algae and floc[5] cover was very high (>75%), indicating significant enrichment. Reed canary grass (*Phalaris arundinacea*) was abundant along the margins with several mid-channel islands also dominated by the species. The riparian areas also supported dense scrub of bramble, hedge bindweed and nettle (*Urtica dioica*). A mature treeline of hawthorn, horse chestnut (*Aesculus hippocastanum*), ash and beech (*Fagus sylvatica*) lined the channel along the north bank downstream of the bridge, providing valuable thermal refugia. Upstream, the banks were grazed and open. The site was bordered by improved pasture (GA1).

Brown trout (*Salmo trutta*), lamprey (*Lampetra* sp.), stone loach (*Barbatula barbatula*) and three-spined stickleback (*Gasterosteus aculeatus*) were recorded via electro-fishing at site A6 (**Appendix A**). The site was of good value for salmonids, supporting a moderate density of mixed-cohort brown trout. Despite significant siltation and enrichment pressures, the site was of most value as a salmonid nursery. Good quality spawning habitat for both salmonids and lamprey were also present but these areas were highly localised (>40m downstream of the bridge). The pool immediately below the bridge apron (a barrier to fish at low flows only) provided good quality holding habitat for adult salmonids but suitable areas were sparse elsewhere given the generally shallow nature of the site. The site was also of good value as a lamprey nursery, with frequent soft sediment deposits supporting a low density of ammocoetes. Despite some good suitability, no European eel were recorded. White-clawed crayfish habitat was of moderate value given less accessible refugia and none were recorded. A regular otter spraint site (mixed age including fresh) was recorded underneath the dry western arch (ITM 655362, 693763). This did not contain any crayfish remains.

[4] An indicator of eutrophication (Weekes et al., 2021)

[5] floc is defined as an aggregation of (mostly dead) organic material, mainly from algae and diatoms, but also with potential origins from decaying macrophytes and associated decomposers (bacteria and fungi). The floc can form a layer at the surface of the substrate, or infiltrate the substrate, generally where there is insufficient flow to keep the material in suspension (Moorkens & Killeen, 2020)

Biological water quality, based on Q-sampling, was calculated as **Q3-4 (moderate status)** (**Appendix B**). No macro-invertebrate species of conservation value greater than 'least concern', according to national red lists, were recorded via Q-sampling.

Given the presence of salmonid and lamprey (*Lampetra* sp.), in addition to utilisation by otter, the aquatic ecological evaluation of site A6 was of **local importance (higher value) (Table 4.4).**

Plate 4.7 Representative image of site A6 on the Crooked River at Timogue Bridge, September 2022 (facing downstream from bridge)

4.1.7 Site A7 – Aghoney Stream, Aghoney

Site A7 was located on the upper reaches of the Aghoney Stream (14A08) at the R426 road and proposed GCR (option 1) crossing. The semi-natural upland eroding watercourse (FW1) averaged 2-2.5m wide in a steep incised valley but was dry at the time of survey. The substrata comprised angular cobble and boulder with occasional mixed gravels, indicating the channel conveys water during wetter periods, i.e. an ephemeral spate channel. Whilst macrophytes were absent, occasional (desiccated) *Rhynchostegium riparoides* and *Thamnobryum alopecurum* was present on larger boulder. The stream was heavily shaded by mature treelines and mixed-broad-leaved woodland (WD1) featuring hazel, ash, hawthorn, blackthorn (*Prunus spinosa*) and sycamore with an understory dominated by ferns and bramble. Historical clear-fell (WS5), immature coniferous plantation (WS2) and coniferous afforestation (WD4) was present downstream.

Site A7 was not of fisheries value given its dry, ephemeral nature and absence of aquatic habitats. Its location in the upper reaches of the stream, with high natural gradients downstream, would likely prelude fish populations during wetted periods. No otter signs were recorded in the vicinity of the site.

Given the dry nature of the site, it was not possible to collected a biological water quality sample at the time of survey.

Given the absence of aquatic habitats in the ephemeral channel, the aquatic ecological evaluation of site A7 was of **local importance (lower value) (Table 4.4).**

Plate 4.8 Representative image of site A7 on the Aghoney Stream, September 2022 (dry, ephemeral channel)

4.1.8 Site A8 – Fossy Lower Stream, Fossy Upper

Site A8 was located on the upper reaches of the Fossy Lower Stream (14F10) at a proposed GCR (option 3) crossing. The small upland eroding watercourse (FW1) had been historically straightened in the vicinity of coniferous plantations with a pipe culvert (0.5m fall) at the forestry track crossing. The stream averaged <1m wide with bank heights of up to 1m and was dry at the time of survey. The substrata comprised angular cobble and boulder with occasional mixed gravels and sands, indicating the channel conveys water during wetter periods, i.e. an ephemeral spate channel. Whilst macrophytes were absent, occasional (desiccated) *Thamnobryum alopecurum* was present on larger boulder. The stream was heavily shaded by mature coniferous woodland (WD4) with bramble-dominated scrub along the riparian zone.

Site A8 was not of fisheries value given its dry, ephemeral nature and absence of aquatic habitats. Its location in the upper reaches of the stream, with high natural gradients downstream, would likely prelude fish and white-clawed crayfish populations during wetted periods. No otter signs were recorded in vicinity of the site.

Given the dry nature of the site, it was not possible to collected a biological water quality sample at the time of survey.

Given the absence of aquatic habitats in the ephemeral channel, the aquatic ecological evaluation of site A8 was of **local importance (lower value) (Table 4.4).**

Plate 4.9 Representative image of site A8 on the Fossy Lower Stream, September 2022 (dry, ephemeral channel)

4.1.9 Site A9 – Fossy Lower Stream, Ballintlea Lower

Site A9 was located on the upper reaches of the Fossy Lower Stream (14F10) at the R426 road and proposed GCR (option 1) crossing. The upland eroding watercourse (FW1) had been locally straightened and deepened historically but retained some semi-natural characteristics instream. However, the stream was semi-dry at the time of survey with no flows and stagnant pools of water only. The channel averaged 2-2.5m wide with steep banks of up to 2.5m in height. Some of these had been recently modified in vicinity of the road crossing, with slumping of spoil into the channel. Indicative of a spate channel, the substrata were dominated by cobble and boulder with localised beds of mixed gravels and frequent scour areas. Siltation was moderate. Macrophytes and aquatic bryophytes were not recorded. The site was heavily shaded by mature treelines of horse chestnut, holly, elder and hawthorn. Tunnelling was present downstream of the bridge. The site was bordered by improved pasture (GA1) with narrow but mature riparian buffers.

No fish were recorded via electro-fishing at site A9 (**Appendix A**). The site was not of fisheries value given its semi-dry, ephemeral nature containing stagnant pools only. However, given some physical suitability, the stream at this location may support a low density of fish during wetter periods. The ephemeral stream had poor suitability for white-clawed crayfish. No otter signs were recorded in the vicinity of the site.

Biological water quality, based on Q-sampling, was calculated as **Q3 (poor status)** (**Appendix B**). However, it should be noted that this is a tentative rating given poor flows and lack of suitable riffle areas for sampling (as per Toner et al., 2005). No macro-invertebrate species of conservation value greater than 'least concern', according to national red lists, were recorded via Q-sampling.

Given the absence of aquatic species or habitats of higher conservation value, in addition to less than good status water quality, the aquatic ecological evaluation of site A9 was of **local importance (lower value)** (**Table 4.4**).

Plate 4.10 Representative image of site A9 on the lower reaches of the Fossy Lower Stream, September 2022 (ephemeral channel)

4.1.10 Site A10 – Timahoe Stream, Fossy Lower

Site A10 was located on the uppermost reaches of the Timahoe Stream (14T09) at the L38401 road and proposed GCR (option 3) crossing. The upland eroding watercourse (FW1) had been extensively straightened and deepened historically and averaged 1.5m wide in a steep trapezoidal channel of up to 2m in height. The stream was dry at the time of survey with a dry, dusty, leaf litter-filled base colonised by terrestrial plants indicative of sporadic water flows (ephemeral channel). Water abstraction (for livestock) was evident (Plate 4.11). The stream crossed under the local road via a pipe culvert with a 0.25m fall on the downstream side. Whilst the substrata featured cobble and small boulder these were bedded in dry mud and largely covered by terrestrial plant growth. No macrophytes or aquatic bryophytes were recorded. The channel was heavily tunnelled by a mature treeline of ash, hawthorn, blackthorn and willow with bramble-dominated scrub. The site was bordered by intensive pasture (GA1).

Site A10 was not of fisheries value given its dry, ephemeral nature and absence of aquatic habitats. Its location in the uppermost reaches of the stream would likely prelude fish and white-clawed crayfish populations during wetted periods. No otter signs were recorded in the vicinity of the site.

Given the dry nature of the site, it was not possible to collected a biological water quality sample at the time of survey.

Given the absence of aquatic habitats in the ephemeral channel, the aquatic ecological evaluation of site A10 was of **local importance (lower value) (Table 4.4).**

Plate 4.11 Representative image of site A10 on the Timahoe Stream, September 2022 (water abstraction for livestock evident)

4.1.11 Site A11 – Stradbally River, Timahoe

Site A11 was located on the Stradbally River at the R426 road and proposed GCR (options 1 & 2) crossing near Timahoe village. The lowland depositing watercourse (FW2) had been straightened and deepened historically, with resulting poor hydromorphology, a trapezoidal channel and bankfull heights of up to 3m. Fractured masonry bank revetments were present downstream of the bridge. The river suffered from low seasonal flows at the time of survey and averaged 2.5m wide and 0.2-0.5m deep, with locally deeper pools to 1.2m. The 2-stage channel was often up to 5m in width with only a narrow water width of 2-2.5m. The profile was of very slow-flowing, shallow glide with occasional pool and very rare riffle (3m section of river only). However, at higher water levels the site would feature swift-flowing deep glide (as indicated by flood debris on riparian trees). The substrata comprised compacted cobble with mixed gravels and boulder. More mobile gravels were present in rare faster-flowing areas adjoining pools. Beds of sand and clay-dominated soft sediment were abundant on the margins of pools, with some more organic-rich areas present under riparian treelines. Siltation was high overall (exacerbated by low seasonal flows). With the exception of a short, shaded section of channel, macrophyte cover was very high with abundant fool's watercress and narrow-fruited watercress (*Nasturtium microphyllum*) (>80% cover). Common duckweed was also present in near-stagnant glide and pool areas. Blue water-speedwell (*Veronica anagallis-aquatica*) and water mint (*Mentha aquatica*) were occasional in open areas of channel. Aquatic bryophytes were limited to occasional *Leptodictyum riparium*. The cover of floc and filamentous algae was relatively high, further indicating enrichment pressures. The riparian zone was dominated by great willowherb (*Epilobium hirsutum*) with abundant reed canary grass, hedge bindweed, broad-leaved dock (*Rumex obtusifolius*) and nettle with high levels of encroachment on the channel (often covering 50% of the channel width). The river was open in the vicinity of the bridge with a mature alder, elder and hawthorn treeline with bramble scrub present 75m downstream. The site was bordered by intensive pasture (GA1).

Brown trout, lamprey (*Lampetra* sp.), stone loach, minnow (*Phoxinus phoxinus*) and three-spined stickleback were recorded via electro-fishing at site A11 (**Appendix A**). The site only supported a low density of juvenile brown trout, with no adults recorded via electro-fishing despite supporting some good holding habitat (i.e. deep pool) and the site was considered of moderate value to salmonids overall. The evident hydromorphological, enrichment and siltation pressures reduced the value of the site as a salmonid nursery considerably. Spawning habitat for both salmonids and lamprey was present but highly localised and significantly compromised by siltation. Some good quality lamprey habitat was present adjoining localised pool areas and supported a low density of mixed cohort ammocoetes. Despite some moderate suitability, no European eel or white-clawed crayfish were recorded. No otter signs were recorded in vicinity of the site.

Biological water quality, based on Q-sampling, was calculated as **Q4 (poor status)** (**Appendix B**). No macro-invertebrate species of conservation value greater than 'least concern', according to national red lists, were recorded via Q-sampling.

Given the presence of salmonids and *Lampetra* sp., in addition to Q4 (good status) water quality, the aquatic ecological evaluation of site A11 was of **local importance (higher value)** (**Table 4.4**).

Plate 4.12 Representative image of site A11 on the Stradbally River, September 2022

4.1.12 Site A12 – Cremorgan Stream, Coolnabacky

Site A12 was located on the Cremorgan Stream (14C24) at the R426 road and proposed GCR (options 1 & 2) crossing, approx. 1km upstream of the Stradbally River confluence. The semi-natural upland eroding watercourse (FW1) was semi-dry at the time of survey, with no flow and local ponding of water only. The channel width averaged 4-5m with bankfull heights of up to 2m. The river was characteristic of a high-energy spate channel with frequent bank scouring and a bed dominated by angular boulder and cobble with frequent mixed gravels. Sand accumulations were frequent along channel margins. Soft sediment deposits were not present but siltation was moderate given the presence of damp mud of the channel bed. Macrophytes and aquatic bryophytes were absent. Cyanobacterial crusts (calcification) were abundant on instream substrata. The river flowed through a mature linear block of mixed broad-leaved woodland (WD1) supporting sycamore, hazel, holly, blackthorn and ash with an ivy, fern and bramble-dominated ground flora. The site was bordered by improved pasture (GA1).

Three-spined stickleback was the only species recorded via electro-fishing at site A12 (**Appendix A**). Despite good physical suitability for salmonids, albeit compromised by low flows none were recorded via electro-fishing of the remnant stagnant pools. Given downstream connectivity and site attributes (high energy, hard substrata, glide and pool habitat etc.), the site likely supports salmonids (and other fish species such as European eel) at higher water levels. Stagnant pools supported low densities of three-spined stickleback only. There was no suitability (even under higher water levels) for lamprey given the spate nature of the channel (i.e. during normal flows). Suitability for white-clawed crayfish was poor. Three otter spraint sites, two fresh (ITM 653149, 691126) and one mixed age (ITM 653160, 691153) were recorded upstream and downstream of the bridge, respectively.

Biological water quality, based on Q-sampling, was calculated as **Q3 (poor status)** (**Appendix B**). However, it should be noted that this is a tentative rating given an absence of flows and lack of suitable riffle areas for sampling (as per Toner et al., 2005). No macro-invertebrate species of conservation value greater than 'least concern', according to national red lists, were recorded via Q-sampling.

Given the presence of otter, the aquatic ecological evaluation of site A12 was of **local importance (higher value) (Table 4.4).**

Plate 4.13 Representative image of site A12 on the Cremorgan Stream, September 2022 (upstream of bridge)

4.1.13 Site A13 – Unnamed stream, Timogue

Site A13 was located on the uppermost reaches of an unnamed Stradbally River tributary, adjacent to a proposed GCR (option 3) crossing of the L3838 road. The stream had been extensively straightened and deepened as far as its confluence with the Stradbally River approx. 0.4km downstream and typically featured a steep trapezoidal channel with bank heights of up to 2m (except at the road crossing where present in a residential lawn). The stream averaged 1.5-2m wide and was dry at the time of survey. The substrata of the ephemeral channel were dominated by mixed gravels and cobble heavily bedded in mud/silt. The site was heavily vegetated with abundant fool's watercress and frequent water mint. Whilst present in open amenity grassland near the road crossing (Plate 4.14), downstream the dry channel was heavily shaded by scrub vegetation dominated by reed canary grass, nettle and bramble with a mature treeline (WL2) of ash and willow. The site was bordered by a residential property (BL3, GA2) and agricultural pasture (GA1).

Site A13 was not of fisheries value given its dry, ephemeral nature and absence of aquatic habitats. The stream would likely have some improved (although still low) fisheries value in its lowermost reaches only during higher flow periods given the proximity of the Stradbally River. No otter signs were recorded in the vicinity of the site.

Given the dry nature of the site, it was not possible to collected a biological water quality sample at the time of survey.

Given the absence of aquatic habitats in the ephemeral channel, the aquatic ecological evaluation of site A13 was of **local importance (lower value) (Table 4.4).**

Plate 4.14 Representative image of site A13 on an unnamed Stradbally River tributary, August 2022 (dry, ephemeral channel)

4.1.14 Site A14 – Stradbally River, Bauteogue Bridge

Site A14 was located on the Stradbally River (14S02) at Bauteogue Bridge, a proposed GCR (option 3) crossing, approx. 4km downstream of site A11. The river suffered from very low seasonal flows at the time of survey with near imperceptible flows, ponding of water and poor fluvial connectivity in the trapezoidal channel (2.5m bankfull heights). The river had been historically straightened and deepened in vicinity of the bridge but demonstrated some good instream recovery. The profile at the time of survey was of near-stagnant glide and pool but under higher flows the river at this location would feature swift-flowing glide and pool. A large plunge pool was present immediately downstream of the rendered bridge apron (c.1m in depth). The substrata were dominated by mixed gravels with occasional areas of cobble and boulder. However, these were compacted and quite heavily calcified. Beds of finer gravels and sand were present in pool tailings. Siltation was moderate overall but exacerbated by very low flows. Soft sediment accumulations were shallow and superficial where present (further indicative of normal higher energy conditions). In terms of macrophytes, fool's watercress and watercress were frequent along the channel margins, with occasional blue water speedwell and water mint. The site was heavily encroached by reed canary grass which often covered >50% of the channel width upstream of the bridge. Common duckweed, branched bur-reed (*Sparganium erectum*) and brooklime (*Veronica beccabunga*) were occasional. The coverage of aquatic bryophytes was high, with abundant *Fontinalis antipyretica* on cobble and boulder. *Rhynchostegium riparioides* was frequent, with *Leptodictyum riparium* occasional. The calcicolous aquatic liverwort, *Riccardia chamedryfolia* was occasional. Filamentous algal mats were abundant. The riparian zones supported abundant reed canary grass, hedge bindweed, nettle, great willowherb and bramble with scattered alder, ash and willow species. Downstream, the river was heavily shaded by a more continuous treeline of mature ash and willow (providing valuable thermal refugia). The site was bordered by agricultural pasture (GA1).

Brown trout, three-spined stickleback, stone loach and minnow were recorded via electro-fishing at site A14 (**Appendix A**). Despite very low seasonal flows, site A14 was of moderate value for salmonids, supporting a low density of mixed-cohort brown trout. Physically, the site provided good quality nursery, spawning and holding habitat but the value was reduced significantly given very low seasonal flows and poor connectivity. The bridge apron was a significant barrier to fish passage at low flows. Better quality glide habitat was present downstream of the bridge. Overhanging macrophyte vegetation and scoured banks (including tree roots) provided valuable holding areas for salmonids. Whilst some good quality lamprey spawning habitat was present, the site was unsuitable as a nursery area given a paucity of soft sediment accumulations. No white clawed crayfish were recorded which was reflective of high levels of calcification and a lack of accessible refugia. A regular otter spraint site (mixed age) was recorded on the bridge ledge, containing fish remains (no crayfish) (ITM 655146, 693889).

Biological water quality, based on Q-sampling, was calculated as **Q3 (moderate status)** (**Appendix B**). However, it should be noted that this is a tentative rating given poor flows and lack of suitable riffle areas for sampling (as per Toner et al., 2005). No macro-invertebrate species of conservation value greater than 'least concern', according to national red lists, were recorded via Q-sampling.

Given the presence of salmonids and utilisation by otter, the aquatic ecological evaluation of site A14 was of **local importance (higher value) (Table 4.4).**

Plate 4.15 Representative image of site A14 on the Stradbally River at Bauteogue Bridge, September 2022 (facing upstream from bridge)

4.1.15 Site A15 – Stradbally River, Stradbally Bridge

Site A15 was located on the Stradbally River (14S02) at Stradbally Bridge, approx. 3.2km downstream of site A14, at the upstream boundary of the River Barrow and River Nore SAC (002162). The lowland depositing watercourse (FW2) had been heavily modified in the vicinity of the bridge with retaining walls and local straightening. The river suffered from low seasonal flows at the time of survey and averaged 8-10m wide upstream of the bridge and 3-4m downstream. The depth averaged 0.2-0.4m deep with very few deeper areas present. The profile was of slow-flowing glide with localised riffle downstream of the bridge. Pool areas were very localised. The substrata were dominated by compacted cobble and boulder with localised mixed gravels (mostly downstream of the bridge in faster-flowing glide). Sand accumulations were also present locally (heavily silted). The substrata were also heavily silted (exacerbated by low seasonal flows), with cyanobacterial crusts (calcification) present. Organic-rich soft sediment accumulations were present in marginal and pool slacks, and also in association with *Ranunculus* beds. The site supported abundant water crowfoot (*Ranunculus* sp.) (40% cover) with abundant fool's watercress. Water starwort (*Callitriche* sp.) and branched bur-reed were occasional, with frequent water mint and blue water speedwell along channel margins. The non-native Canadian pondweed (*Elodea canadensis*) was rare. Common duckweed and ivy-leaved duckweed (*Lemna trisulca*) were both occasional. The moss *Fontinalis antipyretica* was locally frequent on larger boulder and cobble, with occasional *Leptodictyum riparium* and *Fissidens* sp. Given the dominance of *Ranunculus* sp. vegetation, in addition to a high cover of *Fontinalis antipyretica*, the aquatic vegetation community corresponded to the Annex I habitat 'floating river vegetation [3260]'. The river at this location was heavily enriched with excessive cover (>70% in open areas) of filamentous algae and floc. The riparian zone supported a typical nitrophilous community dominated by reed canary grass, nettle, great willowherb and hedge bindweed. The site was bordered by buildings and artificial surfaces (BL3).

Atlantic salmon (*Salmo salar*), brown trout, lamprey (*Lampetra* sp.), minnow and three-spined stickleback were recorded via electro-fishing at site A15 (**Appendix A**). The site was of high value for salmonids, supporting mixed-cohort populations of both Atlantic salmon and brown trout. The site was of highest value as a salmonid nursery, despite evident enrichment and siltation pressures impacting the quality of the cobble and boulder refugia. Spawning habitat for both salmonids and lamprey was present but highly localised, mostly downstream of the bridge. The shallow modified site was of poor value as a holding area although some overhanging vegetation provided valuable thermal refugia. Despite high suitability, no European eel or white-clawed crayfish were recorded. Environmental DNA analysis at the site did not detect white-clawed crayfish but crayfish plague (*Aphanomyces astaci*) was present (see **Table 4.1**). A high number of otter signs were recorded in vicinity of the site. The northernmost (dry) arch of the bridge featured a muddy base with frequent boulders and debris which supported at least 4 no. spraint sites (in vicinity of ITM 657181, 696360). Furthermore, additional otter spraint sites (old) were recorded under the middle arch (ITM 657177, 696347) and on the retaining wall ledge upstream of the bridge (ITM 657161, 696336). An otter couch site and a latrine (in mud) were also identified under the northern arch (ITM 657171, 696352).

Biological water quality, based on Q-sampling, was calculated as **Q3-4 (moderate status)** (**Appendix B**). No macro-invertebrate species of conservation value greater than 'least concern', according to national red lists, were recorded via Q-sampling.

Given the location of the site within the River Barrow and River Nore SAC (002162), the aquatic ecological evaluation of site A15 was of **international importance (Table 4.4)**. The site also supported salmonids (including Atlantic salmon), *Lampetra* sp., highly regular otter utilisation (including a resting area) and Annex I floating river vegetation [3260].

Plate 4.16 Representative image of site A15 on the Stradbally River at Stradbally Bridge, September 2022 (facing downstream form bridge)

4.1.16 Site B1 – Scotland Stream, Aghoney

Site B1 was located on the uppermost reaches of the Scotland Stream (15S06) at a local road and proposed GCR crossing (all options). The semi-natural upland eroding watercourse (FW1) flowed under the local road via a masonry box culvert but was semi-dry at the time of survey with no flow and only localised ponding of stagnant water. The narrow channel meandered over a moderate gradient through a shallow V-shaped valley and averaged 1m wide with bankfull heights of up to 6m. Under higher flows, the channel would feature shallow glide and riffle habitat with occasional small pools associated with meanders and natural falls. Bank scouring was frequent, indicating the spate nature of the stream at this location. Scouring also contributed to siltation of the channel bed (slumping of soil). The substrata were dominated by angular cobble with frequent boulder and coarse gravels. Large woody debris was frequent instream. The site did not support macrophytes, with very localised *Scapania undulata* indicating occasional water flows. The liverwort *Pellia epiphylla* was occasional on muddy banks. The steep banks supported abundant hazel and beech with hawthorn and a well-developed terrestrial moss and fern layer. The site was bordered by coniferous afforestation (WD4) and wet improved grassland (GA1).

No fish were recorded via electro-fishing at site B1 (**Appendix A**). The site was not of fisheries value given its semi-dry, ephemeral nature and location in the upper reaches of the catchment. Given this, and naturally high gradients, connectivity with downstream habitats was poor and the stream is unlikely to support fish at this location even under higher water levels. There was no suitability for white-clawed crayfish. No otter signs were recorded in the vicinity of the site.

Biological water quality, based on Q-sampling, was calculated as **Q2-3 (poor status)** (**Appendix B**). However, it should be noted that this is a tentative rating given an absence of flows and lack of suitable riffle areas for sampling (as per Toner et al., 2005). No macro-invertebrate species of conservation value greater than 'least concern', according to national red lists, were recorded via Q-sampling.

Given the absence of aquatic species or habitats of higher conservation value, in addition to less than good status water quality, the aquatic ecological evaluation of siteB1 was of **local importance (lower value)** (**Table 4.4**).

Plate 4.17 Representative image of site B1 on the Scotland Stream, September 2022

4.1.17 Site B2 – Owveg River, Knocklead

Site B2 was located on the uppermost reaches of the Owveg River (15O01) at a local road crossing. The upland eroding watercourse (FW1) at this location featured a slight flow at the time of survey although still suffered from very low seasonal water levels, with a semi-dry channel. The river had been modified historically upstream of the bridge (straightened and over-deepened) with a steep trapezoidal channel and bankfull heights of up to 4m. Downstream of the rendered bridge apron (barrier to fish passage at low flows), the river retained a semi-natural profile as it meandered through a coniferous forestry block. Here the channel averaged 2-2.5m wide with banks of 1.5-2m high. The shallow site supported only slight flows (<0.05m deep) with occasional ponding areas of up to 0.25m in depth. Under higher water flows, the spate channel would feature a profile dominated by riffle and shallow glide with occasional pool. The substrata were dominated by angular cobble and boulder (some large) with occasional mixed gravels. Sand-silt deposits were occasional along channel margins (mostly originating from bank scouring/slumping). Siltation was moderate overall (exacerbated by low seasonal flows). In more open areas near the bridge supported locally frequent brooklime and watercress and occasional water mint. Aquatic bryophyte cover was low with only localised *Rhynchostegium riparioides*, *Fontinalis antipyretica* and *Leptodictyum riparium* on and near the bridge apron. The riparian zone supported gorse (*Ulex europaeus*), bramble and hawthorn scrub with nettle, wild angelica (*Angelica sylvestris*), pendulous sedge (*Carex pendulata*) and rank grasses. The site was bordered by coniferous afforestation (WD4) with narrow sycamore buffers and improved pasture (GA1).

Brown trout was the only fish species recorded via electro-fishing at site B2 (**Appendix A**). The site was of low value for salmonids, supporting only a very low fish density. Low seasonal flows reduced the value of the habitat significantly, with intermittent flows and poor longitudinal connectivity (including an impassable bridge apron). However, the site was of some low value as a salmonid nursery and spawning habitat, with good quality holding areas for adults absent. Despite some low suitability for European eel, none were recorded. The upland eroding site was unsuitable for lamprey or white-clawed crayfish. No otter signs were recorded in vicinity of the bridge.

Biological water quality, based on Q-sampling, was calculated as **Q3 (poor status)** (**Appendix B**). However, it should be noted that this is a tentative rating given a lack of suitable riffle areas for sampling (as per Toner et al., 2005). No macro-invertebrate species of conservation value greater than 'least concern', according to national red lists, were recorded via Q-sampling.

Given the presence of salmonids, the aquatic ecological evaluation of site B2 was of **local importance (higher value) (Table 4.4).**

Plate 4.18 Representative image of site B2 on the upper reaches of the Owveg River, September2022 (upstream of bridge)

4.1.18 Site B3 – Owveg River, Knocklead

Site B3 was located on the Owveg River (15O01) at the L7792 road and proposed (Pinewoods) GCR crossing. The small upland eroding watercourse (FW1) had been historically straightened and modified in the vicinity of the bridge (retaining walls, cobbled apron) but retained good semi-natural features upstream. The river suffered from very low seasonal water levels at the time of survey with near imperceptible flows and local ponding of water (i.e. intermittent fluvial connectivity). The stream meandered along a slight gradient and averaged 2m wide and 0.1-0.2m deep, with very few deeper areas present (0.3m max.). The profile was of near stagnant glide and stagnant pool but under basal flows the stream at this location would feature shallow glide and frequent riffle areas with occasional small pool (typically on meanders & at LWD). Bank scouring was frequent, further indicative of the spate nature of the channel. The substrata were dominated by angular cobble and boulder with only occasional interstitial mixed gravels. Sand accumulations were present in pools, with soft sediment areas only present adjoining areas exposed to livestock poaching (e.g. immediately downstream of the bridge). Siltation was high overall but this was exacerbated by low seasonal flows (would typically be low to moderate). Macrophyte coverage was high in open areas, with locally abundant watercress and fool's watercress, with frequent corn mint (*Mentha arvensis*) along channel margins. High shading precluded macrophyte growth elsewhere. Aquatic bryophyte coverage was low but some *Leptodictyum riparium* was present. Cover of filamentous algae and floc was high (again, exacerbated by low flows). Upstream of the bridge, the river was shaded by mature willow, ash, hawthorn and blackthorn with bramble scrub, whilst downstream was more open (historically cleared) with scattered scrub (WS1). The site was bordered by improved pasture (GA1).

Atlantic salmon, brown trout, minnow and stone loach were recorded via electro-fishing at site B3 (**Appendix A**). Despite very low seasonal flows, the site was of moderate value for salmonids with a low density of juvenile brown trout and a single Atlantic salmon parr recorded via electro-fishing. Physically, the site was of highest value as a salmonid nursery given a predominance of cobble and boulder refugia. Spawning habitat was present but localised and compromised by siltation pressures and naturally high compaction of the bed. Holding habitat was poor in the small, shallow upland watercourse at this location although some valuable pools were associated with meanders and overhanging tree root systems (thermal refugia). Despite some suitability for European eel, none were recorded. The upland eroding site was unsuitable for lamprey and none were recorded. Suitability for white-clawed crayfish was low and none were recorded. No otter signs were recorded in the vicinity of the site.

Biological water quality, based on Q-sampling, was calculated as **Q4 (good status)** (**Appendix B**). However, it should be noted that this is a tentative rating given poor flows and lack of suitable riffle areas for sampling (as per Toner et al., 2005). No macro-invertebrate species of conservation value greater than ‘least concern’, according to national red lists, were recorded via Q-sampling.

Given the presence of salmonids (including Atlantic salmon), in addition to Q4 (good status) water quality, the aquatic ecological evaluation of site B3 was of **local importance (higher value)** (**Table 4.4**).

Plate 4.19 Representative image of site B3 on the upper reaches of the Owveg River, September 2022

4.1.19 Site B4 – Cleanagh Stream, Cleanagh

Site B4 was located on the upper reaches of the Cleanagh Stream (15C58) at the L7792 road and proposed (Pinewoods) GCR crossing. The small upland eroding watercourse (FW1) suffered from very low seasonal flows at the time of survey, with an imperceptible flow and ponding of water only. The stream flowed over a steep gradient downstream of the masonry box culvert in a deeply incised V-shaped valley with bankfull heights of up to 6m. Bank scouring and erosion was widespread, with slumping of material into the narrow channel. The evidently spate channel featured stagnant pools of up to 0.25m in depth with a cascading profile in a 2m wide channel. The substrata were dominated by angular boulder with localised interstitial cobble, coarse gravels and coarse sands. Siltation was evident but likely exacerbated by low flows. Given the site characteristics , no macrophytes or aquatic bryophytes were recorded. Iron oxide deposits were frequent instream. The valley escarpments supported mature ash, hazel, holly and willow with scrubby understories of ivy, bramble and ferns with mosses such as *Thamnobryum alopecurum*. The site was bordered by improved pasture (GA1) and farm outbuildings (BL3).

No fish species were recorded via electro-fishing at site B4 (**Appendix A**). The site was not of fisheries value given its ephemeral nature in addition to high natural gradients. However, given the close proximity to the downstream connecting Owveg River (<0.2km), the stream may have some low fisheries (salmonid) value during higher flow periods. The box culvert was inaccessible to fish given high gradients. The upland eroding ephemeral channel was unsuitable for white-clawed crayfish. No otter signs were recorded in vicinity of the site.

Biological water quality, based on Q-sampling, was calculated as **Q2-3 (poor status)** (**Appendix B**). However, it should be noted that this is a tentative rating given poor flows and lack of suitable riffle areas for sampling (as per Toner et al., 2005). No macro-invertebrate species of conservation value greater than 'least concern', according to national red lists, were recorded via Q-sampling.

Given the absence of aquatic species or habitats of higher conservation value, in addition to less than good status water quality, the aquatic ecological evaluation of site B4 was of **local importance (lower value)** (**Table 4.4**).

Plate 4.20 Representative image of site B4 on the Cleanagh Stream, September 2022

4.1.20 Site B5 – Garrintaggart Stream, Knockbaun

Site B5 was located on the upper reaches of the Garrintaggart Stream (15G30) at the L7792 road and proposed (Pinewoods) GCR crossing. The diminutive upland eroding watercourse (FW1) flowed under the road via a pipe culvert and suffered from low seasonal flows at the time of survey, with only a slight flow. The stream had been historically straightened and deepened in vicinity of the road crossing, with a steep trapezoidal channel and bankfull heights of 2m. The stream averaged 0.5-1m wide and <0.05m deep with a profile comprised exclusively of very shallow glide. The substrata were heavily compacted cobble and gravels exposed to moderate siltation. Given excessive riparian shading, macrophytes and aquatic bryophytes were not present downstream of the culvert. However, watercress and fool's watercress were abundant upstream of the road crossing (more open channel). The stream at this location was heavily tunnelled (near 100%) with very dense blackthorn and willow hedging (WL2). Open areas near the road were heavily encroached by herbaceous vegetation dominated by great willowherb, wild angelica and meadowsweet (*Filipendula ulmaria*). The site was bordered by intensive pasture (GA1) with coniferous afforestation (WD4) upstream.

No fish species were recorded via electro-fishing at site B5 (**Appendix A**). The site was not of fisheries value given its very shallow and likely ephemeral nature, in addition to the location at the headwaters of the stream. The upland eroding channel was unsuitable for white-clawed crayfish. No otter signs were recorded in vicinity of the site.

Biological water quality, based on Q-sampling, was calculated as **Q3 (poor status)** (**Appendix B**). However, it should be noted that this is a tentative rating given poor flows and lack of suitable riffle areas for sampling (as per Toner et al., 2005). No macro-invertebrate species of conservation value greater than 'least concern', according to national red lists, were recorded via Q-sampling.

Given the absence of aquatic species or habitats of higher conservation value, in addition to less than good status water quality, the aquatic ecological evaluation of site B5 was of **local importance (lower value)** (**Table 4.4**).

Plate 4.21 Representative image of site B5 on the Garrintaggart Stream, September 2022

4.1.21 Site B6 – Garrintaggart Stream, Knockbaun

Site B6 was located on the Garrintaggart Stream (15G30) at the R430 road and proposed (Pinewoods) GCR crossing, approx. 0.2km upstream of the Owveg River confluence. The small upland eroding watercourse (FW1) flowed over a high gradient under the road via a series of culverts. The spate channel suffered from very low seasonal water levels at the time of survey, with an imperceptible flow and localised ponding of water. The stream flowed in a deeply incised natural valley downstream of the road crossing, with bankfull heights of up to 8m. Natural bank erosion (scouring) was high. The channel averaged 1-1.5m wide and <0.1m deep at the time of survey, with localised stagnant pools to 0.3m. Typical of a spate channel, the substrata were dominated by angular cobble and boulder with interstitial mixed gravels. Siltation was high and exacerbated by very low flows. Soft sediment and sand accumulations were present along the channel margins and in depositional pool areas. Given very high shading at the base of the valley, macrophytes were not recorded with only very occasional *Rhynchostegium riparioides* present on boulder. The steep escarpments were densely vegetated by mature ash, elder and holly with abundant ivy, nettle, bramble and ferns. The site was bordered by intensive sloping pasture (GA1).

No fish species were recorded via electro-fishing at site B6 (**Appendix A**). The site was not of fisheries value given poor seasonal flows, high natural gradients, poor connectivity with downstream habitats and the location in the upper reaches of the stream. The upland eroding channel was unsuitable for white-clawed crayfish. No otter signs were recorded in vicinity of the site,

Biological water quality, based on Q-sampling, was calculated as **Q3 (poor status)** (**Appendix B**). However, it should be noted that this is a tentative rating given poor flows and lack of suitable riffle areas for sampling (as per Toner et al., 2005). No macro-invertebrate species of conservation value greater than 'least concern', according to national red lists, were recorded via Q-sampling.

Given the absence of aquatic species or habitats of higher conservation value, in addition to less than good status water quality, the aquatic ecological evaluation of site B6 was of **local importance (lower value)** (**Table 4.4**).

Plate 4.22 Representative image of site B6 on the Garrintaggart Stream, September 2022

4.1.22 Site B7 – Owveg River, Spink Bridge

Site B7 was located on the Owveg River (15O01) at Spink Bridge (R430), a proposed (Pinewoods) GCR crossing, approx. 2.4km downstream of site B3. With the exception of a single large, stagnant plunge pool at the bridge apron (**Plate 4.23**), the high gradient upland eroding watercourse was dry at the time of survey. The river is known to flow underground upstream of this point. The river channel averaged 5-8m wide with bank heights of 2-3m downstream of the bridge crossing. Typical of a spate channel, the substrata were dominated by angular boulder and cobble, with localised beds of mixed gravels. The only water present was located in a deep (1.5m) plunge pool immediately below a fractured bridge apron that featured a fall of c.1.5m and was very poorly passable to fish (impassable to lamprey). The pool supported abundant sand deposits with moderate siltation. With the exception of localised watercress on the dry channel bed, macrophytes were absent. No aquatic bryophytes were recorded. The channel was lined by mature treelines of ash, willow and hazel with bramble scrub. The site was bordered by improved pasture (GA1) with coniferous afforestation (WD4) upstream.

European eel, minnow and stone loach were recorded via electro-fishing at site B7 (**Appendix A**). The site provided high physical suitability for salmonids. However, the dry karstic nature of the channel (other than the plunge pool) precluded the presence of brown trout or Atlantic salmon, despite their presence upstream (at site B3). Salmonid presence upstream provides evidence that salmonids are able to navigate this site during higher water flows. Despite limited suitability for crayfish (i.e. spate channel nature of survey area), a low density of white-clawed crayfish were recorded from the plunge pool via hand-searching of refugia (adults and juveniles). No otter signs were recorded in the vicinity of the site.

Site B7 (a single large plunge pool of stagnant water) was not suitable for biological water quality assessment via Q-sampling. However, a composite sweep sample was taken to gain a representation of the macro-invertebrate community. No macro-invertebrate species of conservation value greater than 'least concern', according to national red lists, were recorded (**Appendix B**).

Given the presence of white-clawed crayfish and European eel, the aquatic ecological evaluation of site B7 was of **local importance (higher value)** (**Table 4.4**).

Plate 4.23 Representative image of site B7 on the Owveg River at Spink Bridge, September 2022 (deep plunge pool in an otherwise dry channel)

4.1.23 Site B8 – Owveg River, Garrintaggart

Site B8 was located on the Owveg River (15O01) at the R430 road and proposed (Pinewoods) GCR crossing, approx. 0.9km downstream of site B7. The lowland depositing watercourse (FW2) had been historically straightened downstream of the bridge but demonstrated some good instream recovery. The channel averaged 3-4m wide and 0.1-0.2m deep, with locally deeper pool to 0.5m (e.g. under bridge). The river suffered from low seasonal water levels at the time of survey, with a profile dominated by shallow very slow-flowing glide and riffle with very occasional small pool. The substrata were dominated by compacted cobble with frequent boulder and mixed gravels. However, these were heavily silted (exacerbated by low seasonal flows) and supported excessive cover of filamentous algae and floc. Boulder habitat dominated underneath the bridge. Beds of soft sediment were present along pool and channel margins but these were shallow and largely superficial. Siltation was high overall, with livestock poaching present upstream and downstream of the bridge. The open channel supported frequent beds of watercress along channel margins and on exposed cobble bars, with more occasional fool's watercress and water mint. Common duckweed was also present but rare overall. Aquatic bryophyte coverage was low but some *Leptodictyum riparium* was present locally on larger cobble and boulder. *Fontinalis antipyretica* was present but rare. The riparian zones supported scattered osier (*Salix viminalis*) and grey willow, hawthorn and alder with abundant great willowherb, broad-leaved dock, reed canary grass and rank grasses, frequent butterbur (*Petasites hybridus*) and bramble-dominated scrub. The site was bordered by intensive pasture (GA1).

Brown trout, European eel, minnow and stone loach were recorded via electro-fishing at site B8 (**Appendix A**). The site was of moderate value for salmonids, despite evident siltation and water quality issues, supporting a low density of mixed-cohort brown trout. Atlantic salmon are known from the site (IFI 2021 data). The site provided some good quality spawning and nursery habitat downstream of the bridge, although the quality of both were impacted by considerable siltation and eutrophication pressures. Marginal macrophyte beds provided valuable nursery refugia and also some limited holding habitat for adults. Holding habitat for larger adults was confined to the deeper pool underneath the bridge This boulder habitat provided high quality European eel habitat, with abundant diurnal refugia by way of boulder and retaining wall crevices. Whilst some moderate quality lamprey spawning habitat was present, no suitable nursery areas were identified (shallow & superficial where present). A single juvenile white-clawed crayfish was recorded via hand searching (6mm carapace length). No otter signs were recorded in vicinity of the site.

Biological water quality, based on Q-sampling, was calculated as **Q4 (poor status)** (**Appendix B**). No macro-invertebrate species of conservation value greater than 'least concern', according to national red lists, were recorded via Q-sampling.

Given the presence of salmonids, European eel and white-clawed crayfish, in addition to Q4 (good status) water quality, the aquatic ecological evaluation of site B8 was of **local importance (higher value)** (**Table 4.4**).

Plate 4.24 Representative image of site B8 on the Owveg River, September 2022 (facing downstream from bridge)

4.1.24 Site B9 – Graiguenahown Stream, Graiguenahown

Site B9 was located on the Graiguenahown Stream (15G29) at the L77932 road and proposed (Pinewoods) GCR crossing, approx. 0.5km upstream of the Owveg River confluence. The small upland eroding watercourse (FW1) had been straightened in vicinity of the twin road pipe culvert, with retaining walls present upstream and (more so) downstream. Whilst the stream had been heavily modified downstream of a residential property (near Spink NS), the channel retained some natural characteristics upstream. Connectivity was poor given the presence of a 0.5m fall on the downstream side of the pipe culvert and the semi-dry channel. The stream suffered from very low seasonal water levels at the time of survey with no flow and stagnant pools of standing water only. These pools were 0.1-0.2m deep, with the exception of a plunge pool immediately below the culvert which was up to 0.5m deep. The semi-dry channel averaged 2m wide with steep banks of 1-1.5m high. The substrata were dominated by cobble and mixed gravels with occasional boulder and marginal sand beds. Macrophytes were absent upstream but downstream of the culvert featured rare watercress and fool's watercress in a heavily encroached channel. Aquatic bryophytes were limited to very occasional *Rhynchostegium riparioides*. Filamentous algae were present (20% cover in open areas) indicating enrichment. Upstream, the stream was heavily shaded by mature hazel, holly, ash, hawthorn, blackthorn and willow (WD1) with bramble scrub. Downstream, the modified channel was open with scattered willow, hazel and butterbur dominating the narrow riparian zones. The site was bordered by residential properties (GA2, BL3) and improved pasture (GA1).

No fish were recorded via electro-fishing at site B9 (**Appendix A**). Whilst the site was physically suitable for salmonids the semi-dry nature caused by low seasonal water levels and poor downstream connectivity to superior fisheries habitats precluded the presence of salmonids and other fish species. Three-spined stickleback were absent, indicating the stream may dry out periodically (i.e. ephemeral).

Suitability for white-clawed crayfish was low and none were recorded. No otter signs were recorded in vicinity of the site.

Biological water quality, based on Q-sampling, was calculated as **Q2-3 (poor status)** (**Appendix B**). However, it should be noted that this is a tentative rating given a lack of suitable riffle areas for sampling (as per Toner et al., 2005). No macro-invertebrate species of conservation value greater than 'least concern', according to national red lists, were recorded via Q-sampling.

Given the absence of aquatic species or habitats of higher conservation value, in addition to less than good status water quality, the aquatic ecological evaluation of site B9 was of **local importance (lower value)** (**Table 4.4**).

Plate 4.25 Representative image of site B9 on the Graiguenahown Stream, September 2022 (downstream of twin pipe culvert)

4.1.25 Site B10 – Owveg River, Graiguenasmuttan Bridge

Site B10 was located on the Owveg River (15O01) at Graiguenasmuttan Bridge, approx. 1.9km downstream of site B8. The river had been historically modified in vicinity of the bridge (e.g. a livestock crossing) but retained a meandering profile throughout. The lowland depositing watercourse (FW2) suffered from low seasonal flows at the time of survey and was dominated by shallow, slow-flowing glide and pool habitat, with rare riffle areas. The river averaged 3m wide and 0.1-0.2m deep, with localised pool to 1.5m on meanders. Frequent bank scouring and bankfull heights of up to 2.5m indicated the channel conveyed significantly higher water volumes seasonally. The substrata were dominated by relatively mobile gravels and cobble, with rare boulder. However, these were exposed to high levels of siltation (exacerbated by high flows). Livestock poaching and livestock access to the channel was excessive. Sand-silt accumulations were present on the inside of meanders and occasionally in association with pool areas. The relatively open channel supported locally frequent beds of watercress with occasional brooklime and fool's watercress. Water starwort (*Callitriche* sp.) and water mint were occasional, with rare branched bur-reed. Aquatic bryophyte coverage was high locally in more shaded glide habitat, with frequent *Leptodictyum riparium* and rare *Fontinalis antipyretica*. Cover of filamentous algae and floc was very high (>70% of the bed), further indicating significant enrichment pressures. The narrow riparian zones supported intermittent treelines of hazel, ash, willow and hawthorn with bramble scrub and typical nitrophilous species such as great willowherb. The site was bordered by intensive pasture (GA1).

Atlantic salmon, brown trout, lamprey (*Lampetra* sp.), minnow and stone loach were recorded via electro-fishing at site B10 (**Appendix A**). The site was of moderate value for salmonids, despite low seasonal flows and evident siltation pressures, supporting a low density of mixed-cohort brown trout and Atlantic salmon. The heavily impacted site provided some good quality holding habitat, typically associated with meanders and large woody debris instream. However, these deeper areas supported a very low density of adult salmonids only. Whilst some physically suitable nursery and spawning habitat was present, the value was again compromised by high levels of siltation and enrichment. Shallow soft sediment accumulations along channel margins supported low densities (c.5 per m^2) of *Lampetra* sp. ammocoetes. Despite some good suitability for European eel, none were recorded. The site was of moderate value for white-clawed crayfish only given poorly condition bed refugia (siltation & calcification), low seasonal flows - none were recorded. However, eDNA sampling at the site produced a positive result for white-clawed crayfish (**Table 4.1**). No otter signs were recorded in vicinity of the site, despite some good suitability.

Biological water quality, based on Q-sampling, was calculated as **Q3-4 (moderate status)** (**Appendix B**). No macro-invertebrate species of conservation value greater than 'least concern', according to national red lists, were recorded via Q-sampling.

Given the presence of salmonids (including Atlantic salmon), *Lampetra* sp. and white-clawed crayfish (detected via eDNA), the aquatic ecological evaluation of site B10 was of **local importance (higher value) (Table 4.4).**

Plate 4.26 Representative image of site B10 on the Owveg River at Graiguenasmuttan Bridge, September 2022 (facing upstream from bridge)

4.1.26 Site C1 – Knocklead Stream, Knockacrin

Site C1 was located on the uppermost reaches of the Knocklead Stream (15K21) at the R426 road crossing. The small upland eroding watercourse (FW1) emanated from a coniferous forestry block (WD4) and passed under the road via a pipe culvert. The stream suffered from very low seasonal flows at the time of survey, with the channel semi-dry and supporting occasional near stagnant pools of water only (i.e. a near imperceptible flow). The stream flowed over a relatively high gradient in a deeply incised, cascading channel typical of upland spate channel. The stream averaged 1m wide and <0.05m deep. The substrata were dominated by siliceous bedrock with occasional superficial mixed gravels. Macrophytes were limited to very localised watercress along channel margins with a low bryophyte cover supporting *Scapania undulata* and very occasional *Racomitrium aciculare* on wet cascade areas. The channel was located in an area of historical clear-fell (WD5) with the riparian zone supporting frequent grey willow and bramble scrub and rosebay willowherb (*Chamaenerion angustifolium*). The site was bordered by mature sitka spruce plantation (WD4).

No fish were recorded via electro-fishing at site C1 (**Appendix A**). The site was not of fisheries value given its semi-dry, ephemeral nature and location in the upper reaches of the catchment. Given this, and naturally high gradients, connectivity with downstream habitats was poor and the stream had no suitability to support fish at this location even under higher water levels. There was no suitability for white-clawed crayfish. No otter signs were recorded in the vicinity of the site.

Biological water quality, based on Q-sampling, was calculated as **Q3 (poor status)** (**Appendix B**). However, it should be noted that this is a tentative rating given poor flows and lack of suitable riffle areas for sampling (as per Toner et al., 2005). No macro-invertebrate species of conservation value greater than 'least concern', according to national red lists, were recorded via Q-sampling.

Given the absence of aquatic species or habitats of higher conservation value, in addition to less than good status water quality, the aquatic ecological evaluation of site C1 was of **local importance (lower value)** (**Table 4.4**).

Plate 4.27 Representative image of site C1 on the Knocklead Stream, August 2022

4.1.27 Site C2 – Clogh River, Coolglass

Site C2 was located on the uppermost reaches of the Clogh River (15C03) within the proposed site boundary. The upland eroding watercourse (FW1) meandered through a coniferous forestry block (WD4) in a deeply incised natural valley with bankfull heights of up to 4m (often 2-3m). The spate river suffered from low seasonal flows at the time of survey with only a slight flow present. The river averaged 2-2.5m wide and 0.1-0.2m deep, with deeper plunge pools associated with natural falls/cascades and frequent meanders. The profile of the natural, high-energy site was of frequent pool and riffle. The substrata were dominated by angular cobble and boulder with abundant bedrock and frequent beds of mixed gravels. There were moderately silted (exacerbated by low flows). Iron-oxidising bacterial deposits were frequent instream. Given the high energy characteristics of the site, macrophytes were limited to very occasional watercress along the river margins. Aquatic bryophyte cover was low with occasional *Scapania undulata* and *Racomitrium aciculare* and rare *Chiloscyphus polya*nthos. The steep (often vertical) bedrock-dominated banks supported occasional *Marchantia polymorpha*. The riparian zone was dominated by moss species such as *Polytrichum* sp. and big shaggy moss (*Rhytidiadelphus triquetrus*) with frequent bramble scrub (WS1) and ferns.

Brown trout was the only fish species recorded via electro-fishing at site C2 and the site was of relatively low value for salmonids given its location in the upper reaches of the catchment and spate nature (**Appendix A**). However, the site nonetheless supported a very low density of trout with some suitable spawning and holding habitat was present. The site was of poor value as a salmonid nursery. Holding areas supporting boulder and cobble provided some low suitability for European eel but none were recorded. The upland eroding channel was unsuitable for lamprey or white-clawed crayfish. However, the site was likely of greater fisheries value during higher flow periods and suitability improved considerably downstream. No otter signs were recorded in the vicinity of the site.

Biological water quality, based on Q-sampling, was calculated as **Q3-4 (moderate status)** (**Appendix B**). No macro-invertebrate species of conservation value greater than 'least concern', according to national red lists, were recorded via Q-sampling.

Given the presence of salmonids, the aquatic ecological evaluation of site C2 was of **local importance (higher value) (Table 4.4).**

Plate 4.28 Representative image of site C2 on the upper reaches of the Clogh River, August 2022

4.1.28 Site C3 – Brennanshill River, Coolglass

Site C3 was located on the upper reaches of the Brennanshill River (15B51) at a local track crossing (box culvert, rendered apron) within the proposed site boundary. The upland eroding watercourse (FW1) meandered through a coniferous forestry block (WD4) in a naturally incised channel with bankfull heights of 1-1.5m. The river suffered from low seasonal flows at the time of survey (very slight flow) and averaged <2m wide and 0.1m deep. The profile of the spate channel comprised riffle with frequent small, shallow pool. The substrata were dominated by cobble and mixed gravels with frequent angular boulder. Natural bank erosion and siltation was moderate (exacerbated by low flows). Woody debris was frequent instream and often formed debris dams and associated pool areas. Given high shading and spate characteristics, macrophyte growth was limited to very occasional watercress along channel margins. Coverage of aquatic bryophytes was low with very occasional *Scapania undulata*, *Racomitrium aciculare* and rare *Leptodictyum riparium*. Filamentous algae were frequent (20% cover), indicating enrichment. Downstream of the coniferous forestry block, the riparian zone supported abundant willow, blackthorn, nettle and bramble scrub, with heavy encroachment of the narrow channel.

Brown trout was the only fish species recorded via electro-fishing at site C3 (**Appendix A**). The site was of moderate value for salmonids, supporting a very low density of mixed-cohort brown trout. Whilst some good quality spawning (finer gravels) and moderate quality nursery habitat (cobble & boulder) were present, low seasonal flows reduced the value of the site considerably (i.e. semi-dry). Although small pools were frequent, these provided poor quality holding habitat for adult salmonids given the small nature of the river at this location. Likewise, the shallow depth and seasonality of the spate site provided poor suitability for European eel (none recorded). The site was likely of greater fisheries value during higher flow periods (given connectivity with downstream habitats) and suitability improved considerably downstream. The upland eroding channel was unsuitable for lamprey or white-clawed crayfish. No otter signs were recorded in the vicinity of the site.

Biological water quality, based on Q-sampling, was calculated as **Q4 (good status)** (**Appendix B**). However, it should be noted that this is a tentative rating given poor flows and lack of suitable riffle areas for sampling given very low summer flows (as per Toner et al., 2005). No macro-invertebrate species of conservation value greater than ‘least concern’, according to national red lists, were recorded via Q-sampling.

Given the presence of salmonids, in addition to Q4 (good status) water quality, the aquatic ecological evaluation of site C3 was of **local importance (higher value)** (**Table 4.4**).

Plate 4.29 Representative image of site C3 on the Brennanshill River, August 2022

4.1.29 Site C4 – Clogh River, Moyadd

Site C4 was located on the Clogh River (15C03) at the Brennanshill River confluence and livestock access point, approx. 2km downstream of site C2. The upland eroding watercourse (FW1) suffered from very low seasonal flows at the time of survey, with only a slight flow and a semi-dry channel with ponding of water. The river averaged 3m wide in a channel of up to 6m. The depth varied from 0.1-0.3m (at very low water levels). The profile was of riffle and glide with frequent pool (glide would predominate at higher water levels). Given the spate nature of the channel, the substrata were dominated by angular, mobile cobble and boulder although beds of exposed mixed gravels and sands were abundant along the exposed margins. Soft sediment accumulations were present locally but limited in extent and shallow, where present (<0.02m). Siltation was low overall but exacerbated by low flows, with some seasonal deposition (of sand-dominated) silt present along channel margins. Livestock poaching was present but not excessive (well-fenced buffer zones). Large woody debris was frequent instream and often resulted in the formation of deeper pools. Macrophyte growth was sparse given high shading and hard mobile substrata. Watercress was present locally along channel margins. Aquatic bryophytes were limited to occasional *Racomitrium aciculare* and *Rhynchostegium* riparioides. *Pellia* sp. liverwort was frequent on muddy banks. The site was heavily shaded by a mature buffer of hazel woodland (WN2), with frequent holly and more occasional grey willow, hawthorn and scattered mature ash. The site was bordered by improved pasture (GA1).

Brown trout, lamprey (*Lampetra* sp.), three-spined stickleback, minnow and stone loach were recorded via electro-fishing at site C4 (**Appendix A**). The site was of moderate value to salmonids despite low (and known regular) low seasonal flows and subsequent reduction in fisheries habitat quality. The site supported a low density of mixed-cohort brown trout (primarily adult fish). Physically, the site was of most value as spawning and nursery area although these attributes were compromised by very low seasonal water levels (i.e. a semi-dry channel with only slight flows). Good quality holding habitat was also present, with frequent small pools and scoured banks providing valuable areas for adult salmonids. These areas were especially important given evident low flows. Furthermore, the heavily shaded nature of the site likely facilitated the persistence of a small salmonid population given the presence of thermal refugia. Despite the upland eroding characteristics and presence of sub-optimal, sand-dominated soft sediment, the site supported *Lampetra* sp. ammocoetes. These were present but highly localised, with one area supporting 14 per m^2. Despite some good suitability for European eel, none were recorded via electro-fishing. Suitability for white-clawed crayfish was low and none were recorded. No otter signs were recorded in vicinity of the site.

Biological water quality, based on Q-sampling, was calculated as **Q3 (poor status)** (**Appendix B**). No macro-invertebrate species of conservation value greater than 'least concern', according to national red lists, were recorded via Q-sampling.

Given the presence of salmonids and *Lampetra* sp., the aquatic ecological evaluation of site C4 was of **local importance (higher value) (Table 4.4).**

Plate 4.30 Representative image of site C4 on the Clogh River, August 2022 (very low water levels)

4.1.30 Site C5 – Moyadd Stream, Kylenabehy

Site C5 was located on the Moyadd Stream (15M22) approx. 50m upstream of the Clogh River confluence. The meandering upland eroding watercourse (FW1) was dry at the time of survey with no flow or ponding of water present. The channel averaged 1.5m wide with naturally incised banks of up to 2m high. Scouring of the banks was indicative of a spate channel, as was the predominance of cobble and boulder substrata. Mixed gravels were also present, locally. These were evident moderately silted, with livestock poaching adding to the siltation load. The ephemeral stream supported very occasional brooklime and watercress, with sparse growth of *Racomitrium aciculare*. Filamentous algae were also present on the bed, indicating enrichment. The narrow channel was heavily shaded by hazel-dominated treelines, with abundant bramble scrub. The site was bordered by historical clear-fell (WS5) with improved pasture (GA1) to the south. Coniferous afforestation (WD4) was present upstream.

Site C5 was not of fisheries value given its dry, ephemeral nature and absence of aquatic habitats. However, given some physical suitability and close proximity to the Clogh River, the stream in its lower reaches may support a low density of fish during wetter periods. No otter signs were recorded in the vicinity of the site.

Given the dry nature of the site, it was not possible to collected a biological water quality sample at the time of survey.

Given the absence of aquatic habitats in the ephemeral channel, the aquatic ecological evaluation of site C5 was of **local importance (lower value) (Table 4.4).**

Plate 4.31 Representative image of site C5 on the Moyadd Stream, August 2022 (dry, ephemeral channel at the Clogh River confluence)

4.1.31 Site C6 – Clogh River, Swan Bridge

Site C6 was located on the Clogh River at Swan Bridge (R430), approx. 1km downstream of site C4. The upland eroding watercourse (FW1) had been historically modified (bank revetment) downstream of the bridge but retained a natural profile upstream of the 3-arch masonry bridge (rendered bed and arch). The spate channel suffered from very low seasonal flows at the time of survey, with only a slight flow and a semi-dry channel with ponding of water causing habitat fragmentation and poor fluvial connectivity. The river averaged 3-5m wide and 0.2-0.4m deep (where water was present). Whilst the river upstream of the bridge featured stagnant pools, the river would typically be dominated by glide habitat and shallow riffle over bedrock. The substrata were dominated by calcareous bedrock (>70%) with localised angular cobble and boulder. Mixed gravels were present locally (e.g. pool slacks) but these were limited in extent and heavily silted (exacerbated by low flows). Shallow, organic-rich soft sediment deposits were abundant upstream of the bridge in depositional glide. Livestock poaching was evidently contributing to the siltation load (as well as upstream). Given bedrock substrata and high shading, macrophytes were limited to occasional marginal brooklime and narrow-fruited watercress. The moss *Fontinalis antipyretica* was locally abundant on bedrock with very occasional *Rhynchostegium riparioides* on larger boulder. The river was heavily shaded by dense scrubby treelines of willow, hawthorn and sycamore with abundant bramble and dog rose (*Rosa canina*). The site was bordered by residential properties (with amenity grassland, GA2) and improved pasture (GA1).

Brown trout, lamprey (*Lampetra* sp.), three-spined stickleback, minnow and stone loach were recorded via electro-fishing at site C6 (**Appendix A**). The site was of moderate value for salmonids and supported a low density of juvenile brown trout, despite low seasonal water levels and evident siltation pressures. Whilst spawning habitat was sparse and of moderate quality (at best), some good quality nursery and holding habitat was present. The semi-dry channel over bedrock and the bridge aprons created impassable barriers to salmonid migration at low flows. The site was of good value as a *Lampetra* sp. nursery, with shallow (<5cm) organic-rich soft sediment deposits supporting a relatively high density (>c.10 per m^2) of particularly large ammocoetes (**Appendix A**). Lamprey spawning habitat (finer gravels) was present but limited in extent at exposed to siltation pressures. Despite some suitability for European eel (scoured banks, pool areas etc.), none were recorded. There was low suitability for white-clawed crayfish given a paucity of suitable refugia and burrowing habitat and none were recorded. No otter signs were recorded in the vicinity of the site.

Biological water quality, based on Q-sampling, was calculated as **Q4 (good status)** (**Appendix B**). However, it should be noted that this is a tentative rating given poor flows and lack of suitable riffle areas for sampling (as per Toner et al., 2005). No macro-invertebrate species of conservation value greater than 'least concern', according to national red lists, were recorded via Q-sampling.

Given the presence of salmonids and *Lampetra* sp., in addition to Q4 (good status) water quality, the aquatic ecological evaluation of site C3 was of **local importance (higher value)** (**Table 4.4**).

Plate 4.32 Representative image of site C6 on the Clogh River at Swan Bridge, August 2022 (upstream of bridge with near-dry bedrock bed visible in background)

4.1.32 Site C7 – Clogh River, Clogh Bridge

Site C7 was located on the Clogh River (15C03) at Clogh Bridge, approx. 4km downstream of site C6. The lowland depositing watercourse (FW2) suffered from very low seasonal flows at the time of survey, with only a slight flow and resulting habitat fragmentation and poor fluvial connectivity. The river had been modified in the vicinity of the bridge (upstream and downstream), with bank revetment, a weir and local straightening. The river averaged 6-8m wide and 0.2.-0.6m deep, with deeper areas present >50m upstream. The profile comprised near-stagnant glide and pool (ponding) with localised riffle areas associated with the weir aprons. The substrata were dominated by heavily silted boulder and cobble with frequent interstitial mixed gravels. Areas of improved quality mixed gravels (mostly coarse) with lower siltation were present between macrophyte beds locally upstream of the bridge. Soft sediment deposits were frequent along channel margins given evident livestock poaching pressures. The weir apron(s) downstream of the bridge were cobbled. Given low flows and evident enrichment, the river was heavily vegetated upstream of the bridge. Non-native Canadian pondweed (*Elodea canadensis*) was abundant (30% cover) with occasional water starwort (*Callitriche* sp.) and curled pondweed (*Potamogeton crispus*) (indicator of enrichment). Branched bur reed was occasional instream. Whorled mint (*Mentha x verticillata*) was frequent along channel margins and on exposed mid-channel areas. Brooklime, narrow-fruited watercress, common duckweed, lesser pondweed (*Potamogeton pusillus*) and broad-leaved pondweed (*Potamogeton natans*) were also present but rare overall. Aquatic bryophytes were limited to very occasional *Fontinalis antipyretica* (locally frequent on cobbled bridge apron). The cover of filamentous algae was excessive (50% cover), indicating significant eutrophication. The open (grazed) riparian zones supported a narrow fringe of nettle, water forget-me-not (*Myosotis scorpiodes*), marsh marigold (*Caltha palustris*), great willowherb, thistles and water figwort (*Scrophularia umbrosa*) with an intermittent treeline of willow, sycamore, hawthorn, blackthorn and bramble along the west bank. The site was bordered by intensive agricultural pasture (GA1).

Brown trout, lamprey (*Lampetra* sp.), three-spined stickleback, minnow and perch (*Perca fluviatilis*) were recorded via electro-fishing at site C7 (**Appendix A**). The site was of high value to salmonids, supporting a high density of adult brown trout. The site was of most value as an adult holding habitat, with deeper glide areas and macrophyte beds providing valuable holding areas and thermal refugia in an otherwise open, shallow channel. The site was of poor value as a nursery habitat given poor seasonal flows (physically suitable but no juveniles recorded). Spawning habitat was present for both salmonids and lamprey but was limited in extent and exposed to siltation pressures. Atlantic salmon are also known from this site (IFI 2021 data). The site supported a low density of *Lampetra* sp. ammocoetes, despite apparent widespread suitability (e.g. silt deposits associated with rooting macrophyte areas). Despite some good suitability, no European eel or white-clawed crayfish were recorded. However, eDNA sampling at the site produced a positive result for white-clawed crayfish but also crayfish plague (**Table 4.1**). The weir located downstream of the bridge was a significant barrier to fish passage and was poorly passable to salmonids and impassable to lamprey at low and basal flows (i.e. 0.8m fall, no functional fish pass) (**Plate 4.34**). A regular otter spraint site (mixed age including fresh) was recorded under the eastern arch of the bridge (ITM 656347, 682442), with a second old site also recorded on the upstream side of the same arch (ITM 656349, 682447).

Biological water quality, based on Q-sampling, was calculated as **Q2-3 (poor status)** (**Appendix B**). However, it should be noted that this is a tentative rating given poor flows and lack of suitable riffle areas for sampling (as per Toner et al., 2005). No macro-invertebrate species of conservation value greater than 'least concern', according to national red lists, were recorded via Q-sampling.

Given the presence of salmonids (including Atlantic salmon) and Annex II *Lampetra* sp., the aquatic ecological evaluation of site E2 was of **local importance (higher value) (Table 4.4).**

Plate 4.33 Representative image of site C7 on the Clogh River at Clogh Bridge, August 2022 (facing upstream from bridge)

Plate 4.34 The historical weir at Clogh Bridge is a significant barrier to fish passage at low flows

4.1.33 Site D1 – Douglas River, Shanragh Bridge

Site D1 was located on the upper reaches of the Douglas River (14D03) at Shanragh Bridge, approx. 2.8km east of the proposed site boundary. The upland eroding watercourse (FW1) had been modified in the vicinity of the road crossing, with a cobbled bridge apron and bank modifications (revetment) present. However, the river was otherwise natural with an incised, often V-shaped valley and banks of up to 3m high. Bank scouring was frequent and indicative of spate characteristics. The river flowed over a moderate gradient and averaged 4-5m wide and 0.1-0.2m deep. As the river suffered from low seasonal flows at the time of survey, the 7-8m wide channel was often only partially wetted. The profile was of shallow glide and riffle over boulder cascades with frequent small pools (to a maximum depth of 0.5m). A larger pool was present immediately downstream of the cobbled bridge apron (**Plate 4.35**). The high-energy site featured substrata dominated by compacted angular cobble and boulder with mixed interstitial gravels. Beds of mixed gravels were also present at the tailing of pools. Siltation was low with no soft sediment accumulations present. Given the spate nature of the site and high shading, macrophytes were limited to occasional watercress in open areas near the bridge. Aquatic bryophyte coverage was low overall, though the moss *Rhynchostegium riparium* was locally frequent on the bridge apron. The red alga *Lemanea fluviatilis*[6] was present on stable cobble and boulder but rare. Filamentous algae were present (<1%), indicating enrichment. The river was heavily shaded by mature linear woodland (WN2) dominated by hazel with ash, holly, hawthorn and bramble and ivy scrub. The site was bordered by a residential property (BL3, GA2) and improved pasture (GA1).

Brown trout, three-spined stickleback and stone loach were recorded via electro-fishing at site D1 (**Appendix A**). Site D1 was considered of moderate value for salmonids. However, despite the presence of good quality nursery habitat and good quality (albeit localised) spawning substrata, the site supported only a very low density of brown trout. This was perhaps reflective of low seasonal flows (i.e. fish had perhaps dropped down the system). Frequent small pools provided some suitable holding habitat for smaller adults although the paucity of deeper areas reduced suitability for larger migratory salmonids (e.g. Atlantic salmon). The cobbled bridge apron, in addition to natural cascades, were barriers to fish passage at low flows (depth <0.05m). Despite some moderate suitability as a nursery habitat, no European eel were recorded. The upland eroding site was not suitable for lamprey or white-clawed crayfish. Furthermore, eDNA sampling at the site produced a negative result for white-clawed crayfish (**Table 4.1**). No otter signs were recorded in the vicinity of the site.

Biological water quality, based on Q-sampling, was calculated as **Q4 (poor status)** (**Appendix B**). No macro-invertebrate species of conservation value greater than 'least concern', according to national red lists, were recorded via Q-sampling.

Given the presence of salmonids, in addition to Q4 (good status) water quality, the aquatic ecological evaluation of site D1 was of **local importance (higher value)** (**Table 4.4**).

[6] A macroalgal species typical of fast-flowing, non-alkaline waters (Weekes et al., 2014)

Plate 4.35 Representative image of site D1 on the upper reaches of the Douglas River, August 2022 (downstream of bridge)

4.2 White-clawed crayfish

Small white-clawed crayfish populations were recorded from sites B7 and B8 on the Owveg River. Whilst site B7 (Spink Bridge) supported a low number of adult crayfish, only a single juvenile was recorded from site B8.

Environmental DNA analysis detected white-clawed crayfish in the Owveg River (site B10) and Clogh River (C7) but not in the Stradbally River (A15) or Douglas River (D1) (see below section 4.3). No white-clawed crayfish remains were identified in field inspection of 12 no. otter spraint sites and a latrine at sites recorded across the Stradbally River, Cremorgan Stream and Clogh River.

4.3 eDNA analysis

Composite water samples collected from the from the Stradbally River (site A15), Owveg River (B10), Clogh River (C7) and Douglas River (D1) returned a negative result for freshwater pearl mussel eDNA, i.e. freshwater pearl mussel eDNA not present or was present below the limit of detection in a series of 12 qPCR replicates (0 positive replicates out of 12, respectively) (**Table 4.1** above; **Appendix C**). These results were considered as evidence of the species' absence at and or upstream of the sampling locations and support the absence of records for the species within the wider survey area.

White-clawed crayfish eDNA was detected at sites B10 on the Owveg River and C7 on the Clogh River (11 and 1 positive qPCR replicates out of 12, respectively) (**Table 4.1**; **Appendix C).** However, no crayfish eDNA was detected in the Stradbally River at Stradbally Bridge (site A15) or Douglas River (D1), i.e. eDNA not present or was present below the limit of detection in a series of 12 qPCR replicates**.**

Crayfish plague eDNA was detected in the Stradbally River at site A15 (11 positive qPCR replicates out of 12) and Clogh River at site C7 (1 positive qPCR replicates out of 12) (**Table 4.1**; **Appendix C).**

Table 4.1 eDNA results in the vicinity of the proposed Coolglass wind farm, Co. Laois (positive qPCR replicates out of 12 in parentheses)

Sample	Watercourse	Freshwater pearl mussel [7]	White-clawed crayfish	Crayfish plague
FK784	Stradbally River (site A15)	Negative (0/12)	Negative (0/12)	**Positive (11/12)**
FK772	Owveg River (site B10)	Negative (0/12)	**Positive (12/12)**	Negative (0/12)
FK785	Clogh River (site C7)	Negative (0/12)	**Positive (1/12)**	**Positive (1/12)**
FK774	Douglas River (site D1)	Negative (0/12)	Negative (0/12)	Negative (0/12)

4.4 Otter signs

Despite some good suitability at numerous survey locations, otter signs were only recorded at a total of four sites during the course of aquatic surveys undertaken in August-September 2022.

Regular otter spraint sites were recorded at sites A12 on the Cremorgan Stream (3 no. spraint sites), A14 and A15 on the Stradbally River (total of 7 no. sites) and site C7 on the Clogh River (2 no. sites). A latrine and couch (resting) area were also identified under Stradbally Bridge at site A15.

No breeding (holts) areas were identified in the 150m vicinity of the survey sites in August-September 2022.

4.5 Invasive aquatic species

The invasive macrophyte Canadian pondweed (*Elodea canadensis*) was recorded at site A15 on the Stradbally River at Stradbally Bridge and site C7 on the River Clogh at Clogh Bridge. The species is very widespread in Ireland and is listed on the Third Schedule of the European Communities (Birds and Natural Habitats) Regulations 2011-2021 (S.I. 477/2011). It is considered a high-risk invasive species in Irish waters (O' Flynn et al., 2014).

Environmental DNA analysis detected the non-native pathogen crayfish plague (*Aphanomyces astaci*) in the Stradbally River and Clogh River (**Table 4.1**; see section 4.3 above).

[7] The historical range of freshwater pearl mussel is known from the River Nore between Poorman's Bridge to Ballyragget. The Stage 1 and 2 surveys completed for this report in addition to the eDNA sampling recorded no live mussels along c.4km of the Nore between Archer's Island and Ballyragget Bridge (Appendix D, Freshwater Pearl Mussel Survey).

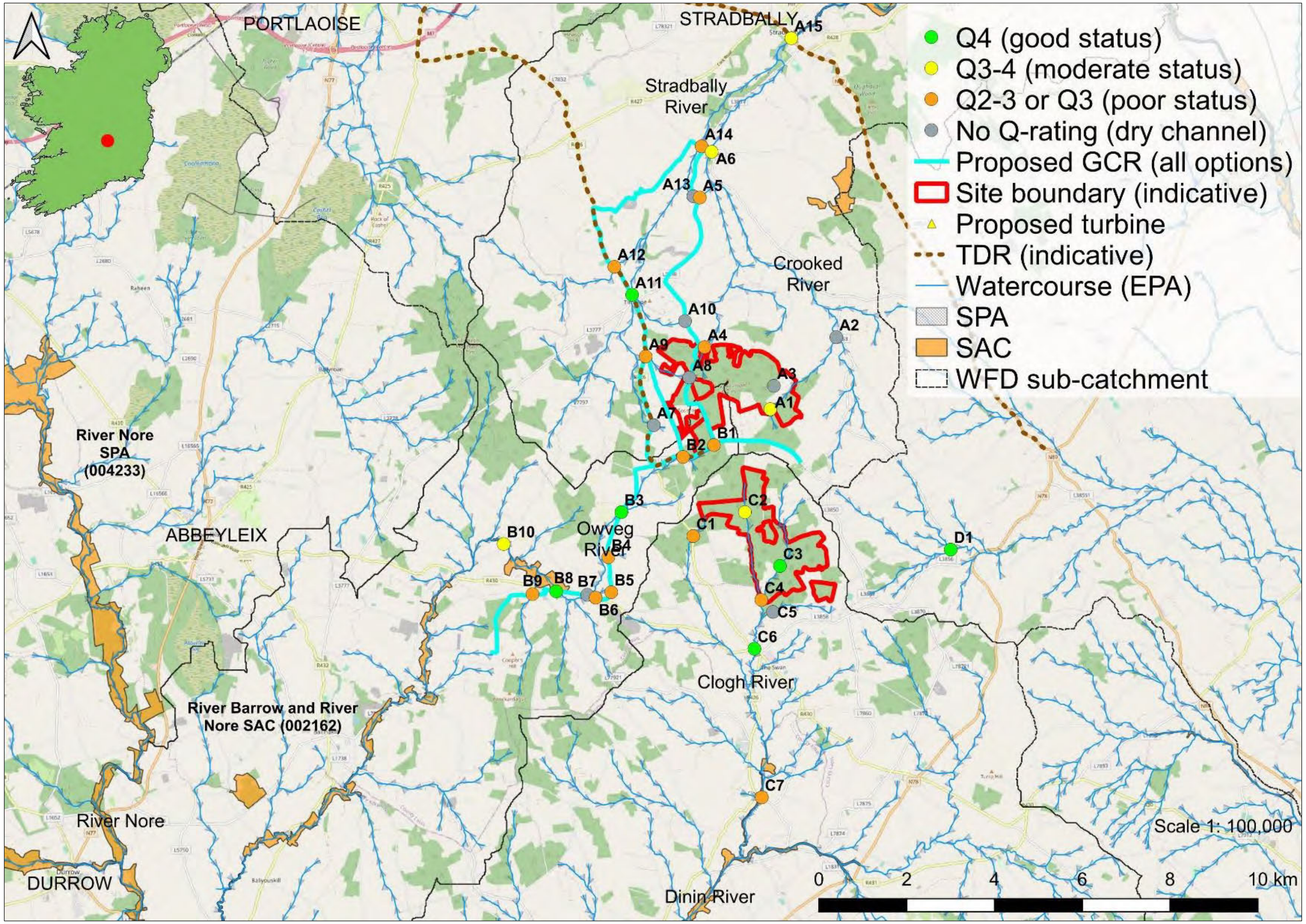

Figure 4.1 Overview of the biological water quality status in the vicinity of the proposed Coolglass wind farm project, Co. Laois, August 2022

4.6 Biological water quality (macro-invertebrates)

No rare or protected macro-invertebrate species (according to national red lists) were recorded in the biological water quality samples taken from *n*=25 wetted riverine sites in August-September 2022 (**Appendix A**).

Sites on the Stradbally River (site A11), Owveg River (B3 & B8), Brennanshill River (C3), Clogh River (C6) and Douglas River (D1) achieved **Q4 (good status)** given the presence of fair numbers (5-10%) of EPA group A species such as the mayfly *Ecdyonurus* dispar and *Heptagenia* sp. (**Appendix B**). Low numbers of group A mayfly *Rithrogena semicolorata* (site A11 & D1) and the stonefly *Nemoura cinerea* (B8) were also present. Therefore, these 6 no. sites met the target good status (≥Q4) requirements of the European Union Environmental Objectives (Surface Waters) (Amendment) Regulations 2019 and the Water Framework Directive (2000/60/EC) (**Figure 4.1** above). Given low seasonal flows at the time of survey and resulting sub-optimal sampling conditions (Toner et al., 2005), the ratings for sites B3, C3 and C6 were considered tentative.

Sites on the Fallowbeg Upper Stream (A1), Crooked River (A6), Stradbally River (A15), Owveg River (B10) and Clogh River (C2) achieved **Q3-4 (moderate status)** water quality. This was given the low numbers (<5%) of group A species, namely the mayfly species *Ecdyonurus dispar* and *Heptagenia* sp. The sites also supported low numbers of group B species such as the mayfly *Alainites muticus* or the stonefly *Leuctra hippopus* (**Appendix B**).

The 14 no. remaining sites on the Honey Stream (A4), Honey Stream North (A5), Fossy Lower Stream (A9), Cremorgan Stream (A12), Stradbally River (A14), Scotland Stream (B1), Owveg River (B2), Cleanagh Stream (B4), Garrintaggart Stream (B5 & B6), Graiguenahown Stream (B9), Knocklead Stream (C1) and Clogh River (C4 & C7) achieved **Q2-3 or Q3 (poor status)**. This rating was based on an absence of group A species, an absence or low numbers of group B species (such as the caddis *Potamophylax cingulatus* and the stonefly *Leuctra hippopus*), and a dominance of group C species, particularly the mayflies *Baetis rhodani*, freshwater shrimp *Gammarus duebeni*, the non-native New Zealand mud snail (*Potamopyrgus antipodarum*) and biting midge larvae (non-*Chironomus* spp.) (**Appendix B**). Sites B1, B4, B9 and C7 were considered as **Q2-3 (poor status)** due to a higher proportion (but not dominance of) of group D (highly pollution tolerant) and group E (most pollution tolerant) species such as the snail *Ampullacaena balthica* and midge larvae (*Chironomus* spp.), respectively (**Appendix B**). Given low seasonal flows at most of these sites at the time of survey and resulting sub-optimal sampling conditions (Toner et al., 2005), the ratings for sites A4, A5, A9, A12, B1, B2, B4, B5, B6, B9, C1 and C7 were considered tentative.

4.7 Macrophytes and aquatic bryophytes

No rare or protected macrophytes or aquatic bryophytes were recorded at the *n*=33 survey sites.

An aquatic vegetation community representative of the Annex I habitat 'Water courses of plain to montane levels with the *Ranunculion fluitantis* and *Callitricho-Batrachion* vegetation or aquatic mosses [3260]' (aka floating river vegetation) was present at site A15 on the Stradbally River at Stradbally Bridge. This site supported abundant water crowfoot (*Ranunculus* sp.) (40% cover) and a high cover of aquatic bryophytes such as *Fontinalis antipyretica*, in addition to other indicator species such as water starwort (*Callitriche* sp.) (Weekes et al., 2018; EC, 2013; Kelleher et al., 2011). The site was located within the River Barrow and River Nore SAC (002162) for which floating river vegetation is listed as a qualifying interest (NPWS, 2011).

4.8 Aquatic ecological evaluation

An aquatic ecological evaluation of each survey site was based on the results of desktop review (i.e., presence of fish of conservation value), fisheries habitat assessments, the presence of protected or rare invertebrates (e.g. white-clawed crayfish, freshwater pearl mussel), environmental DNA analysis, the presence of rare macrophytes and aquatic bryophytes and or associated representations of Annex I habitats. Furthermore, biological water quality status also informed the aquatic evaluation (**Table 4.4** below).

Site A15 on the Stradbally River was evaluated as **international importance** given its location within the River Barrow and River Nore SAC (002162).

A total of 15 no. sites on the Crooked River (A6), Stradbally River (A11, A14), Cremorgan Stream (A12), Owveg River (B2, B3, B7, B8, B10), Clogh River (C2, C6 & C7), Brennanshill River (C3) and the Douglas River (D1) were evaluated as **local importance (higher value) (Table 4.4)**. This evaluation was primarily due to the presence of salmonids, lamprey (*Lampetra* sp.) and or other aquatic species of high conservation value, such as white-clawed crayfish or otter.

The remaining 17 no. survey sites on the Fallowbeg Stream (A1), Crooked River (A2), unnamed stream (A3), Honey Stream (A4), Honey Stream North (A5), Aghoney Stream (A7), Fossy Lower Stream (A8 & A9), Timahoe Stream (A10), unnamed stream (A13), Scotland Stream (B1), Cleanagh Stream (B4), Garrintaggart Stream (B5 & B6), Graiguenahown Stream (B9), Knocklead Stream (C1) and the Moyadd Stream (C5) were evaluated as **local importance (lower value)** in terms of their aquatic ecology given an absence of species or habitats of high conservation value.

Table 4.2 Summary of fish species of higher conservation value recorded via electro-fishing per survey site in the vicinity of the proposed Coolglass wind farm, August-September 2022

Site	Watercourse	Atlantic salmon	*Lampetra* sp.	Brown trout	European eel	Other species
A1	Fallowbeg Upper Stream	No fish recorded – dry channel				
A2	Crooked River	No fish recorded – dry channel				
A3	Unnamed stream	No fish recorded – dry channel				
A4	Honey Stream	No fish recorded				
A5	Honey Stream North	No fish recorded				
A6	Crooked River		✓	✓		Three-spined stickleback, stone loach
A7	Aghoney Stream	No fish recorded				
A8	Fossy Lower Stream	No fish recorded – dry channel				
A9	Fossy Lower Stream	No fish recorded				

Site	Watercourse	Atlantic salmon	*Lampetra* sp.	Brown trout	European eel	Other species
A10	Timahoe Stream	No fish recorded – dry channel				
A11	Stradbally River		✓	✓		Three-spined stickleback, stone loach, minnow
A12	Cremorgan Stream					Three-spined stickleback
A13	Unnamed stream	No fish recorded				
A14	Stradbally River			✓		Three-spined stickleback, stone loach, minnow
A15	Stradbally River	✓	✓	✓		Three-spined stickleback, minnow
B1	Scotland Stream	No fish recorded				
B2	Owveg River			✓		
B3	Owveg River	✓		✓		Minnow, stone loach
B4	Cleanagh Stream	No fish recorded				
B5	Garrintaggart Stream	No fish recorded				
B6	Garrintaggart Stream	No fish recorded				
B7	Owveg River				✓	Minnow, stone loach
B8	Owveg River			✓	✓	Minnow, stone loach
B9	Graiguenahown Stream	No fish recorded				
B10	Owveg River	✓	✓	✓		Minnow, stone loach
C1	Knocklead Stream	No fish recorded				
C2	Clogh River			✓		
C3	Brennanshill River			✓		
C4	Clogh River		✓	✓		Three-spined stickleback, stone loach, minnow
C5	Moyadd Stream	No fish recorded – dry channel				
C6	Clogh River		✓	✓		Three-spined stickleback, stone loach, minnow
C7	Clogh River		✓	✓		Perch, minnow, three-spined stickleback
D1	Douglas River			✓		Three-spined stickleback, stone loach

Conservation value: Atlantic salmon (*Salmo salar*), brook lamprey (L*ampetra planeri*) and river lamprey (*Lampetra fluviatilis*) are listed under Annex II of the Habitats Directive [92/42/EEC]. Atlantic salmon and river lamprey are also listed under Annex V of the Habitats Directive [92/42/EEC]. European eel are 'critically endangered' according to most recent ICUN red list (Pike et al., 2020) and listed as 'critically engendered' in Ireland (King et al., 2011). With the exception of the Inland Fisheries Acts 1959 to 2017, brown trout and coarse fish species have no legal protection in Ireland.

Table 4.3 Summary of aquatic species (excluding fish) and habitats of higher conservation value recorded in the vicinity of the proposed Coolglass wind farm, August 2022 (occurrence in **bold** for clarity)

Site	Watercourse	White-clawed crayfish	Freshwater pearl mussel	Otter signs[4]	Annex I aquatic habitats	Rare or protected macrophytes/ aquatic bryophytes	Rare or protected macro-invertebrates	Other species/habitats of high conservation value
A1	Fallowbeg Upper Stream	None recorded		None recorded	Not present	None recorded	None recorded	**Smooth newt populations recorded in small pools c.200m west of site**
A2	Crooked River	None recorded		None recorded	Not present	None recorded	None recorded	
A3	Unnamed stream	None recorded		None recorded	Not present	None recorded	None recorded	
A4	Honey Stream	None recorded		None recorded	Not present	None recorded	None recorded	
A5	Honey Stream North	None recorded		None recorded	Not present	None recorded	None recorded	
A6	Crooked River	None recorded		None recorded	Not present	None recorded	None recorded	
A7	Aghoney Stream	None recorded		None recorded	Not present	None recorded	None recorded	
A8	Fossy Lower Stream	None recorded		None recorded	Not present	None recorded	None recorded	
A9	Fossy Lower Stream	None recorded		None recorded	Not present	None recorded	None recorded	
A10	Timahoe Stream	None recorded		None recorded	Not present	None recorded	None recorded	
A11	Stradbally River	None recorded		None recorded	Not present	None recorded	None recorded	
A12	Cremorgan Stream	None recorded		**3 no. regular spraint sites**	Not present	None recorded	None recorded	
A13	Unnamed stream	None recorded		None recorded	Not present	None recorded	None recorded	
A14	Stradbally River	None recorded		**Regular spraint site**	Not present	None recorded	None recorded	
A15	Stradbally River	None recorded; negative eDNA result at site	**Negative eDNA result at site, no records in catchment**	**Couch & latrine identified with 6 no. regular spraint sites**	**Floating river vegetation [3260] present**	None recorded	None recorded	

Site	Watercourse	White-clawed crayfish	Freshwater pearl mussel	Otter signs[4]	Annex I aquatic habitats	Rare or protected macrophytes/ aquatic bryophytes	Rare or protected macro-invertebrates	Other species/habitats of high conservation value
B1	Scotland Stream	None recorded		None recorded	Not present	None recorded	None recorded	
B2	Owveg River	None recorded		None recorded	Not present	None recorded	None recorded	
B3	Owveg River	None recorded		None recorded	Not present	None recorded	None recorded	
B4	Cleanagh Stream	None recorded		None recorded	Not present	None recorded	None recorded	
B5	Garrintaggart Stream	None recorded		None recorded	Not present	None recorded	None recorded	
B6	Garrintaggart Stream	None recorded		None recorded	Not present	None recorded	None recorded	
B7	Owveg River	**Adults recorded**		None recorded	Not present	None recorded	None recorded	
B8	Owveg River	**Single juvenile recorded**		None recorded	Not present	None recorded	None recorded	
B9	Graiguenahown Stream	None recorded		None recorded	Not present	None recorded	None recorded	
B10	Owveg River	**None recorded but positive eDNA result at site**	**Negative eDNA result at site, no records in catchment**	None recorded	Not present	None recorded	None recorded	
C1	Knocklead Stream	None recorded		None recorded	Not present	None recorded	None recorded	
C2	Clogh River	None recorded		None recorded	Not present	None recorded	None recorded	
C3	Brennanshill River	None recorded		None recorded	Not present	None recorded	None recorded	
C4	Clogh River	None recorded		**Regular spraint site**	Not present	None recorded	None recorded	
C5	Moyadd Stream	None recorded		**Regular spraint site**	Not present	None recorded	None recorded	
C6	Clogh River	None recorded		None recorded	Not present	None recorded	None recorded	
C7	Clogh River	**None recorded but positive eDNA result at site**	**Negative eDNA result at site, no records in catchment**	**3 no. regular spraint sites**	Not present	None recorded	None recorded	

Site	Watercourse	White-clawed crayfish	Freshwater pearl mussel	Otter signs[4]	Annex I aquatic habitats	Rare or protected macrophytes/ aquatic bryophytes	Rare or protected macro-invertebrates	Other species/habitats of high conservation value
D1	Douglas River	None recorded; negative eDNA result at site	**Negative eDNA result at site, no records in catchment**	None recorded	Not present	None recorded	None recorded	

*** Conservation value:** White-clawed crayfish (*Austropotamobius pallipes*), freshwater pearl mussel (*Margaritifera margaritifera*) and Eurasian otter (*Lutra lutra*) are listed under Annex II and Annex V of the Directive on the Conservation of Natural Habitats of Wild Fauna and Flora (92/43/EEC) ('EU Habitats Directive') and all are protected under the Irish Wildlife Acts 1976-2021. White-clawed crayfish (Füreder et al., 2010) and freshwater pearl mussel (Moorkens et al., 2017) are also both listed as 'Endangered' according to the IUCN Red List. The European Union (Invasive Alien Species) (Freshwater Crayfish) Regulations 2018 (SI 354/2018) affords further protection to native white-clawed crayfish by prohibiting the introduction and spread of five no. invasive 'Union concern' crayfish species listed under EU Regulation 1143/2014. Smooth newt (*Lissotriton vulgaris*) are protected under the Irish Wildlife Acts 1976-2021.

[4] Otter signs within 150m of the survey site

Table 4.4 Aquatic ecological evaluation summary of the Coolglass wind farm survey sites according to NRA (2009) criteria

Site no.	Watercourse	EPA code	Evaluation of importance	Rationale summary
A1	Fallowbeg Upper Stream	14F06	Local importance (lower value)	Upper reaches of natural, high gradient spate channel with poor fisheries value; no fish recorded via electro-fishing; **Q3-4** (moderate status) water quality; no aquatic species or habitats of high conservation value
A2	Crooked River	14C02	Local importance (lower value)	Upper reaches of modified lowland ephemeral channel with no fisheries & aquatic value (dry at time of survey); no electro-fishing or biological water quality sample possible; no aquatic species or habitats of high conservation value
A3	Unnamed stream	n/a	Local importance (lower value)	Upper reaches of high gradient, modified ephemeral channel with no fisheries & aquatic value (dry at time of survey); no electro-fishing or biological water quality sample possible; no aquatic species or habitats of high conservation value
A4	Honey Stream	14H01	Local importance (lower value)	Upper reaches of semi-dry, modified channel with poor flows and fisheries value; no fish recorded via electro-fishing; **Q3** (poor status) water quality (tentative rating); no aquatic species or habitats of high conservation value
A5	Honey Stream North	14H21	Local importance (lower value)	Heavily modified, heavily vegetated ephemeral channel with imperceptible flows, of poor fisheries & aquatic value; **Q3** (poor status) water quality (tentative rating); no aquatic species or habitats of high conservation value
A6	Crooked River	14C02	**Local importance (higher value)**	Historically modified, heavily silted, heavily enriched lowland watercourse of good value to salmonids & moderate value to lamprey; brown trout, stone loach, three-spined stickleback & low density of *Lampetra* sp. recorded via electro-fishing; regular otter spraint site under bridge; **Q3-4** (moderate status) water quality
A7	Aghoney Stream	14A08	Local importance (lower value)	Upper reaches of natural ephemeral spate channel with no fisheries & aquatic value (dry at time of survey); no electro-fishing or biological water quality sample possible; no aquatic species or habitats of high conservation value
A8	Fossy Lower Stream	14F10	Local importance (lower value)	Upper reaches of modified, high gradient ephemeral spate channel with no fisheries & aquatic value (dry at time of survey); no electro-fishing or biological water quality sample possible; no aquatic species or habitats of high conservation value
A9	Fossy Lower Stream	14F10	Local importance (lower value)	Historically modified ephemeral spate channel with stagnant pools, of poor fisheries & aquatic value; **Q3** (poor status) water quality (tentative rating); no aquatic species or habitats of high conservation value
A10	Timahoe Stream	14T09	Local importance (lower value)	Upper reaches of heavily modified ephemeral channel with no fisheries & aquatic value (dry at time of survey); no electro-fishing or biological water quality sample possible; no aquatic species or habitats of high conservation value
A11	Stradbally River	14S02	**Local importance (higher value)**	Historically modified, heavily vegetated lowland watercourse of moderate value to salmonids & lamprey; brown trout, stone loach, minnow, three-spined stickleback & low density of *Lampetra* sp. recorded via electro-fishing; **Q4** (good status) water quality

Site no.	Watercourse	EPA code	Evaluation of importance	Rationale summary
A12	Cremorgan Stream	14C24	**Local importance (higher value)**	Semi-natural, high-energy calcareous but ephemeral river that was mostly dry at the time of survey; high physical suitability for salmonids (but none recorded at time of survey); three-spined stickleback recorded via electro-fishing from remnant pools; 3 no. otter spraint sites recorded; **Q3** (poor status) water quality (tentative rating)
A13	Unnamed stream	n/a	Local importance (lower value)	Heavily modified, heavily vegetated ephemeral channel with no fisheries & aquatic value (dry at time of survey); no electro-fishing or biological water quality sample possible; no aquatic species or habitats of high conservation value
A14	Stradbally River	14S02	**Local importance (higher value)**	Semi-natural, heavily vegetated calcareous lowland depositing river with very low water levels at the time of survey; of moderate value to salmonids; brown trout, stone loach, minnow & three-spined stickleback recorded via electro-fishing; regular otter spraint site recorded under bridge; **Q3** (poor status) water quality
A15*	Stradbally River	14S02	**International importance**	Located within the River Barrow and River Nore SAC (002162); heavily modified, heavily enriched lowland depositing river with low summer flows but high aquatic value; Atlantic salmon, brown trout, *Lampetra* sp., minnow & three-spined stickleback recorded via electro-fishing; Annex I floating river vegetation [3260] present; 6 no. otter spraints sites, latrine & couch (resting area) recorded; **Q3-4** (moderate status) water quality
B1	Scotland Stream	15S06	Local importance (lower value)	Upper reaches of semi-dry, semi-natural ephemeral spate channel with poor flows and fisheries value; no fish recorded via electro-fishing; **Q2-3** (poor status) water quality (tentative rating); no aquatic species or habitats of high conservation value
B2	Owveg River	15O01	**Local importance (higher value)**	Upper reaches of historically modified spate channel with very low water levels at the time of survey; brown trout recorded via electro-fishing; **Q3** (poor status) water quality (tentative rating)
B3	Owveg River	15O01	**Local importance (higher value)**	Upper reaches of semi-natural spate channel with very low water levels at the time of survey but of moderate value to salmonids; Atlantic salmon, brown trout, stone loach & minnow recorded via electro-fishing; **Q4** (good status) water quality (tentative rating)
B4	Cleanagh Stream	15C58	Local importance (lower value)	Small ephemeral spate channel with stagnant pools, of poor fisheries & aquatic value; no fish recorded via electro-fishing; **Q2-3** (poor status) water quality (tentative rating); no aquatic species or habitats of high conservation value
B5	Garrintaggart Stream	15G30	Local importance (lower value)	Upper reaches of modified semi-dry, spate channel with poor flows and fisheries value (likely ephemeral); no fish recorded via electro-fishing; **Q3** (poor status) water quality (tentative rating); no aquatic species or habitats of high conservation value
B6	Garrintaggart Stream	15G30	Local importance (lower value)	Semi-natural, high gradient spate channel with very low water levels at the time of survey; no fish recorded via electro-fishing; **Q3** (poor status) water quality (tentative rating); no aquatic species or habitats of high conservation value

Site no.	Watercourse	EPA code	Evaluation of importance	Rationale summary
B7	Owveg River	15O01	**Local importance (higher value)**	Large, moderate gradient, karstic ephemeral spate channel known to dry out seasonally; single large stagnant pool of water remaining (dry elsewhere) but of high aquatic value; European eel, minnow & stone loach recorded via electro-fishing; white-clawed crayfish recorded via hand searching; no biological water quality sample possible;
B8	Owveg River	15O01	**Local importance (higher value)**	Semi-natural, enriched, calcareous lowland depositing river with low water levels at the time of survey. The site was considered of moderate fisheries value; brown trout, European eel, minnow & stone loach recorded via electro-fishing; white-clawed crayfish recorded; **Q4** (good status) water quality
B9	Graiguenahown Stream	15G29	Local importance (lower value)	Historically modified channel with poor flows and fisheries value; no fish recorded via electro-fishing; **Q2-3** (poor status) water quality (tentative rating); no aquatic species or habitats of high conservation value
B10*	Owveg River	15O01	**Local importance (higher value)**	Semi-natural, calcareous, enriched lowland depositing river with low water levels at the time of survey but of good fisheries value; Atlantic salmon, brown trout, *Lampetra* sp., minnow & stone loach recorded via electro-fishing; white-clawed crayfish recorded (eDNA only); **Q3-4** (moderate status) water quality
C1	Knocklead Stream	15K21	Local importance (lower value)	Upper reaches of high gradient, semi-natural spate channel with very low water levels at the time of survey (likely ephemeral); no fish recorded via electro-fishing; **Q3** (poor status) water quality (tentative rating); no aquatic species or habitats of high conservation value
C2	Clogh River	15C03	**Local importance (higher value)**	Uppermost reaches of upland eroding river with low flows at the time of survey but of some lower value for salmonids; brown trout recorded via electro-fishing; **Q3-4** (moderate status) water quality
C3	Brennanshill River	15B51	**Local importance (higher value)**	Uppermost reaches of small, semi-natural upland eroding river with low flows at the time of survey but of some lower value for salmonids; brown trout recorded via electro-fishing; **Q4** (good status) water quality (tentative rating)
C4	Clogh River	15C03	**Local importance (higher value)**	Upland eroding spate channel with high siltation & very low water levels at the time of survey that was considered of moderate fisheries value; brown trout, *Lampetra* sp., three-spined stickleback, minnow & stone loach recorded via electro-fishing; **Q3** (poor status) water quality
C5	Moyadd Stream	15M22	Local importance (lower value)	Small upland eroding ephemeral channel with no fisheries & aquatic value (dry at time of survey); no electro-fishing or biological water quality sample possible; no aquatic species or habitats of high conservation value
C6	Clogh River	15C03	**Local importance (higher value)**	Semi-natural upland eroding spate river with very low water levels at the time of survey but of high fisheries value; brown trout, minnow, stone loach & high density of *Lampetra* sp. recorded via electro-fishing; **Q4** (good status) water quality
C7	Clogh River	15C03	**Local importance (higher value)**	Historically modified, semi-natural, enriched lowland depositing channel with very low water levels at the time of survey but of high fisheries value; brown trout,

Site no.	Watercourse	EPA code	Evaluation of importance	Rationale summary
				Lampetra sp., three-spined stickleback, minnow & perch recorded via electro-fishing; Atlantic salmon also known from site (IFI data); white-clawed crayfish recorded (eDNA only); 2 no. otter spraints sites recorded; **Q2-3** (poor status) water quality (tentative rating)
D1	Douglas River	15D03	**Local importance (higher value)**	Upper reaches of natural, high gradient upland eroding spate channel with low water levels at the time of survey; brown trout, three-spined stickleback & stone loach recorded via electro-fishing; **Q4** (good status) water quality

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Conservation value: Atlantic salmon (*Salmo salar*), sea lamprey (*Petromyzon marinus*), brook lamprey (*Lampetra planeri*), river lamprey (*Lampetra fluviatilis*), white-clawed crayfish (*Austropotamobius pallipes*) and otter (*Lutra lutra*) are listed under Annex II of the Habitats Directive [92/42/EEC]. Atlantic salmon, river lamprey, freshwater pearl mussel, white-clawed crayfish and otter are also listed under Annex V of the Habitats Directive [92/42/EEC]. Freshwater pearl mussel and otters (along with their breeding and resting places) are also protected under provisions of the Irish Wildlife Acts 1976 to 2021. European eel are 'critically endangered' according to most recent ICUN red list (Pike et al., 2020) and listed as 'critically engendered' in Ireland (King et al., 2011). With the exception of the Inland Fisheries Acts 1959 to 2017, brown trout and coarse fish species have no legal protection in Ireland.

5. Discussion

5.1 Most valuable areas for aquatic ecology

Site A15 on the Stradbally River was evaluated as **international importance** given its location within the River Barrow and River Nore SAC (002162). The site also supported Atlantic salmon, lamprey (*Lampetra* sp.), the Annex I habitat 'Water courses of plain to montane levels, with submerged or floating vegetation of the *Ranunculion fluitantis* and *Callitricho-Batrachion* (low water level during summer) or aquatic mosses [3260]' and highly regular otter activity, including a legally protected couch (resting area) for otter. The above species and habitats are also listed as qualifying interests for this European site.

A total of 15 no. sites on the Crooked River (A6), Stradbally River (A11, A14), Cremorgan Stream (A12), Owveg River (B2, B3, B7, B8, B10), Clogh River (C2, C6 & C7), Brennanshill River (C3) and the Douglas River (D1) were evaluated as **local importance (higher value)** (**Table 4.4**). This evaluation was primarily due to the presence of salmonids (*n*=13 sites) and or lamprey (*Lampetra* sp.) (*n*=7 sites). Other aquatic species of high conservation value, such as white-clawed crayfish (B7, B8, B10, C7) or otter (A12, A14, A15, C7) were also present at certain sites (**Table 4.2. 4.3**). Sites A11, B3, B8, C3, C6 and D1 also achieved Q4 (good status) water quality (**Appendix B**).

The remaining 17 no. survey sites on the Fallowbeg Stream (A1), Crooked River (A2), unnamed stream (A3), Honey Stream (A4), Honey Stream North (A5), Aghoney Stream (A7), Fossy Lower Stream (A8 & A9), Timahoe Stream (A10), unnamed stream (A13), Scotland Stream (B1), Cleanagh Stream (B4), Garrintaggart Stream (B5 & B6), Graiguenahown Stream (B9), Knocklead Stream (C1) and the Moyadd Stream (C5) were evaluated as **local importance (lower value)** in terms of their aquatic ecology given an absence of aquatic species or habitats of high conservation value and **less than Q4 (good status)** water quality. Sites A1, A2, A3, A8, A10 and C5 were of **local importance (lower value)** given an absence of aquatic habitats at the time of survey (i.e. dry, ephemeral channels).

5.1.1 Fish species of high conservation value

Apart from sites A12 on the Cremorgan Stream and B7 on the Owveg River (semi-dry spate channels), salmonids were recorded at all 15 no. sites supporting fish during the survey (**Table 4.2**). This was despite widespread low water levels in addition to siltation, eutrophication and or hydromorphological pressures. Atlantic salmon were present (in low densities) at 3 no. sites only, on the Stradbally River (A15) and Owveg River (B3 & B10). The Stradbally River and Crooked River, draining to the north of the proposed project, supported the highest densities of Atlantic salmon and brown trout, respectively (**Appendix A**).

Lamprey ammocoetes (*Lampetra* sp.) were recorded from 7 no. sites (**Table 4.2**), typically in low densities due to sub-optimal and or limited nursery habitat. Particularly high densities were present at sites C4 (14 per m^2) and C6 (13 per m^2) on the Clogh River. Low numbers of early-stage transformers (no speciation possible) were also recorded from sites on the Crooked River (A6) and Clogh River (C4 & C6). The siltation pressures and low summer flows observed across the study area reduced the quality of lamprey habitat, in addition to the often, high energy/spate characteristics of the survey watercourses (**Appendix A**).

Despite widespread suitability, European eel were only recorded in low densities from sites B7 and B8 on the Owveg River (**Table 4.2; Appendix A**). European eel are Red-listed in Ireland (King et al., 2011) and are classed as 'critically endangered' on a global scale (Pike et al., 2020). As eel occurrence decreases significantly with increasing distance from the sea (Degerman et al., 2019), the paucity of eel observed in the Nore_SC_010, Barrrow_SC_050 and Dinin (North)_SC_010 river sub-catchments can be partly explained by the distance between the survey area and marine habitats (Chadwick et al., 2007) (>100-140km instream distance). The absence of eel from many suitable sites also likely reflects the high number of barriers to fish passage present in the Nore and Barrow catchments as well as widespread low summer flow conditions (**Appendix A**).

5.1.2 Otter

Despite some good suitability at numerous survey locations, otter signs were only recorded at a total of four sites on the Cremorgan Stream (A12), Stradbally River (A14 & A15) and Clogh River (C7). This paucity of signs was considered to mainly reflect the influence of low (summer) water levels and flows on the health and distribution of fish populations, the key prey resource of otter (Krawczyk et al., 2016; Ruiz-Olmo & Jiménez, 2009). Site A15 on the Stradbally River at Stradbally Bridge was highly important for otter, supporting a total of 7 no. spraint sites, a latrine and (underneath the bridge) a couch (resting) area. This site supported a wide range of fish species and size classes during the survey period, despite low summer flows. Otters are food-limited and prey availability is a crucial factor in determining mortality, breeding success and the status of local populations (Sittenhaler et al., 2019; Ruiz-Olmo et al., 2002). No breeding (holt) areas were identified in the vicinity of the survey sites.

5.1.3 Freshwater pearl mussel

No freshwater pearl mussel eDNA was detected in the Stradbally River (site A15), Owveg River (B10), Clogh River (C7) or Douglas River (D1) samples collected in September 2022 (0 positive qPCR replicates out of 12, respectively) (**Table 4.1**; **Appendix C**). Suitability was poor or absent throughout the survey sites (heavy siltation, enrichment, historical modifications, spate channels, ephemeral channels etc.). These results were in keeping with the known distribution of this species within the wider survey area, i.e. only known from the River Nore (**Figure 3.1**).

However, whilst the historical range of the species in the River Nore extends from Poorman's Bridge to Ballyragget, stage 1 and 2 surveys completed for this report recorded no live mussels along c.4km of the Nore between Archer's Island and Ballyragget Bridge (**Appendix D**). This survey has reaffirmed that no live freshwater pearl mussels have been found in the River Nore downstream of the River Erkina confluence (near Durrow) since 2007 (**Appendix D**).

5.1.4 White-clawed crayfish & crayfish plague

Small, white-clawed crayfish populations were recorded from sites B7 and B8 on the Owveg River. Whilst site B7 (Spink Bridge) supported a low number of adult crayfish, only a single juvenile was recorded from site B8. Whilst not recorded via hand searching of instream refugia or sweep netting at the sites in question, white-clawed crayfish eDNA was detected at sites B10 on the Owveg River and C7 on the Clogh River (11 and 1 positive qPCR replicates out of 12, respectively) (**Table 4.1**; **Appendix C).**

There were no known records for crayfish in the Clogh River prior to this survey (NPWS data). The weak eDNA signature at site C7, coupled with the failure to record live crayfish elsewhere on the river and an absence of crayfish remains in otter spraint, would suggest the presence of a small, cryptic crayfish population within the Clogh River and or its tributaries. The detection of crayfish plague at site C7 is likely to jeopardise any such populations within the system.

In contrast to the known distribution of the species, eDNA analysis did not detect white-clawed crayfish at and or upstream of site A15 on the Stradbally River. Furthermore, no white-clawed crayfish remains were identified in field inspection of 12 no. otter spraint sites and a latrine at sites recorded across the Stradbally River or its tributary the Cremorgan Stream. Whilst highly sensitive and often detectable over long distances instream (including in crayfish; Chucholl et al., 2021), the detection of environmental DNA from an upstream (riverine) population depends on downstream transport of genetic material. The low summer flows present on the Stradbally at the time of survey may have limited the flow of eDNA and thus influenced detection rates of crayfish (i.e. DNA may have temporarily settled out of suspension; Buxton et al., 2018). The patchy distribution and often low abundances of white-clawed crayfish in a given river system may also strongly influence eDNA detection probability (Sint et al., 2022).

However, despite an apparent absence of hosts, crayfish plague was detected on the Stradbally River (A15) (**Table 4.1; Appendix C**). Crayfish plague is listed at one of the world's 100 worst invasive species (GISD, 2022; Lowe et al., 2000) and is becoming highly prevalent across Ireland. The first outbreaks of the pathogen in the wider Barrow catchment occurred in 2017, resulting in widespread mortality (NPWS, 2017). Environmental DNA monitoring (aside from this report) has continued to detect and confirm the spread of crayfish plague in the Barrow catchment since (Swords et al., 2021). *Aphanomyces astaci* is considered an obligate crayfish parasite not capable of surviving for a long period outside a crayfish host (Strand et al., 2011; Söderhall & Cerenius, 1999). Thus, the detection of crayfish plague in the Stradbally River exemplifies the recent rapid spread of the plague and likely extirpation of the historical crayfish population known from the river (pers. obs.). Our results highlight the importance of a multifaceted approach to crayfish surveying, using a combination of crayfish surveys, inspection of otter spraint and eDNA to improve detection rates.

5.1.5 Macro-invertebrates & biological water quality

No rare or protected macro-invertebrate species (according to national red lists) were recorded in the biological water quality samples taken from *n*=25 riverine sites in August-September 2022 (**Appendix B**).

Only a total of 6 no. sites on the Stradbally River (site A11), Owveg River (B3 & B8), Brennanshill River (C3), Clogh River (C6) and Douglas River (D1) achieved **Q4 (good status)** water quality and therefore met the target good status (≥Q4) water quality requirements of the European Union Environmental Objectives (Surface Waters) (Amendment) Regulations 2019 and the Water Framework Directive (2000/60/EC) (**Figure 4.1**).

The biological water quality of the survey area was evidently impacted by low water levels and poor summer flows in numerous watercourses at the time of sampling. The Q-rating for a total of 15 no. sites were considered tentative (**Appendix B**) given poor flows and or an absence of suitable riffle areas for sampling (as per Toner et al., 2005). Impacts from agriculture (e.g. eutrophication and siltation) are known to be significant threats to water quality in the wider survey area (EPA 2018a, 2018b, 2019) and this was supported by observations made during the aquatic surveys.

5.2 Aquatic ecology summary

The majority of the surveyed watercourses in the vicinity of the study area suffered from very low (summer) water levels and flows during August-September 2022, resulting in reduced habitat and water quality, often poor fluvial connectivity, habitat fragmentation and fish passage issues. Low summer flows are common on certain rivers such as the upper Owveg River (karstic), Cremorgan Stream and Clogh River. Approximately half (15 no.) sites suffered from very low water levels or were completely dry at the time of survey. Low summer flows, in addition to considerable agricultural (eutrophication, siltation) pressures, are significant threats to aquatic ecology in the vicinity of the proposed Coolglass wind farm.

Nevertheless, salmonids and lamprey (*Lampetra* sp.) populations were widespread in the survey area. While brown tout were widespread, Atlantic salmon were present only in the Stradbally River and Owveg River while European eel were only recorded from the Owveg River. Otter signs were recorded on the Cremorgan Stream, Stradbally River and Clogh River only. The paucity of signs would reflect the lower order small size of many of the watercourses with otter presence negatively corelated with smaller stream width and altitude (i.e. otter favour larger more productive riverine sites). White-clawed crayfish were recorded, through a combination of traditional and eDNA methodologies, on the Owveg River and Clogh River. Annex I floating river vegetation [3260] was recorded at a single site only (site 15, Stradbally River).

Sites on the Stradbally River (site A11), Owveg River (B3 & B8), Brennanshill River (C3), Clogh River (C6) and Douglas River (D1) were the only ones to achieve **Q4 (good status)** and meet the target good status (≥Q4) biological water quality requirements of the European Union Environmental Objectives (Surface Waters) (Amendment) Regulations 2019 and the Water Framework Directive (2000/60/EC). The limited number of good status sites was due to not only low summer flows but also widespread hydromorphological and agricultural pressures within the catchments adjoining the proposed project.

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7. Appendix A – fisheries assessment report

Please see accompanying fisheries assessment report

8. Appendix B – Q-sample results (biological water quality)

Table 8.1 Macro-invertebrate Q-sampling results for sites A1, A4, A5, A6, A9, A11, A12, A14, A15, B1B2, B3 & B4, August-September 2022

Group	Family	Species	A1	A4	A5	A6	A9	A11	A12	A14	A15	B1	B2	B3	B4	EPA class
Ephemeroptera	Heptageniidae	*Ecdyonurus dispar*				6		11			1		3	4		A
Ephemeroptera	Heptageniidae	*Heptagenia* sp.	1													A
Ephemeroptera	Heptageniidae	*Rhithrogena semicolorata*						1								A
Ephemeroptera	Baetidae	*Alainites muticus*	2			21	1			1	2					B
Plecoptera	Leuctridae	*Leuctra hippopus*	1					2					4			B
Trichoptera	Cased caddis pupa	sp. indet.											1	2		B
Trichoptera	Glossosomatidae	*Agapetus fuscipes*			2				25							B
Trichoptera	Limnephilidae	*Halesus radiatus*								4				3		B
Trichoptera	Limnephilidae	*Potamophylax cingulatus*							3							B
Trichoptera	Sericostomatidae	*Sericostoma personatum*			3	1		3		4						B
Ephemeroptera	Ephemerellidae	*Serratella ignita*				31		1			3		1			C
Ephemeroptera	Baetidae	*Baetis rhodani*	3	12	7	104		14		22	12		11	1	3	C
Ephemeroptera	Caenidae	*Caenis rivulorum*												1		C
Trichoptera	Hydropsychidae	*Hydropsyche instabilis*	3			1		4								C
Trichoptera	Hydropsychidae	*Hydropsyche siltalai*						5								C
Trichoptera	Polycentropodidae	*Plectrocnemia conspersa*	5										1		1	C
Trichoptera	Polycentropodidae	*Polycentropus kingi*												4		C
Trichoptera	Polycentropodidae	*Polycentropus flavomaculatus*				1								4		C
Trichoptera	Rhyacophilidae	*Rhyacophila dorsalis*				1										C
Gastropoda	Planorbidae	*Ancylus fluviatilis*	2				3						38		5	C
Gastropoda	Tateidae	*Potamopyrgus antipodarum*				12		35		8	1		63		7	C
Gastropoda	Lymnaeidae	*Lymnaea stagnalis*								2						C
Gastropoda	Bithyniidae	*Bithynia tentaculata*								8						C
Crustacea	Gammaridae	*Gammarus duebeni*	31	24	12	102	2	27	3	1	112	13	1			C

Group	Family	Species	A1	A4	A5	A6	A9	A11	A12	A14	A15	B1	B2	B3	B4	EPA class
Coleoptera	Dytiscidae	Dytiscidae larva				1										C
Coleoptera	Dytiscidae	*Hydroporus palustris*											1			C
Coleoptera	Dytiscidae	*Ilybius fuliginosus*											1			C
Coleoptera	Dytiscidae	*Nebrioporus depressus*								12						C
Coleoptera	Dytiscidae	*Stictotarsus duodecimpustulatus*											1			C
Coleoptera	Elmidae	*Brychius elevatus*				1				1						C
Coleoptera	Elmidae	*Elmis aenea*	1	2	5	5		18		5			7			C
Coleoptera	Elmidae	*Limnius volckmari*			1	2		5								C
Coleoptera	Gyrinidae	*Gyrinus substriatus*		2				3								C
Coleoptera	Gyrinidae	*Orectochilus villosus*						1								C
Coleoptera	Halipliidae	*Haliplus ruficollis group*						1								C
Diptera	Chironomidae	non-*Chironomus* spp.	10	1		1	9	3			21	8	2	1	17	C
Diptera	Culicidae	sp. indet.											4			C
Diptera	Dixidae	sp. indet.						1							1	C
Diptera	Muscidae	sp. indet.									1					C
Diptera	Pediciidae	*Dicranota* sp.				1		3								C
Diptera	Simuliidae	sp. indet.	3	3				15			20					C
Hemiptera	Corixidae	*Corixa punctata*								1						C
Hemiptera	Gerridae	*Gerris* sp.		1				2		1		12		7	14	C
Hemiptera	Notonectidae	*Notonecta obliqua*											1			C
Hemiptera	Veliidae	*Velia caprai*					1					3			2	C
Hemiptera	Veliidae	Veliidae nymph					2		2				1		2	C
Platyhelminthes	Planariidae	*Polycelis* sp.										2				C
Arachnida	Hydrachnidiae	sp. indet.					2	1	1		1					C
Gastropoda	Lymnaeidae	*Ampullacaena balthica*						15		27						D
Crustacea	Asellidae	*Asellus aquaticus*			6	1		1	1	1						D

Group	Family	Species	A1	A4	A5	A6	A9	A11	A12	A14	A15	B1	B2	B3	B4	EPA class
Hirudinidae	Glossiphoniidae	sp. indet.				1				1	1					D
Diptera	Chironomidae	*Chironomus* spp.	13					1				12		11	10	E
Abundance			**75**	**45**	**36**	**293**	**20**	**173**	**35**	**99**	**175**	**50**	**141**	**38**	**62**	
Q-rating			Q3-4	Q3*	Q3*	Q3-4	Q3*	Q4	Q3*	Q3	Q3-4	Q2-3*	Q3*	Q4*	Q2-3*	
WFD status			Mod	Poor	Poor	Mod	Poor	Good	Poor	Poor	Mod	Poor	Poor	Good	Poor	

* tentative Q-rating due to poor flows and or absence of suitable riffle areas for sampling (Toner et al., 2005)

Table 8.2 Macro-invertebrate Q-sampling results for sites B5, B6. B7, B8, B9, B10, C1, C2, C3, C4, C6, C7 &D1, August-September 2022

Group	Family	Species	B5	B6	B7 †	B8	B9	B10	C1	C2	C3	C4	C6	C7	D1	EPA class
Ephemeroptera	Heptageniidae	*Ecdyonurus dispar*				25		12					4		1	A
Ephemeroptera	Heptageniidae	*Heptagenia* sp.								2	6				7	A
Ephemeroptera	Heptageniidae	*Rhithrogena semicolorata*													1	A
Plecoptera	Nemouridae	*Nemoura cinerea*				1										A
Ephemeroptera	Baetidae	*Alainites muticus*	4				2	4		1	3	1				B
Plecoptera	Leuctridae	*Leuctra hippopus*	1			15	12	8		2	4	1	1		1	B
Trichoptera	Cased caddis pupa	sp. indet.	1	5						9	3		2	9		B
Trichoptera	Glossosomatidae	*Agapetus fuscipes*											2			B
Trichoptera	Leptoceridae	*Mystacides* sp.						1								B
Trichoptera	Limnephilidae	*Potamophylax cingulatus*		10	2				3	1						B
Trichoptera	Sericostomatidae	*Sericostoma personatum*		5		1						5			1	B
Ephemeroptera	Ephemerellidae	*Serratella ignita*				14		33							8	C
Ephemeroptera	Baetidae	*Baetis rhodani*				43	5	67	1		3	3		3	15	C
Ephemeroptera	Caenidae	*Caenis rivulorum*						1						3		C
Trichoptera	Hydropsychidae	*Hydropsyche instabilis*				6	6	2			1					C
Trichoptera	Hydropsychidae	*Hydropsyche siltalai*											1			C

Group	Family	Species	B5	B6	B7 †	B8	B9	B10	C1	C2	C3	C4	C6	C7	D1	EPA class
Trichoptera	Philopotamidae	*Philopotamus montanus*													1	C
Trichoptera	Philopotamidae	*Wormaldia occipitalis*													1	C
Trichoptera	Polycentropodidae	*Plectrocnemia conspersa*		1			4		2	2	2				2	C
Trichoptera	Polycentropodidae	*Polycentropus kingi*				1		2		1			4	5		C
Trichoptera	Polycentropodidae	*Polycentropus flavomaculatus*						1								C
Trichoptera	Rhyacophilidae	*Rhyacophila dorsalis*				4									5	C
Gastropoda	Planorbidae	*Ancylus fluviatilis*		15					3	26	3	34	2	1		C
Gastropoda	Tateidae	*Potamopyrgus antipodarum*		56		1		37						51		C
Crustacea	Gammaridae	*Gammarus duebeni*	9			5	1	2	11			1		5	6	C
Coleoptera	Dytiscidae	*Dytiscus marginalis*			1											C
Coleoptera	Dytiscidae	Dytiscidae larva		6			2				2			1		C
Coleoptera	Dytiscidae	*Hydroporus tessellatus*									1					C
Coleoptera	Dytiscidae	*Ilybius ater*					1		1							C
Coleoptera	Dytiscidae	*Nebrioporus depressus*			22			38					1			C
Coleoptera	Dytiscidae	*Oreodytes sanmarkii*										4				C
Coleoptera	Dytiscidae	*Oreodytes septetrionelis*						5								C
Coleoptera	Dytiscidae	*Stictotarsus duodecimpustulatus*					1						2	1		C
Coleoptera	Elmidae	*Brychius elevatus*				1		18								C
Coleoptera	Elmidae	*Elmis aenea*		1		3		3		1			5		4	C
Coleoptera	Elmidae	*Limnius volckmari*				2		2				1				C
Coleoptera	Gyrinidae	*Gyrinus substriatus*			9											C
Coleoptera	Halipliidae	*Haliplus lineatocollis*			1											C
Coleoptera	Halipliidae	*Haliplus ruficollis group*												1		C
Coleoptera	Hydraenidae	*Hydraena gracilis*				1										C
Coleoptera	Scirtidae	Scirtidae larva	1													C

Group	Family	Species	B5	B6	B7 †	B8	B9	B10	C1	C2	C3	C4	C6	C7	D1	EPA class
Diptera	Chironomidae	non-*Chironomus* spp.		3	2	6	7	3	17	7	8	12	6	2	2	C
Diptera	Culicidae	sp. indet.		1					2	2	1	1				C
Diptera	Dixidae	sp. indet.	1						8		4					C
Diptera	Muscidae	sp. indet.													1	C
Diptera	Pediciidae	*Dicranota* sp.				1										C
Diptera	Simuliidae	sp. indet.				3		79							8	C
Diptera	Tipuliidae	sp. indet.						2								C
Hemiptera	Corixidae	Corixidae nymph		6							1					C
Hemiptera	Gerridae	*Gerris* sp.	*6*		11	2		2		8						C
Hemiptera	Veliidae	*Velia caprai*		1					1	2		1				C
Hemiptera	Veliidae	Veliidae nymph	1	1					3	1	1					C
Arachnida	Hydrachnidiae	sp. indet.							1			10	2			C
Gastropoda	Lymnaeidae	*Ampullacaena balthica*			22	11		26						154		D
Gastropoda	Sphaeriidae	sp. indet.													1	D
Crustacea	Asellidae	*Asellus aquaticus*						2						29		D
Megaloptera	Sialidae	*Sialis lutaria*												2		D
Hirudinidae	Glossiphoniidae	sp. indet.								1				2		D
Diptera	Chironomidae	*Chironomus* spp.		6	21		31	25	7	21	6	5	9			E
Annelidae	Oligochaeta	sp. indet.	1													n/a
Nematomorpha	Gordiidae	sp. indet.		1						1						n/a
Abundance			**25**	**118**	**91**	**146**	**72**	**375**	**60**	**88**	**49**	**79**	**41**	**269**	**65**	
Q-rating			Q3*	Q3*	n/a	Q4	Q2-3*	Q3-4	Q3*	Q3-4	Q4*	Q3	Q4*	Q2-3*	Q4	
WFD status			Poor	Poor	n/a	Good	Poor	Mod	Poor	Mod	Good	Poor	Good	Poor	Good	

* tentative Q-rating due to poor flows and or absence of suitable riffle areas for sampling (Toner et al., 2005)

† sweep sample taken from stagnant pool, no Q-rating possible

9. Appendix C – eDNA analysis lab report

Folio No: E15390
Report No: 1
Client: Triturus Environmental Ltd
Contact: Bill Brazier

TECHNICAL REPORT

ANALYSIS OF ENVIRONMENTAL DNA IN WATER FOR AQUATIC SPECIES DETECTION

SUMMARY

When aquatic organisms inhabit a waterbody such as a pond, lake or river they continuously release small amounts of their DNA into the environment. By collecting and analysing water samples, we can detect these small traces of environmental DNA (eDNA) to confirm the presence or absence of the target species within the waterbody.

RESULTS

Date sample received in laboratory: 12/09/22
Date results reported: 20/09/2022
Matters affecting result: None

TARGET SPECIES: Crayfish plague *(Aphanomyces astaci)*

Lab ID	Site Name	OS Reference	SIC	DC	IC	Result	Positive Replicates
FK784	A15 – Stradbally River	ITM 657185 696352	Pass	Pass	Pass	Positive	11/12
FK785	C7 - Clogh River	ITM 656513 679057	Pass	Pass	Pass	Positive	1/12
FK772	B10 – Owveg River	ITM 650631 684829	Pass	Pass	Pass	Negative	0/12
FK774	D1 – Douglas River	ITM 660818 684702	Pass	Pass	Pass	Negative	0/12

Forensic Scientists and Consultant Engineers
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Tel: +44 (0)1332 292003 Email: scientifics@surescreen.com
Company Registration No. 08950940

SureScreen Scientifics

TARGET SPECIES: Freshwater pearl mussel *(Margaritifera margaritifera)*

Lab ID	Site Name	OS Reference	SIC	DC	IC	Result	Positive Replicates
FK784	A15 – Stradbally River	ITM 657185 696352	Pass	Pass	Pass	Negative	0/12
FK785	C7 - Clogh River	ITM 656513 679057	Pass	Pass	Pass	Negative	0/12
FK772	B10 – Owveg River	ITM 650631 684829	Pass	Pass	Pass	Negative	0/12
FK774	D1 – Douglas River	ITM 660818 684702	Pass	Pass	Pass	Negative	0/12

TARGET SPECIES: White-clawed crayfish *(Austropotamobius pallipes)*

Lab ID	Site Name	OS Reference	SIC	DC	IC	Result	Positive Replicates
FK784	A15 – Stradbally River	ITM 657185 696352	Pass	Pass	Pass	Negative	0/12
FK785	C7 - Clogh River	ITM 656513 679057	Pass	Pass	Pass	Positive	1/12
FK772	B10 – Owveg River	ITM 650631 684829	Pass	Pass	Pass	Positive	12/12
FK774	D1 – Douglas River	ITM 660818 684702	Pass	Pass	Pass	Negative	0/12

If you have any questions regarding results, please contact us: ForensicEcology@surescreen.com

Reported by: **Chelsea Warner** Approved by: **Gabriela Danickova**

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SureScreen Scientifics

METHODOLOGY

The samples detailed above have been analysed for the presence of target species eDNA following scientifically published eDNA assays and protocols which have been thoroughly tested, developed and verified for use by SureScreen Scientifics.

The analysis is conducted in two phases. The sample first goes through an extraction process where the filter is incubated in order to obtain any DNA within the sample. The extracted sample is then tested via real time PCR (also called q-PCR) for each of the selected target species. This process uses species-specific molecular markers (known as primers) to amplify a select part of the DNA, allowing it to be detected and measured in 'real time' as the analytical process develops. qPCR combines amplification and detection of target DNA into a single step. With qPCR, fluorescent dyes specific to the target sequence are used to label targeted PCR products during thermal cycling. The accumulation of fluorescent signals during this reaction is measured for fast and objective data analysis. The primers used in this process are specific to a part of mitochondrial DNA only found in each individual species. Separate primers are used for each of the species, ensuring no DNA from any other species present in the water is amplified.

If target species DNA is present, the DNA is amplified up to a detectable level, resulting in positive species detection. If target species DNA is not present then amplification does not occur, and a negative result is recorded.

Analysis of eDNA requires scrupulous attention to detail to prevent risk of contamination. True positive controls, negative controls and spiked synthetic DNA are included in every analysis and these have to be correct before any result is declared and reported. Stages of the DNA analysis are also conducted in different buildings at our premises for added security.

SureScreen Scientifics Ltd is ISO9001 accredited and participate in Natural England's proficiency testing scheme for GCN eDNA testing. We also carry out regular inter-laboratory checks on accuracy of results as part of our quality control procedures.

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SureScreen Scientifics

INTERPRETATION OF RESULTS

SIC: **Sample Integrity Check** [Pass/Fail]
When samples are received in the laboratory, they are inspected for any tube leakage, suitability of sample (not too much mud or weed etc.) and absence of any factors that could potentially lead to inconclusive results.

DC: **Degradation Check** [Pass/Fail]
Analysis of the spiked DNA marker to see if there has been degradation of the kit or sample, between the date it was made to the date of analysis. Degradation of the spiked DNA marker may indicate a risk of false negative results.

IC: **Inhibition Check** [Pass/Fail]
The presence of inhibitors within a sample are assessed using a DNA marker. If inhibition is detected, samples are purified and re-analysed. Inhibitors cannot always be removed, if the inhibition check fails, the sample should be re-collected.

Result: **Presence of eDNA** [Positive/Negative/Inconclusive]

Positive: DNA was identified within the sample, indicative of species presence within the sampling location at the time the sample was taken or within the recent past at the sampling location.

Positive Replicates: Number of positive qPCR replicates out of a series of 12. If one or more of these are found to be positive the pond is declared positive for species presence. It may be assumed that small fractions of positive analyses suggest low level presence, but this cannot currently be used for population studies. Even a score as low as 1/12 is declared positive. 0/12 indicates negative species presence.

Negative: eDNA was not detected or is below the threshold detection level and the test result should be considered as evidence of species absence, however, does not exclude the potential for species presence below the limit of detection.

Inconclusive: Controls indicate inhibition or degradation of the sample, resulting in the inability to provide conclusive evidence for species presence or absence.

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10. Appendix D – Stage 1 & 2 freshwater pearl mussel survey report

Sweeney Consultancy
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E-mail sweeneyconsultancy@gmail.com

Survey of the Freshwater Pearl Mussel (*Margaritifera margaritifera*) in the River Nore Downstream of the R. Erkina Confluence

September 2022

Due to the sensitive nature of data concerning the locations of freshwater pearl mussels, distribution of this report should be restricted and not released to the public.

Cover Photo: Empty Freshwater Pearl Mussel in the River Nore at [redacted] June 2016.

TABLE OF CONTENTS

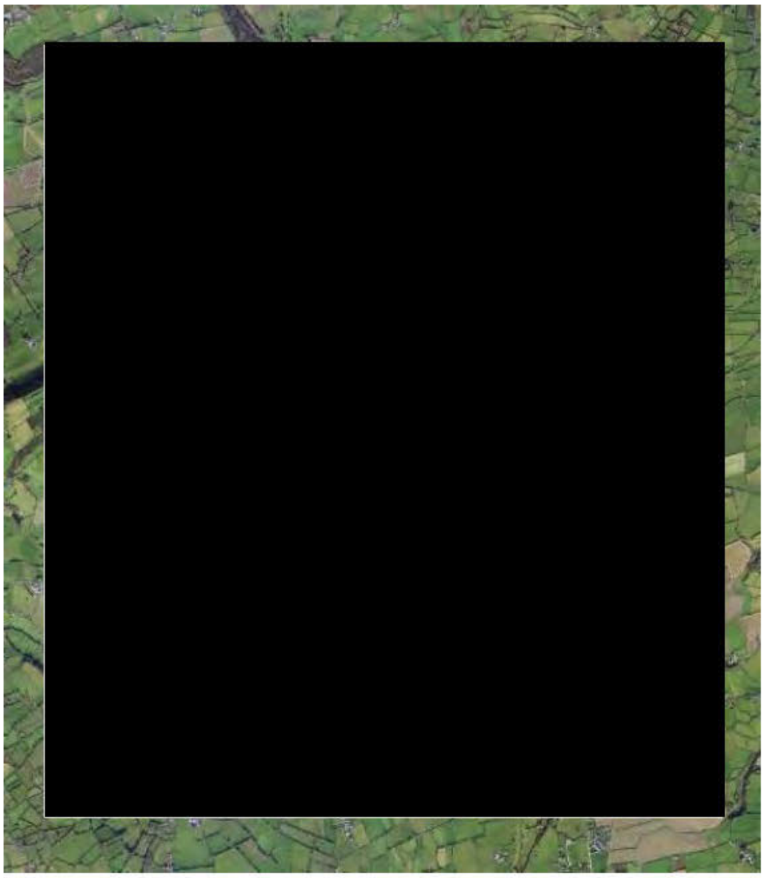
1. INTRODUCTION

1.1 Background

The Freshwater Pearl Mussel (*Margaritifera margaritifera*) is a Qualifying Interest of the River Barrow and River Nore Special Area of Conservation (Site Code 002162). The Nore population was formerly given species status (*Margaritifera durrovensis*), but genetic research has now placed it within the *Margaritifera margaritifera* taxon. Sweeney Consultancy was commissioned by Triturus Environmental Ltd. to undertake a Freshwater Pearl Mussel (FPM) survey in a section of the River Nore where historical records indicate the possible presence of this protected species.

FPM surveys have been conducted by Sweeney Consultancy in recent years in the vicinity of [redacted] from where the most recent records of this species downstream of the River Erkina confluence are known. Data collected in these surveys is reviewed. To further inform the status of FPM in the River Nore, it was decided that a section of river from [redacted] would be surveyed (Figure 1).

Figure 1. River Nore FPM survey areas



2. METHODOLOGY

Field surveying was undertaken on 04 August, 2022. The river habitat surveyed was from the upstream end of [redacted]. For surveying and reporting purposes, the channel was divided into eight sections of approximately 500m (Figure 2 and Table 1).

Figure 2. River Nore FPM survey sections

Table 1. River Nore FPM survey section locations

[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]

Grid reference were recorded using a hand-held Garmin GPS 72H. Photographs were taken with a waterproof digital camera (Aquapix W3048) and are presented in Appendix 1. The habitat quality for freshwater pearl mussels was visually, based on the criteria outlined by Hastie et al. (2000) and by Skinner et al. (2003). A licensed FPM survey (Licence No C56/2022) was carried out in accordance with the standard methodology (Anon 2004), by viewing the riverbed with a bathyscope while wading in a wetsuit and by snorkelling a few deeper sections.

3. RESULTS

3.1. SURVEY RESULTS: ARCHER'S ISLAND TO BALLYRAGGET BRIDGE

3.1.1. Section 1

From slow, deep glide upstream of [redacted] (Photo 1), the river flows fast over mainly calcified bedrock in two channels, one on either side of the island (Photos 2 & 3). Moderate shade from bankside and island trees. A very limited amount of habitat suitable for FPM was identified in areas out of the main flow, where there is some gravel and sand among the bedrock.

No FPM were found.

3.1.2. Section 2

Slow-moderate flowing deep glide over mostly sand and silt in an unshaded channel (Photo 4). Unsuitable for FPM.

No FPM were found.

3.1.3. Section 3

Initially fast flowing shallow glide over cobble and gravel, but mostly calcified, limiting the suitability for FPM (Photo 5). Then there is a change to moderately fast flow over cobble, gravel and sand, which would be more suitable FPM habitat (Photo 6).

No FPM were found.

3.1.4. Section 4

At the upstream end, there is moderately fast glide over a sandy substratum with some cobble and gravel (Photo 7), then slowing down and deepening at the S-bend just upstream of the [redacted] (Photo 8). Towards the end of this section, flow is faster again, over cobble and gravel, where the most suitable FPM habitat in this stretch occurs (Photo 9).

No FPM were found.

3.1.5. Section 5

This section is fast-flowing over cobble, gravel and sand (Photo 10). The treated effluent from the [redacted], via a diffuser.

No FPM were found.

3.1.6. Section 6

Initially fast flowing shallow riffle over cobble and gravel (Photo 11), but deepening quickly to slide over a silty substratum, unsuitable for FPM (Photo 12).

No FPM were found.

3.1.7. Section 7

The water depth and slower flow in this section (Photo 13) is due to the weir downstream.

The habitat is unsuitable for FPM

No FPM were found.

3.1.8. Section 8

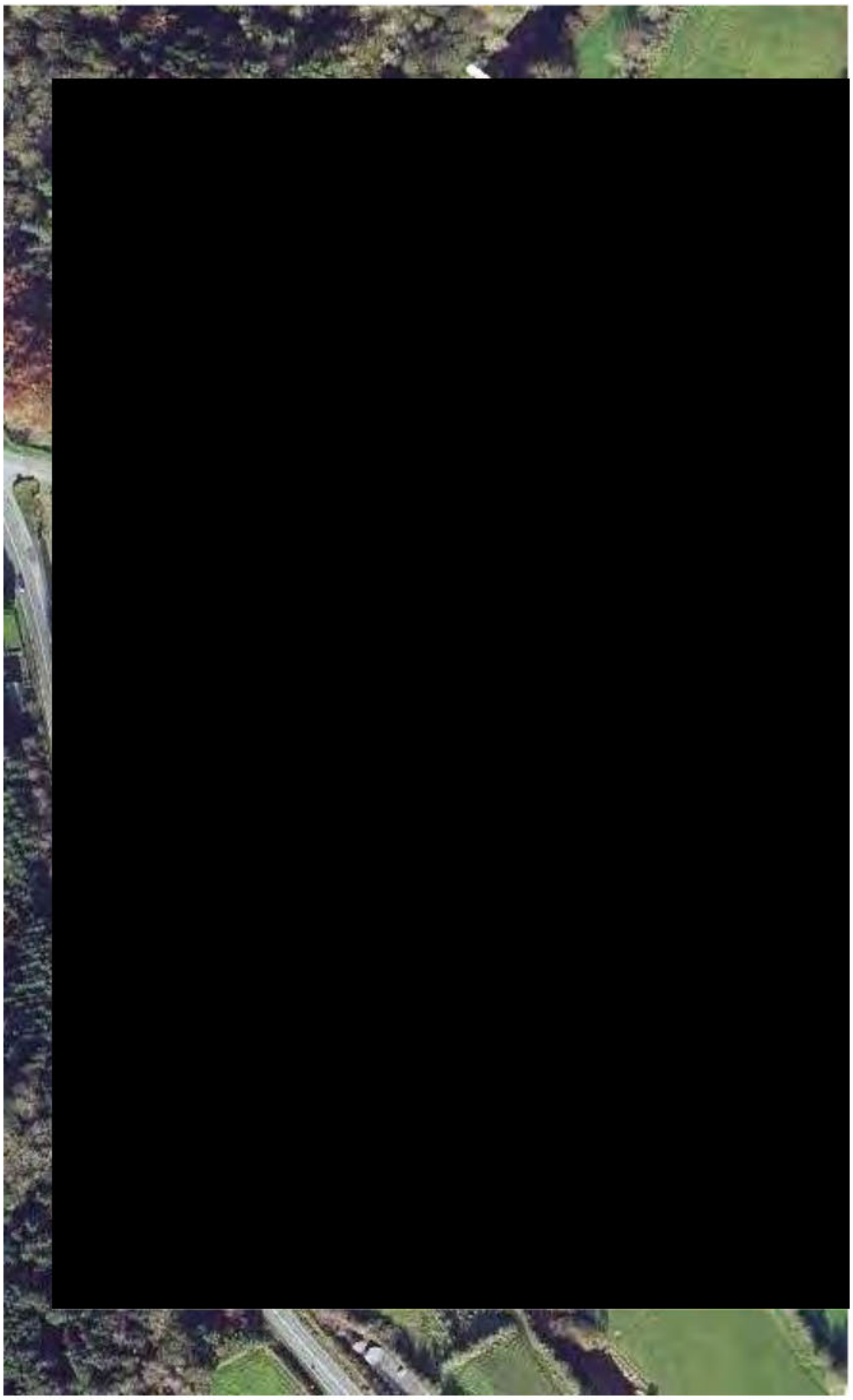
There is fast flow over the broken weir at [redacted] (Photo 14). The river habitat upstream of the weir and downstream to [redacted] Bridge consists of glide over a silted substratum, which is unsuitable for FPM (Photo 15).

No FPM were found.

3.2. SURVEY RESULTS: ERKINA CONFLUENCE TO ARCHER'S ISLAND

From the [redacted] there are several historical records of live FPM in the Nore. [redacted]. No live mussels were subsequently found here by Sweeney Consultancy during annual biological assessments3) for the [redacted] discharge licence. [redacted]. Following bankside and instream works along a short section of the right bank of the river in 2020, Sweeney Consultancy was commissioned to survey a section of the river, from 150m upstream to 150m downstream of [redacted] in 2022. For completeness, this survey was extended to downstream of the location where mussels were recorded in 2000 (Figure 3). No mussels were found in this survey.

Figure 3. [redacted]



4. CONCLUSIONS

No live freshwater pearl mussels have been found in the River Nore downstream of the Erkina confluence since 2007. This survey, combined with other recent data indicate that FPM no longer occur here.

APPENDIX 1- PHOTOGRAPHS

Photo 1: Upstream end of [redacted]

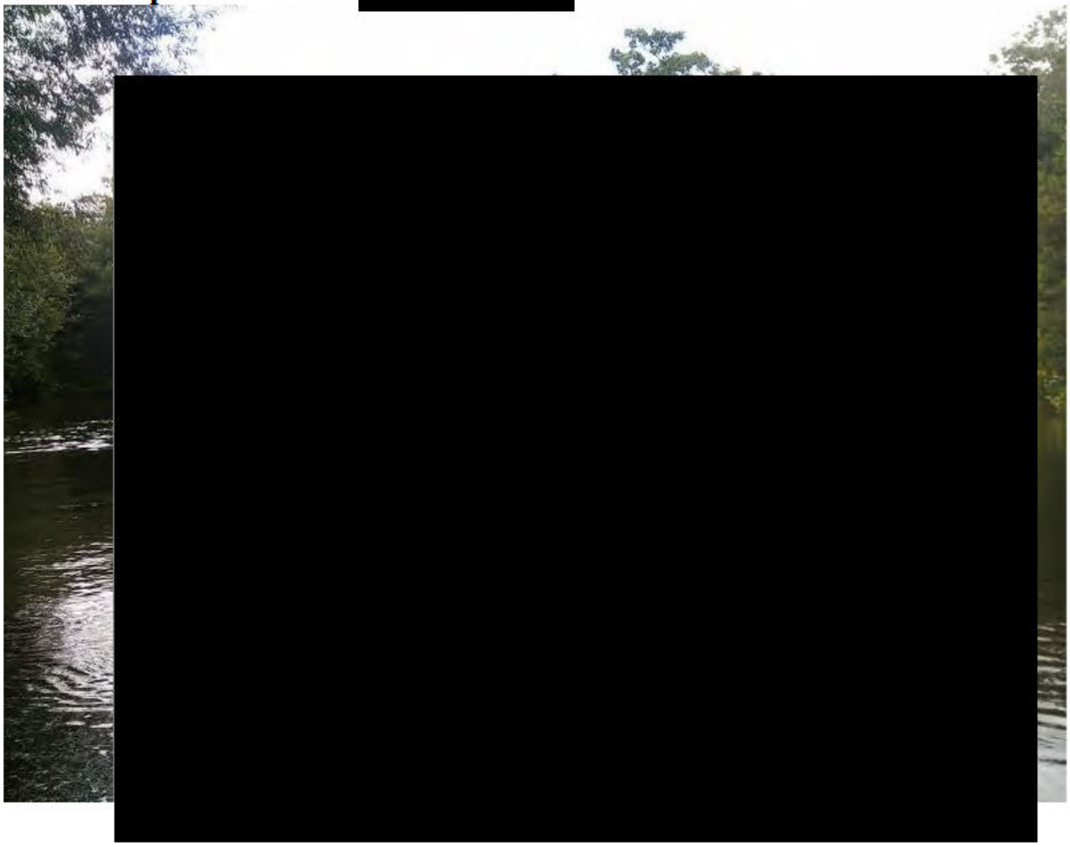


Photo 2: Left channel on eastern side of [redacted]

Photo 3: Right channel on western side of [redacted]

Photo 4: Section 2

Photo 5: Section 3, upper end

Photo 6: Section 3, lower end

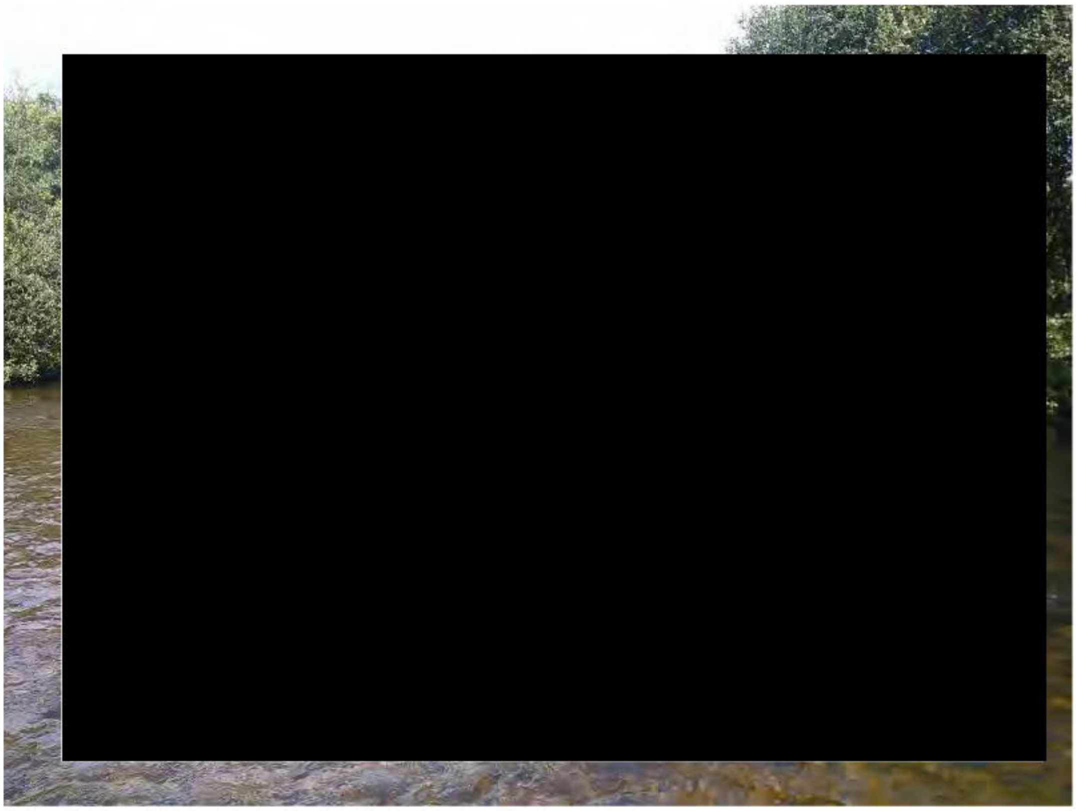


Photo 7: Section 4, upper end

Photo 8: Section 4 deep glide at bend

Photo 9: Section 4, lower end

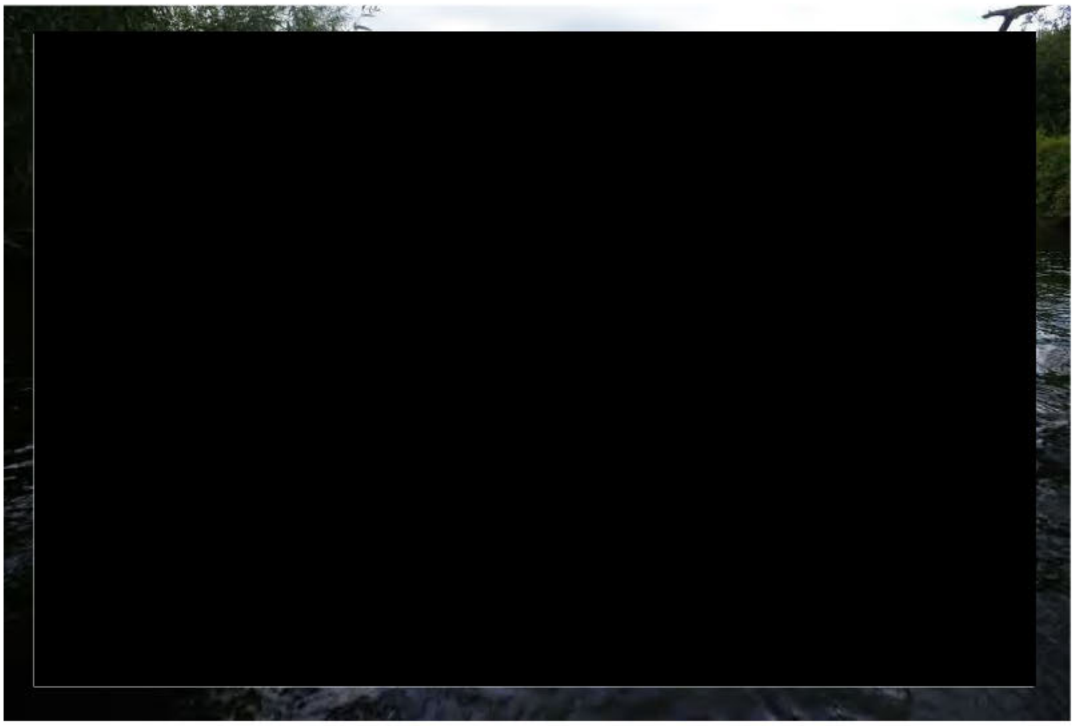


Photo 10: Section 5, downstream of [redacted]

Photo 11: Section 6, upper end

Photo 12: Section 6, lower end

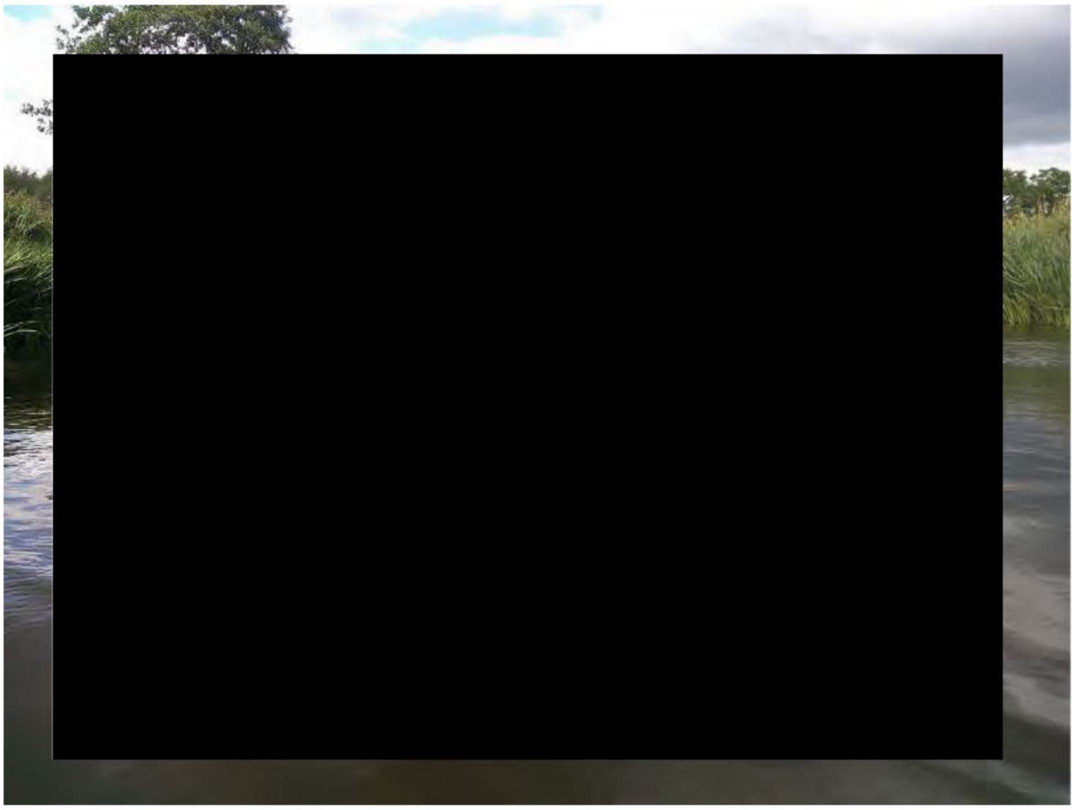


Photo 13: Section 7

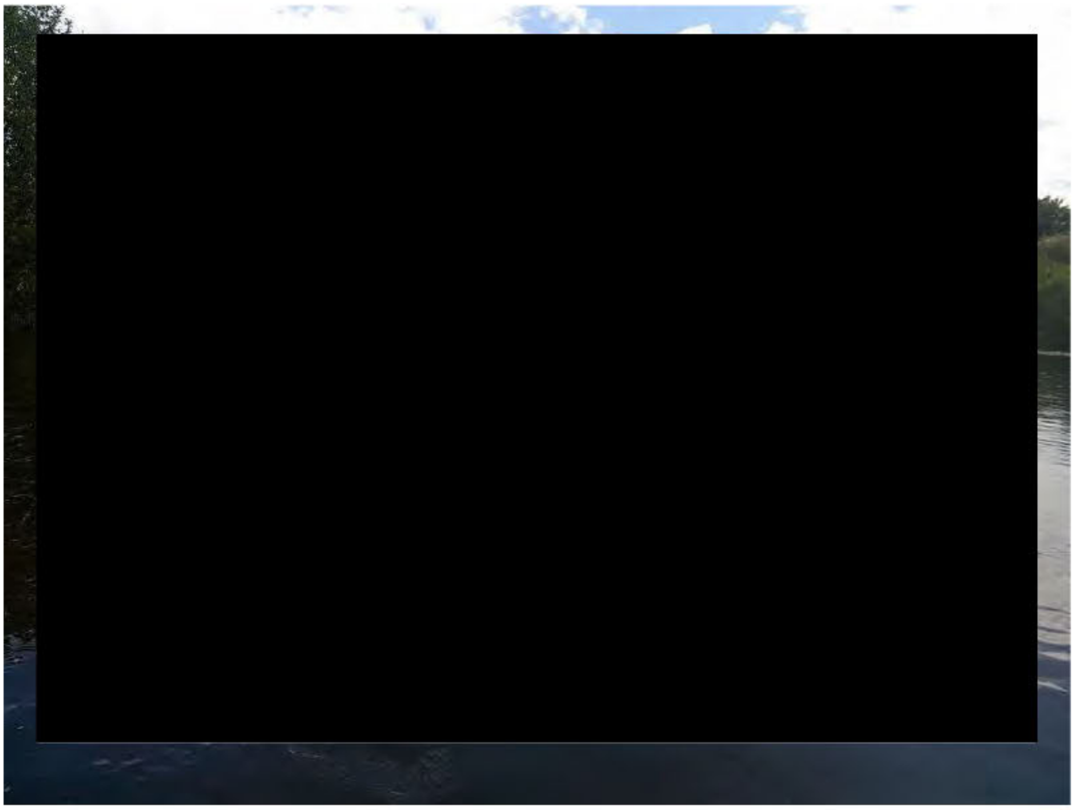


Photo 14: Section 8, broken weir

Photo 15: Section 8, lower end

Photo 16: Calcified empty FPM shells, [redacted]., 2016

APPENDIX 2 - REFERENCES

Anon (2004). *Margaritifera margaritifera*. Stage 1 and Stage 2 survey guidelines. *Irish Wildlife Manuals*, No. 12. National Parks and Wildlife Service, Department of Environment, Heritage and Local Government, Dublin, Ireland.

Hastie L.C., Boon P.J. and Young M.R. (2000). Physical microhabitat requirements of freshwater pearl mussel *Margaritifera margaritifera* (L.). *Hydrobiologia* 429 59-71

Skinner, A, Young M. & Hastie L. (2003). Ecology of the Freshwater Pearl Mussel. *Conserving Natura 2000 Rivers Ecology Series No. 2 English Nature, Peterborough.*

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Fisheries assessment of Coolglass wind farm, Co. Laois

Prepared by Triturus Environmental Ltd. for SLR Consulting

December 2022

Please cite as:

Triturus (2022). Fisheries assessment of Coolglass wind farm, Co. Laois. Report prepared by Triturus Environmental Ltd. for SLR Consulting. December 2022.

Table of contents

1. Introduction

1.1 Background

Triturus Environmental Ltd. were commissioned by SLR Consulting to undertake a baseline fisheries assessment of numerous watercourses in the vicinity of the proposed Coolglass (formerly Fossy) wind farm, located approximately 11km southeast of Portlaoise, Co. Laois (**Figure 2.1**).

The survey was undertaken to establish baseline fisheries data used in the preparation of the EIAR for the proposed project. In order to gain an accurate overview of the existing and potential fisheries value of the riverine watercourses within the vicinity of the proposed project, a catchment-wide electro-fishing survey across *n*=33 riverine sites was undertaken (**Table 2.1; Figure 2.1**). Electro-fishing helped to identify the importance of the watercourses as nurseries and habitats for salmonids, lamprey and European eel (*Anguilla anguilla*), as well as other species, and helped to further inform impact assessment and any subsequent mitigation for the project.

Triturus Environmental Ltd. made an application under Section 14 of the Fisheries (Consolidation) Act, 1959 as substituted by Section 4 of the Fisheries (Amendment) Act, 1962, to undertake a catchment-wide electro-fishing survey in the vicinity of the proposed Coolglass wind farm. Permission was granted on the 4th August 2022 and the survey was undertaken between the 31st August and 3rd September 2022.

1.2 Fisheries asset of the survey area

The survey sites were located within Nore_SC_060, Dinin[North]_SC_10, Barrow_SC_050 and Barrow_SC_070 river sub-catchments (**Figure 2.1**). The proposed wind farm was not located within a European site although shared downstream hydrological connectivity, via several pathways, with the River Barrow and River Nore SAC (002162). Fisheries survey sites were present on the Fallowbeg Upper Stream (EPA code: 14F06), Crooked River (14C02) an unnamed tributary, Honey Stream (14H01), Honey Stream North (14H21), Aghoney Stream (14A08), Fossy Lower Stream (14F10), Timahoe Stream (14T09) and Stradbally River (14S02) in the Barrow_SC_050 river sub-catchment. Sites were also surveyed on the Scotland Stream (15S06), Owveg River 915O01), Cleanagh Stream (15C58), Garrintaggart Stream (15G30), Graiguenahown Stream (15G29), Knocklead Stream (15K21), Clogh River (15C03), Brennanshill River (15B51), Moyadd Stream (15M22) and the Douglass River (15D03) in the Nore_SC_060, Dinin[North]_SC_10 and Barrow_SC_070 river sub-catchments (**Table 2.1**).

The Stradbally River is a valuable brown trout nursery and also supports stone loach, minnow and three-spined stickleback and, in the lower reaches, Atlantic salmon and invasive dace (*Leuciscus leuciscus*) (Gordon et al., 2021; IFI 2020 data[1]; Delanty et al., 2017).

The Crooked River, a tributary of the Stradbally River, is known to support brown trout and stone loach (Delanty et al., 2017). Lamprey (*Lampetra* sp.) are also present in both the Stradbally and Crooked Rivers (IFI 2020 data; Gallagher et al., 2019; King, 2006).

[1] Inland Fisheries Ireland data for Water Framework Directive Fish Ecological Status 2008-2021. Available at https://opendata-ifigis.hub.arcgis.com/datasets/IFIgis::water-framework-directive-fish-ecological-status-2008-2021/

The Douglas River, a tributary of the River Barrow, is known to support Atlantic salmon, brown trout, lamprey (*Lampetra* sp.), minnow, stone loach and three-spined stickleback (Gordon et al., 2021a; Delanty et al., 2017). Lamprey are present in the lower catchment only, with none recorded in the vicinity of Shanragh Bridge (survey site D1) in 2017 (Gallagher et al., 2019).

The Owveg (syn. Owenbeg) River, a tributary of the River Nore, is known to support Atlantic salmon, brown trout, stone loach, lamprey (*Lampetra* sp.), three-spined stickleback and minnow (IFI 2021 data[1]; Galetech Energy Services, 2020). High densities of Atlantic salmon and brown trout, in addition to minnow and lamprey (*Lampetra* sp.), were recorded from the lower Owveg River (Loughill Bridge) in 2021 (Triturus, 2021).

The Clogh River, a tributary of the Dinin River, is known to support brown trout, minnow, stone loach and three-spined stickleback at Clogh Bridge (survey site C7) (Matson et al., 2018), with Atlantic salmon, pike and lamprey (*Lampetra* sp.) also recorded in the river in addition to these species in 2020 (Gordon et al., 2021b).

A number of significant barriers to fish passage (mostly ramps but also weirs & culverts) have been identified on numerous watercourses in vicinity of the proposed project, namely the Crooked River, Stradbally River, Aghoney Stream, Douglas River, Owveg River and Clogh River (AMBER Barrier Tracker app data; AMBER Consortium, 2020; **Figure 1.1**).

Fisheries data for the other watercourses within the survey area was not available at the time of survey.

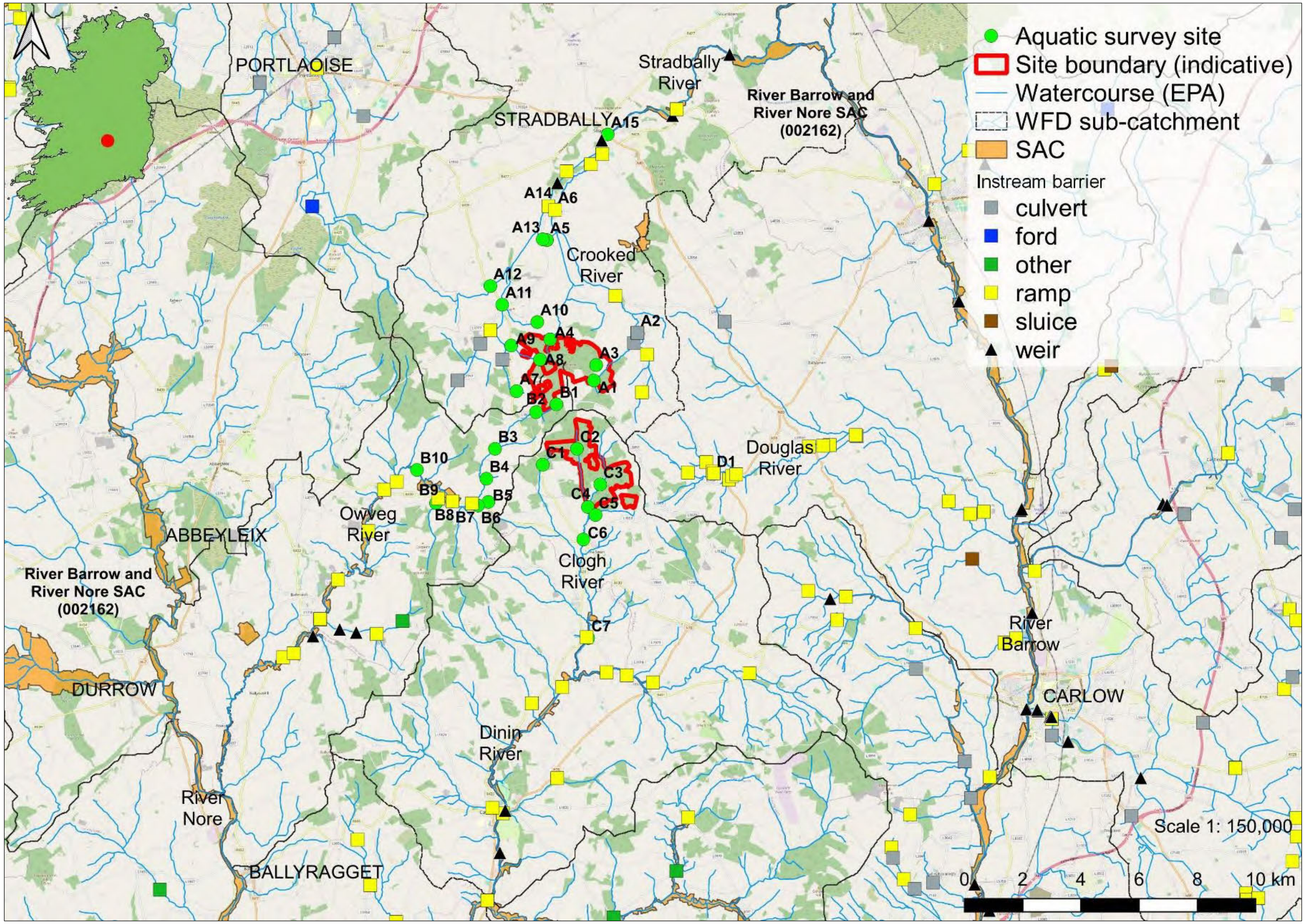

Figure 1.1 Overview of the known instream barriers in the vicinity of Coolglass wind farm, Co. Laois (source: AMBER data)

2. Methodology

2.1 Fish stock assessment (electro-fishing)

A single anode Smith-Root LR24 backpack (12V DC input; 300V, 100W DC output) was used to electro-fish sites on watercourses in the vicinity of the proposed Coolglass wind farm between the 31st August and 3rd September 2022 following notification to Inland Fisheries Ireland and under the conditions of a Department of the Environment, Climate and Communications (DECC) licence. Both river and holding tank water temperature was monitored continually throughout the survey to ensure temperatures of 20°C were not exceeded, thus minimising stress to the captured fish due to low dissolved oxygen levels. A portable battery-powered aerator was also used to further reduce stress to any captured fish contained in the holding tank.

Salmonids, European eel and other captured fish species were transferred to a holding container with oxygenated fresh river water following capture. To reduce fish stress levels, anaesthesia was not applied to captured fish. All fish were measured to the nearest millimetre and released in-situ following a suitable recovery period.

As three primary species groups were targeted during the survey, i.e., salmonids, lamprey, and eel, the electro-fishing settings were tailored for each species. By undertaking electro-fishing using the rapid electro-fishing technique (see methodology below), the broad characterisation of the fish community at each sampling reach could be determined as a longer representative length of channel can be surveyed. Electro-fishing methodology followed accepted European standards (CEN, 2003) and adhered to best practice (e.g., CFB, 2008).

Electro-fishing was proposed for all riverine survey sites. However, sites A2 (Crooked River), A3 (unnamed stream), A7 (Aghoney Stream), A8 (Fossy Lower Stream), A10 (Timahoe Stream), A13 (unnamed stream), B7 (Owveg River) and C5 (Moyaddd Stream) were dry at the time of survey. Therefore, the catchment-wide electro-fishing (CWEF) survey was undertaken across a total of n=25 sites (see **Table 2.1, Figure 2.1**).

2.1.1 Salmonids and European eel

For salmonid species and European eel, as well as all other incidental species, electro-fishing was carried out in an upstream direction for a 10-minute CPUE, an increasingly common standard approach for wadable streams (Matson et al., 2018). A total of approx. 50-100m channel length was surveyed at each site, where feasible, in order to gain a better representation of fish stock assemblages. At certain, more minor watercourse sites or sites with limited access, it was more feasible to undertake electro-fishing for a 5-minute CPUE. Discrepancies in fishing effort (CPUE) between sites are accounted for in the subsequent results section (**Table 3.1**).

Relative conductivity of the water at each site was checked in-situ with a conductivity meter and the electro-fishing backpack was energised with the appropriate voltage and frequency to provide enough draw to attract salmonids and European eel to the anode without harm. For the high conductivity waters of the sites (draining limestone geologies) a voltage of 200-230v, frequency of 35-40Hz and pulse duration of 3.5-4ms was utilised to draw fish to the anode without causing physical damage.

2.1.2 Lamprey

Electro-fishing for lamprey ammocoetes was conducted using targeted quadrat-based electro-fishing (as per Harvey & Cowx, 2003) in objectively suitable areas of sand/silt, where encountered. As lamprey take longer to emerge from silts and require a more persistent approach, they were targeted at a lower frequency (30Hz) burst DC pulse setting which also allowed detection of European eel in sediment, if present. Settings for lamprey followed those recommended and used by Harvey & Cowx (2003), APEM (2004) and Niven & McAuley (2013). Using this approach, the anode was placed under the water's surface, approx. 10-15cm above the sediment, to prevent immobilising lamprey ammocoetes within the sediment. The anode was energised with 100V of pulsed DC for 15-20 seconds and then turned off for approximately five seconds to allow ammocoetes to emerge from their burrows. The anode was switched on and off in this way for approximately two minutes. Immobilised ammocoetes were collected by a second operator using a fine-mesh hand net as they emerged.

Lamprey species were identified to species level, where possible, with the assistance of a hand lens, through external pigmentation patterns and trunk myomere counts as described by Potter & Osborne (1975) and Gardiner (2003).

2.2 Fisheries habitat

A broad appraisal / overview of the upstream and downstream habitat at each site was also undertaken to evaluate the wider contribution to salmonid and lamprey spawning and general fisheries habitat. River habitat surveys and fisheries assessments were also carried out utilising elements of the approaches in the River Habitat Survey Methodology (Environment Agency, 2003) and Fishery Assessment Methodology (O'Grady, 2006) to broadly characterise the riverine sites (i.e., channel profiles, substrata etc.).

2.3 Biosecurity

A strict biosecurity protocol following IFI (2010) and the Check-Clean-Dry approach was adhered to during surveys for all equipment and PPE used. Disinfection of all equipment and PPE before and after use with Virkon™ was conducted to prevent the transfer of pathogens or invasive propagules between survey sites. Surveys were undertaken at sites in a downstream order to minimise the risk of upstream propagule mobilisation. Particular cognisance was given towards preventing the spread or introduction of crayfish plague given the known distribution of white-clawed crayfish in the wider survey area and previous outbreaks of crayfish plague in the wider Barrow and Nore catchments. Furthermore, staff did not undertake any work in a known crayfish plague catchment for a period of <72hrs in advance of the survey. Where feasible, equipment was also thoroughly dried (through UV exposure) between survey areas. Any aquatic invasive species or pathogens recorded within or adjoining the survey areas were geo-referenced. All Triturus staff are certified in 'Good fieldwork practice: slowing the spread of invasive non-native species' by the University of Leeds.

Table 2.1 Location of *n*=33 survey sites in the vicinity of Coolglass wind farm, Co. Laois

Site no.	Watercourse	EPA code	Location	X (ITM)	Y (ITM)
A1	Fallowbeg Upper Stream	14F06	Fallowbeg Upper	[redacted]	[redacted]
A2	Crooked River	14C02	Local road crossing, Luggacurreen	[redacted]	[redacted]
A3	Unnamed stream	n/a	Fallowbeg Upper	[redacted]	[redacted]
A4	Honey Stream	14H01	L38401 road crossing, Fossy Upper	[redacted]	[redacted]
A5	Honey Stream North	14H21	Proposed GCR crossing, L3838	[redacted]	[redacted]
A6	Crooked River	14C02	Timogue Bridge	[redacted]	[redacted]
A7	Aghoney Stream	14A08	Proposed GCR crossing, R426	[redacted]	[redacted]
A8	Fossy Lower Stream	14F10	Proposed GCR crossing, Fossy Upper	[redacted]	[redacted]
A9	Fossy Lower Stream	14F10	Proposed GCR crossing, R426	[redacted]	[redacted]
A10	Timahoe Stream	14T09	Proposed GCR crossing, Fossy Lower	[redacted]	[redacted]
A11	Stradbally River	14S02	Proposed GCR crossing, R426	[redacted]	[redacted]
A12	Cremorgan Stream	14C24	Proposed GCR crossing, R426	[redacted]	[redacted]
A13	Unnamed stream	n/a	Proposed GCR crossing, L3838	[redacted]	[redacted]
A14	Stradbally River	14S02	Bauteogue Bridge	[redacted]	[redacted]
A15	Stradbally River	14S02	Stradbally Bridge, N80	[redacted]	[redacted]
B1	Scotland Stream	15S06	Proposed GCR crossing, L3851	[redacted]	[redacted]
B2	Owveg River	15O01	Knocklead	[redacted]	[redacted]
B3	Owveg River	15O01	L7792 road crossing	[redacted]	[redacted]
B4	Cleanagh Stream	15C58	L7792 road crossing	[redacted]	[redacted]
B5	Garrintaggart Stream	15G30	L7792 road crossing	[redacted]	[redacted]
B6	Garrintaggart Stream	15G30	R430 road crossing	[redacted]	[redacted]
B7	Owveg River	15O01	Spink Bridge	[redacted]	[redacted]
B8	Owveg River	15O01	R430 road crossing, Garrintaggart	[redacted]	[redacted]
B9	Graiguenahown Stream	15G29	Graiguenahown	[redacted]	[redacted]
B10	Owveg River	15O01	Graiguenasmuttan Bridge	[redacted]	[redacted]
C1	Knocklead Stream	15K21	R426 road crossing	[redacted]	[redacted]
C2	Clogh River	15C03	Coolglass	[redacted]	[redacted]
C3	Brennanshill River	15B51	Coolglass	[redacted]	[redacted]
C4	Clogh River	15C03	Moyadd	[redacted]	[redacted]
C5	Moyadd Stream	15M22	Kylenabehy	[redacted]	[redacted]
C6	Clogh River	15C03	Swan Bridge	[redacted]	[redacted]
C7	Clogh River	15C03	Clogh Bridge	[redacted]	[redacted]
D1	Douglas River	15D03	Shanragh Bridge	[redacted]	[redacted]

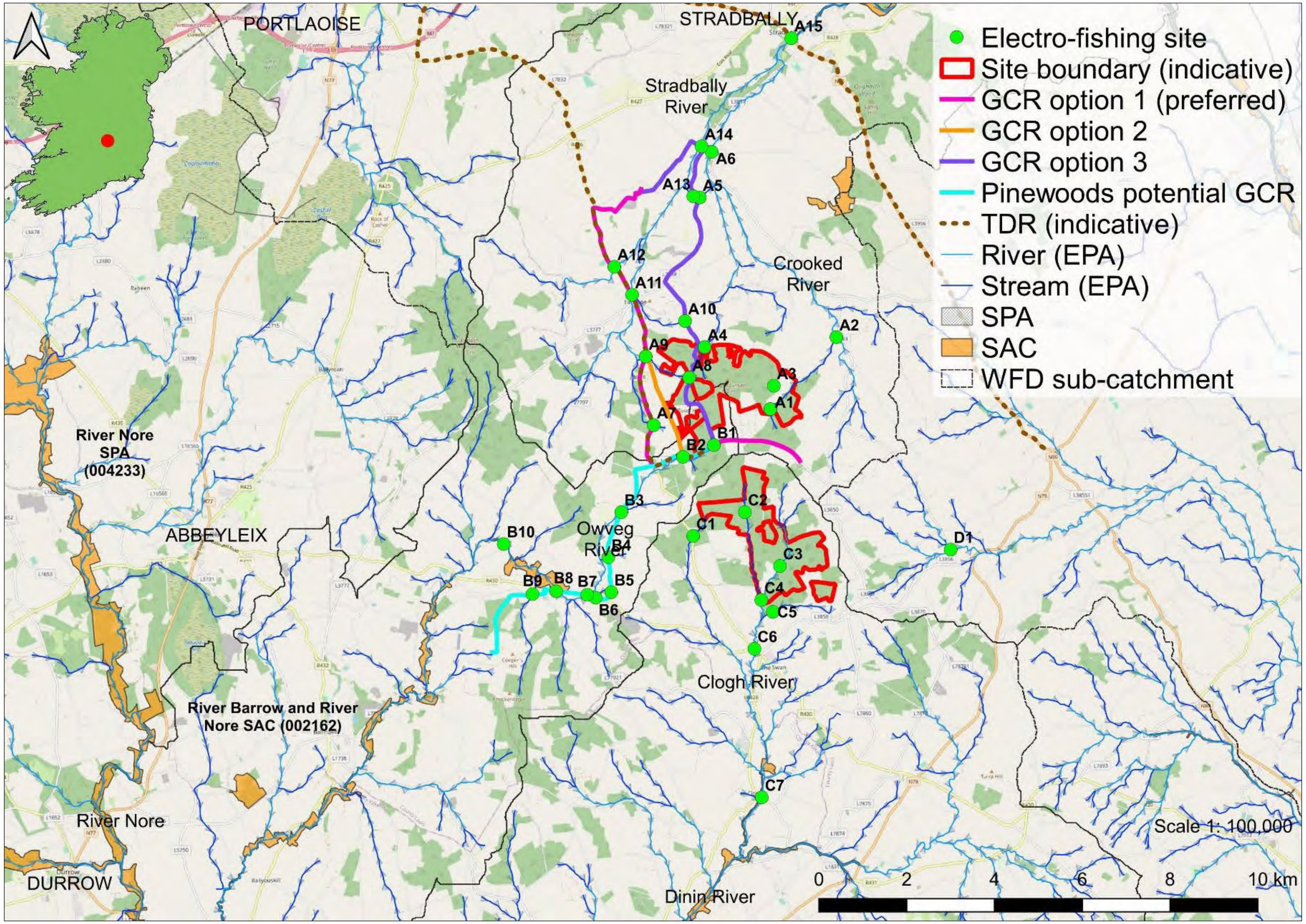

Figure 2.1 Overview of the *n*=33 electro-fishing survey site locations in the vicinity of Coolglass wind farm, Co. Laois

3. Results

A catchment-wide electro-fishing survey of *n*=33 riverine sites in the vicinity of the proposed Coolglass wind farm was conducted between the 31st August and 3rd September 2022 following notification to Inland Fisheries Ireland. The results of the survey are discussed below in terms of fish population structure, population size and the suitability and value of the surveyed areas as nursery and spawning habitat for salmonids, European eel and lamprey species. Scientific names are provided at first mention only.

3.1 Fish stock assessment (electro-fishing)

3.1.1 Site A1 – Fallowbeg Upper Stream, Fallowbeg Upper

No fish were recorded via electro-fishing at site A1. Despite some physical suitability for salmonids and European eel, the site did not support fish at the time of survey. This reflected low seasonal flows and also high natural gradients which would reduce the inherent fisheries value of the stream at this location.

Plate 3.1 Representative image of site A1 on the upper reaches of the Fallowbeg Upper Stream, September 2022

3.1.2 Site A2 – Crooked River, Luggacurreen

Site A2 was not of fisheries value given its dry, ephemeral nature and absence of aquatic habitats. Given the dry nature of the site, it was not possible to undertake electro-fishing at this site at the time of survey.

Plate 3.2 Representative image of site A2 on the upper reaches of the Crooked River, September 2022 (dry, ephemeral channel)

3.1.3 Site A3 – Unnamed stream, Fallowbeg Upper

Site A3 was not of fisheries value given its dry, ephemeral nature and absence of aquatic habitats. Given the dry nature of the site, it was not possible to undertake electro-fishing at this site at the time of survey. Its location in the upper reaches of the stream, with high natural gradients downstream, would likely prelude fish populations during wetted periods.

Plate 3.3 Representative image of site A3 on an unnamed Crooked River tributary, September 2022

3.1.4 Site A4 – Honey Stream, Fossy Upper

No fish were recorded via electro-fishing at site A4. This reflected low seasonal flows, its likely ephemeral nature and poor connectivity with downstream habitats which would reduce the inherent fisheries value of the stream at this location.

Plate 3.4 Representative image of site A4 on the Honey Stream, September 2022

3.1.5 Site A5 – Honey Stream North, Timogue

No fish were recorded via electro-fishing at site A5. This reflected low seasonal flows, its ephemeral nature and poor connectivity with downstream habitats which would reduce the inherent fisheries value of the stream at this location. The stream would have some improved (although still low) fisheries value during higher flow periods given the proximity of the Crooked River.

Plate 3.5 Representative image of site A5 on the Honey North Stream, September 2022 (semi-dry channel)

3.1.6 Site A6 – Crooked River, Timogue Bridge

Brown trout (*Salmo trutta*) (*n*=25), lamprey (*Lampetra* sp.) (*n*=5), stone loach (*Barbatula barbatula*) (*n*=1) and three-spined stickleback (*Gasterosteus aculeatus*) (*n*=1) were recorded via electro-fishing at site A6 (**Figure 3.1**).

The site was of good value for salmonids, supporting a moderate density of mixed-cohort brown trout. Despite significant siltation and enrichment pressures, the site was of most value as a salmonid nursery. Good quality spawning habitat for both salmonids and lamprey were also present but these areas were highly localised (>40m downstream of the bridge). The pool immediately below the bridge apron (a barrier to fish at low flows only) provided good quality holding habitat for adult salmonids but suitable areas were sparse elsewhere given the generally shallow nature of the site. The site was also of good value as a lamprey nursery, with frequent soft sediment deposits supporting a low density of ammocoetes. Despite some good suitability, no European eel were recorded.

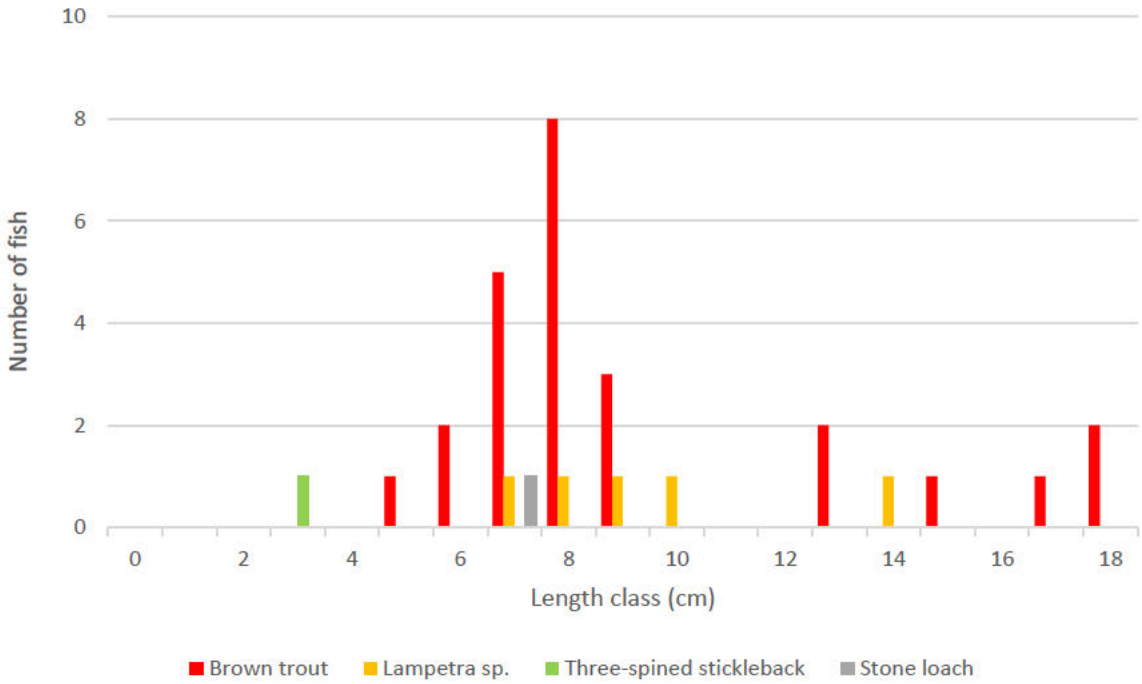

Figure 3.1 Length frequency distribution recorded via electro-fishing at site A6 on the Crooked River, September 2022

Plate 3.6 Mixed-cohort brown trout recorded at site A6 on the Crooked River at Timogue Bridge, September 2022

3.1.7 Site A7 – Aghoney Stream, Aghoney

Site A7 was not of fisheries value given its dry, ephemeral nature and absence of aquatic habitats. Given the dry nature of the site, it was not possible to undertake electro-fishing at this site at the time of survey. Its location in the upper reaches of the stream, with high natural gradients downstream, would likely prelude fish populations during wetted periods.

Plate 3.7 Representative image of site A7 on the Aghoney Stream, September 2022 (dry, ephemeral channel)

3.1.8 Site A8 – Fossy Lower Stream, Fossy Upper

Site A8 was not of fisheries value given its dry, ephemeral nature and absence of aquatic habitats. Given the dry nature of the site, it was not possible to undertake electro-fishing at this site at the time of survey. Its location in the upper reaches of the stream, with high natural gradients downstream, would likely prelude fish populations during wetted periods.

3.1.9 Site A9 – Fossy Lower Stream, Ballintlea Lower

No fish were recorded via electro-fishing at site A9. The site was not of fisheries value given its semi-dry, ephemeral nature containing stagnant pools only. However, given some physical suitability, the stream at this location may support a low density of fish during wetter periods.

Plate 3.8 Representative image of site A8 on the Fossy Lower Stream, September 2022 (dry, ephemeral channel)

Plate 3.9 Representative image of site A9 on the lower reaches of the Fossy Lower Stream, September 2022 (ephemeral channel)

3.1.10 Site A10 – Timahoe Stream, Fossy Lower

Site A10 was not of fisheries value given its dry, ephemeral nature and absence of aquatic habitats. Given the dry nature of the site, it was not possible to undertake electro-fishing at this site at the time of survey. Its location in the uppermost reaches of the stream would likely prelude fish populations during wetted periods.

Plate 3.10 Representative image of site A10 on the Timahoe Stream, September 2022 (water abstraction for livestock evident)

3.1.11 Site A11 – Stradbally River, Timahoe

Brown trout (*n*=6), lamprey (*Lampetra* sp.) (*n*=8) stone loach (*n*=1), minnow (*Phoxinus phoxinus*) (*n*=54) and three-spined stickleback (*n*=3) were recorded via electro-fishing at site A11 (**Figure 3.2**).

The site was of good value for salmonids but supported only a low density of juvenile brown trout, with no adults recorded via electro-fishing. This was in spite of some high physical suitability in terms of holding habitat (deep pool). The evident hydromorphological, enrichment and siltation pressures reduced the value of the site as a salmonid nursery considerably. Spawning habitat for both salmonids and lamprey was present but highly localised and significantly compromised by siltation. Some good quality lamprey habitat was present adjoining localised pool areas and supported a low density of mixed-cohort ammocoetes. Despite some moderate suitability, no European eel were recorded.

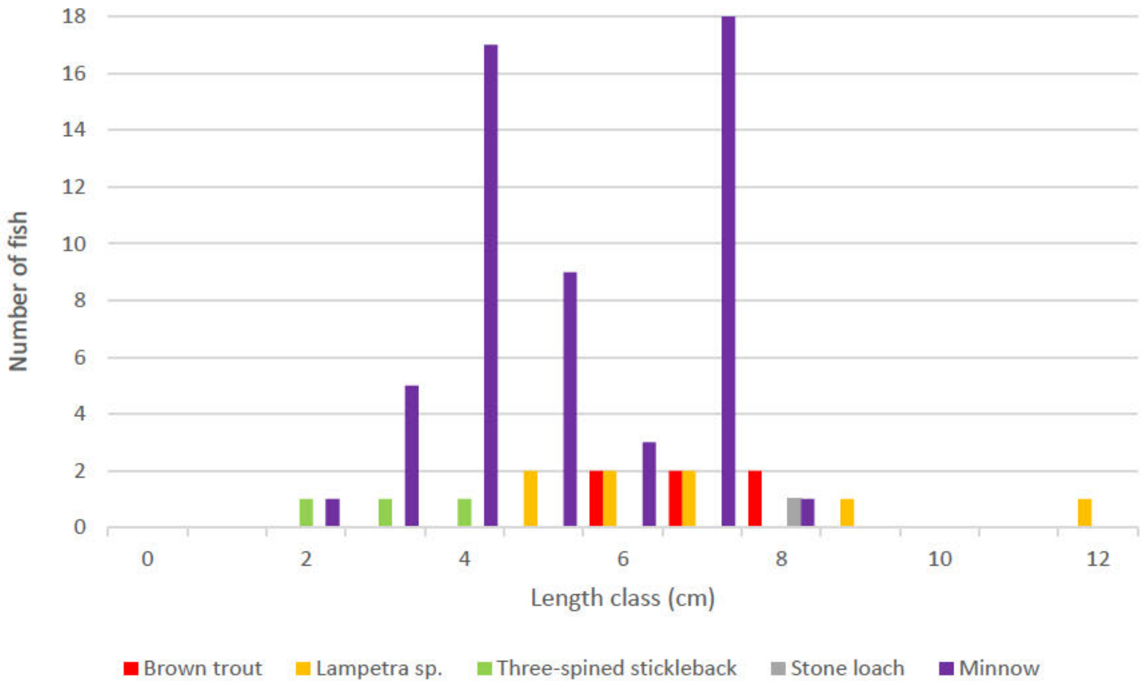

Figure 3.2 Length frequency distribution recorded via electro-fishing at site A11 on the Stradbally River, September 2022

Plate 3.11 Stone loach, brown trout and minnow recorded at site A11 on the Stradbally River, September 2022

3.1.12 Site A12 – Cremorgan Stream, Coolnabacky

Three-spined stickleback (*n*=14) was the only species recorded via electro-fishing at site A12 (**Figure 3.3**).

Despite high physical suitability for salmonids, none were recorded via electro-fishing of stagnant remnant pools. Given downstream connectivity and site attributes (high energy, hard substrata, glide and pool habitat etc.), the site likely supports salmonids (and other fish species such as European eel) at higher water levels. Stagnant pools supported low densities of three-spined stickleback only. There was no suitability (even under higher water levels) for lamprey.

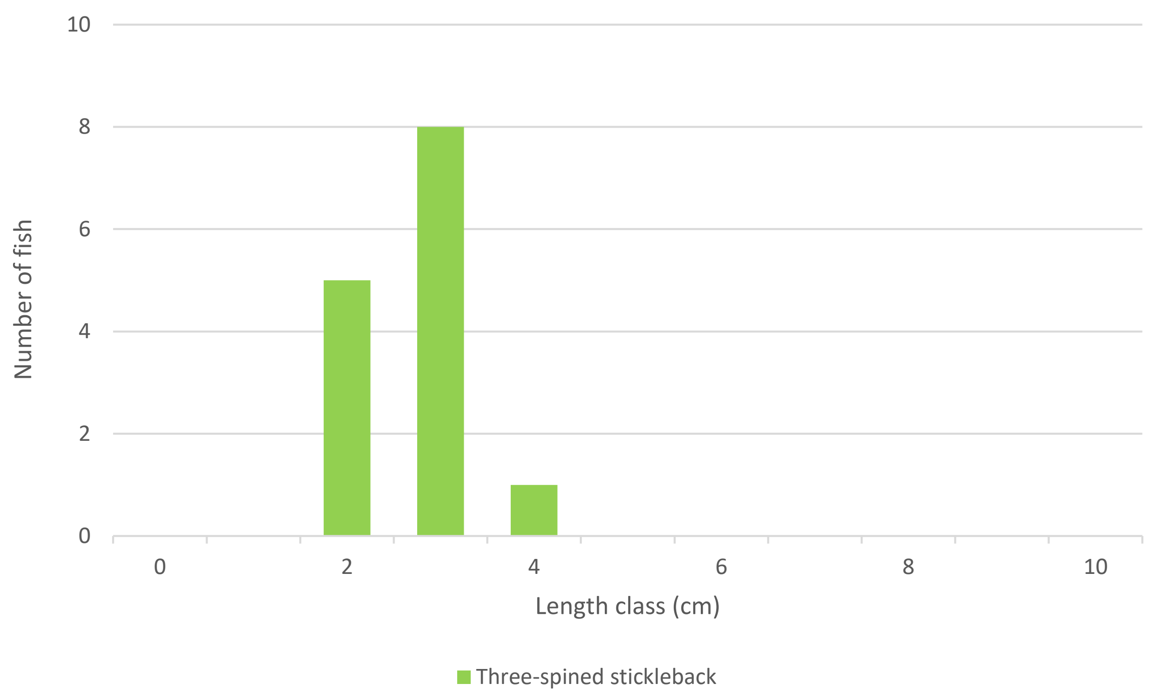

Figure 3.3 Length frequency distribution recorded via electro-fishing at site A12 on the Cremorgan Stream, September 2022

Plate 3.12 Representative image of site A12 on the Cremorgan Stream, September 2022

3.1.13 Site A13 – Unnamed stream, Timogue

Site A13 was not of fisheries value given its dry, ephemeral nature and absence of aquatic habitats. Given the dry nature of the site, it was not possible to undertake electro-fishing at this site at the time of survey. The stream would likely have some improved (although still low) fisheries value in its lowermost reaches only during higher flow periods given the proximity of the Stradbally River.

Plate 3.13 Representative image of site A13 on an unnamed Stradbally River tributary, August 2022 (dry, ephemeral channel)

3.1.14 Site A14 – Stradbally River, Bauteogue Bridge

Brown trout (*n*=11), three-spined stickleback (*n*=19), stone loach (*n*=1) and minnow (*n*=28) were recorded via electro-fishing at site A14 (**Figure 3.4**).

Despite very low seasonal flows, site A14 was of good value for salmonids, supporting a low density of mixed-cohort brown trout. Physically, the site provided good quality nursery, spawning and holding habitat but the value was reduced significantly given very low seasonal flows and poor connectivity. The bridge apron was a significant barrier to fish passage at low flows. Better quality glide habitat was present downstream of the bridge. Overhanging macrophyte vegetation and scoured banks (including tree roots) provided valuable holding areas for salmonids. Whilst some good quality lamprey spawning habitat was present, the site was unsuitable as a nursery area given a paucity of soft sediment accumulations.

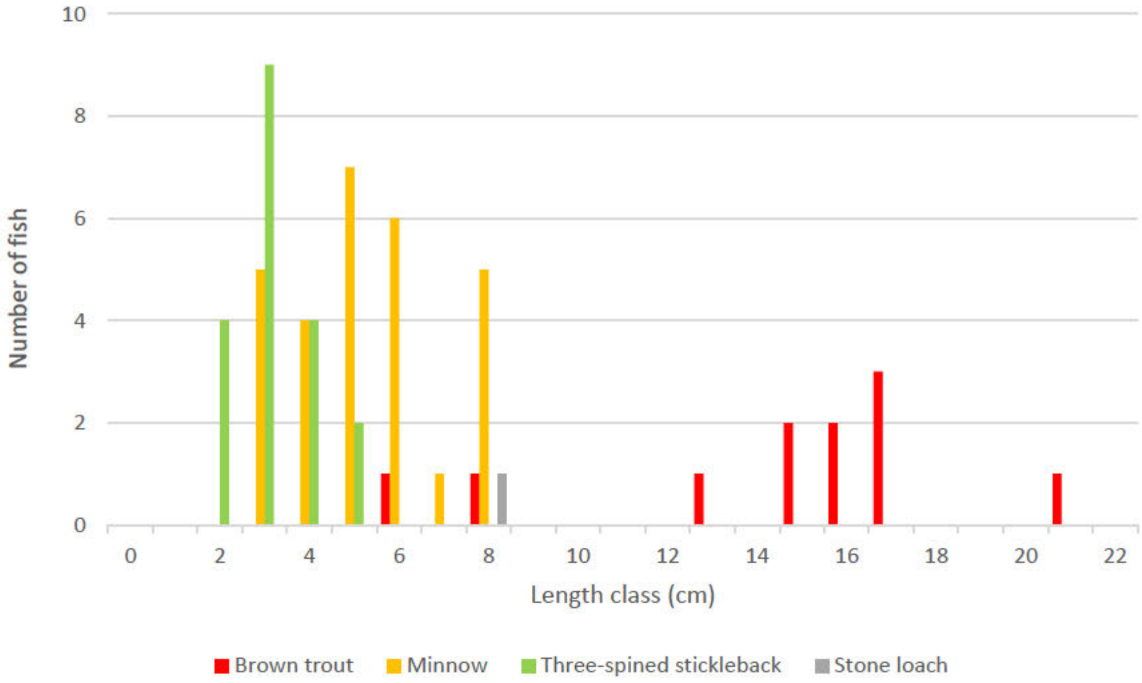

Figure 3.4 Length frequency distribution recorded via electro-fishing at site A14 on the Stradbally River, September 2022

Plate 3.14 Brown trout and minnow recorded at site A14 on the Stradbally River at Bauteogue Bridge, September 2022

3.1.15 Site A15 – Stradbally River, Stradbally Bridge

Atlantic salmon (*Salmo salar*) (*n*=9), brown trout (*n*=26), lamprey (*Lampetra* sp.) (*n*=6), minnow (*n*=38) and three-spined stickleback (*n*=25) were recorded via electro-fishing at site A15 (**Figure 3.5**).

The site was of high value for salmonids, supporting mixed-cohort populations of both Atlantic salmon and brown trout. The site was of highest value as a salmonid nursery, despite evident enrichment and siltation pressures impacting the quality of the cobble and boulder refugia. Spawning habitat for both salmonids and lamprey was present but highly localised, mostly downstream of the bridge. The shallow modified site was of poor value as a holding area although some overhanging vegetation provided valuable thermal refugia. Despite high suitability, no European eel were recorded.

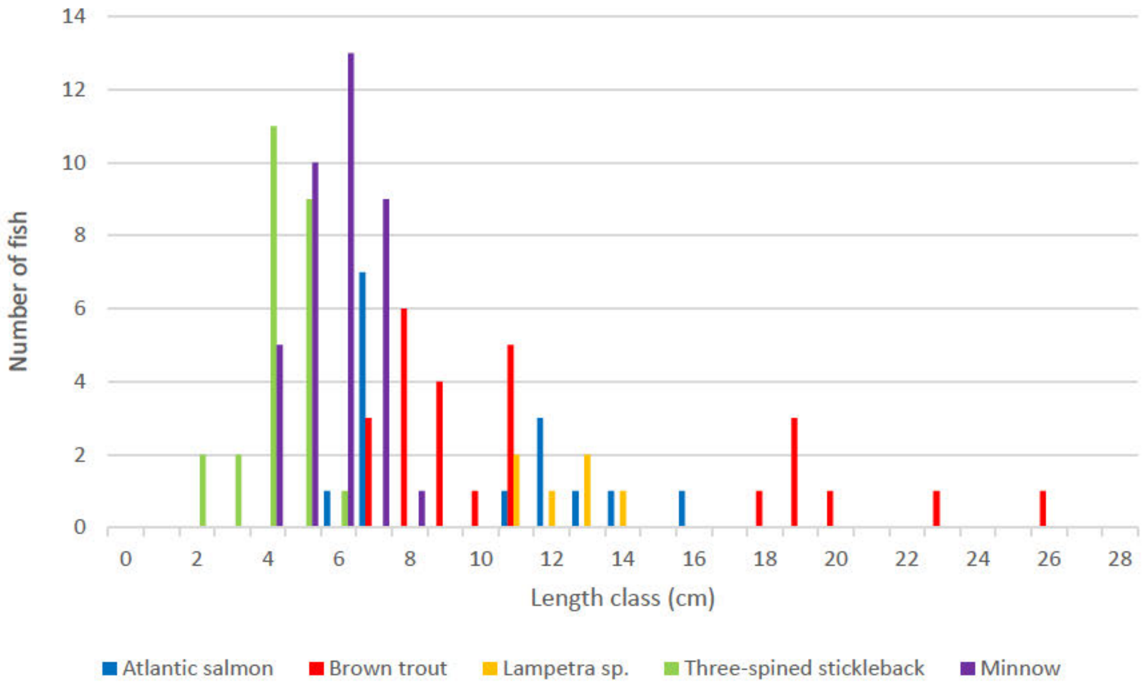

Figure 3.5 Length frequency distribution recorded via electro-fishing at site A15 on the Stradbally River, September 2022

Plate 3.15 Juvenile brown trout (top) and Atlantic salmon (bottom) recorded at site A15 on the Stradbally River at Stradbally Bridge, September 2022

3.1.16 Site B1 – Scotland Stream, Aghoney

No fish were recorded via electro-fishing at site B1. The site was not of fisheries value given its semi-dry, ephemeral nature and location in the upper reaches of the catchment. Given this, and naturally high gradients, connectivity with downstream habitats was poor and the stream is unlikely to support fish at this location even under higher water levels.

Plate 3.16 Representative image of site B1 on the Scotland Stream, September 2022

3.1.17 Site B2 – Owveg River, Knocklead

Brown trout (*n*=2) was the only fish species recorded via electro-fishing at site B2 (**Figure 3.6**).

The site was of low value for salmonids, supporting only a very low fish density. Low seasonal flows reduced the value of the habitat significantly, with intermittent flows and poor longitudinal connectivity (including an impassable bridge apron). However, the site was of some low value as a salmonid nursery and spawning habitat, with good quality holding areas for adults absent. Despite some low suitability for European eel, none were recorded. The upland eroding site was unsuitable for lamprey.

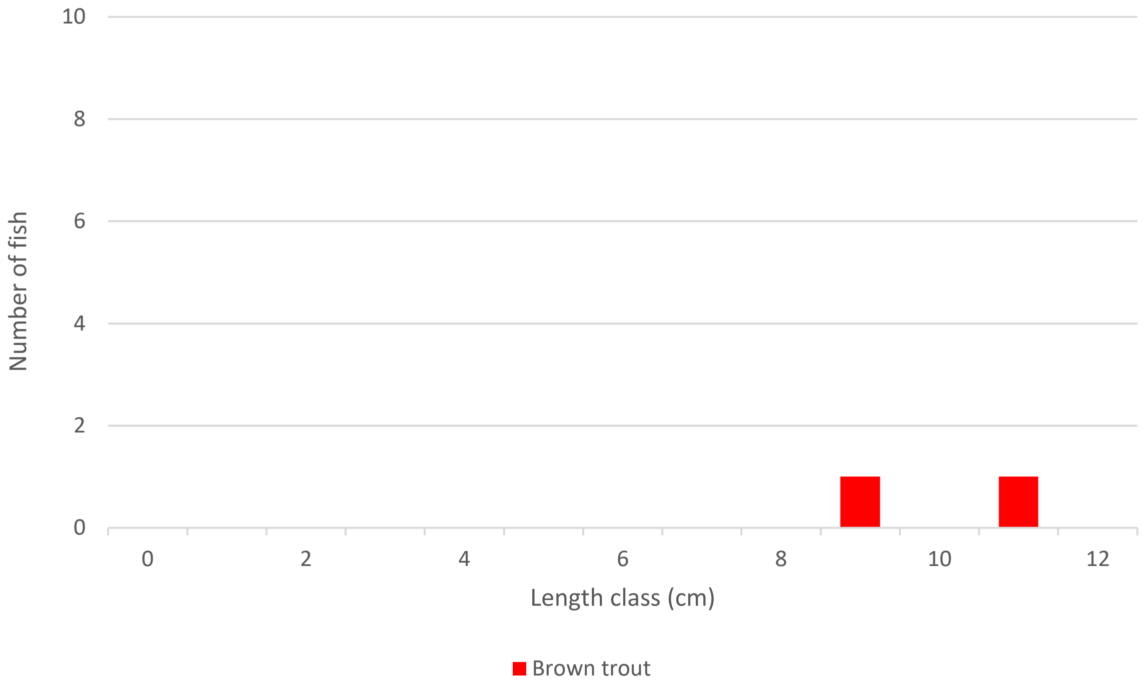

Figure 3.6 Length frequency distribution recorded via electro-fishing at site B2 on the upper reaches of the Owveg River, September 2022

Plate 3.17 Representative image of site B2 on the upper reaches of the Owveg River, September2022 (upstream of bridge)

3.1.18 Site B3 – Owveg River, Knocklead

Atlantic salmon (*n*=1), brown trout (*n*=11), minnow (*n*=30) and stone loach (*n*=3) were recorded via electro-fishing at site B3 (**Figure 3.7**).

The site was of good value for salmonids, despite very low seasonal flows, with a low density of juvenile brown trout and a single Atlantic salmon parr recorded via electro-fishing. Physically, the site was of highest value as a salmonid nursery given a predominance of cobble and boulder refugia. Spawning habitat was present but localised and compromised by siltation pressures and naturally high compaction of the bed. Holding habitat was poor in the small, shallow upland watercourse at this location although some valuable pools were associated with meanders and overhanging tree root systems (thermal refugia). Despite some suitability for European eel, none were recorded. The upland eroding site was unsuitable for lamprey.

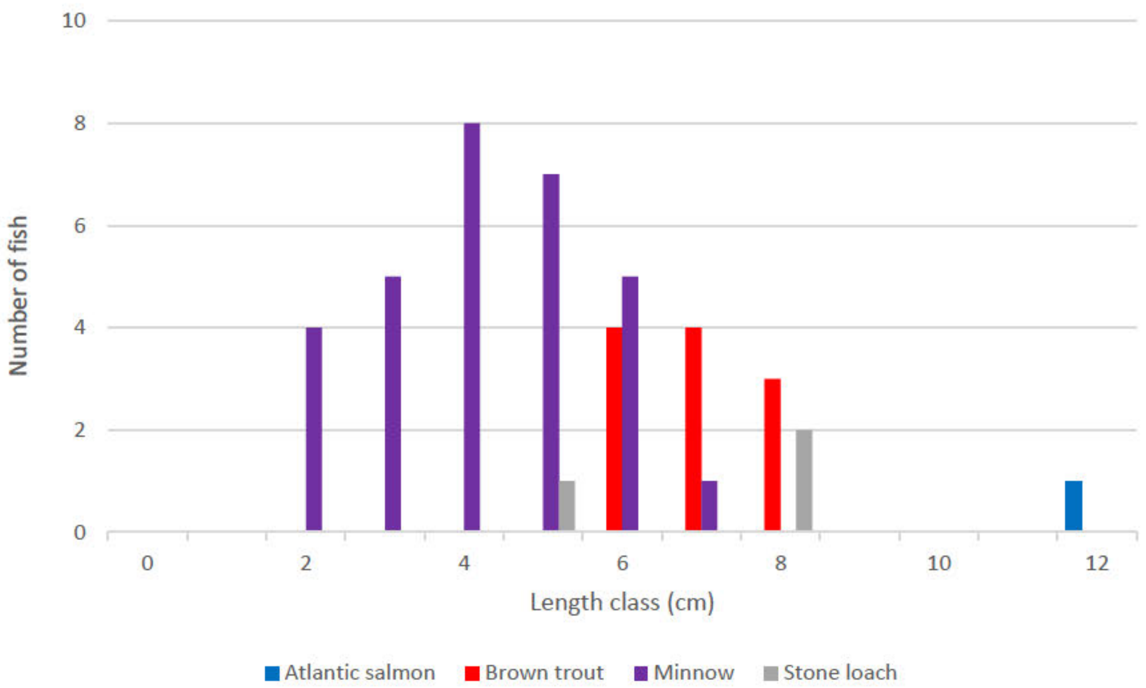

Figure 3.6 Length frequency distribution recorded via electro-fishing at site B3 on the upper reaches of the Owveg River, September 2022

Plate 3.18 Atlantic salmon, brown trout, minnow and stone loach recorded at site B3 on the upper reaches of the Owveg River, September 2022

3.1.19 Site B4 – Cleanagh Stream, Cleanagh

No fish species were recorded via electro-fishing at site B4. The site was not of fisheries value given its ephemeral nature (stagnant pools only) in addition to high natural gradients. However, given the close proximity to the downstream connecting Owveg River (<0.2km), the stream may have some low fisheries (salmonid) value during higher flow periods. The box culvert was inaccessible to fish given high gradients. The upland eroding ephemeral channel was unsuitable for lamprey.

Plate 3.19 Representative image of site B4 on the Cleanagh Stream, September 2022

3.1.20 Site B5 – Garrintaggart Stream, Knockbaun

No fish species were recorded via electro-fishing at site B5. The site was not of fisheries value given its very shallow and likely ephemeral nature, in addition to the location at the headwaters of the stream.

Plate 3.20 Representative image of site B5 on the Garrintaggart Stream, September 2022

3.1.21 Site B6 – Garrintaggart Stream, Knockbaun

No fish species were recorded via electro-fishing at site B6. The site was not of fisheries value given poor seasonal flows, high natural gradients, poor connectivity with downstream habitats and the location in the upper reaches of the stream.

Plate 3.21 Representative image of site B6 on the Garrintaggart Stream, September 2022

3.1.22 Site B7 – Owveg River, Spink Bridge

European eel (*n*=4), minnow (*n*=55) and stone loach (*n*=2) were recorded via electro-fishing at site B7 (**Figure 3.7**).

The site provided high physical suitability for salmonids. However, the dry karstic nature of the channel (other than the plunge pool) precluded the presence of brown trout or Atlantic salmon, despite their presence upstream (at site B3). The presence of salmonids upstream supports that salmonids are able to navigate this site under higher water flows. Suitability for European eel was moderate given the spate characteristic of the channel. The typically upland eroding site was unsuitable for lamprey.

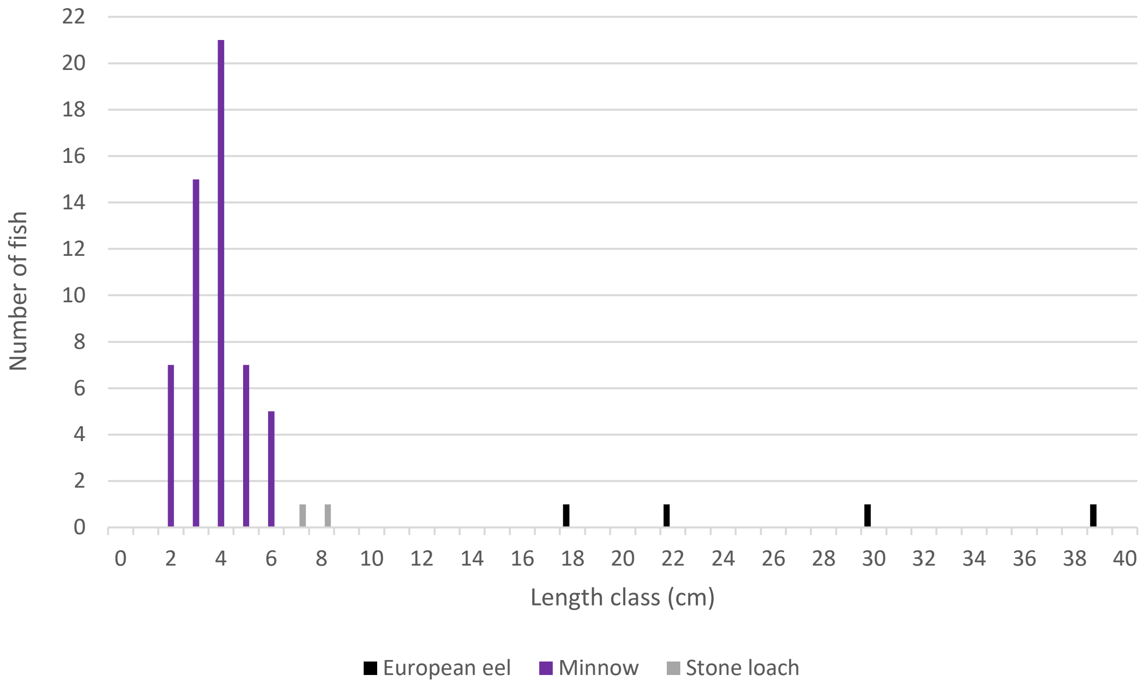

Figure 3.7 Length frequency distribution recorded via electro-fishing at site B7 on the Owveg River, September 2022

Plate 3.22 Representative image of site B7 on the Owveg River at Spink Bridge, September 2022 (deep plunge pool in an otherwise dry channel)

3.1.23 Site B8 – Owveg River, Garrintaggart

Brown trout (*n*=9), European eel (*n*=4), minnow (*n*=105) and stone loach (*n*=3) were recorded via electro-fishing at site B8 (**Figure 3.8**).

The site was of good value for salmonids, despite evident siltation and water quality issues, supporting a low density of mixed-cohort brown trout. Atlantic salmon are known from the site (IFI 2021 data). The site provided some good quality spawning and nursery habitat downstream of the bridge, although the quality of both were impacted by considerable siltation and eutrophication pressures. Marginal macrophyte beds provided valuable nursery refugia and also some limited holding habitat for adults. Holding habitat for larger adults was confined to the deeper pool underneath the bridge This boulder habitat provided high quality European eel habitat, with abundant diurnal refugia by way of boulder and retaining wall crevices. Whilst some moderate quality lamprey spawning habitat was present, no suitable nursery areas were identified (shallow & superficial where present). Minnow were abundant, reflecting the high levels of enrichment observed.

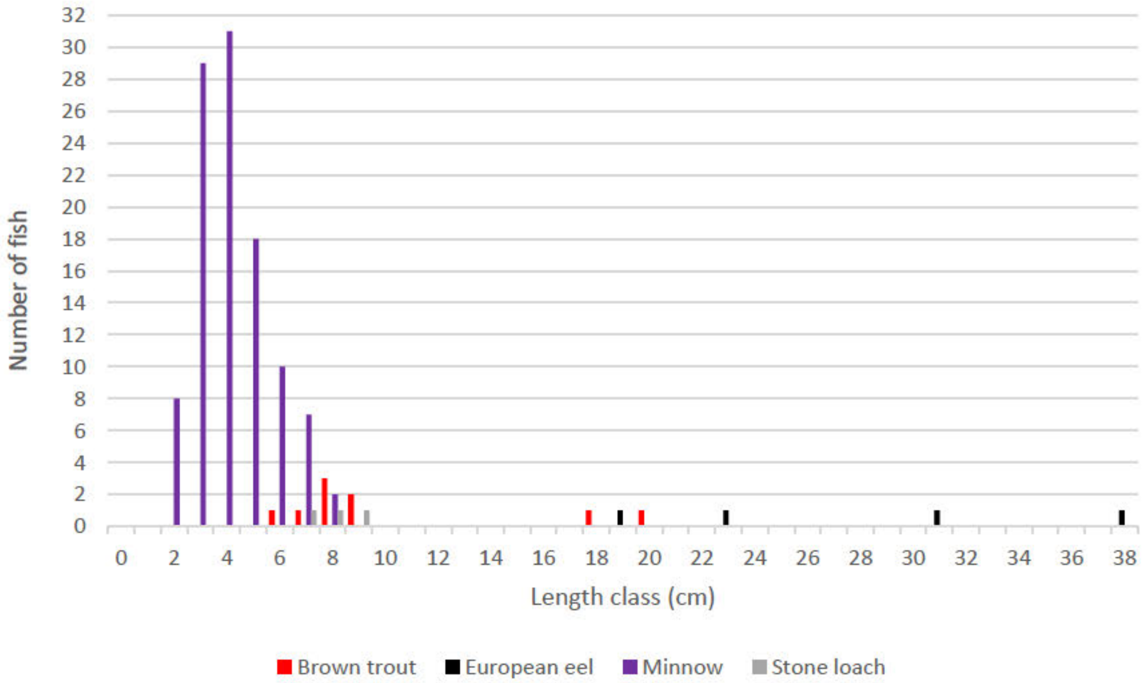

Figure 3.8 Length frequency distribution recorded via electro-fishing at site B8 on the Owveg River, September 2022

Plate 3.23 European eel recorded at site B8 on the Owveg River, September 2022

3.1.24 Site B9 – Graiguenahown Stream, Graiguenahown

No fish were recorded via electro-fishing at site B9. Whilst the site was physically suitable for salmonids the semi-dry nature caused by low seasonal water levels and poor downstream connectivity to superior fisheries habitats precluded the presence of salmonids and other fish species. Three-spined stickleback were absent, indicating the stream may dry out periodically (i.e. ephemeral).

Plate 3.24 Representative image of site B9 on the Graiguenahown Stream, September 2022 (downstream of twin pipe culvert)

3.1.25 Site B10 – Owveg River, Graiguenasmuttan Bridge

Atlantic salmon (*n*=2), brown trout (*n*=6), lamprey (*Lampetra* sp.) (*n*=14), minnow (*n*=85) and stone loach (*n*=11) were recorded via electro-fishing at site B10 (**Figure 3.9**).

The site was of good value for salmonids, despite low seasonal flows and evident siltation pressures, supporting a low density of mixed-cohort brown trout and Atlantic salmon. The heavily impacted site provided some good quality holding habitat, typically associated with meanders and large woody debris instream. However, these deeper areas supported a very low density of adult salmonids only. Whilst some physically suitable nursery and spawning habitat was present, the value was again compromised by high levels of siltation and enrichment. Shallow soft sediment accumulations along channel margins supported low densities (c.5 per m^2) of *Lampetra* sp. ammocoetes. Despite some good suitability for European eel, none were recorded.

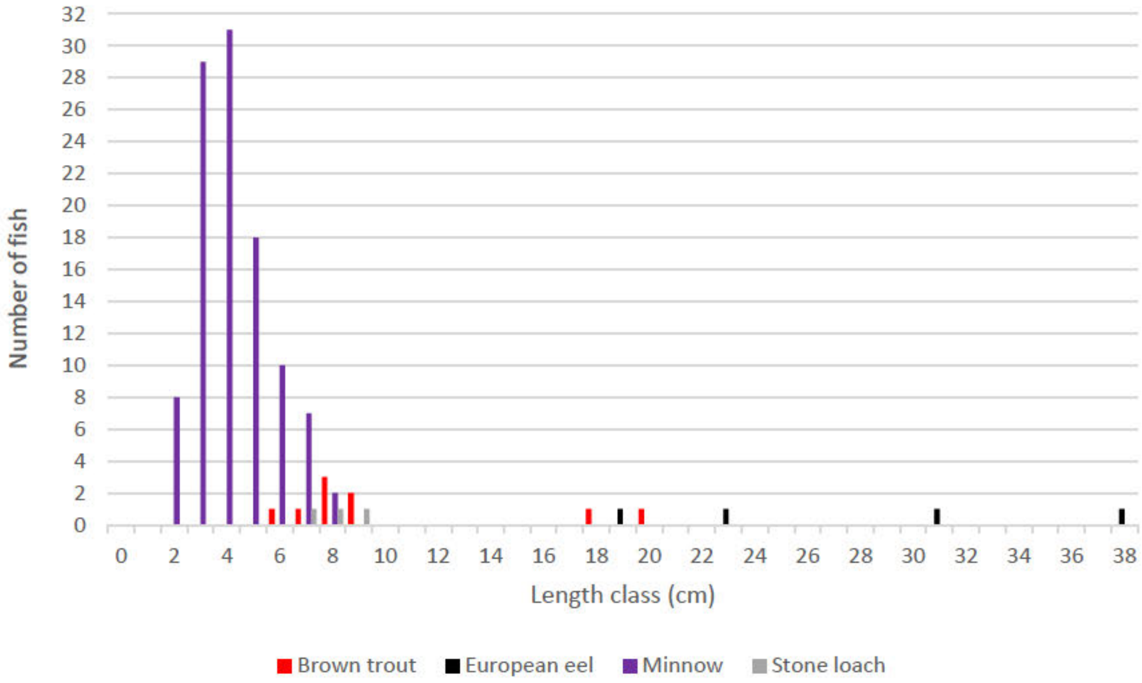

Figure 3.9 Length frequency distribution recorded via electro-fishing at site B10 on the Owveg River, September 2022

Plate 3.25 Atlantic salmon (top) and brown trout (bottom) recorded at site B10 on the Owveg River at Graiguenasmuttan Bridge, September 2022

3.1.26 Site C1 – Knocklead Stream, Knockacrin

No fish were recorded via electro-fishing at site C1. The site was not of fisheries value given its semi-dry, ephemeral nature and location in the upper reaches of the catchment. Given this, and naturally high gradients, connectivity with downstream habitats was poor and the stream had no suitability to support fish at this location even under higher water levels.

Plate 3.26 Representative image of site C1 on the Knocklead Stream, August 2022

3.1.27 Site C2 – Clogh River, Coolglass

Brown trout (*n*=2) was the only fish species recorded via electro-fishing at site C2 (**Figure 3.10**).

The site was of relatively low value for salmonids given its location in the upper reaches of the catchment and spate nature. However, the site supported a very low density of trout and some suitable spawning and holding habitat was present. The site was of poor value as a salmonid nursery. Holding areas supporting boulder and cobble provided some low suitability for European eel but none were recorded. The upland eroding channel was unsuitable for lamprey.

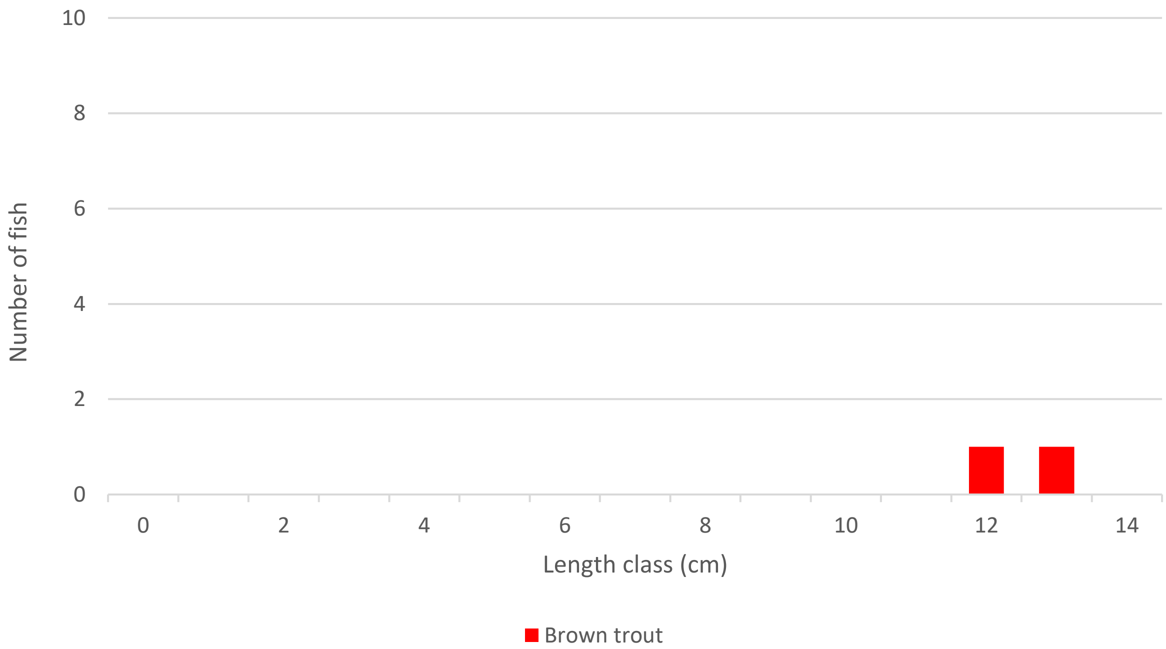

Figure 3.10 Length frequency distribution recorded via electro-fishing at site C2 on the upper reaches of the Clogh River, September 2022

Plate 3.27 Representative image of site C2 on the upper reaches of the Clogh River, August 2022

3.1.28 Site C3 – Brennanshill River, Coolglass

Brown trout (*n*=2) was the only fish species recorded via electro-fishing at site C3 (**Figure 3.11**).

The site was of moderate value for salmonids, supporting a very low density of mixed-cohort brown trout. Whilst some good quality spawning (finer gravels) and moderate quality nursery habitat (cobble & boulder) were present, low seasonal flows reduced the value of the site considerably (i.e. semi-dry). Although small pools were frequent, these provided poor quality holding habitat for adult salmonids given the small nature of the river at this location. Likewise, the shallow depth and seasonality of the spate site provided poor suitability for European eel (none recorded). The upland eroding channel was unsuitable for lamprey. The site was likely of greater fisheries value during higher flow periods (given connectivity with downstream habitats) and suitability improved considerably downstream.

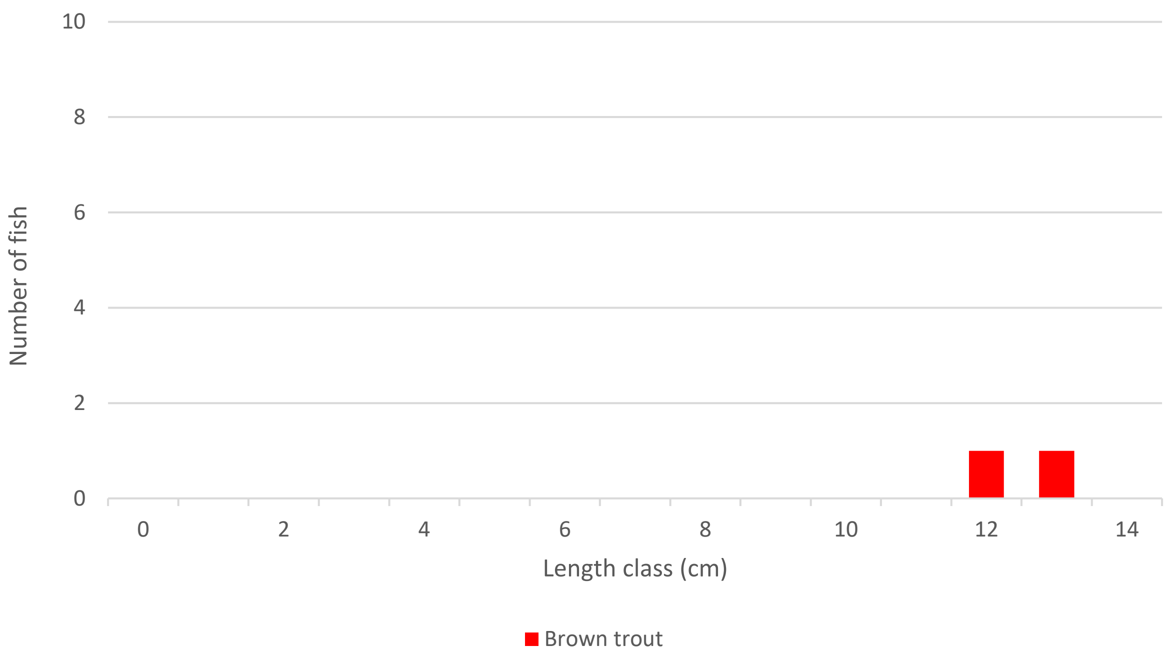

Figure 3.11 Length frequency distribution recorded via electro-fishing at site C3 on the Brennanshill River, August 2022

Plate 3.28 Juvenile brown trout recorded at site C3 on the Brennanshill River, August 2022

3.1.29 Site C4 – Clogh River, Moyadd

Brown trout (*n*=8), lamprey (*Lampetra* sp.) (*n*=14), three-spined stickleback (*n*=22), minnow (*n*=16) and stone loach (*n*=12) were recorded via electro-fishing at site C4 (**Figure 3.12**).

The site was of good value to salmonids despite low (and known regular) low seasonal flows and subsequent reduction in fisheries habitat quality. The site supported a low density of mixed-cohort brown trout (primarily adult fish). Physically, the site was of most value as spawning and nursery area although these attributes were compromised by very low seasonal water levels (i.e. a semi-dry channel with only slight flows). Good quality holding habitat was also present, with frequent small pools and scoured banks providing valuable areas for adult salmonids. These areas were especially important given evident low flows. Furthermore, the heavily shaded nature of the site likely facilitated the persistence of a small salmonid population given the presence of thermal refugia. Despite the upland eroding characteristics and presence of sub-optimal, sand-dominated soft sediment, the site supported *Lampetra* sp. ammocoetes. These were present but highly localised, with one area supporting 14 per m^2. Despite some good suitability for European eel, none were recorded via electro-fishing.

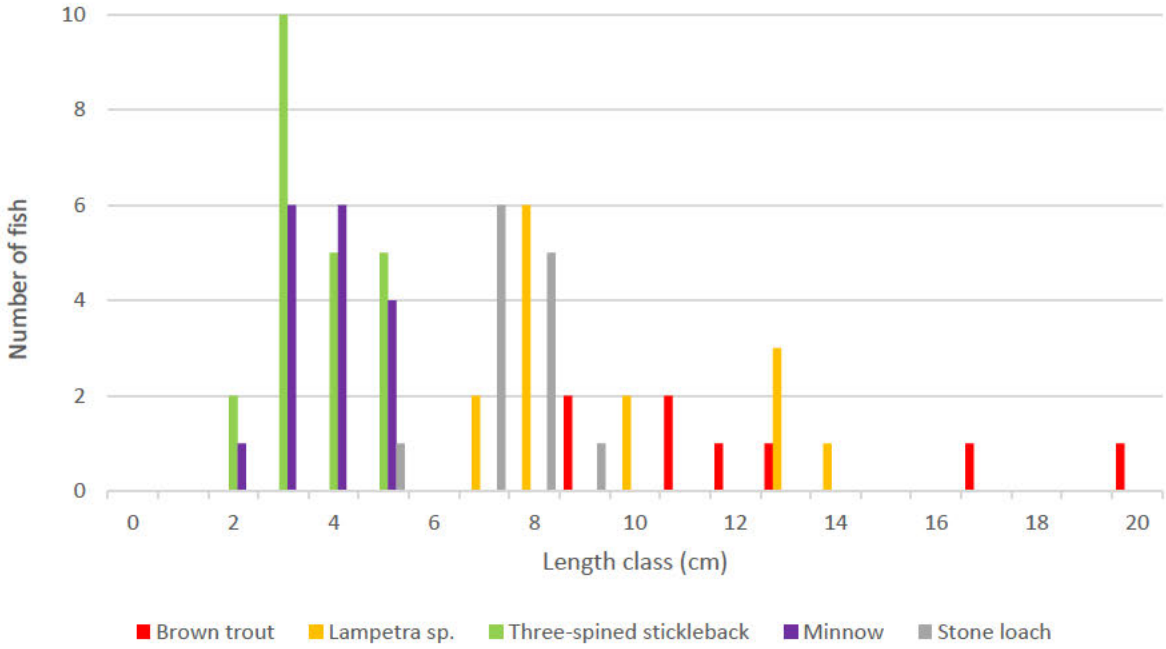

Figure 3.12 Length frequency distribution recorded via electro-fishing at site C4 on the Clogh River, August 2022

Plate 3.29 *Lampetra* sp. ammocoetes recorded at site C4 on the Clogh River, August 2022

3.1.30 Site C5 – Moyadd Stream, Kylenabehy

Site C5 was not of fisheries value given its dry, ephemeral nature and absence of aquatic habitats. Given the dry nature of the site, it was not possible to undertake electro-fishing at this site at the time of survey. However, given some physical suitability and close proximity to the Clogh River, the stream in its lower reaches may support a low density of fish during wetter periods.

Plate 3.30 Representative image of site C5 on the Moyadd Stream, August 2022 (dry, ephemeral channel at the Clogh River confluence)

3.1.31 Site C6 – Clogh River, Swan Bridge

Brown trout (*n*=3), lamprey (*Lampetra* sp.) (*n*=39), three-spined stickleback (*n*=2), minnow (*n*=21) and stone loach (*n*=7) were recorded via electro-fishing at site C6 (**Figure 3.13**).

The site was of good value for salmonids and supported a low density of juvenile brown trout, despite low seasonal water levels and evident siltation pressures. Whilst spawning habitat was sparse and of moderate quality (at best), some good quality nursery and holding habitat was present. The semi-dry channel over bedrock and the bridge aprons created impassable barriers to salmonid migration at low flows. The site was of highest value as a *Lampetra* sp. nursery, with shallow (<5cm) organic-rich soft sediment deposits supporting a relatively high density (>c.10 per m^2) of particularly large ammocoetes (**Plate 3.31**). Lamprey spawning habitat (finer gravels) was present but limited in extent at exposed to siltation pressures. Despite some suitability for European eel (scoured banks, pool areas etc.), none were recorded.

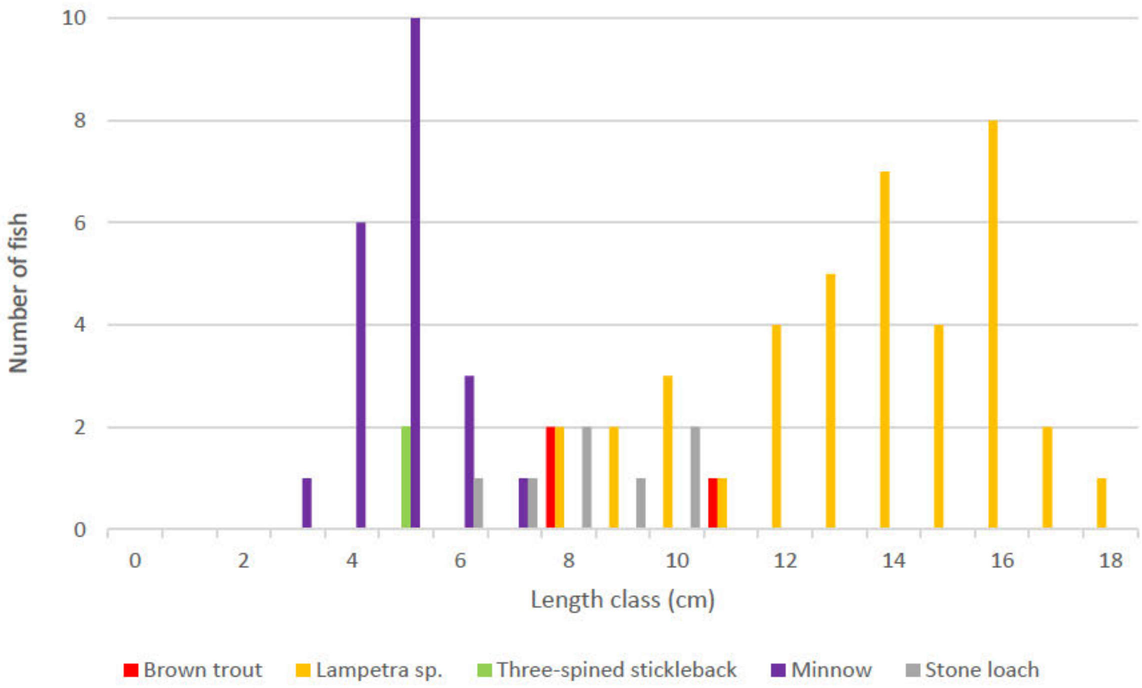

Figure 3.13 Length frequency distribution recorded via electro-fishing at site C6 on the Clogh River, August 2022

Plate 3.31 Example of particularly large *Lampetra* sp. ammocoete recorded at site C6 on the Clogh River at Swan Bridge, August 2022

3.1.32 Site C7 – Clogh River, Clogh Bridge

Brown trout (*n*=33), lamprey (*Lampetra* sp.) (*n*=4), three-spined stickleback (*n*=4), minnow (*n*=60) and perch (*Perca fluviatilis*) (*n*=3) were recorded via electro-fishing at site C7 (**Figure 3.14**).

The site was of high value to salmonids, supporting a high density of adult brown trout. The site was of most value as an adult holding habitat, with deeper glide areas and macrophyte beds providing valuable holding areas and thermal refugia in an otherwise open, shallow channel. The site was of poor value as a nursery habitat given poor seasonal flows (physically suitable but no juveniles recorded). Spawning habitat was present for both salmonids and lamprey but was limited in extent and exposed to siltation pressures. Atlantic salmon are also known from this site (IFI 2021 data). The site supported a low density of *Lampetra* sp. ammocoetes, despite apparent widespread suitability (e.g. macrophyte-related silt deposits). Despite some good suitability, no European eel were recorded.

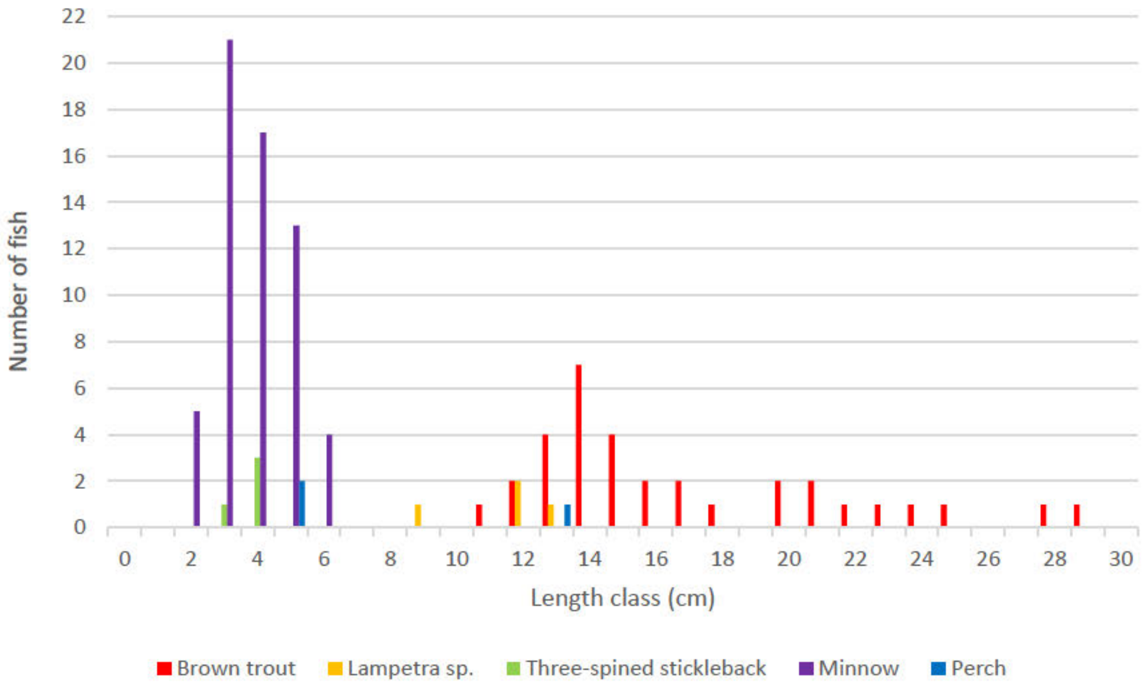

Figure 3.14 Length frequency distribution recorded via electro-fishing at site C7 on the Clogh River, August 2022

Plate 3.32 Large adult brown trout recorded at site C7 on the Clogh River at Clogh Bridge, August 2022

3.1.33 Site D1 – Douglas River, Shanragh Bridge

Brown trout (*n*=3), three-spined stickleback (*n*=3) and stone loach (*n*=1) were recorded via electro-fishing at site D1 (**Figure 3.15**).

Site D1 was of good value for salmonids. However, despite the presence of good quality nursery habitat and good quality (albeit localised) spawning substrata, the site supported only a very low density of brown trout. This was perhaps reflective of low seasonal flows (i.e. fish had perhaps dropped down the system). Frequent small pools provided some suitable holding habitat for smaller adults although the paucity of deeper areas reduced suitability for larger migratory salmonids (e.g. Atlantic salmon). The cobbled bridge apron, in addition to natural cascades, were barriers to fish passage at low flows (depth <0.05m). Despite some moderate suitability as a nursery habitat, no European eel were recorded. The upland eroding site was not suitable for lamprey.

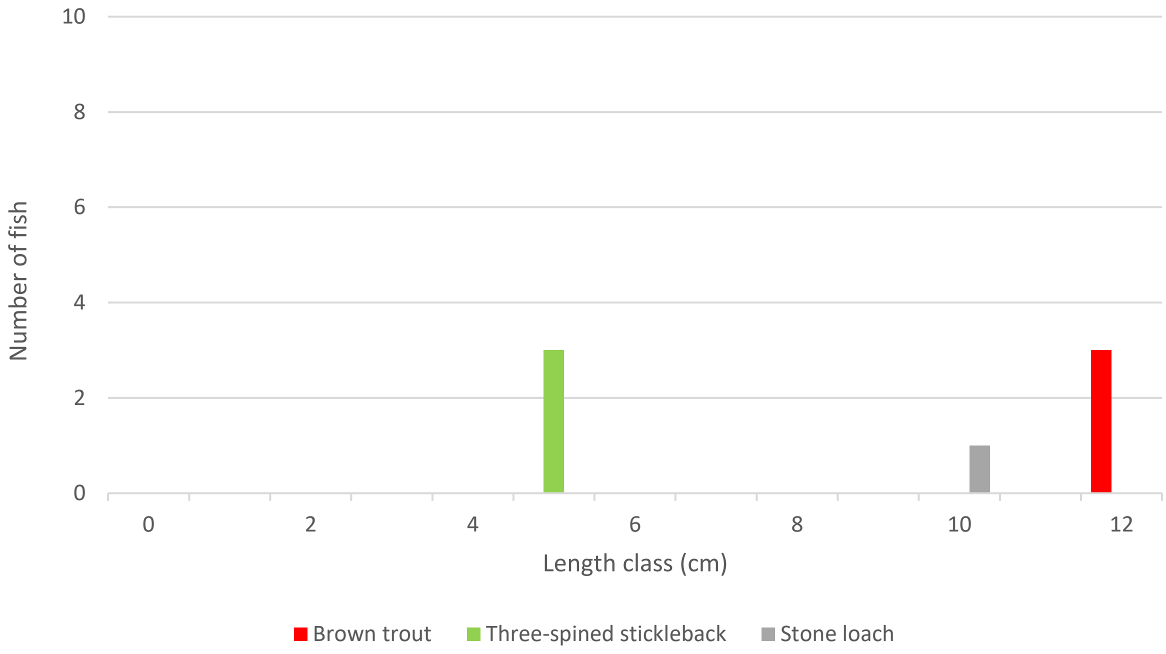

Figure 3.15 Length frequency distribution recorded via electro-fishing at site D1 on the Douglas River, August 2022

Plate 3.33 Brown trout and three-spined stickleback recorded at site D1 on the upper reaches of the Douglas River, August 2022

Table 3.1 Fish species densities per m^2 recorded at sites in the vicinity of the proposed Coolglass wind farm via electro-fishing in August-September 2022 (values in bold represent the highest densities recorded for each species, respectively)

Site	Watercourse	CPUE (elapsed time)	Approx. area fished (m^2)	Fish density (number fish per m^2)							
				Atlantic salmon	Brown trout	*Lampetra* sp.	European eel	Minnow	Stone loach	Three-spined stickleback	Perch
A1	Fallowbeg Upper Stream	Dry channel		n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
A2	Crooked River	Dry channel		n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
A3	Unnamed stream	Dry channel		n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
A4	Honey Stream	5	20	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
A5	Honey Stream North	5	10	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
A6	Crooked River	10	165	0.000	**0.152**	2 per m^2	0.000	0.000	0.006	0.006	0.000
A7	Aghoney Stream	Dry channel		n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
A8	Fossy Lower Stream	Dry channel		n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
A9	Fossy Lower Stream	Dry channel		n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
A10	Timahoe Stream	Dry channel		n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
A11	Stradbally River	10	150	0.000	0.040	2.67 per m^2	0.000	0.360	0.007	0.020	0.000
A12	Cremorgan Stream	5	20	0.000	0.000	0.000	0.000	0.000	0.000	**0.700**	0.000
A13	Unnamed stream	Dry channel		n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
A14	Stradbally River	10	180	0.000	0.061	0.000	0.000	0.156	0.006	0.106	0.000
A15	Stradbally River	10	240	**0.038**	0.108	1.5 per m^2	0.000	0.158	0.000	0.104	0.000

Site	Watercourse	CPUE (elapsed time)	Approx. area fished (m^2)	Fish density (number fish per m^2)							
				Atlantic salmon	Brown trout	*Lampetra* sp.	European eel	Minnow	Stone loach	Three-spined stickleback	Perch
B1	Scotland Stream	5	5	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
B2	Owveg River	5	80	0.000	0.025	0.000	0.000	0.000	0.000	0.000	0.000
B3	Owveg River	5	90	0.011	0.122	0.000	0.000	0.333	0.033	0.000	0.000
B4	Cleanagh Stream	5	70	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
B5	Garrintaggart Stream	5	10	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
B6	Garrintaggart Stream	5	60	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
B7	Owveg River	5	20	0.000	0.000	0.000	**0.200**	**2.750**	**0.100**	0.000	0.000
B8	Owveg River	10	195	0.000	0.046	0.000	0.021	0.538	0.015	0.000	0.000
B9	Graiguenahown Stream	5	5	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
B10	Owveg River	10	210	0.010	0.029	5.6 per m^2	0.000	0.405	0.052	0.000	0.000
C1	Knocklead Stream	5	15	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
C2	Clogh River	10	150	0.000	0.013	0.000	0.000	0.000	0.000	0.000	0.000
C3	Brennanshill River	10	110	0.000	0.027	0.000	0.000	0.000	0.000	0.000	0.000
C4	Clogh River	10	195	0.000	0.041	**14 per m^2**	0.000	0.082	0.062	0.113	0.000
C5	Moyadd Stream	Dry channel		n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
C6	Clogh River	10	220	0.000	0.014	13 per m^2	0.000	0.095	0.032	0.009	0.000
C7	Clogh River	10	240	0.000	0.138	2 per m^2	0.000	0.250	0.000	0.017	**0.013**
D1	Douglas River	10	250	0.000	0.012	0.000	0.000	0.000	0.004	0.012	0.000

Table 3.2 Summary of fish species of higher conservation value recorded via electro-fishing per survey site in the vicinity of the proposed Coolglass wind farm, August-September 2022

Site	Watercourse	Atlantic salmon	*Lampetra* sp.	Brown trout	European eel	Other species
A1	Fallowbeg Upper Stream	No fish recorded – dry channel				
A2	Crooked River	No fish recorded – dry channel				
A3	Unnamed stream	No fish recorded – dry channel				
A4	Honey Stream	No fish recorded				
A5	Honey Stream North	No fish recorded				
A6	Crooked River		✓	✓		Three-spined stickleback, stone loach
A7	Aghoney Stream	No fish recorded				
A8	Fossy Lower Stream	No fish recorded – dry channel				
A9	Fossy Lower Stream	No fish recorded				
A10	Timahoe Stream	No fish recorded – dry channel				
A11	Stradbally River		✓	✓		Three-spined stickleback, stone loach, minnow
A12	Cremorgan Stream					Three-spined stickleback
A13	Unnamed stream	No fish recorded				
A14	Stradbally River			✓		Three-spined stickleback, stone loach, minnow
A15	Stradbally River	✓	✓	✓		Three-spined stickleback, minnow
B1	Scotland Stream	No fish recorded				
B2	Owveg River			✓		
B3	Owveg River	✓		✓		Minnow, stone loach
B4	Cleanagh Stream	No fish recorded				
B5	Garrintaggart Stream	No fish recorded				
B6	Garrintaggart Stream	No fish recorded				
B7	Owveg River				✓	Minnow, stone loach
B8	Owveg River			✓	✓	Minnow, stone loach
B9	Graiguenahown Stream	No fish recorded				
B10	Owveg River	✓	✓	✓		Minnow, stone loach
C1	Knocklead Stream	No fish recorded				
C2	Clogh River			✓		
C3	Brennanshill River			✓		

Site	Watercourse	Atlantic salmon	*Lampetra* sp.	Brown trout	European eel	Other species
C4	Clogh River		✓	✓		Three-spined stickleback, stone loach, minnow
C5	Moyadd Stream	No fish recorded – dry channel				
C6	Clogh River		✓	✓		Three-spined stickleback, stone loach, minnow
C7	Clogh River		✓	✓		Perch, minnow, three-spined stickleback
D1	Douglas River			✓		Three-spined stickleback, stone loach

Conservation value: Atlantic salmon (*Salmo salar*), brook lamprey (L*ampetra planeri*) and river lamprey (*Lampetra fluviatilis*) are listed under Annex II of the Habitats Directive [92/42/EEC]. Atlantic salmon and river lamprey are also listed under Annex V of the Habitats Directive [92/42/EEC]. European eel are 'critically endangered' according to most recent ICUN red list (Pike et al., 2020) and listed as 'critically engendered' in Ireland (King et al., 2011). With the exception of the Inland Fisheries Acts 1959 to 2017, brown trout and coarse fish species have no legal protection in Ireland.

4. Discussion

The watercourses in the vicinity of the proposed Coolglass wind farm were typically small, modified, upland eroding and lowland depositing channels (many of which were ephemeral). Historical drainage pressures (straightening & deepening), eutrophication and siltation have significantly reduced the quality and heterogeneity of aquatic habitats in the vicinity of the proposed project. Low summer water levels and ephemeral conditions are a characteristic of the Nore_SC_060, Dinin[North]_SC_10, Barrow_SC_050 and Barrow_SC_070 river sub-catchments and were evidently a major issue for fish populations in the vicinity of the proposed project. Intermittent flows resulted in degraded fisheries habitat, particularly due to high thermal stress and agricultural (siltation and eutrophication) pressures. Low water levels also exacerbated known instream barriers (AMBER Consortium, 2020) on many watercourses (**Figure 1.1; Plate 4.1**). A total of 17 no. sites did not support fish at the time of survey (i.e. dry or semi-dry channels).

4.1 Salmonids

With the exception of sites A12 on the Cremorgan Stream and B7 on the Owveg River (semi-dry spate channels), salmonids were recorded at all 15 no. sites supporting fish during the survey (**Table 3.1, 3.2**). This was in spite of widespread low water levels in addition to siltation, eutrophication and or hydromorphological pressures. Salmonid populations were typically small, where encountered. Atlantic salmon were present (in low densities) at 3 no. sites only, on the Stradbally River (A15) and Owveg River (B3 & B10). The Stradbally River and Crooked River, draining to the north of the proposed project, supported the highest densities of Atlantic salmon and brown trout, respectively (**Table 3.1**). As might be expected given they are the most significant watercourses in vicinity of the project, the Stradbally, Crooked, Owveg, Clogh, and to a lesser extent, Douglas rivers provided the best quality salmonid habitat.

In lowland rivers, Atlantic salmon density is known to be positively correlated with instream vegetation (especially *Ranunculus* sp.) and numbers of nearby upstream spawning areas (redds), whilst brown trout density is typically dependant on flow velocity heterogeneity (Marsh et al., 2020). Historical straightening and deepening of watercourses removes habitat and hydromorphological heterogeneity, encourages sediment deposition and invariably results in an irreparable reduction in fisheries potential, particularly for salmonids (O'Grady et al., 2017, O'Grady, 2006). Diffuse siltation is one of the greatest threats to salmonid populations, particularly in agricultural catchments (Evans et al., 2006) such as that of the proposed Coolglass wind farm. Sediment not only blocks interstitial spaces in substrata (colmation) and limits oxygen supply to salmonid eggs (required for healthy embryonic development & successful hatching) but can also smother substrata, thus reducing available spawning habitat and impact macro-invertebrate communities on which salmonids feed (Kelly-Quinn et al., 2020; Davis et al., 2018; Conroy et al., 2016; Cocchiglia et al., 2012; Louhi et al., 2008, 2011; Walling et al., 2003; Soulsby et al., 2001).

Eutrophication (primarily from agriculture) is considered a primary threat to the health of Irish rivers (Trodd et al., 2022) and is evidently impacting salmonid (and fisheries) habitat in the vicinity of the proposed project. The presence of more nutrient-tolerant species like minnow, and to a lesser degree stone loach, in higher abundances than salmonids is also indicative of enrichment and declining water quality status (Kelly et al., 2007). Such shifts in fish community structure were observed on numerous watercourses, including the Stradbally, Clogh and Owveg Rivers.

4.2 Lamprey

Lamprey ammocoetes (*Lampetra* sp.) were recorded from 7 no. sites on the Crooked River (site A6), Stradbally River (A11 & A15), Owveg River (B10), Clogh River (C4, C6 & C7) (**Table 3.2**). Low numbers of early-stage transformers were also recorded from sites on the Crooked River (A6) and Clogh River (C4 & C6) but speciation in the field was not possible due to the early stage of development (Gardiner, 2003). The siltation pressures and low summer flows observed across the study area reduced the quality of lamprey habitat, in addition to the often high energy/spate characteristics of the survey watercourses. Few sites featured optimal conditions for larval *Lampetra* spp., i.e. fine, organic-rich sediment deposits ≥5cm in depth (Aronsuu & Virkkala, 2014; Goodwin et al., 2008; Gardiner, 2003). *Lampetra* spp. generally fine, clean gravels required for spawning (Dawson et al., 2015; Rooney et al., 2013; Lasne et al., 2010). The quality of lamprey spawning habitat was compromised by siltation throughout the survey area (also for salmonids).

Ammocoetes were typically in low densities due to sub-optimal and or limited nursery habitat. However, particularly high densities were present at sites C4 (14 per m^2) and C6 (13 per m^2) on the Clogh River, which was considered the most important watercourse for lamprey in the wider survey area. *Lampetra* sp. demonstrating a patchy distribution in the survey area – a pattern previously noted in the Barrow catchment (Delanty et al., 2017; King, 2006) and others (pers. obs.). Larval lamprey dispersal and settlement is passive and entirely regulated by local, dynamic hydrographical (flow) regimes (Kelly & King, 2001; Malmqvist, 1983; Potter, 1980; Hardisty & Potter 1971) and distribution is often sporadic in watercourses which suffer from low summer flows and poor fluvial connectivity (such as those in the vicinity of the proposed project). This was exemplified at several survey sites where only low densities of larvae were recorded in seemingly suitable burial habitats (e.g. sites A15, C7).

4.3 European eel

European eel are Red-listed in Ireland (King et al., 2011) and are classed as 'critically endangered' on a global scale (Pike et al., 2020). European eel were only recorded in low densities from sites B7 and B8 on the Owveg River (**Table 3.1, 3.2**), despite widespread suitability elsewhere. As outlined above, this limited distribution was considered primarily as a result of low summer flows, as well as abundant instream migration barriers within the wider Nore_SC_060, Nore_SC_080 and Dinin[North]_SC_010 river sub-catchments (**Figure 1.1**). Furthermore, as eel occurrence decreases significantly with increasing distance from the sea (Degerman et al., 2019), the paucity of eel observed can be partly explained by the distance between the survey area and marine habitats (Matondo et al., 2021; Chadwick et al., 2007) (>100-140km instream distance).

Plate 4.1 The historical weir at Clogh Bridge, an example of a significant barrier to fish passage at low flows

Plate 4.2 Example of a natural and artificial barrier to fish passage on the karstic Owveg River at Spink Bridge (site B7), where the river frequently runs dry over an excessively high & fractured bridge apron

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SLR

Appendix 4

Turbine Specification

Coolglass Wind Farm NIS

Coolglass Wind Farm Limited

SLR Project No.: 501.V00727.00006

11 July 2023

Siemens Gamesa 5.X
Reaching new heights

SIEMENS Gamesa
RENEWABLE ENERGY

Siemens Gamesa technology with benchmark performance and proven reliability

SG 6.6-155 and SG 6.6-170: Siemens Gamesa next-generation solutions conceived to deliver an outstanding value proposition for our customers

Imagine how the future becomes present to take wind energy to the next level

At Siemens Gamesa, we strive to anticipate opportunities in an increasingly discerning market. Our wind technology expertise, backed by more than 40 years of experience and over 117 GW installed throughout the world, equips us with the right tools for imagining the future, making it present and taking wind energy to the next level.

We know what this means: technological leadership, solid track record, commitment to excellence, passion for what we do. And we deliver it now to our customers. This is how the new Siemens Gamesa 5.X onshore platform is born.

Siemens Gamesa 5.X is a new generation of turbines that takes Siemens Gamesa to new heights:

- In performance, cost-efficiency and reliability.
- In power output and rotor size to offer the most competitive LCoE.
- In technology, built upon Siemens Gamesa know-how and expertise.
- In versatility, with a modular, flexible design that facilitates logistics, construction and service.
- In site adaptability, to configure the optimal solution for each project.
- In value for our customers.

Proven technology

The new Siemens Gamesa 5.X onshore platform has its roots in Siemens Gamesa technology, synonymous with innovation, know-how and reliability accredited through experience. Siemens Gamesa 5.X incorporates proven technologies, minimizing risk and guaranteeing reliability for its two new product models: SG 6.6-155 and SG 6.6-170 wind turbines. These include a doubly-fed generator and partial converter combination, a compact drive train design with a three-stage gearbox, and the use of components widely validated on the other Siemens Gamesa platforms. The result is a wind turbine design that gives optimum performance and LCoE.

Benchmark in power output and rotor size

Siemens Gamesa 5.X goes one step further to become the new generation platform that combines a flexible power rating from 5.6 MW to 6.6 MW with two of the largest rotor diameters in the market, 155 and 170 meters, resulting in maximum performance in high-, medium- and low-wind conditions.

SG 6.6-155 and SG 6.6-170 turbines mean greater AEP per wind turbine and optimized CAPEX for the project. This is also due to their versatility, with a modular, flexible design for maximum ease of logistics, construction and O&M, as well as reducing the OPEX, which results in a lower Cost of Energy for projects.

Unique, tailored solutions

Siemens Gamesa 5.X considers profitability to be a key factor in generating value for our customers. Contributing factors to profitability include:

- Configuring flexible, personalized power modes fully tailored to the needs of each site.
- An extensive catalog of towers with multiple available technologies and the additional capability to create specific project designs.
- The use of advanced control strategies that enable intelligent load reduction and a greater applicability for the Siemens Gamesa 5.X platform in different wind conditions.
- A modular, optimized structure for local transport and construction conditions.
- A maintainability-oriented design with advanced diagnostics and remote operation solutions, as well as the possibility of replacing large turbine components without requiring a main crane.
- Optional product solutions to cover all types of market requirements.

Technical specifications

	SG 6.6-155	SG 6.6-170
General details		
Rated power	6.6 MW	
Wind class	Medium and high	Low and medium
Flexible power rating	From 5.6 MW to 6.6 MW	
Control	Pitch and variable speed	
Rotor		
Diameter	155 m	170 m
Swept area	18,869 m^2	22,697 m^2
Tower		
Height	90, 102.5, 122.5, 165 m and site-specific	100, 115, 135, 145, 155, 165 m and site-specific
Technology		
Type	Geared	
First prototype		
Date	2021	

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11/2021

Vestas

EnVentus™

platform

Wind. It means the world to us.™

The foundation for the future of wind

We are pioneers. We keep moving and improving. It's what Vestas does. EnVentus™ is the next phase of this journey. By connecting heritage with innovation, Vestas creates solutions that responsibly address tomorrow's energy challenges.

Market opportunities
Our customers are demanding ever more advanced wind turbines, enabling profitable project realisation in increasingly challenging locations as the renewable energy landscape expands and diversifies; larger, more powerful turbines responsive to evolving grid requirements.

Customised to maximise
EnVentus™ represents the next generation in the evolution of wind turbines. Designed to encompass a wide range of turbine configurations, system designs apply modularity to meet customisation and market demands more efficiently. Combined with the extensive Vestas portfolio of solutions, EnVentus™ variants can maximise the potential of each unique wind site.

On the shoulders of giants
EnVentus™ is the realisation of a vision to connect the best engineering from Vestas. Building on more than 164 GW of tried and tested technology, EnVentus™ aims to ensure continued leadership. Using technology and experience from both on- and offshore, the EnVentus™ platform architecture combines advanced proven system designs that deliver innovation.

By connecting advanced modular design with more than **164 GW** of tried and tested technology, EnVentus™ aims to ensure continued technology leadership.

Connecting certainty with innovation

The EnVentus™ platform is the result of meticulous and careful evaluation of an unbroken line of Vestas technology solutions. With more than 164 GW of wind turbine capacity installed and 40 years of experience in relentlessly pursuing better performance through technology and service, EnVentus™ is Vestas' next generation in the evolution of wind turbines.

We know wind

Vestas is the right partner to help you realise the full potential of your wind site. We have the largest installed capacity in the industry and currently monitor over 49,000 turbines across the globe:

Tangible proof of our commitment to making renewable energy solutions that are productive, reliable and economical.

Turbines across the globe:

49,000

Proven technology
The EnVentus™ platform architecture connects proven system designs from the 2 MW platform, 4 MW platform and 9 MW platform turbine technology. The result is one versatile platform that delivers a higher level of robustness and performance with the ability to meet varying grid compliance requirements around the world.

System efficiency
The EnVentus™ platform architecture features a full-scale converter, proven from the 4 MW platform, capable of meeting complex and differing grid requirements in local markets. The full-scale converter is matched by a permanent magnet generator for maximum system efficiency and balanced by a medium-speed drivetrain. Known from the 9 MW platform, the EnVentus™ powertrain is optimised to reduce structural loads and has been chosen for reasons of mechanical robustness and flexibility. Combined with advanced load management strategies, the EnVentus™ platform enables siting at increasingly complex project conditions.

Latest solutions
The EnVentus™ platform architecture benefits from the latest developments in control systems, applying the Vestas Control System 8000 also operating on the 4 MW platform. Similarly, the portfolio of standard towers are based on Tubular Steel Tower (TST), High Tubular Steel Tower (HTST), Concrete Hybrid Towers (CHT), or Large Diameter Steel Tower (LDST) technology, reaching hub heights of up to 169m.

V150-6.0 MW™ ,V162-6.2 MW™ , V162-7.2 MW™ and V172-7.2 MW™ turbine blades are the result of incremental improvements to proven technical solutions. All EnVentus™ turbines feature slender profile and pre-bent blades, optimised for weight through application of carbon pultrusion material and a structural shell blade design, enabling the optimisation of the structural loads while increasing the rotor sizes. Vestas' most advanced aerofoil design ensures high aerodynamic performance and excellent sound power levels.

Tested to the limit
By applying reusable modules, versatility in offering can be achieved while adhering to Vestas' rigorous testing standards. The Vestas Test Centre is unrivalled in the wind industry. We test nacelle components using accelerated life testing under mixed and aggregated environmental conditions. For critical components, Highly Accelerated Life Testing (HALT) identifies potential failure modes and mechanisms. Specialised test rigs ensure strength and robustness for the gearbox, generator, yaw and pitch system, lubrication system and accumulators. Our quality control system ensures that each component is manufactured to design specifications and performs at site. We systematically monitor measurement trends that are critical to quality, locating defects before they occur.

40 years of experience

The EnVentus™ platform architecture connects proven system designs from the 2 MW, 4 MW, and 9 MW platform.

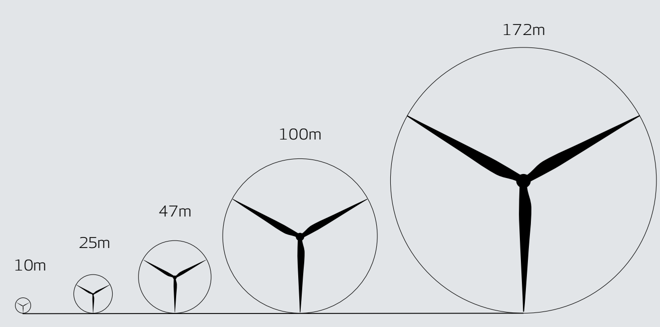
Maximised site potential

The Vestas EnVentus™ platform adds four new variants to the wide range of existing Vestas turbines, providing the ability to create an even more finely matched combination of turbines to harness available wind energy in any specific location.

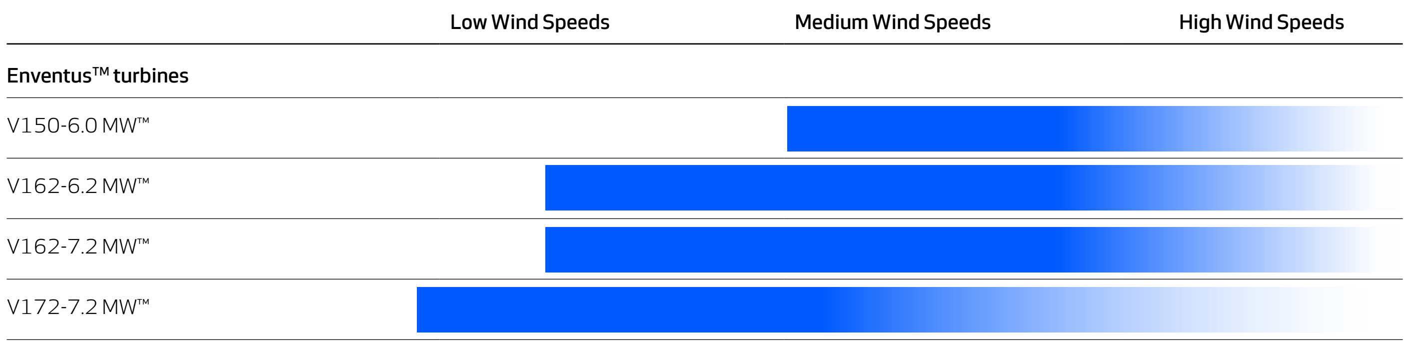
Versatility at the core
Through advanced modularity in design, EnVentus™ aims to meet customisation needs more efficiently combining reusable modules depending on unique market and project conditions. Designed with global applicability in mind, EnVentus™ based variants benefit from a full-scale converter enabling compliance with varying market-specific grid code requirements. The wide range of standard hub heights, options, and modes of operation contribute to the ability to meet specific requirements.

Business case flexibility
The relationship between rotor size and rating help maximise turbine level production. This makes the variants especially suitable for projects limited by the number of wind turbines installed. Combining double-digit* annual energy production improvements in low, medium and high wind speeds, the EnVentus turbines are ready to secure project realisation in auction and permit-based environments.

Rotor size development



*Depending on site specific conditions.



Options available for the EnVentus™ platform:

- Additional operating modes
- Aviation Markings on the Blades
- Vestas Bat Protection System
- Aviation Lights
- Condition Monitoring Solution
- Fire Supression
- Lightning detection
- Load Optimised Modes
- Low Temperature Operation to -30°C
- Oil Debris Monitoring System
- Vestas Shadow Flicker Control System
- Service Personnel Lift
- Vestas Ice Detection™
- Vestas Anti-Icing System™

V150-6.0 MW™

The V150-6.0 MW™ lifts the larger rotor introduced with V150-4.2 MW™ into stronger wind speeds. Combined with its higher generator rating, it increases the production potential at WTG level by more than 20 percent compared to V136-4.2 MW™ in medium wind speed conditions. Applying Vestas' most advanced aerofoil blade design combined with lower rotational speeds of the EnVentus™ drivetrain, means realisation of power production potential at very low sound power levels. A comprehensive portfolio of standard and site-specific towers allow for application in tip height constraint markets, varying from 180m to 244m.

V162-6.2 MW™

With a swept area of over 20,000m², the V162-6.2 MW™ applies a larger rotor to achieve higher energy production paired with a high capacity factor. Due to the large operational envelope, the V162-6.2 MW™ has great relative siteability on both turbulence and average wind speeds. With a maximum Sound Power Level of 104.8dB(A), the V162-6.2 MW™ delivers over 30 percent higher energy production than the V150-4.2 MW™.

V162-7.2 MW™ & V172-7.2 MW™

With flexible ratings of 6.5 MW, 6.8 MW and 7.2 MW, the V162-7.2 MW™ and V172-7.2 MW™ improve annual energy production through enhancements in powertrain and power conversion systems. Improved siteability in hot climates is enabled through the optional larger CoolerTop. The modularised nacelle design improves transportability of the nacelle unit and provides flexibility to service and upgrades over the turbine's operational lifetime. The V172-7.2 MW™ is designed for low to medium average wind conditions, whereas the V162-7.2 MW™ caters more for applications in medium to high wind segments, especially where tip height restrictions may apply.

All of Vestas

As part of the suite of Vestas offerings, the EnVentus turbines can be combined with an extensive list of technology options to create customised solutions to suit the needs of each unique project. By adding options to the standard turbine, we can enhance the performance and adaptability of the wind power project and facilitate a shorter permitting cycle at restricted sites. These options can be a decisive factor in realising your specific project and the business case certainty of your investments. Additionally, the well-established Vestas manufacturing and global supply chain setup ensure the ability to deliver, while supporting local requirement.

The knowledge to control

Knowledge about wind project planning is key. When planning a wind power plant, there are a broad range of factors over its entire lifecycle that will impact its success in the long-term. These range from financing and siting, to grid requirements and the regulatory framework. One of the first and most important steps is to identify the most suitable location for your wind power plant. Vestas' siting capabilities cover all the steps from finding a site, until delivering a fully optimised power plant set up.

Using the largest weather library in the industry, site-specific met mast campaigns and advanced analytical tools, Vestas examines a broad spectrum of wind and weather data to evaluate potential sites and establish which of them can provide optimum conditions for your project.
In addition, Vestas can optimise the layout of your wind power plant and the technology selection with high accuracy by implementing detailed simulations of the conditions on site and analyse their effects over the whole operating life of the plant. Put simply, it finds the optimal balance between the estimated ratio of annual revenue to operating costs over the lifetime of your plant, to determine your project's true potential and provide a firm basis for your investment decision.

The complexity and specific requirements of grid connections vary considerably across the globe, making the optimal design of electrical components for your wind power plant essential. By identifying grid codes early in the project phase and simulating extreme operating conditions, Vestas' Electrical PreDesign provides you with an ideal way to build a grid compliant, productive and highly profitable wind power plant. It allows customised collector network cabling, substation protection and reactive power compensation, which boost the cost efficiency of your business.

Advanced monitoring and real-time plant control
All our wind turbines can benefit from VestasOnline® Business, the latest Supervisory Control and Data Acquisition (SCADA) system for wind power plants.

This flexible system includes an extensive range of monitoring and management functions to control your wind power plant. VestasOnline® Business enables you to optimise production levels, monitor performance and produce detailed, tailored reports from anywhere in the world. The VestasOnline® Power Plant Controller offers scalability and fast, reliable real-time control and features customisable configuration, allowing you to implement any control concept needed to meet local grid requirements.

Condition monitoring and maintenance
Operating a large wind power plant calls for efficient management strategies to minimise downtime and operational expenses. Vestas offers 24/7 monitoring, performance reporting and predictive maintenance solutions to improve turbine performance and availability.

Vestas Condition Monitoring Solution (CMS) enables to predict the failure of components by analysing vibration signals, preventing major equipment damages and enabling to optimise the service planning according to the energy production and weather conditions. Additionally, Vestas' Active Output Management® (AOM) provides detailed plans and long-term agreements for maintenance, online monitoring, optimisation and troubleshooting. It is possible to get a full scope contract, combining turbine technology with guaranteed time or energy-based availability performance targets, thereby creating a solid base for your power plant investment.

Vestas' transparency towards Sustainability

g/kWh

5.6-7.1

1086

CO_2 comparison between the EnVentus™ platform and a coal power plant

Energy neutral

5.9 - 7.4

months of operation

Energy return

32 - 41

times

Recyclability rate

84%-87%

Sustainability metrics depending on project and site specific conditions

Vestas Sustainability

In 2020, we introduced our sustainability strategy, Sustainability in Everything We Do. At Vestas we are working to improve our own environmental performance, create value for local communities, promote a safe, diverse, and inclusive workplace, while leading the transition to a world powered by sustainable energy. We believe these efforts will help to elevate the standards of our industry as a whole. Read more about Vestas sustainability strategy at www.vestas.com/en/sustainability.

Life Cycle Assessments (LCA)

Since 1999, we have been developing wind turbine LCAs to give 'cradle-to-grave' evaluations of the environmental impact of our products and solutions. These evaluations concentrate on two key actions: documenting the environmental performance of Vestas wind turbines and analysing the results to reduce the environmental impact of our turbines. The LCAs provide environmental impact transparency to help customers achieve their own sustainability ambitions. To view our current portfolio of Life Cycle Assessments visit the following page: www.vestas.com/en/sustainability/reports-and-ratings.

As part of our commitment to customers, we also offer customised wind power plant LCAs, called Vestas® SiteLCA™. These assessments determine key indicators of environmental performance, taking the wind turbine type, site specific conditions and production supply chain into consideration. SiteLCA™ provides customers or project developers with transparent environmental facts for a specific wind power plant.

V150-6.0 MW™ IEC S

Power regulation	Pitch regulated with variable speed

Operating data

Rated power	6,000kW
Cut-in wind speed	3m/s
Cut-out wind speed*	25m/s
Wind class	IEC S

Standard operating temperature range from -20°* to +45°C

* High Wind Operation available as standard

Sound power

Maximum	104.9dB(A)*

* Sound Optimised Modes available dependent on site and country

Rotor

Rotor diameter	150m
Swept area	17,672m²
Aerodynamic brake	full blade feathering with 3 pitch cylinders

Electrical

Frequency	50/60Hz
Converter	full scale

Gearbox

Type	two planetary stages

Tower

Hub heights	105m (IEC S)
	125m (IEC S/DIBt S)
	148m (DIBt S)
	155m (IEC S)
	166m (DIBt S)
	169m (DIBt S)

Turbine options

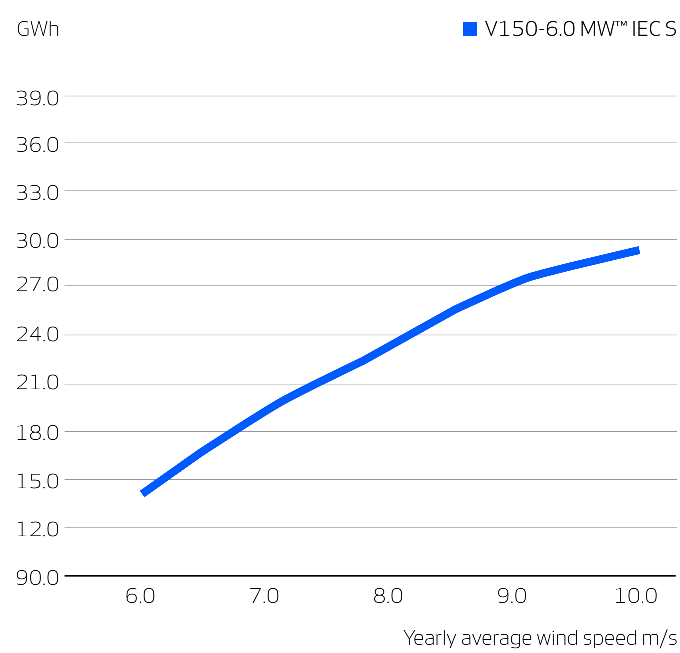
- Condition Monitoring System
- Oil Debris Monitoring System
- Service Personnel Lift
- Low Temperature Operation to -30°C
- Vestas Ice Detection™
- Vestas Anti-Icing System™
- Vestas Shadow Flicker Control System
- Aviation Lights
- Aviation Markings
- Fire Suppression System
- Vestas Bat Protection System
- Lightning Detection System

Sustainability

Carbon Footprint	5.6g CO_2e/kWh
Return on energy break-even	5.9 months
Lifetime return on energy	41 times
Recyclability rate	85%

Configuration: 155m hub height, Vavg=8.0m/s, k=2.48. Depending on site-specific conditions. Metrics are based on an externally reviewed Life Cycle Assessment available on vestas.com

Annual energy production



Assumptions
One wind turbine, 100% availability, 0% losses, k factor = 2
Standard air density = 1.225, wind speed at hub height

V162-6.2 MW™ IEC S

Power regulation	Pitch regulated with variable speed

Operating data

Rated power	6,200kW
Cut-in wind speed	3m/s
Cut-out wind speed*	25m/s
Wind class	IEC S

Standard operating temperature range from -20°C to +45°C

* High Wind Operation available as standard

Sound power

Maximum	104.8dB(A)*

* Sound Optimised Modes available dependent on site and country

Rotor

Rotor diameter	162m
Swept area	20,612m^2
Aerodynamic brake	full blade feathering with 3 pitch cylinders

Electrical

Frequency	50/60Hz
Converter	full scale

Gearbox

Type	two planetary stages

Tower

Hub heights	119m (IEC S/DIBt S)
	125m (IEC S)
	166m (IEC S/DiBt S)
	169m (DIBt S)

Turbine options

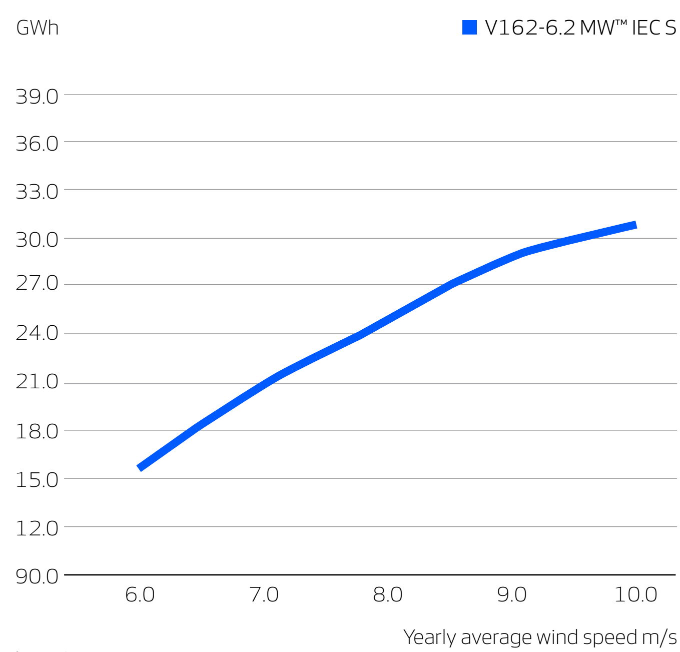
- 6.0 MW Operational Mode
- Condition Monitoring System
- Oil Debris Monitoring System
- Service Personnel Lift
- Low Temperature Operation to -30°C
- Vestas Ice Detection™
- Vestas Anti-Icing System™
- Vestas Shadow Flicker Control System
- Aviation Lights
- Aviation Markings
- Fire Suppression System
- Vestas Bat Protection System
- Lightning Detection System

Sustainability

Carbon Footprint	6.2g CO_2e/kWh
Return on energy break-even	6.5 months
Lifetime return on energy	37 times
Recyclability rate	84%

Configuration: 149m hub height, Vavg=7.4m/s, k=2.22. Depending on site-specific conditions. Metrics are based on an externally reviewed Life Cycle Assessment available on vestas.com

Annual energy production



Assumptions
One wind turbine, 100% availability, 0% losses, k factor = 2
Standard air density = 1.225, wind speed at hub height

V162-7.2 MW™ IEC S

Power regulation	Pitch regulated with variable speed

Operating data

Standard rated power	7,200kW
Cut-in wind speed	3m/s
Cut-out wind speed*	25m/s
Wind class	IEC S

Standard operating temperature range from -20°C to +45°C

* High Wind Operation available as standard

Sound power

Maximum	105.5dB(A)*

* Sound Optimised Modes available dependent on site and country

Rotor

Rotor diameter	162m
Swept area	20,612m^2
Aerodynamic brake	full blade feathering with 3 pitch cylinders

Electrical

Frequency	50/60Hz
Converter	full scale

Gearbox

Type	two planetary stages

Tower

Hub heights	119m (IEC S/DIBt S) 169m (IEC S)* 169m ((DIBt S))

* Includes 3m raised foundation

Turbine options

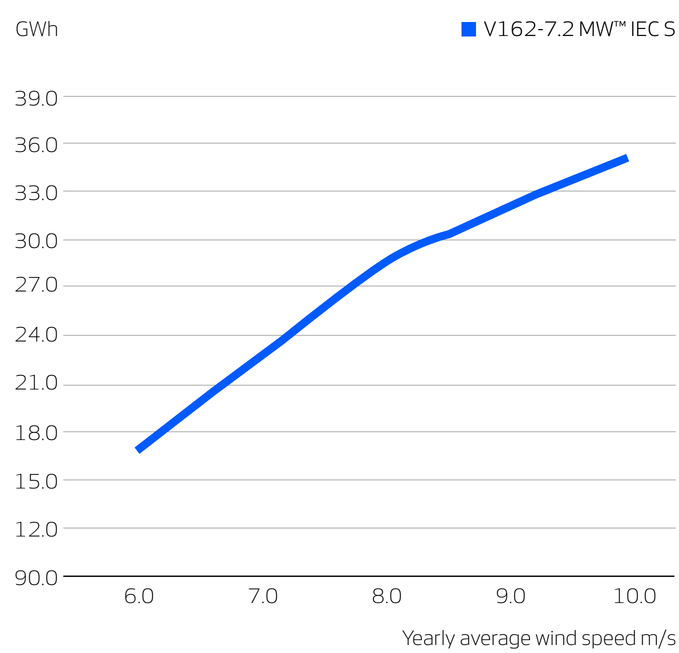
- 6.5 MW Operational Mode
- 6.8 MW Operational Mode
- Oil Debris Monitoring System
- High Temperature CoolerTop
- Service Personnel Lift
- Low Temperature Operation to -30°C
- Vestas Ice Detection™
- Vestas Anti-Icing System™
- Vestas Shadow Flicker Control System
- Aviation Lights
- Aviation Markings
- Fire Suppression System
- Vestas Bat Protection System
- Lightning Detection System

Sustainability

Carbon Footprint	7.1g CO_2e/kWh
Return on energy break-even	7.4 months
Lifetime return on energy	32 times
Recyclability rate	87%

Configuration: 149m hub height, Vavg=7.4m/s, k=2.22. Depending on site-specific conditions. Metrics are based on an externally reviewed Life Cycle Assessment available on vestas.com

Annual energy production



Assumptions
One wind turbine, 100% availability, 0% losses, k factor = 2
Standard air density = 1.225, wind speed at hub height

V172-7.2 MW™ IEC S

Power regulation	Pitch regulated with variable speed

Operating data

Standard rated power	7,200kW
Cut-in wind speed	3m/s
Cut-out wind speed*	25m/s
Wind class	IEC S

Standard operating temperature range from -20°C to +45°C

* High Wind Operation available as standard

Sound power

Maximum	106.9dB(A)*

* Sound Optimised Modes available dependent on site and country

Rotor

Rotor diameter	172m
Swept area	23,235m^2
Aerodynamic brake	full blade feathering with 3 pitch cylinders

Electrical

Frequency	50/60Hz
Converter	full scale

Gearbox

Type	two planetary stages

Tower

Hub heights*	114m (IEC S)**
	150m (IEC S)**
	164m (DIBt)
	166m (IEC S)
	175m (DIBt)
	199m (DIBt)

*Site specific towers available on request
**Preliminary

Turbine options

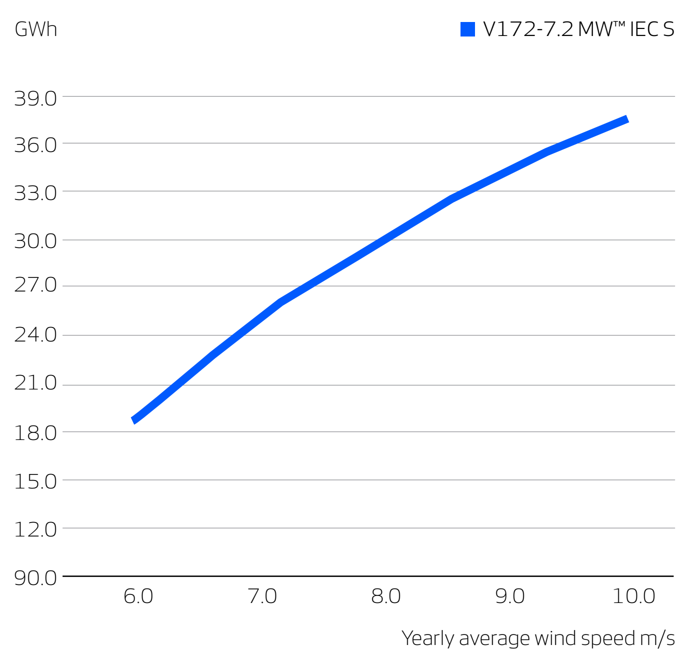
- 6.5 MW Operational Mode
- 6.8 MW Operational Mode
- Oil Debris Monitoring System
- High Temperature CoolerTop
- Service Personnel Lift
- Low Temperature Operation to -30°C
- Vestas Ice Detection™
- Vestas Anti-Icing System™
- Vestas Shadow Flicker Control System
- Aviation Lights
- Aviation Markings
- Fire Suppression System
- Vestas Bat Protection System
- Lightning Detection System

Sustainability

Carbon Footprint	6.4g CO_2e/kWh
Return on energy break-even	6.9 months
Lifetime return on energy	34 times
Recyclability rate	86.6%

Configuration: 166m hub height, Vavg=7.4m/s, k=2.48. Depending on site-specific conditions. Metrics are based on an internal streamlined assessment. An externally reviewed Life Cycle Assessment will be made available on vestas.com once finalised.

Annual energy production



Assumptions
One wind turbine, 100% availability, 0% losses, k factor = 2
Standard air density = 1.225, wind speed at hub height

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01/2023-EN

SLR

Appendix 5

Construction and Environmental Management Plan (CEMP)

Coolglass Wind Farm

NIS Coolglass Wind Farm Limited

SLR Project No.: 501.V00727.00006

11 July 2023

Construction Environmental Management Plan (CEMP)

Coolglass Wind Farm EIAR Volume 2

Coolglass Wind Farm Limited

Prepared by:

SLR Consulting Limited

4/5 Lochside View, Edinburgh Park, Edinburgh, EH12 9DH

SLR Project No.: 501.V00727.00006

27 June 2023

Revision: 2.0

Revision Record

Revision	Date	Prepared By	Checked By	Authorised By
0.1(internal)	31 May 2023	NB	DK	
1.0 (issue)	2 June 2023			CL
1.1 (revision)	26 June 2023	CL	DK	
2.0 (final)	27 June 2023			CL

Table of Contents

Tables in Text

1.0 Introduction

1.1 Background

This document presents a Construction Environmental Management Plan (CEMP) for Coolglass Wind Farm which sets out the principles and procedures for environmental management during construction of the wind farm (hereafter referred to as the Proposed Development).

Will planning permission be granted, this CEMPwillwill, the CEMP will be a key construction contract document, which will ensure that all mitigation measures, which are considered necessary to protect the environment are implemented.will.

The document will be read in conjunction with **Chapter 2: Site Description and Design Evolution** and **Chapter 3: Description of Development**, of the EIA Report and the required mitigation measures set out in **EIAR Appendix 3.3 Schedule of Environmental Commitments and Mitigation Measures**.

The CEMP is a fluid document that will evolve during the different phases of the project. As such it will be subject to constant review to address:

- any conditions required in the planning consent;
- to ensure it reflects best practice at the time of construction;
- to ensure it incorporates the findings of pre-construction site investigations;
- changes resulting from the construction methods used by the contractor(s); and
- unforeseen conditions encountered during construction.

1.2 Aims and Objectives

The CEMP will be maintained and updated on Site and will be augmented by associated design specifications and Construction (Design and Management) (CDM) 2015 Regulations documentation such as the PSCS's Construction Phase Plan.

Where appropriate, the CEMP, or plans within the CEMP, will form part of the Site induction which will be mandatory for all employees, contractors and visitors attending the Site. All employees and contractors will need to familiarise themselves with the relevant contents of the CEMP and supporting appendices as directed.

Management practices and mitigation measures have been developed for those aspects of the construction works that could potentially affect the environment.

The objectives of the CEMP are to:

- outline the proposed mechanisms for ensuring the delivery of environmental measures to avoid or reduce environmental effects identified;
- ensure procedures are in place so that there is a prompt response to effects requiring remediation, including reporting and any additional mitigation measures required to prevent a recurrence;
- provide the content that willwill be supplied in the construction method statements and strategies that will be prepared in order to secure mitigation measures in relation to different design aspects of the proposed development;

- ensure compliance with legislation and identify where it will be necessary to obtain authorisation from relevant statutory bodies;
- ensure that appropriate proposed development monitoring and reporting will be in place;
- provide a framework for reporting, compliance auditing and inspection to ensure environmental aims will be met; and
- set out the applicant's expectations to guide contractors on their requirements with regards to environmental commitments and environmental management.

1.3 Site Setting

The Proposed Development is located approximately 11km southeast of Portlaoise, 14km northwest of Carlow and 11km east of Abbeyleix. The Proposed Development site includes lands contained within the following townlands: Fossy Upper, Aghoney, Gorreelagh, Knocklead, Scotland, Brennanshill, Monamantry, Coolglass, Crissard, Kylenabehy, County Laois.

The Proposed Development is located across two prominent hills- Fossy Mountain and Wolfhill, comprised of two no. clusters of development and briefly comprises thus:

- The northern cluster of the Proposed Development is comprised of a geographical area defined by Fossy Lower Road at the northernmost extent, the R426 at the westernmost extent, Luggacurren Road at its easternmost extend, and Knocklead Road to its southernmost extent. Elements of the Proposed Development which will be located in the northern cluster, if consented, comprise;
  - 7 no. turbines (turbine nos 1-7) and their associated access tracks, hardstandings and foundations;
  - 1 no. 110 kV substation;
  - 1 no. temporary construction compound (TCC1);
  - 1 no permanent 102.5m meteorological mast;
  - 1 no. site access point (AP1);
  - A recreational amenity trail (part of a future separate planning application);
  - The origin of 2 no. cable routes from the proposed on-site substation (part of a future separate planning application);
  - A 33kV collector cable which connects both clusters to the proposed on-site substation.
- The southern cluster of the Proposed Development is comprised of a geographical area defined by Knocklead Road at its southernmost extent, Crissard Road at its easternmost extent, Knocklead/Moyadd road at its westernmost extent and Slatt Lower road at its southernmost extent. Elements of the Proposed Development which will be located in the southern cluster, if consented, comprise:
  - 6 no. turbines (turbine no's 8-13) and their associated access tracks, hardstandings and foundations;
  - 1 no. Borrow pit;
  - 1 no. temporary construction compound (TCC2);
  - 1 no. site access point (AP2).

Coolglass Wind Farm Limited (the applicant) is applying to An Bord Pleanála for consent for the Proposed Development (as defined in Section 3.1.1).

An approximate National Grid Reference is SF 532 455.

1.4 Project Description

The Proposed Development which consists of a 13 no turbine wind farm development and associated works on land within the townlands of Fossy Upper, Aghoney, Gorreelagh, Knocklead, Scotland, Brennanshill, Monamantry, Coolglass, Crissard, Kylenabehy, Monamanry, Brennanshill, Knocklead, Aghoney, Timahoe, Carrigeen, Ballygormill South, Money Upper, Hophall, Rathleague, Ballymooney, Rathbrennan, County Laois. The site is 731 ha in size. The development will consist of:

- Construction of 13 No. wind turbines within two clusters with an overall ground to blade tip height of 180m. The wind turbines will have a rotor diameter ranging from 155m to 162m inclusive and a hub height ranging from 99 to 102.5m inclusive.
- Construction of permanent turbine hardstands and turbine foundations.
- Construction of 1 no. permanent 110 kV electrical substation including 2 no. control buildings with welfare facilities, all associated electrical plant and equipment, security fencing and gates, all associated underground cabling, wastewater holding tank, and all ancillary structures and works.
- Construction of a 33kV collector cable circuit connecting the wind farm two clusters along the L3851/Knocklead Road
- Construction of two temporary construction compounds with associated temporary site offices, parking areas and security fencing.
- Development of one on-site borrow pit.
- Construction of new permanent internal site access roads, upgrade of existing internal site access roads, including passing bays and all associated drainage infrastructure
- Development of an internal site drainage network and sediment control systems.
- All associated underground electrical and communications cabling connecting the wind turbines to the wind farm substation.
- Ancillary forestry felling to facilitate construction of the development.
- All associated site development works including berms, landscaping, and soil excavation.
- Improvement of a site entrance to an existing access off the L3851/Knocklead local road to include localised widening of the road and creation of a splayed entrance to facilitate the delivery of abnormal loads and turbine component deliveries. Improvements include removal of existing vegetation for visibility splays to facilitate the use of the access for the delivery of construction materials to the site.
- A new site entrance slip road from the L3851 / Knocklead local road to facilitate the delivery of abnormal loads and turbine component deliveries. Works at this location require the removal of existing forestry to facilitate the use of the access for the delivery of construction materials to the site and for use during the operational phase.

- Construction related temporary upgrade works on the turbine delivery route to facilitate the delivery of turbine components to include the use of temporary road surfaces at a roundabout at the southern exit of Junction 16 of the M7, the R425/N80 roundabout and the R426 – L3851 junction.
- The erection of a permanent meteorological mast 102.5m in height

2.0 Implementation

2.1 Implementation and Control

Compliance with the CEMP is the key control measure required during construction to mitigate environmental impact. It documents the principles and processes to be followed to implement all relevant agreed environmental mitigation.

The PSCS will be required to prepare a series of method statements. These method statements will detail how the contractor intends to implement the mitigation set out in the CEMP and will be integrated with their detailed Construction Method Statements.

3.0 Roles and Responsibilities

During construction there will be key responsibilities for the applicant, the PSCS and their teams. Establishing roles and responsibilities in relation to construction will be important in order to ensure the successful construction of the proposed development, including the implementation of the CEMP. The personnel, who will implement, monitor and respond to the CEMP, will be the applicant construction team and the PSCS.

3.1 Safety and Health

The construction works will be undertaken in accordance with primary safety and health legislation, namely:

- Safety, Health and Welfare at Work Act 2005;
- Health and Welfare at Work (General Application) Regulations 2007; and
- Safety, Health and Welfare at Work (Construction) Regulations 2013.

The construction works for the proposed development will fall under the Safety, Health & Welfare at Work (Construction) Regulations 2013. It is a key appointment in the construction process. As such, the Project Supervisor Construction Stage (PSCS) will provide a Construction Phase (Safety & Health) Plan in accordance with the regulations. This plan will include (but not be limited to) a construction programme, emergency procedures, site layouts and fire plans, method statements and details of the proposed induction programme. This induction programme will include both the PSCS's site specific rules as well as the Client's requirements and will include instructions to all staff regarding the Emergency Pollution Prevention Plan (EPPP) and relevant procedures.

An induction will be required for all workers (permanent / temporary / contractor / subcontractor), site visitors, applicant representatives or other 3rd parties. Inductions will be documented.

Plant operators and construction staff will be trained by the PSCS with regard to spill prevention/mitigation measures and procedures and in the use of relevant mitigation material (e.g. spill kits).

Staff and subcontractors employed by the PSCS will be trained and have to prove certification for any plant, vehicle or use of specialist equipment such as electrical and hot works.

3.2 Construction Management Team

The applicant will appoint a Construction Management Team, led by a Construction Site Manager. The team will include, as a minimum, a Resident Engineer.

Prior to appointment of a PSCS, the applicant will own the CEMP and the document will become uncontrolled copies when printed.

It will be the team's responsibility to ensure that the PSCS adheres to and complies with the principles of the CEMP and their Method Statements. This will likely be the responsibility of the Resident Engineer, the ECoW and the applicant Construction Manager. The team will also be responsible for:

- regular liaison with the PSCS's Site Manager;
- maintaining environmental risk registers;
- communicating with regulators and consultees such as the EPA and the local planning authority regarding any changes that need to be made to the CEMP including the Schedule of Mitigation; and
- ensuring that any required changes are approved and updated within the CEMP.

The applicant Construction Manager, ECoW and Resident Engineer will have the power to stop works at any stage will it be deemed necessary, i.e. if there areare risks posed to environmental receptors from construction that can not be mitigated immediately.

3.2.1 Ecological Clerk of Works (ECoW)

An Ecological Clerk of Works (ECoW), will be appointed during the period of construction and post-construction restoration. The appointment of the ECoW will be approved by Laois County Council (LCC).

The purpose of the ECoW will be to provide environmental advice and monitor compliance, not implement measures. The ECoW will have a number of different tasks to carry out during construction and prior to the outset of each construction phase. They will be required to keep an active register of all issues that arise during the works and report as required to LCC, Coillte and the EPA.

The ECoW will have sufficient powers to:

- oversee construction work and identify where mitigation measures are required;
- authorise temporary stoppage of works if required; and
- to review working methods and advise whether alternative or more appropriate working methods require to be adopted.

The ECoW will undertake the following activities:

- to work with the PSCS to induct all site personnel with regards to key environmental sensitivities and mitigation measures to be applied during construction. Toolbox talks shall be given by the ECoW throughout the construction period in the event that additional unforeseen issues arise that require alternative working methods

- undertaking site walkovers, ensuring implementation of the water management plan with reference to water quality protection and appropriate locations for fuel and oil stores;
- liaising with contractors during the construction phase;
- inspecting working areas and ensuring compliance with the CEMP;
- undertaking water quality monitoring;
- providing advice on sediment and drainage management;
- communicating with all site personnel regarding any environmental issues and mitigation measures;
- oversee the need for all necessary licenses regarding protected species are obtained, if required with the support of suitably qualified and experienced Ecologists; and
- documenting and reporting any environmental issues and incidents as required to the applicant, LCC, Coillte and the EPA.

3.2.2 Resident Engineer

The applicant will appoint a Resident Engineer for the construction of the proposed development. The Resident Engineer will provide support to the applicant Construction Management Team and will have day to day responsibility for monitoring the proposed development onsite on behalf of the Construction Manager.

The Resident Engineer will have a wide range of duties including but not limited to:

- overseeing construction works to ensure conformance with the specification, monitoring quality and progress and most importantly ensure that health, safety and the environment is given a high priority at all times. The Resident Engineer will effectively be Developer's eyes and ears on the site and will report directly to the applicant Construction Manager;
- authority to stop the construction works in the case of a health and safety, environmental or quality issue. This will be applicable where to delay will cause additional or prolonged risk or damage;
- daily visual inspections of working areas to identify possible construction issues from a quality, environmental, programme and safety perspective. Any issues will be raised directly with the contractor;
- working closely with the ECoW to ensure that ecological and environmental requirements dictated by the CEMP, best practice and the planning conditions are adhered to by the works contractors;
- reviewing construction related documents from all contractors – including method statements and risk assessments and providing comments directly onsite to the PSCS; and
- reporting all environmental or health and safety incidents and near misses to the Construction Manager in a form and timescale required by the Construction Management Team.

3.3 PSCS

The PSCS will be required to comply with and regularly review the CEMP throughout the construction period.

The PSCS and their team (including any sub-contractors) will be responsible for:

- undertaking their duties in accordance with CDM 2015;
- liaising with the applicant's Construction Management Team;
- completing the construction of the proposed development in a manner which complies with all relevant laws, rules and regulations;
- acquiring licenses and permits as necessary for their works;
- ensuring that all method statements in line with the principals set out in the CEMP have been provided;
- planning, managing, monitoring and coordinating all pertinent activities relating to construction;
- liaising with and providing justification to the regulators and consultees such as the EPA and LCC if any significant changes are required from the Schedule of Mitigation;
- developing and implementing an Environmental Incident Response Plan and ensuring that all personnel (including sub-consultants and sub-contractors) understand and are aware of procedures to be undertaken will an environmental incident occur. This will sit as an additional appendix in the CEMP;
- ensuring that all personnel receive training and are aware of the potential to damage to sensitive environmental receptors and procedures required to be implemented to avoid, minimise and mitigate against such damage;
- verifying the competence and resources of all personnel working on the proposed development and any sub-consultants and sub-contractors that are engaged on the proposed development; and
- implementing the Mitigation Appendix.

3.4 All Site Personnel

All site personnel, including all members of the applicant and PSCS's teams, all sub-contractors and sub-consultants will be required to:

- attend all inductions and site specific training including toolbox talks carried out by the ECoW; and
- implement control measures throughout the site, as required.

3.5 Communication

The applicant will inform LCC prior to any construction starting on site and communication will be maintained with updates of any incidents or significant changes notified within one week of occurrence. The applicant will provide contact details to the LCC of:

- the Resident Engineer – who will be on site for the majority of the construction phase.
- the applicant's Construction Project Manager; and
- the applicant's communication contact.

Any resident who has a question regarding the construction of the proposed development will be directed to one of these contacts. All questions will be logged and responded to within a specified number of days.

Careful monitoring of any complaints received, including recording details of the location of the affected party, time of the disturbance and nature of the issue will assist with managing the works to reduce the likelihood of further incidents.

4.0 Construction Staging

4.1 Site Access

Those activities that may give rise to audible noise at the surrounding properties and heavy goods vehicle deliveries to the site will be limited to the hours 07:00 to 19:00 Monday to Friday and 07:00 to 13:00 on Saturdays. Turbine deliveries will only take place outside these times with the prior consent of the Council and An Garda Síochána.. Those activities that are unlikely to give rise to noise audible at the site boundary will continue outside of the stated hours.

The Site Manager will be responsible for developing and implementing a Site Traffic Management Plan as set out in **Chapter 12: Traffic and Transportation**. The applicant will work in partnership with LCC and the supply chain to reduce the impact of the development on the local community.

Parking for staff and contractors will be situated within the boundary of the site for the duration of the works as far as is reasonably practicable. All vehicles will reverse park to improve safety of the site.

An appropriate speed limit (section 5.3.1) will apply for vehicles onsite and will be selected, monitored and enforced by the PSCS. Maximum vehicle load capacities will not be exceeded.

4.2 Construction

The following phases will be taken into consideration for the construction works:

- Phase 1 – Site set-up:
    - widening of 2 site entrances along L3851if required;
    - construction of access track approach to compound location;
    - site compound set-up, including installation of welfare facilities;
- Phase 2 – Construction:
    - construction of access tracks;
    - construction of turbine foundations and crane hardstandings;
    - construction of substation, including all civil and electrical works;
    - installation of Proposed Development cabling;
- Phase 3 – Commissioning:
    - turbine delivery and construction;
    - Proposed Development commissioning;
    - turbine and wind farm reliability run;
- Phase 4 – Demobilisation:
    - take over;

- snagging; and
- decommissioning of temporary compounds / structures and restoration of the site.

A detailed construction programme will be provided by the PSCS as part of the final CEMP and the Construction Phase Plan.

4.3 Post Construction Reinstatement

Good practice techniques for vegetation and habitat reinstatement as defined in the Project Habitat Species Management Plan (HSMP)will be adopted and implemented on areas subject to disturbance during construction as soon as practicable.

The following reinstatement works will be implemented:

- re-use of turves;
- re-use of topsoil/peat where appropriate; and
- reseeding with appropriate species.

For clarity, the following are definitions for the different soil make-up of the natural ground between the surface and rockhead (from top down):

(a) Vegetation:

This is typically plant matter that can be removed/stripped above the ground level (i.e. does not include roots/topsoil). This can vary depending on the nature of the vegetation encountered on site.

(b) Turf/Turves:

This is typically a layer of matted earth formed by grass and plant roots. The matted earth layer will normally be 30-50mm thick.

(c) Topsoil:

The upper layer of soil usually containing significantly more organic matter than is found in lower layers. This can vary in depth but is typically 200mm thick. This can be excavated with the turf and depends on whether the turf is required elsewhere, or the topsoil needs to exclude the turf.

(d) Superficial Soils:

This is a generic term used for all material between topsoil and rockhead. This can vary in depth and content throughout the depth profile at any location.

(e) Weathered Rock:

This is a layer that may exist above rockhead that is neither rock nor superficial material but a mixture of both. It can be mostly fractured rockhead as a result of physical and chemical weathering processes. When excavated it may have elements of fractured rock and superficial material as the boundary can be difficult to distinguish.

In some cases this can provide suitable engineering material for construction of foundations, embankments, tracks etc.

(f) Rockhead:

This is a naturally occurring solid aggregate of minerals which lies beneath the superficial soils.

5.0 General Construction Good Practice

5.1 Handling of Excavated Materials

The construction of tracks, turbine foundations and crane hardstanding areas as well as the establishment of the construction compound, substation compound will require the stripping and excavation of soil and its reuse or temporary storage. Excavations will generate material comprising peat, soil and rock. Description of the existing land, soils and geological setting is provided in EIAR **Chapter 8 Land, Soils and Geology**. Where possible, soils and peat will be used for reinstatement works associated with access tracks, cable trenches, turbine foundations, crane hardstandings and the temporary construction area. The upper vegetated turves will be used to dress infrastructure edges and to replace stripped and stored turves.

Excavated material will be used as soon as practicable and as close as possible to the area it is excavated from, however some temporary storage will be required. Soils in areas taken for temporary use will be stockpiled close to excavation location.

5.2 Materials Storage

Granular, non-organic material required to be stored temporarily will be compacted, to reduce the potential for erosion and transfer of sediment and stockpiled in designated areas at least 50m from a watercourse. Temporary stockpiles will need to be appropriately sited away from marshy grassland, bog or heath where possible, with the locations agreed in advance with the ECoW.

Where soils can not be transferred immediately to an appropriate restoration area, short term storage will be required. In this case, the following good practice will apply:

- soil will be stored around the turbine perimeters at a sufficient distance from the cut face to prevent overburden induced failure;
- local gullies, diffuse drainage lines (or very wet ground) and locally steep slopes will be avoided for storage;
- stored upper turves (incorporating vegetation) will be reinstated adjacent to similar habitats as advised by the ECoW;
- monitoring of stockpiles/excavation areas will occur during and following rainfall events; and
- if material is stockpiled on a slope, silt fences shall be utilised to reduce sediment transport in accordance with CIRA guidance C532. Additional measures may also be necessary to control flow of water and sediment transport on site in accordance with this guidance.

Material excavated during new and upgraded access track construction will be stored adjacent to the track and Granular, non-organic material compacted in order to limit instability and erosion potential. There is no peat on the Proposed Development Site.

Silt fences shall be employed in combination with the measures described in 'CIRA Control of water pollution from construction sites. Guidance for consultants and contractors (C532)' where required to minimise sediment levels in run-off.

All soils stripped from the borrow pit(s) will be retained in clearly demarcated stockpiles of no greater than 3m height in locations immediately around the edges of borrow pit excavation.

5.3 The Management and Movement of Concrete

5.3.1 Accidental Spillage

An appropriately sized spill kit(s) will be provided and maintained onsite, consideration will be given to suitable locations across the active areas of the site and to having vehicles including plant carry a spill kit. All vehicles will also have a spill kit. This kit will contain materials, such as absorbent granules and pads, absorbent booms and collection bags. These are designed to halt the spread of spillages and will be deployed, as necessary, will a spillage occur elsewhere within the construction compound.

A speed limit of 15mph will apply for vehicles onsite and will be monitored and enforced by the PSCS. Maximum vehicle load capacities will not be exceeded.

5.3.2 Vehicle Washing

There will be a wash-out facility within the construction compound consisting of a sump overlain with a geosynthetic membrane. The geosynthetic membrane will filter out the concrete fines leaving water to pass through to the sump. The sump water will either be pumped to a licenced carrier and taken offsite for approved disposal. No washing of concrete-associated vehicles will be undertaken outside the wash out facility, and the area will be signposted, with all site contractors informed of the locations.

5.3.3 Concrete Pouring for Turbine Foundations

To prevent pollution incidents, all concrete pours are planned and specific procedures will be adopted in accordance with Construction Industry Research and Information Association (CIRIA) C532 Control of water pollution from construction sites: guidance for consultants and contractors. These procedures will include:

- ensuring that all excavations are sufficiently dewatered before concrete pours begin and that dewatering continues while the concrete cures. Construction good practice will be followed to ensure that fresh concrete is isolated from the dewatering system;
- ensuring that covers are available for freshly placed concrete to avoid the surface of the concrete washing away during heavy precipitation; and
- perimeter drains with the installation of silt traps.

The excavated area will be back-filled with compacted layers of graded material from the original excavation, where this is suitable, and capped with soil. The finished surface around the base of each turbine, will be capped with crushed aggregate providing a walkway to allow for safe personnel access.

5.4 Surplus and Waste Material

5.4.1 Introduction

A Waste Management Plan (WMP) will be prepared in line with the relevant National Waste Management Guidelines and the European Waste Management Hierarchy, as enshrined in the Waste Management Act 1996, as amended.

The WMP will detail how all waste materials will be managed, including the management of excavated materials.

The PSCS will ensure that all waste from the site is dealt with in accordance with the requirements under the above Acts and that materials will be handled efficiently, and waste managed appropriately.

Appropriate waste management, disposal and waste carrier documentation and licences will be obtained (e.g. complete waste transfer notes prior to waste leaving site, ensure all waste carriers have a valid waste carrier's registration certificate, ensure wastes are disposed of at a correctly licensed facility (please note the facilities listed in Chapter 3 of Volume 2 of the accompanying EIAR), complete notification for hazardous waste to the EPA).

Waste streams will include wastes generated by plant, machinery and construction workers over the period of the works, for example waste oils, sewage, refuse (paper, carton, plastic etc.), wooden pallets, waste batteries, fluorescent tubes etc.

5.4.2 Soils and Spoils

Any materials excavated on site in the course of the construction works will be stored on site ideally close to the excavation location and re-used where it is appropriate to do so. As such, offsite disposal of this material is not anticipated.

5.4.3 Hazardous and Other Wastes

Table 5-1 lists some of the waste types that may be generated during the construction works. Although some waste types may be generated in locations other than the construction compounds such waste materials will be stored within the construction compounds only. Waste materials generated outside the construction compounds will be taken to the compounds on a daily basis to be managed thereafter.

Table 5-1: Common Construction Wastes

EWC Code	Description
13 01 10*	Used mineral hydraulic oil (non-chlorinated)
13 02 08*	Other waste engine, gear or lube oil
13 02 05*	Waste engine, gear or lube oil (non-chlorinated)
13 02 08*	Other waste engine, gear or lube oil
16 01 07*	Oil filters
20 01 23*	Discarded equipment containing CFCs e.g. waste fridges & freezers
16 06 01*	Lead batteries
16 07 08*	Oily waste from transport and storage tanks
16 10 01*	Hazardous liquid wastes to be treated off-site
20 01 21*	Fluorescent tubes and other mercury-containing waste
20 01 33*	Hazardous batteries and accumulators that are collected separately
15 02 02*	Absorbents, filter materials, wiping cloths, clothing contaminated by dangerous substances
15 01 01	Cardboard or paper packaging
15 01 02	Plastic packaging e.g. toner & ink cartridges, polythene sheeting
15 01 03	Wooden packaging e.g. timber pallets

EWC Code	Description
15 01 04	Metallic packaging e.g. drink cans, paint tins
16 01 03	Tyres
16 01 15	Antifreeze fluids that do not contain dangerous substances e.g. Coolants
16 01 17	Ferrous metal from vehicles e.g. car parts
16 02 14	Non-hazardous waste electricals e.g. washing machines, power tools
16 05 05	Gases in pressure containers i.e. gas cylinders
17 01 01	Concrete
17 02 01	Wood from construction or demolition e.g. timber trusses, supports, frames, doors
17 04 11	Cables that do not contain dangerous substances e.g. electric cabling
20 01 01	Paper & card similar to that from households e.g. office paper, junk mail
20 01 30	Non-hazardous detergent e.g. flushing agent/universal cleaner
20 01 39	Separately collected plastics e.g. plastic containers, bottles
20 03 01	Mixed waste similar to that from households e.g. mixed office, kitchen & general waste
20 03 04	Septic tank sludge

*Denotes Hazardous Waste, as categorised by the European Waste Catalogue.

Foul water from the onsite facilities at the construction works compound will be removed from site by an appropriately licensed contractor (see also Section 7.4.4).

5.4.4 Regulatory Compliance

Waste will be transferred to a licensed waste management. The PSCS will need to check that the site is licensed and that the licence permits the site to take the type and quantity of waste involved. Copies of the waste management licence will be held on file.

A record of waste movements willwill be completed by all parties involved and will be retained for a period of two years. Sub-contractors hauling waste offsite will complete their own waster movement records and copy them to the PSCS.

It will be the responsibility of the PSCS to ensure that other parties involved in the transport, storage and disposal of waste are legally entitled to carry out their duties.

5.5 Dust Mitigation

Good practice measures as listed below will be adopted during construction to control the generation and dispersion of dust such that significant impacts on neighbouring habitats will not occur. The hierarchy for mitigation will be prevention – suppression – containment:

- The internal access roads will be constructed prior to the commencement of other major construction activities. These roads will be finished with graded aggregate;
- A water bowser will be available to spray work areas (wind turbine area and grid connection route) and haul roads, especially during periods of excavations works coinciding with dry periods of weather, in order to suppress dust migration from the site;
- All loads which could cause a dust nuisance will be covered to minimise the potential for fugitive emissions during transport;

- Gravel will be used at the site exit point to remove any dirt from tyres and tracks before travelling along public roads;
- Re-vegetate earthworks and exposed areas/soil stockpiles to stabilise surfaces as soon as practicable.
- The access and egress of construction vehicles will be controlled to designated locations, along defined routes, with all vehicles required to comply with onsite speed limits;
- Construction vehicles and machinery will be serviced and in good working order;
- Wheel washing facilities will be provided at the entrance/exit point of the Proposed Development site;
- The developer in association with the contractor will be required to implement a dust control plan as part of the CEMP. In the event the Planning Authority decides to grant permission for the Proposed Development, the CEMP will address the requirements of any relevant planning conditions, including any additional mitigation measures which are conditioned by the Planning Authority or as required by the ECoW.
- Receptors which receive dusting and soiling from local routes entering the site; and dwellings directly adjacent to the grid connection route construction that experience dust soiling, where appropriate, and with the agreement of the landowner, will have the facades of their dwelling cleaned if required will soiling have taken place;
- Ensure all vehicles switch off engines when stationary – no idling vehicles; and
- Exhaust emissions from vehicles operating within the site, including trucks, excavators, diesel generators or other plant equipment, will be controlled by the contractor by ensuring that emissions from vehicles are minimised through regular servicing of machinery.

5.6 Noise Management

The sources of construction noise are temporary and vary both in location and their duration as the different elements of the site are constructed, and arise primarily through the operation of large items of plant and equipment such as bulldozers, diesel generators, vibration plates, concrete mixer trucks, rollers etc. Noise also arises due to the temporary increase in construction traffic near the site. The level of noise varies depending on the different elements of the site being constructed.

The predicted noise levels from onsite construction activity from the Proposed development are predominantly below the noise limit for the threshold of significance. Some tasks, whilst at shortest distance to the nearest NSR, have the potential to exceed the limit for a period. To reduce the potential effects of construction noise, the following types of mitigation measures are proposed:

- Those activities that may give rise to audible noise at the surrounding properties and heavy goods vehicle deliveries to the site will be limited to the hours 07:00 to 19:00 Monday to Friday and 07:00 to 13:00 on Saturdays. Turbine deliveries will only take place outside these times with the prior consent of the Council and the An Garda Síochána.. Those activities that are unlikely to give rise to noise audible at the site boundary will continue outside of the stated hours.
- All construction activities shall adhere to good practice as set out in BS 5228.

- All equipment will be maintained in good working order and any associated noise attenuation such as engine casing and exhaust silencers shall remain always fitted.
- Where flexibility exists, activities will be separated from residential neighbours by the maximum possible distances.
- A site management regime will be developed to control the movement of vehicles to and from the Development site.
- Construction plant capable of generating significant noise and vibration levels will be operated in a manner to restrict the duration of the higher magnitude levels.

5.7 Site Lighting

Temporary site lighting will be occasionally required for specific activities to ensure safe working conditions, during periods of limited natural light but will be carried out within the limits of the permissible working hours. The type of lighting will be non-intrusive and specifically designed to negate or minimise any effect to local properties and any other environmental considerations.

Given the proposed size and scope of the development, it is most likely that the construction timetable will require elements of the works to be undertaken during periods of the year when natural daylight is limited.

The use of artificial lighting may therefore be required in order to facilitate the works, such as vehicle and plant headlights; construction and compound lighting; office complex lighting; and localised floodlights/mobile lighting units. There will be fewer requirements for artificial lighting in the summer months when natural lighting will be present during normal working hours. There are no known issues with regards to the limit of lighting levels in this area, but lighting will be provided to meet the required lighting levels for the respective works which are being undertaken, especially where there is plant and machinery involved. Any issues identified with regards to limiting the lighting levels, either the lux values, or the time/duration of the lighting will be amended with the guidance of the ECoW as part of the developed construction method statement.

5.8 Vehicle Storage

Appropriate areas will be provided adjacent to or within the site compound to allow staff and visitor vehicles to be parked. In addition, appropriate provision will be made for the layover of HGV traffic, to ensure that the adjacent road remains clear and available for use at all times. The track design incorporates spurs and crane pads which from time to time could be required to temporarily store vehicles i.e. as waiting areas.

6.0 Pollution Prevention Measures

6.1 Environmental Incident and Emergency Response Plan

The PSCS will be responsible for developing and implementing an Environmental Incident and Emergency Response Plan. The plan will provide reference to procedures to be followed in the event of a specific incident. if an environmental incident occurred, the following actionswill take place immediately:

- mitigation will be implemented to stop or reduce impacts from the incident;
- if these are ineffective, work in the area will cease immediately;

- if necessary, monitoring will be undertaken to identify the source of the incident if not immediately obvious;
- work will only recommence once it is considered that it will not continue to adversely impact sensitive environmental receptors; and
- provision of a full report by the PSCS and separately by the ECoW to the applicant following an incident occurring.

The Environmental Incident and Emergency Response Plan will reflect site-specific conditions/issues. The PSCS will submit the detailed Plan to the applicant for approval prior to any construction works commencing onsite. The Plan will provide:

- a summary of local environmental sensitivities, e.g. environmentally designated areas, protected species or habitats and high amenity areas;
- a description of the construction works and appropriate references to other environmental plans and construction method statements;
- an inventory of stored materials and emergency response spill kits;
- details on training requirements, evidence of training of site staff / plant operators in emergency response procedures including inclusion of Environmental Incident and Response training in site inductions and tool box talks; and key staff contacts for environmental management and emergency response;
- detailed procedures to be taken in the event of an incident or emergency (including procedures for positioning and movement of plant) and identification of relevant personnel who will be responsible for implementing such procedures; and
- contact telephone numbers for the emergency services and the EPA Pollution out of hours Lo Call number (0818 33 55 99).

A plan of the site will also be provided, detailing:

- all areas of potential pollution sources including the locations of car parks, delivery and fuel / chemical storage areas, oil separator equipment, excavations, and any other high risk areas that could give rise to pollution;
- the location of potential sensitive environmental receptors, including sensitive habitats or species, surface watercourses, drains or culverts where pollution may travel to; and
- the location of spill kits and other pollution control or emergency response equipment.

The procedures for responding to a major pollution incident will be a regular topic at onsite tool box talks and management meetings in order to ensure that the incident response plan is fully understood by all personnel, and that all involved know their role in it. Any lessons learnt from any response to real incidents will be fed back into the plan to ensure that best practice is followed.

6.2 Re-Fuelling of Vehicles, Plant and Machinery

Re-fuelling of mobile plant and machinery will be carried out at a designated location within the site.

Vehicle re-fuelling will take place either at a dedicated impermeable refuelling pad or by mobile double bunded bowsers at their place of work. The refuelling pad will have an impermeable base and bund with a capacity of 110% with sumps provided such that they do not drain directly into the surface water drains. Drainage will be passed through oil interceptors prior to discharge. Refuelling will be carried out using an approved mobile fuel bowser with a suitable pump and hose. Absorbent material (spill kits) will be available onsite and will be deployed to contain drips and small spillages.

All other fuels, oils and potential contaminants, as well as waste oils, will be stored in secure, fit for purpose containers within bunded containment as appropriate and in accordance with the EPA guidance. The bunded containment will have a capacity of 110% of the volume to be stored and will have impervious, secured walls and base. Maintenance of mobile plant will take place within the construction compounds only and will comply with relevant EPA guidance.

There will be no fuel storage outside the contractors designated site. Plant will be maintained in good operational order and any fuel/oil leaks recorded for attention. Absorbent pads/granules in the case of an accidental leak/spillage will be available at the temporary construction compound.

6.3 Spillage

Spillage of fuel, oil and chemicals will be minimised by implementation of an Emergency Response Plan (ERP) which will be prepared by the PSCS. In the event of any spillage or pollution of any watercourse the emergency spill procedures as described in the ERP will be implemented immediately. Procedures developed in the ERP will be adhered to for storage of fuels and other potentially contaminative materials to minimise the potential for accidental spillage.

6.4 Other Storage

Stone material stockpiles will be limited to within work areas. This material will be transported and deposited directly to the point of use from the storage point.

Stripped topsoil/superficial soil will be stockpiled in a suitable location away from the area of movement of heavy vehicles, machinery and equipment, to minimise compaction of soil. Stockpiling of excavated material will be managed such that the potential contamination of down slope water supplies and/or natural drainage systems is mitigated / minimised.

Low mound stockpiles will be formed from excavated material, adjacent to construction areas, away from open drains.

Waste storage and raw material will be at the construction works compound and will be suitably stockpiled in a safe manner that prevents any migration of silts/contamination.

6.5 Prevention of Mud and Debris on Public Roads

Plant and wheel washing facilities and road sweepers will be provided as required to prevent mud and deposits from being transferred from site onto the public roads.

Plant and wheel washing, where provided, will be located within the designated hard standings at least 10m from the nearest watercourse or surface water drain. Runoff from the facilities will be captured within a purpose designed system for recycling and re-use where possible within the site. Settled solids will be regularly removed and disposed of by an appropriately licensed contractor.

6.6 Cement

It is anticipated that ready-mixed concrete will be brought onto the construction site from an offsite source for use as required.

Any bagged cement will be stored within a soil bunded area on pallets above the ground and covered with secured plastic sheeting to minimise the risk of wind-blown cement and uncontrolled washout occurring.

Any spilled cement will be removed by shovelling/excavator and suitably disposed offsite.

6.7 Waste and Litter

Waste storage/recycling materials will be stored at the designated location on site. Section 5.4 details principles for waste minimisation, recycling and disposal of waste streams.

With respect to the control of litter on site, all such waste will be collected and stored within sealed containers within the site compound and serviced by a registered waste carrier. No disposal of litter will be permitted at other locations.

6.8 Hydrocarbon Contamination

6.8.1 Vehicle Maintenance

As noted in Section 5.0, plant and machinery will be regularly maintained to ensure that the potential for fuel or oil leaks/spillages is minimised. All maintenance will be conducted on suitable absorbent spill pads to minimise the potential for groundwater and surface water pollution. All machinery will be equipped with drip pans to contain minor fuel spillage or equipment leakages.

6.8.2 Chemical Storage

All fuels, oils and other chemicals will be stored in secure, fit for purpose containers within bunded containment as appropriate and in accordance with EPA guidance. The bunded containment will have a capacity of 110% of the volume to be stored and will have impervious, secured walls and base.

The bunded area will be underlain by an impermeable ground membrane layer to reduce the potential pathways for contaminants to enter watercourses and groundwater.

7.0 Drainage and Surface Water Management

7.1 Introduction

Control of water is of great importance during construction to prevent exposed soils eroding and silting up surrounding drainage channels and watercourses. It is essential that the works have little or no impact on the existing hydrology in order to minimise potential impact on ecology and environmental quality of the surrounding area.

The following could be used across the site to adequately protect hydrological, and related, resources.

7.2 Site Induction and Training

All employees and contractors will undergo a site induction to ensure that they are familiar with the site rules prior to any work commencing on site. In addition, the PSCS will ensure that all operatives and contractors responsible for handling fuel, oil, concrete or cement or other potential pollutants undergo a thorough induction programme with respect to the relevant proposed pollution control measures. The relevant programme will include, as a minimum, the following:

- waste management;
- emergency response plan procedures;
- materials management;
- habitat and species protection,
- surface water management;
- potential sources of pollution and their effects on the environment;
- requirements of the contract and legislation with respect to pollution;
- the PSCS's pollution avoidance plan;
- traffic management and routing, including areas where access is not permitted; and
- training in the use of pollution control equipment.

7.3 Site Drainage

During the construction phase of the proposed development, measures will be adopted, in order to prevent silt, chemicals and/or other contaminants from being washed into existing watercourses. Areas exposed due to the removal of existing structures and/or vegetation are more susceptible to erosion during heavy rainfall so areas will be reinstated as soon as possible to minimise this effect.

This will include control of pollution to the water environment around the following aspects of site infrastructure:

- access routes;
- foundations;
- hardstanding areas and new structures

The appropriate methodologies to cover water control and the means of drainage from all hard surfaces and structures within the site are described in the following sections.

7.4 Management of Sediment and Surface Waters

Good practice construction techniques will be adopted for the management of sediment and surface water run-off generated during the construction phase of the proposed development. Sustainable Drainage Systems (SuDS) will be used where applicable.

Drainage from the site will include elements of SuDS design. SuDS replicate natural drainage patterns and have a number of benefits:

- SuDS will attenuate run-off, thus reducing peak flow and any flooding issues that might arise downstream; and

- SuDS will treat run-off, which can reduce sediment and pollutant volumes in run-off before discharging back into the water environment; and

In addition, a wet weather protocol will be implemented to manage activities during periods of heavy and prolonged precipitation to be approved by LCC.

Heavy or prolonged rainfall during construction and operation may lead to sediment transport or vegetation causing blockage to infrastructure drainage channels or any temporary watercourse crossing structures. Regular monitoring and prompt maintenance of these assets will ensure that the drainage system continues to function as designed.

7.5 Foul Drainage

Effluent and waste from onsite construction personnel will be captured and stored for offsite disposal by a licensed contractor, where there is no connection to the public foul sewer

8.0 Water Quality Monitoring and Contingency

8.1 Water Quality Monitoring

Water quality monitoring during the construction phase will be undertaken for the surface water catchments that serve the site, to ensure that none of the tributaries of the main channels are carrying pollutants or suspended solids. Monitoring will be carried out monthly on these catchments.

With regard to the protection of the water environment the following risks will be addressed:

- siltation of watercourses;
- discolouration of raw water;
- potential pollution from construction traffic due to diesel spillage or similar;
- alteration of raw water quality resulting from imported track construction material;
- excavation and earthworks
- use of large quantities of concrete;
- site compound and associated drainage/foul drainage and diesel spill issues; and
- the PSCS will compile a monitoring and maintenance plan for the drainage system and surface water runs which will as a minimum include:
    - visual monitoring/inspections

during site works including and water crossing construction works, the relevant drainage/surface water runs potentially being impacted by these works will be inspected on a daily basis by the ECoW while works are ongoing in this area.

A Water Quality Monitoring Plan (WQMP) will be developed to form part of the Construction Method Statement (CMS), which will be submitted to the appropriate planning authorities prior to construction and development. The WQMP will be implemented to monitor surface water quality, fish populations and macroinvertebrate community prior to, during and post-construction. A robust baseline of water quality in surface watercourses / drainage channels downstream of construction works will be established prior to construction commencing and used a benchmark of water quality for the construction phase monitoring.

The purpose of the WQMP is to:

- ensure that the commitments put forward in the EIA Report are fulfilled with regards to identified ground and surface water receptors;
- provide a specification for monitoring prior to, during and after construction;
- provide a record of water quality across the site that can be compared to rainfall and site activities;
- provide reassurance of the effectiveness of pollution prevention measures installed to protect surface watercourses throughout the construction period; and
- provide data to identify any potential pollution incidents, and to inform a structured approach to manage and control such incidences.

The WQMP will outline details for the monitoring of surface watercourses down gradient of works areas including watercourse crossings, access tracks, turbine foundations and borrow pits and at control sites (up gradient of works areas), and will include:

- planning level monitoring locations;
- frequency of monitoring prior to, during and after construction;
- parameters for field hydrochemistry testing and laboratory analysis including as a minimum pH, electrical conductivity, suspended solids, dissolved metals, nutrients and hydrocarbons;
- sampling and analysis protocols;
- relevant environmental quality standards (EQS);
- responsibilities for monitoring –the ECoW will be responsible for daily monitoring of watercourses particularly around active works areas and watercourse crossings. Further monitoring on a less frequent basis (i.e. monthly) may be done by an external party;
- procedures to be followed in the event of an environmental incident; and
- recording and communicating of results.

A Private Water Supply (PWS) Action Plan will be developed and will include details regarding all water monitoring and reporting, pollution incident reporting and emergency mitigation measures to address a temporary or permanent material change in either the quality or quantity of an existing private water supply. The PWS Action plan shall include as a minimum:

- the provision of an emergency hotline telephone number for householders so that they can contact the project with any concern regarding water quality or quantity;
- the contact details of householders downgradient of work areas to alert in the event of a pollution incident;
- the provision of an alternative water supply, if required, during any periods of PWS disruption; and/or
- to supply affected properties with filters for particulate removal.

8.2 Laboratory Analysis

This monitoring will involve laboratory analysis of water samples taken at agreed locations across the site and will continue throughout the construction phase and immediately following construction. Monitoring will be used to allow a rapid response to any pollution incident as well as assess the impact of good practice or remedial measures. Monitoring frequency will increase during the construction phase.

The performance of the good practice measures will be kept under constant review by the water monitoring schedule, based on a comparison of data taken during the construction phase with a baseline data set, sampled prior to the construction period and through the observance of any trends in water quality change over time.

8.3 Emergency Response

Drainage networks provide a conduit for rapid transport of silty water and potential contamination from surface spills of fuels / oils, concrete or chemicals. A pollution emergancy incident will include any discharge to the drainage network that could potentially cause environmental damage. Examples of pollution emergency incidents include:

- fuel drips or spills during refuelling;
- leaking plant or equipment;
- leaks from fuel or chemical containers;
- contaminated water or sediment / silt entering a watercourse or drainage network;
- windblown dust and waste;
- excess silt deposition in drainage ditches, channels, culverts following heavy rainfall events;
- operational failures of pumps and pipelines; and
- failures of treatment or sediment controls.

The PSCS will be required to prepare an Environmental Incident and Emergency Response Plan (Section 6.1) which will provide emergency response contacts, reporting procedures, and procedures for dealing with all potential pollution incidents during the construction of the proposed development.

8.4 Specific Measures for Protecting Groundwater Receptors

Areas of potential GWDTE are sustained by surface water and rainfall rather than by groundwater. Measures will be required to sustain surface water flow paths to maintain these habitats.

9.0 Construction Phase

9.1 Introduction

This section describes in more detail the key components of construction and the impact they may have on the environment.

The overall site design has been developed in accordance with recommendations adopted from the EIA Report and to reflect the requirements and specifications for transporting wind turbine components to the proposed turbine locations.

9.2 Temporary Compound

The works will include the construction of two Temporary Construction Compounds (TCCs), located at TC1 655313,687358, TC2 656514,686243.

The temporary construction compounds will have a footprint of 120m x 60m (7,200m^2), and will contain the following:

- temporary modular building(s) to be used as a site office;
- welfare facilities;
- parking for construction staff and visitors;
- reception area;
- fuelling point or mobile fuel bowser;
- secure storage areas for tools; and
- waste storage facilities.

Welfare facilities will be provided for the duration of the construction period in accordance with the Safety, Health and Welfare at Work (Construction) Regulations 2013. Facilities for waste management, refuelling, power, water supply and chemical/material storage will be provided.

Where and when compound lighting is required, it will be designed to minimise light pollution to the surrounding area. All lights will face inwards.

The compound will also be used as a storage compound for various components, fuels and materials required for construction.

The compound will be built by stripping topsoil and regrading, then laying geotextile and an imported stone layer. The stripped topsoil will be stored adjacent to the compound in a linear bund typically no greater than 2m in elevation. Superficial soil will be stripped and stored separately from the topsoil. This will be stored in a similar manner to the topsoil but will depend on the volume which is required to be excavated.

It is proposed that uncontaminated surface run-off from the compound is accommodated in a swale or soakaway which will be constructed as a perimeter ditch to avoid contamination of watercourses will there be a spillage and from fines washout. All other run-off from the site will follow natural drainage patterns and newly installed drainage routes.

The compound area will be reinstated at the end of the construction period. Reinstatement will involve removal of the imported material and underlying geotextile. The exposed substrate will be gently ripped and the stored superficial soil and topsoil replaced. The surface will be re-seeded as required using the same seed mix as that used for the reinstatement of track verges and batter.

9.3 Welfare Facilities and Services

Welfare facilities will be provided in accordance with Safety, Health and Welfare at Work (Construction) Regulations 2013 during the construction period and will include mobile toilets with provision for sealed waste storage and removal. Sewage waste will be be tankered offsite by a licensed approved waste contractor, including regular emptying by an approved contractor.

Potable water will be imported as bottled water. The water will be used for messing purposes during the construction phase.

The welfare facilities will most likely have in-built water bowsers to provide a water supply for sanitation etc.

Electricity will be provided by onsite generators. All electrical equipment and its installation and maintenance will be undertaken by a qualified and competent person.

9.4 Transport Routes

Both construction workers and materials needed for the construction works will be delivered to site using the public road network. A Construction Traffic Management Plan (CTMP) has been provided (see Technical Appendix 12.2 found in Volume 3 of this EIAR.

The proposed abnormal load route required to transport turbine components to the site is shown on **EIAR Figure 12.5.** The turbine delivery route will leave Dublin port and join with the M50 motorway via the Dublin Port Tunnel. The transport will continue along the M50, exiting the M50 onto the N7 National Road / M7 Motorway; the transport will continue west before exiting the N7 at Junction 16.

The transport route exits the motorway at Junction 16 to travel west on the R425 for a short distance before heading south on the R426, through the town of Timahoe. The transport will continue along the R426 Regional Road before heading east on Knocklead Road before accessing either the southern or northern clusters via existing forestry tracks.

The proposed abnormal load route has been assessed and verified for the movement of wind turbine components (including blade, tower sections and nacelle), transported as abnormal loads. Abnormal indivisible loads (AILs) are those which exceed the length, weight or height criteria defined in 'Road Traffic (Permits for Specialised Vehicles) Regulations 2009, S.I. No. 147 of 2009', and 'Road Traffic (Specialised Vehicle Permits) (Amendment) Regulations 2010, S.I. 461 of 2010

It is anticipated that HGVs and deliveries will travel predominantly from Portlaoise to the north as this is the largest town in the vicinity of the Site, with a small percentage travelling along the R426 from the south. Light vehicles are likely to travel from both directions along the R426.

Full detail of the assessment of effects on the road network is provided in **Chapter 12: Site Access, Traffic and Transport.**

In the event consent has been received and prior to construction, the route will be further inspected by suitable engineers, in conjunction with the police and the relevant highway authorities, with a view to finalising the TMP and to obtaining a suitable licence for the movement of abnormal loads.

9.5 Borrow Pits

1.1.1 General

In order to construct the access tracks, passing places and formation of new hardstanding areas such as crane pads, site construction compounds and laydown areas, crushed rock is required. It is proposed to source this material from one no. onsite borrow pit, to reduce the need to import materials.

These borrow pits will be stripped back of topsoil which will be stored adjacent to the respective borrow pit site for future reinstatement.

9.5.1 Materials Storage

Prior to the excavation of the borrow pit(s) and following construction of appropriate SuDS measures, vegetation and soils will be removed and stored in overburden stockpiles. Overburden stockpiles will be located adjacent to the borrow pit(s) and compacted in order to limit instability and erosion potential. Silt fences will be employed to minimise sediment levels in runoff from the stockpiles.

Rock stockpiles will be stored in already-worked areas of the borrow pit(s) or, before these are available, stockpiles will be located on safe and stable designated areas approved by a qualified engineer, identified on a plan of the working area of the borrow pit(s) and agreed with the ECoW.

Overburden or rock stockpiles will be stored at least 50m from watercourses in order to reduce the potential for sediment to be transferred into the wider hydrological system.

9.5.2 Surface Water Management

Temporary interception bunds and drainage ditches will be constructed upslope of the borrow pit(s) to prevent surface water runoff from entering the excavation. Swales will also be implemented to convey and attenuate excess surface water flow away from borrow pit(s). These methods will be kept to a minimal depth and gradient, with check dams, silt traps and buffer strips also utilised where possible to minimise erosion and sedimentation at peak flows.

Infiltration trenches will also be placed downslope of the borrow pit(s) and overburden and rock stockpiles and will be designed to treat run-off before discharging back into the drainage network. Silt fences will be used to intercept sediment-laden surface run-off in addition to infiltration trenches.

9.5.3 Borrow Pit Dewatering

Limited dewatering of the borrow pit(s) may be necessary. Water will be treated by a settlement lagoon(s) and by discharge onto vegetated surfaces.

Outflow from settlement lagoon(s) in proximity to the borrow pit(s) will discharge to surface water drains (please see accompanying planning drawings).

It is unlikely that groundwater ingress will be significant. However, the floors of the borrow pit(s) will have a gravity drain design. All floor water will drain to an adequately sized sump to allow sediment to settle out before discharge to surrounding vegetated surfaces.

Excavation machinery will be regularly maintained to ensure that there is minimal potential for fuel or oil leaks/spillages to occur. All maintenance will be conducted on suitable absorbent spill pads to minimise the potential for groundwater and surface water pollution.

9.6 Access Tracks

9.6.1 General

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

As part of the design mitigation all of the proposed infrastructure will be sited at least 50m from any watercourse and there will be no new watercourse crossings.

It is anticipated that access tracks will be constructed from aggregate won from onsite borrow pits and will be constructed to the best practices for wind farm access tracks.

Access tracks will be constructed to a minimum running width of 5m (wider on bends), plus willers of approximately 1m on either side, to accommodate the maximum transport requirements. Track willers may be up to a width of 3m to accommodate cabling along the access track alignment.

The access tracks for the proposed development have been carefully designed. The tracks have been designed to follow the existing contours to minimise the requirement for cut and fill and will be formed to minimise the gradient. The access tracks will be a minimum of 5m wide (straight sections) with appropriate widening on bends (please refer to the accompanying planning drawings) with additional provision of inter-visible passing places at track junctions and crane hardstandings. The average working corridor for the construction of access tracks (and where relevant cable trenches) will be 14m.

For the construction of tracks topsoil will be stored beside the track for use in reinstatement of willers at the end of the construction period where appropriate. The material will be stored/stockpiled in accordance with good practice so that it will be reused for reinstatement.

9.6.2 Existing Tracks

There is approximately 5km of existing access track within the site boundary, which will be used to access the main part of the proposed development site.

9.6.3 New/ Upgraded Tracks

There will be up to approximately 14.3km of internal access tracks required to be upgraded as part of the proposed development.

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

- stripping of surface vegetation (turves) and careful stockpiling of this material;
- excavating the remaining superficial soil materials and stockpiling this material;
- where different superficial 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 will 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.

Access tracks will be formed from a sub-base of general fill and finished off with a cap-stone / wearing course of graded crushed rock to provide a nominal Type-B (Series 800) finish. Wearing course stone will be of a suitable material that is not susceptible to breaking down / weathering to a high fines content material.

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, which could lead to some track material being washed away. 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 regular basis by the Contractor.

9.6.4 Cut Tracks and Drainage

In areas where the soil is wet the track formation will be created by a cut (and fill) or by a cut operation where the side slope is severe. A lateral drain will be established on the uphill side of the track to drain water from the slopes and cross drains will be established at intervals of no less than 30m, or to suit the profile of the track/ditch to facilitate drainage. Topsoil, where present, will be stored beside the track for use in re-instatement of track willers where appropriate.

9.6.5 Management of Surface Water

New access tracks will be designed to have adequate cross fall or camber to avoid ponding of rainwater and surface run-off. Run-off from the access tracks and existing drainage ditches will be directed into swales that intercept, filtrate and convey the runoff.

Check dams will be installed within the swales and existing drainage ditches where required in order to increase the attenuation of run-off and allow sediment to drop out.

Permanent swales and drainage ditches adjacent to access tracks will have outlets at required intervals to reduce the volume of water collected in a single channel and, therefore, reduce the potential for erosion. Outfall pipes will drain into a bunded section of the drainage ditch to allow suspended solids to settle. Further measures will include the use of flocculent to further facilitate the settlement of suspended solids, if required by the Local Authority.

The PSCS will be responsible for the management of all surface water runoff, including the design and management of a drainage scheme compliant with SuDS principles.

9.6.6 Protection of Watercourse Crossings

Upgraded watercourse crossings will be appropriately designed so that they do not alter the natural drainage and can accommodate flow. All access road river/stream crossings will require a Section 50 application (Arterial Drainage Act, 1945). The river/stream crossings will be designed in accordance with OPW guidelines/requirements on applying for a Section 50 consent.

9.6.7 Loose Track Material

Loose material from the use of access tracks will be prevented from entering watercourses by utilising the following measures:

- silt fences will be erected between areas at risk of erosion and watercourses;
- silt fences and swales will be inspected daily and cleaned out as required to ensure their continued effectiveness;
- excess silt will be disposed of in designated areas at least 50m away from any watercourses or drainage ditches;
- water bars will be implemented on slopes greater than 1 in 20;
- culverts, swales and drains will be checked after periods of heavy precipitation;

- the inlets and outlets of settlement lagoons, retention basins and extended detention basins will be checked on a daily basis for blockages; and
- the access tracks will be inspected on a daily basis for areas where water collects and ponds.

9.6.8 Floating Tracks and Drainage

If

Floating track construction essentially comprises the laying of a geosynthetic (geotextile mat or geogrid reinforcement) across the superficial soils prior to constructing the track. Where necessary, risk from run-off will be mitigated by directing drainage to settlement ponds. Erosion processes on the track side embankments and cuttings will be mitigated by ensuring that gradients are below stability thresholds, which will also enable effective regeneration of vegetation or reseeding with appropriate species. Sediment traps will be required in the early years following construction until natural regeneration/ reseeding is established. Will significant erosion or sedimentation, (which is not expected) take place at any location it will be addressed by re-grading of slopes.

9.6.9 Onsite Vehicle Movements

Access tracks will be designed to be single track, a minimum of 5m wide including the provision of intervisible passing places at appropriate locations taking account of horizontal and vertical track alignments. Additional widening will be provided on bends to facilitate the movement of the large delivery vehicles associated with turbine tower and blade delivery, and these will double as passing places where appropriate.

During the periods of delivery of the large components, the Contractor will use appropriate site communications and access control techniques to enable safe one-way operation of the tracks.

The presence of crane pads within the construction compound will facilitate traffic movement onsite. Internal track junctions will also be used to facilitate multiple options for construction traffic movement. This will allow vehicle to move more direct between construction locations and double as passing places.

9.6.10 Unstable Ground

While not predicted, 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.

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

- access track construction in the immediate area of the unstable ground will cease with immediate effect;
- the PSCS will immediately assess the situation and develop a solution; and

9.6.11 Signage

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

9.7 Turbine Foundations

9.7.1 General

A total of 13 turbines will be erected on reinforced concrete gravity foundations, approximately 30m diameter.

Proposed turbine foundation locations will be inspected by the ECoW to ensure that all potential environmental constraints have been identified, demarcated and/or mitigated for prior to the on-set of construction in that area. Construction of Turbine Foundations

The volume of concrete required for each turbine foundation will be approximately 1400m^3 and will be batched onsite using imported cement and aggregates either imported or sourced from the borrow pits. Each turbine will also require steel reinforcement which will be delivered to site on a flatbed vehicle and then connected together to provide the reinforcing cage (see **Figure 3)**.

The turbines require reinforced concrete foundations that measure approximately 30m in diameter. To facilitate the construction of this, an area up to 3m wider around the perimeter will be required e.g. approximately 36m total diameter to create a working area.

Figure 3 shows a planning level turbine foundation design.

The following construction activities associated with the turbine foundations are detailed as follows:

- 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 until a suitable formation can be achieved. Where rock is encountered 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 will be assessed and appropriate mitigation measures implemented where required in consultation with the ECoW;
- the foundation design is based on the most efficient use of materials and local ground conditions;
- temporary fencing will 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;
- cut-off ditches will be used at the perimeter of foundation excavations to divert the clean water away from the work areas thereby reducing the volume of water potentially requiring pumping/treatment in silt traps/settlement lagoons. It is not anticipated that large scale dewatering will be required during the excavations. Water from dewatering of excavations will be pumped via surface silt traps to ensure that sediment does not enter surrounding watercourses. Settlement lagoons will be employed in areas where the level of runoff is likely to exceed levels normally contained within a silt trap, however it is considered unlikely that these will be

required. Wash-out areas at each base, (if required) will be lined and contained to prevent wash-out water entering drainage/surface waters. The material from the wash-out will be disposed of appropriately offsite (see Chapter 3);

- following excavation, levels will be set to allow the blinding concrete to be placed and finished to the required line and level;
- the steel reinforcement will then be finished to the required design specification. The steel reinforcement will then be delivered to site and stockpiled adjacent to the respective turbine base;
- 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. Spraying of mould oil and storage of such sprayed materials will be undertaken in such a 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;
- cable ducts will be checked so as not to leave sharp corners that will cause cable snagging. All earthing cable or strip connections will also be examined to prove their adequacy to withstand the rigors of the concrete placing process;
- concrete will be batched onsite. As with all concrete deliveries, a record will be kept against each turbine to indicate the source of supply, type and consistency of the mix. A record will also be kept of the personnel involved, the time and date the pour commenced and finished;
- 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. Pouring will follow best working practice procedures and fresh concrete will be protected from hot and cold weather as required;
- shutters will be carefully loosened, removed and cleaned no earlier than 24 hours from the finish of the pour; and

backfilling to the turbine base will proceed in layers of approximately 0.3m with compaction as necessary. Further layers of material will be laid until the original till level is attained. Soil will be replaced from the appropriate storage area until the original ground level is reached, or a shallow mound (up to 500mm above existing ground level) is formed. In the event that there is limited onsite material to compact above the turbine foundation, then imported material may be required. This will be a well graded granular product.

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.

Following the completion of all construction activities, the area surrounding the base will be reinstated.

9.8 Crane Pads

Crane pads will be required to allow installation and removal of the turbine components. As with access tracks, topsoil and superficial soil will be removed wherever possible and stored separately adjacent to the removal area for later reinstatement up to the edge of the hardstanding.

The area will be set out to the required dimensions and excavated to a suitable formation. Coarse rock fill will then be placed and compacted in layers using compaction equipment. Geotextile may be used depending on the suitability of the underlying strata. The final surface will be formed from selected granular material and trimmed to allow surface water run-off to drainage ditches. The crane pad will remain *in-situ* for the operational life of the proposed development.

Figure 4 shows the planning level crane hardstanding layout.

9.9 Substation Compound and Control Building

9.9.1 Substation Compound

The main substation compound will include an area for car parking and High Voltage (HV) equipment, such as transformers and circuit breakers and a control building.

Lighting will be limited within the compound to emergency flood lights around the switchgear, security/motion sensor lights to building, and then any internal lighting within the building.

9.9.2 Control Building

The main control building will be a single storey blockwork structure or pre-fabricated panels, built on a pre-cast concrete base measuring approximately 15m x 25m and 5m high. It is proposed that the building will have a rendered finish; the final external finishes will be agreed with LCC. The control building will be used as a control room for the electrical switchgear.

A planning level control building elevation is shown in **Figure 6**.

Welfare facilities including a toilet will be provided in the control building for the duration of the operation of the proposed development. Sewage waste will be tankered offsite by a licensed approved waste contractor.

A rainwater collection and purification system will be installed to service the welfare room, and electricity will be provided from a local electricity connection or a back-up diesel generator.

9.10 Cable Laying

For the purposes of this CEMP, two cable routes will be assessed and the most suitable (see Chapter 1 and 3) will be taken forward into a separate planning application.

- Option 1 comprises a cable route between the proposed onsite substation and the Pinewoods substation. This route is 9.9km in length.
- Option 2 comprises a cable route between the proposed onsite substation and Coolnabacky substation. This route is 10.1km in length.

Underground power cables will run from each turbine location to the onsite substation. s. Cables will be laid in a trenching operation. Single cable trenches will likely be 450mm wide; whilst double cable trenches could extend to 1300-1640mm wide. Trenches will be 1075-1205mm deep. Planning level cable trench arrangements are shown on **Figure 9**.

Electrical cabling is buried or ducted adjacent to the access track network. Cable trenches will either be excavated into existing ground, made ground (such as access track verges) or areas consisting of shallow peat. Irrespective, the cable trenches will require excavation, laying of the cables and backfilling with original material from the point of origin.

The position of trenches will be marked out and the line stripped of turves and superficial soils and set aside for reinstatement. Ecologically sensitive areas will be avoided by construction plant or vehicles. The majority of cable run installation will be undertaken adjacent to and within the track construction zone, to minimise intrusion into the surrounding areas.

Following testing, the trench will be backfilled and compacted in layers with suitable material and reinstated with previously excavated superficial soils (from which stones will have been removed). Sand will be imported to site and will be placed around the cables as protection. Suitable duct marker tape will be installed in the trench prior to backfilling.

Clay bunds will be placed at intervals to prevent longitudinal drainage.

9.11 Soil Storage

Superficial soils will be excavated and stored temporarily. Most of the soil resources within areas directly affected by construction activities will be able to be stored and reinstated as close as possible to where they are excavated in accordance with best practice; so that the site will be restored with minimal movement of material from its original location.

At turbine foundations topsoil will be stripped keeping the top 200mm of turf intact. This material will be stored adjacent to the base working area and will be limited in height to 2m to minimise the risk of overheating. Superficial soil will then be stripped and stored, keeping this material separate from the topsoil.

Following excavation of the turbine foundation area and construction of the foundation (concrete/reinforced steel) the area will be backfilled with spoil. The area will be reinstated using the retained topsoil/turf where appropriate materials are available. Where required a gravel area will be left around the tower base for access. Reinstatement at turbine foundations will begin as soon as possible after foundation and plinth installation is complete.

The risk of water pollution from excavation works in terms of sediment loss will be prevented / mitigated by the following measures:

- careful location of turbine bases and track line to minimise excavation where applicable;
- stripped topsoil/superficial soil will not be stored adjacent or in close proximity to watercourses, where a construction area requiring soil stripping is close to a watercourse the soil will be stored a suitable distance from the watercourse;

- soil will be stored in accordance with best practice in order to remain intact as the soil will be essential to the site reinstatement;
- where turf requires excavation for track construction an excavator will lift turf and place it to the side leaving space between the edge of the track and the embankment to be constructed. The excavator will then lift out the soil and will place it to the side of the proposed track. The soil stored by the side of the access track will be graded by an excavator and the turves will be replaced by the excavator over the graded soil beside the track. The timescale for this operation is short and the methodology has been successfully applied at other wind farms; and
- excavated soil will not be placed onto water reservoirs or placed where it will block established surface or drainage channels.

9.12 Watercourses

9.12.1 General

As part of the design mitigation, all wind turbines and associated infrastructure (with the exception of tracks) have been sited with a minimum separation of 50m from watercourses where possible.

Tracks have been routed to minimise any crossing of the watercourse, where possible. However, if track crossings are required, then the these will be constructed.

Chapter 10: Hydrology, Hydrogeology, Geology and Soils of the EIA Report will include details of water crossings.

All access road river/stream crossings will require a Section 50 application (Arterial Drainage Act, 1945). The river/stream crossings will be designed in accordance with OPW guidelines/requirements on applying for a Section 50 consent.

All construction works on the site, and specifically construction works to be undertaken within and in the vicinity of the watercourse, will be completed in compliance with best practice as detailed within this document.

The ECoW will be consulted on all watercourse crossing works. Surveys by the ECoW will be carried out immediately prior to construction of the crossing.

9.12.2 Best Practice

General good practice in watercourse crossing design is detailed below:

- where appropriate, the watercourse will be routed through culverts appropriately sized and designed not to impede the flow of water and will allow safe passage for wildlife, such as fish, water voles, otters etc. (i.e. the crossings will have a capacity well in excess of the design flow);
- when installing culverts, care will be taken to ensure that the construction does not pose a permanent obstruction to migrating species of fish, or riparian mammals (i.e. the crossing will make provision for fish and wildlife migration);
- culverts will be sized so that they do not interfere with the bed of the stream during construction, (i.e. the crossing will leave the watercourse in as natural condition as possible);

- culverts with a single orifice will be used in preference to a series of smaller culverts that may be more likely to become blocked with flotsam and create erosion (i.e. the crossing will not constrict the channel);
- ease and speed of construction are important to minimise disruption to the watercourse and surrounding habitat;
- designed for the life of the project;
- low maintenance; and
- visually in keeping with the surroundings.

In accordance with OPW guidance, the watercourse crossing will be designed on a case by case basis to be appropriate for the width of watercourse being crossed, and the prevailing ecological and hydrological situation (i.e. the "sensitivity" of the watercourse). A number of factors, both environmental and engineering will influence the selection of structure type and the design of the crossing.

The river crossing will be designed to convey a minimum 1 in 200 year plus climate change return period flood event, and individually sized and designed to suit the specific requirements and constraints of its location.

The watercourse crossing will include splash boards and run-off diversion measures to prevent direct siltation of watercourses.

9.12.3 Culverts

Medium to large culverts or large Armco culverts will be used where a culverted solution is desirable or where a small piped culvert is not appropriate for environmental or capacity reasons.

9.12.4 Relevant Mitigation

The following is a summary of the mitigation measures and general good practice associated with the development of watercourse crossing:

- appropriate care will be given to the construction of the crossing and all loose materials left from construction will be collected and disposed accordingly;
- site track crossings will be constructed with granular materials, which will limit the production of surface runoff and the direct discharge of sediment into the watercourse;
- the methods of drainage proposed for the site tracks prevent the significant discharge of surface runoff and suspended solids into the watercourse adjacent to the tracks. This is owing to the runoff being collected within the upslope ditch, the presence of culverts at appropriate intervals so as to limit longitudinal flow and the discharging of water to the downslope ground. There will therefore be no long runs of ditches that directly discharge into watercourse;
- the watercourse crossing will be designed to avoid disruption and / or habitat loss to aquatic systems or to affect free passage of fish; and
- minimum buffer strip of 50m will be kept free from development from the top of the banks of any watercourse/waterbody.

10.0 Pre-Construction Surveys, Protected Species and Monitoring

10.1 Water Quality Monitoring

Prior to the works commencing, baseline water quality monitoring will be undertaken by an appropriately qualified and experienced independent consultant to establish the water quality prior to any interference from the works.

The monitoring shall be undertaken in accordance with the WQMP developed by the Project Supervisor Construction Stage (PSCS) and as detailed within Section 8.0.

This water quality monitoring is to be agreed and reviewed by the Developer in advance of the works commencing to ensure that the conditions during the monitoring and the testing undertaken are representative and allow a suitable benchmark to be established.

10.2 Archaeology/ Cultural Heritage

Monitoring, in the form of a watching brief will be conducted on all ground-breaking works within the site due to the potential for preservation of previously unrecorded archaeology. Due to the nature of the landscape and its historical value, archaeological monitoring will prevent any loss of knowledge from the landscape. Any monitoring will be undertaken by a suitably qualified and licensed archaeologist. Ecology

Mitigation measures to prevent adverse effects on downstream Natura 2000 sites during construction are provided in full in the NIS (Technical Appendix 15.10 found in Volume III of this EIAR). These will ensure no deterioration in the quality of water entering the River Barrow and River Nore SAC, the River Nore SPA and Royal Canal pNHA and will ensure there will be impacts on any QI habitats and species. The same is true for IEF non-QI aquatic habitats and species.

These measures are taken from Chapter 9 and the CEMP (Technical Appendix 3.2 found in Volume III of this EIAR).

Within the design of the proposal, good practice environmental and pollution control measures will be ~~are~~ employed regarding current best practice guidance such as~~, but not limited to,~~ the following:

- CIRIA C648, 'Control of Pollution from Linear Construction Project' (2006);
- CIRIA C532, 'Control of water pollution from construction sites: guidance for consultants and contractors' (2001);
- CIRIA C741, 'Environmental good practice on site guide' (2015, 4th edition);
- CIRIA C697, 'SuDS and Maintenance Manual; (2007);
- IFI, 'Requirements for the Protection of Fisheries Habitats during Construction and Development Works at River Sites'; and
- Design took account of IFI consultation to minimise the number of watercourse crossings and to ensure there were appropriate set-back distances between any infrastructure and watercourses (see Chapter 9).

Mitigation measures in the NIS include implementing the requirements in the following guidance:

- Forestry and Water Quality Guidelines – Forest Service (DMNR, 2000)13;
- Code of Best Forest Practice – Ireland;

- Forestry and Freshwater Pearl Mussel Requirements – Site Assessment and Mitigation Measures (Forest Service, 2009) 15; and
- Forest Operations & Water Quality Guidelines (Coillte, 2009).

The Forest Service of the Department of Agriculture, Fisheries and Food implements the principles of Sustainable Forest Management through its environmental guidelines 'Code for best forestry practice Ireland' and its inspection and monitoring procedures. The Forest Service also has guidance in relation to freshwater pearl mussel: 'Forestry and Freshwater Pearl Mussel Requirements – Site Assessment and Mitigation Measures' to further develop its commitment to environmental protection. This document gives specific mitigation measures which are mandatory in specific locations and circumstances in the designated Freshwater Pearl Mussel catchments such as the Barrow and Nore. Within these catchments particular emphasis is placed upon the area that lies within 6 km hydrological distance of an identified Freshwater Pearl Mussel (FPM) population. From the River Barrow and River Nore SAC Conservation objectives, the location of Pearl mussel is between 13 km and 20 km from the p~~P~~roposed d~~D~~evelopment, and therefore the mitigation methods for FPM will not be required and the 'Forest Service Guideline' will be ~~required~~ implemented instead.

Drainage will be based on a Sustainable Drainage System (SuDS) through minimising, interception, treatment dispersal and dilution. The SWMP specifies how water pollution will not occur as a result of construction activity for the p~~P~~roposed d~~D~~evelopment. It has also been designed to regulate the rate of surface water run- off, encourage settlement of sediment locally and to minimise the quantity of sediment laden storm water.

Erosion control (i.e. preventing sediment runoff) is more effective than sediment control for the prevention of water pollution, this principle will be adopted in the SWMP. Erosion control measures are less likely to fail during times of high rainfall, require less maintenance and are more cost effective. The works programme will include the ensuring the following controls are in place before site clearance or earth works are commenced:

- Erosion control;
- Sediment control;
- Drainage control; and
- Runoff control.

Once works on site have commenced, the area of exposed ground will be minimised, runoff will be prevented from entering the site from adjacent ground, appropriate control and containment measures will be undertaken. Monitoring and maintenance of erosion and sediment controls will occur throughout the p~~P~~roposed d~~D~~evelopment. Establishing vegetation as soon as practical where soil is exposed will also be a priority.

All silt and erosion control measures will be based on the peak flow set out in CIRIA (2006).

10.2.1 Habitat and Species Management Plan

A Habitat and Species Management Plan (HASMP) will be used to prevent the spread of invasive and non-native species and is contained in Appendix 15.11. In particular, quarry material will be treated to ensure that invasive third-schedule Japanese knotweed (plus other non-native plants) is not spread during construction works and any works near watercourses will not spread invasive third-schedule Canadian pondweed.

A pre-construction walkover survey of the works corridor will confirm the presence of any invasive/non-native species that may have escaped into the area since the baseline surveys are conducted.

11.0 Reinstatement

During construction of the infrastructure elements (detailed in Section 9), the vegetated layer will be stripped over the area of the excavation and stored locally with the growing side up. The remaining organic topsoil and subsoils will be excavated down to formation level, or a suitable stratum, and again will be stored local to the point of excavation but shall remain segregated to avoid mixing of materials.

For all reinstated areas, immediate aftercare provision will include an inspection of reinstated areas after completion of the reinstatement work at each location. In addition, the operator will make regular maintenance visits to the site and will visually monitor the success of re-vegetation.

Making Sustainability Happen

Appendix 6

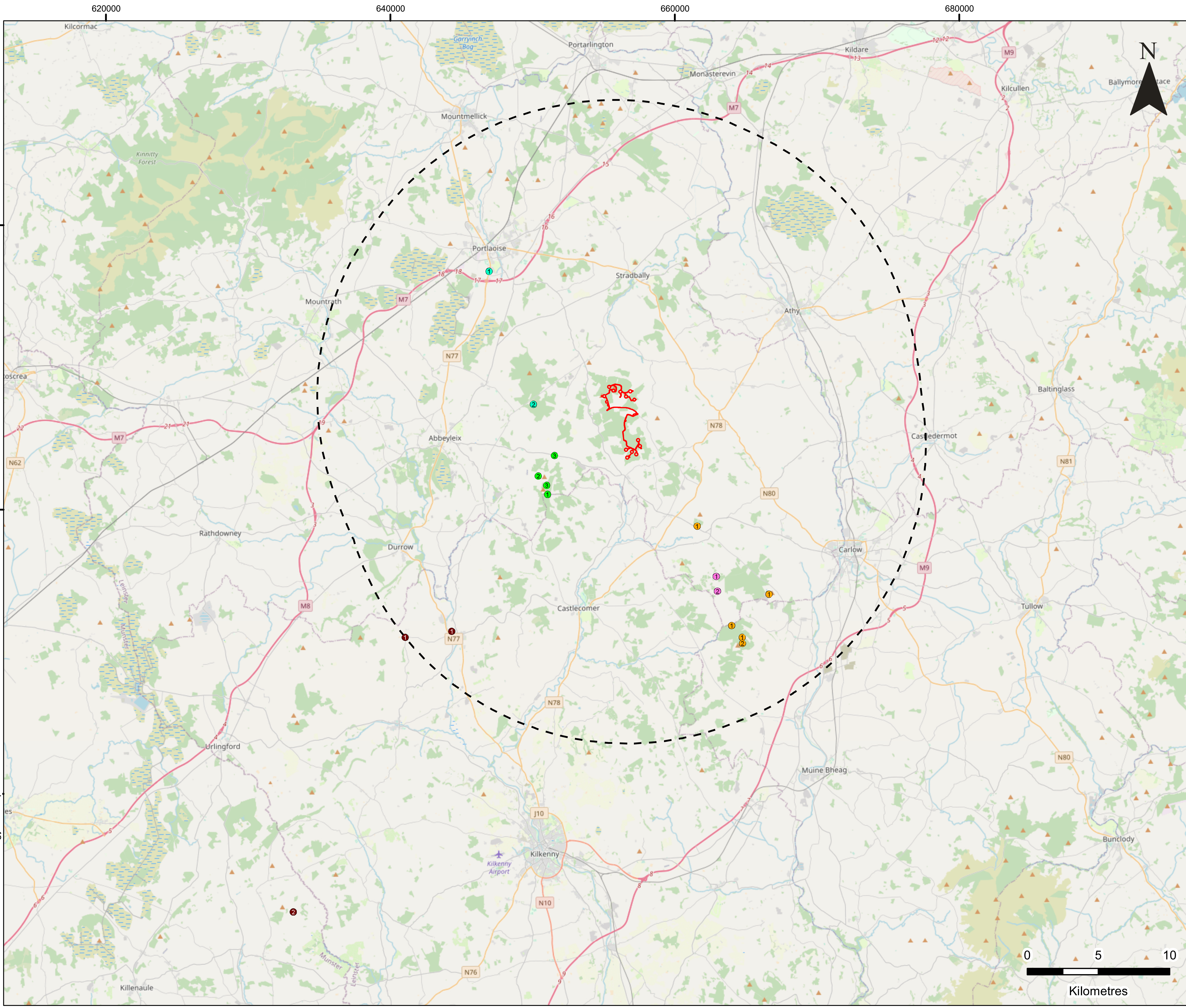
Wind Farms in 20 km

Coolglass Wind Farm NIS

Coolglass Wind Farm Limited

SLR Project No.: 501.V00727.00006

11 July 2023



LEGEND

Proposed Development Site Boundary

Proposed Development Site Boundary 20 km Buffer

Renewable Energy Projects

1 Bilboa Wind Farm - Grid Connection

2 Bilboa Wind Farm - Wind Farm Development and Alterations

1 Cullenagh Wind Farm - Grid Connection

2 Cullenagh Wind Farm - Wind Farm Development

1 Farranrory Wind Farm - Grid Connection

2 Farranrory Wind Farm - Wind Farm Development

1 Gortahile Wind Farm - Retaining of Entrance Road

2 Gortahile Wind Farm - Wind Farm Development

1 Pinewood Wind Farm - Further Works

2 Pinewood Wind Farm - Grid Connection

3 Pinewood Wind Farm - Wind Farm Development

0 5 10

Kilometres

Statkraft

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COOLGLASS WIND FARM
ENVIRONMENTAL IMPACT
ASSESSMENT REPORT

DESCRIPTION OF THE DEVELOPMENT

CUMULATIVE DEVELOPMENTS IN THE VICINITY OF THE PROPOSED DEVELOPMENT

FIGURE 3-4

Scale	Date
1:250,000 @ A3	JUNE 2023

02036.00787.0071.0 Renewable Energy Developments

Applicant / Development Name	Development Type	Reg. Ref.	Distance to Development
Michael Johnson	restoration of existing quarry to agricultural grassland and to include the importation of inert soil and stones (EWC class 17 05 04) at a rate of 15,000 tonnes per year to facilitate same development and associated site works.	20247 (Laois) Granted 19/11/2020	4km
Bilboa Wind Farm	installation of approximately 4.6 ('km') of underground cables within Carlow County Council ('CCC') boundary and approximately 2.0km within Laois County Council ('LCC') boundary with a voltage of up to 38 kilovolts and associated works, including a new substation with LCC, for the connection of the consented Bilboa Wind Farm (Planning Register References: Carlow County Council 11/154; An Bord Pleanala PL 01.240245) to the national electricity grid; upgrading of an existing forestry track within CCC; construction of two new onsite access track within CCC; re-orientation and increasing in size of a crane hardstanding area within CCC; and road strengthening and widening along an updated turbine delivery route, within LCC, pursuant to the consented Bilboa Wind Farm (Planning Register References: Carlow County Council 11/154; An Bord Pleanala PL 01.240245).	Date Granted: 12.07.2021 (Laois Co. Co.) / 13.07.2021 (Carlow Co. Co.) Grant Date: 19/11/2020	17km
Bilboa Wind Farm	installation of approximately 4.6 kilometers ('km') of underground cables within Carlow County Council ('CCC') boundary and approximately 2.0km within Laois County Council ('LCC') boundary with a voltage of up to 38 kilovolts and associated works, including a new substation with LCC, for the connection of the consented Bilboa Wind Farm (Planning Register References: Carlow County Council 11/154; An Bord Pleanala PL 01.240245) to the national electricity grid; upgrading of an existing forestry track within CCC; construction of two new onsite access track within CCC; re-orientation and increasing in size of a crane hardstanding area within CCC; and road strengthening and widening along an updated turbine delivery route, within LCC, pursuant to the consented Bilboa Wind Farm (Planning Register References: Carlow County Council 11/154; An Bord Pleanala PL 01.240245).	Laois (20281) / Carlow (20282) Date Granted: 15.02.2022	17km
Bord Na Móna Powergen Ltd.	Develop a Renewable Gas Facility, associated peat deposition area and external and internal road upgrades at Cúil Na Móna Bog within the townland of Clonboyne and Clonkeen, Portlaoise, Co. Laois. The total area of the proposed development is 17.34 Ha and consists of the following elements: 1. Renewable Gas Facility (6.85 Ha) including the following: Weighbridge and Weighbridge Office - 21m2 in area 4.45m high, Administration Building 228m2 in area 5.1m high, Reception Building 2,700m2 in area 11.75m high, Odour Abatement unit 400m2 in area stack height 18m, Tank Farm - 2 no. primary digestion tanks (6,500m3) 22m high; 2 no. secondary digestion tanks (5,650m3) 17.2m high; 2 no. buffer storage (450m3) 6m high; 4 no. liquid feed intake tanks (100m3) 12m high; 2 no. process water tanks (30m3) 7.5m high; 4 no. pasteurisation	ABP-309293-21 / 19530 (Laois) 3rd Party appealed on 06/10/2022	14km

Applicant / Development Name	Development Type	Reg. Ref.	Distance to Development
	tanks (30m3) 7.5m high, Gas Upgrade and Injection Plant 1,278m2, Covered Digestate lagoon 55,100m3 capacity, Surface Water Attenuation pond 20m x 30m, Wastewater below ground holding tank 10m3 capacity, Palisade site fencing 2.4m high, 1,420m in length, On-site electrical sub-station up to 22m2, Circulation yard area 3,500m2 incl. 28 no. car parking spaces. 2. Peat deposition and surrounding area (9.13Ha) 3. External road upgrades including proposed new roundabout, upgrade of R445 and local access road to existing site entrance - 660m in length (0.91Ha) 4. Internal upgrade of site access road - 443m in length (0.45Ha). Permission is sought for a period of 10 years and is a development that is for the purpose of an activity requiring an Industrial Emission Licence from the EPA		
Lagan Materials Limited (Spink Quarry)	Develop as follows: the continued use and operation of the existing quarry including deepening of the quarry. Extraction will be confined to the existing permitted quarry area (P.A. Ref. 10/383) comprising an extraction area of c. 14.5 ha within an overall application area of c. 19.6 ha. The development will include provision of new site infrastructure, including portacabin site office / canteen, toilets, concrete batching plant and truck washdown facility, hydrocarbon interceptors, mobile crushing and screening plant, upgrading of the water management system, provision of holding tank for wastewater, and other ancillaries. The proposed development will utilise/upgrade the existing in-situ quarry infrastructure, including site access, internal roads, storeroom, wheel wash, weighbridge, aggregate storage bays, refuelling hard stand, water settlement pond system, and other ancillaries.	21700 (Laois)	3km
Pinewood Wind Limited	11 wind turbines, electricity substation, switch room, equipment compound, site access tracks, 7 site entrances, meteorological mast, upgrade of road junction. Townlands: Knockardugar, Boleybawn, Garrintaggart, Ironmills, Co. Laois	PL11.248518 (ABP) / 16/260 (Laois) Granted 03/09/2021	4km
Pinewood Wind Limited	A 110kv 'loop in/loop-out' Air-Insulated Switchgear substation, electricity lines, on-site access tracks and all associated site development works. Townlands: Knockardagur, Ballinakill, County Laois	ABP-308448-20 Granted 22/11/2021	4km
Pinewood Wind Limited	2 kilometres of site access tracks, underground electricity and communications cabling and site drainage works. Townlands: Lands at Crutt, County Kilkenny.	PL10.248392 (ABP) /17/62 (Laois)	4km

Applicant / Development Name	Development Type	Reg. Ref.	Distance to Development
		Granted 03/09/2019	
Cullenagh Wind Farm	develop 18 no. wind turbines each with a hub height of up to 85m and a rotor diameter of up to 93m with an overall tip height of up to 131.5m (including associated transformers and hardstands at each turbine). Permission is also being sought for the provision of internal access roads and strengthening and widening of existing internal forestry access roads; 1 no. permanent meteorological mast of approx. 86m in height; a 38KV single storey substation compound (including switchrooms, control room and ancillary areas) with sanitary facilities and holding tank & 6 no. associated car parking spaces; underground electrical and communication cables linking the turbines with the substation compound; widening of 2 no. existing entrances on the L3777 for temporary construction access, temporary construction compound, and all associated site development and drainage works.	PL11.232626 (ABP) / 13268 (Laois(Granted 14/6/2014	3.5km
Gortahile Wind Farm	a ten year planning permission for a renewable energy development with a 40-year operational life (from the date of commissioning of the renewable energy development). The entirety of the development constitutes the provision of a 9-turbine wind farm and all associated works on lands in both Counties Tipperary and Kilkenny.	04935 (Laois) Granted 27/10/2024	11km
Farranrory Wind Farm and Cable route	erect 7 no. wind turbines, up to 80m hub height & up to 45m blade length, access roads, control building & ancillary site works / a ten-year appropriate period planning permission for development of this site: the proposed development will constitute the provision of the following: the installation of 2.25 km of 38kV underground cable route comprising cable ducting and associated electrical cabling and all other ancillary works including joint bays, culverts, maker posts and all associated developments. Advisory Note: The full extent of the cable route is 33.8 km	Wind Farm-211620 Tipperary (granted 30/32021 Cable route 20972 Tipperary Granted 14/11/2022	17km
Lisdowney Wind Farm (Kilkenny)	for a modification for the redesign of a previously approved development at site address Lisdowney, Ballyragget, Co. Kilkenny planning reference no 08/1511. The previously approved development consisted of a wind farm with 4 turbines, a meteorological mast, electrical control transformer building, burrow pit and associated site roads. The proposed revision is to optimise the layout of the 4 turbines and associated road infrastructure and associated ancillary works and increase the	08/1500, modified under 12/172 (Kilkenny)	11

Applicant / Development Name	Development Type	Reg. Ref.	Distance to Development
	hub height from 64m up to a hub height of 80m and increase the maximum blade tip height from 99.5m to 121.5m.	Granted 23/7/2012	

SLR

Appendix 7

Habitat and Species Management Plan

Coolglass Wind Farm NIS

Coolglass Wind Farm Limited

SLR Project No.: 501.V00727.00006

11 July 2023

Habitats and Species Management Plan

Coolglass Windfarm Vol 2

Prepared by:

SLR Environmental Consulting (Ireland) Ltd

35 Friary Street, Kilkenny, R95 FP62

SLR Project No.: 501.V00727.00006

6 July 2023

Revision: 02

Making Sustainability Happen

Revision Record

Revision	Date	Prepared By	Checked By	Authorised By
0.0 (Internal)	23 May 2023	Dr Jonathon Dunn	Stephanie Boocock	
0.1 (Client Issue)	13 July 2023	Dr Jonathon Dunn		Dr Jonathon Dunn
0.2 (Revision)	Click to enter a date.			
0.3 (Client Issue	Click to enter a date.			
0.4 (Revision)	Click to enter a date.			
0.5 (Final)				

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Figures

1.0 Introduction

This report has been prepared by SLR Consulting Limited (SLR) on behalf of Coolglass Wind Farm Limited (the 'Applicant'), located in Co. Laois. The report presents a Habitat and Species Ecological Management Plan (HSMP) for Coolglass wind farm (the 'Proposed Development') for an initial 20-year period. The HSMP forms a commitment from the development proposal and should be read in conjunction with Environmental Impact Assessment Report (EIAR) chapter 15 (biodiversity) and associated Natura Impact Statement (NIS) report. Any mitigation or compensation measures set out in this document do not relate to any mitigation measures set out in the NIS. All measures in the HSMP will be implemented in full.

1.1 Scope

This HSMP sets out the key objectives and methods by which parts of the Proposed Development lands (the 'Site') will be managed to the benefit of biodiversity. The HSMP is intended to cover the establishment and management of habitats and species required to compensate for impacts identified within the EIAR. Measures to mitigate impacts such as the spread of invasive and non-native species are also included, along with enhancement measures such as the provision of additional nesting habitat for birds and hibernacula for amphibians and reptiles.

Further information about mitigation measures to be employed during the construction period is included in the Construction Environmental Management Plan (CEMP).

2.0 Habitats

The following sections sets out measures to establish, monitor and maintain hedgerows, treelines and broad-leaved woodland that will be implemented in full.

2.1 Hedgerow and treeline creation/enhancement

2.1.1 Objectives 1.0, 2.0 and 3.0

The objectives relating to hedgerow/treeline creation/enhancement are set out below along with associated measures to successfully establish and manage these habitats. Objectives and criteria for success have been developed in accordance with the Green, Low-Carbon, Agri-Environment Scheme (GLAS) specifications (Department of Agriculture, Food and the Marine, 2020) and the Hedgerow Appraisal System (Foulkes et al., 2013).

Figure 1 shows the locations for proposed hedgerow and treeline creation, which are all within the red-line boundary.

Objective 1.0 Establishment of new hedgerows/treelines

- Plant 939 m of new hedgerows and 141 m of new treelines using native fruit and seed-bearing species (e.g. hawthorn ***Crataegus monogyna***, blackthorn ***Prunus spinosa***, dog rose ***Rosa canina,*** guelder rose ***Viburnum opulus***, hazel ***Corylus avellana,*** holly ***Ilex aquifolium***, spindle ***Euonymus europaeus*** and alder buckthorn ***Frangula alnus*** for hedgerows and bird cherry ***Prunus padus***, crab apple ***Malus sylvestris***, goat willow ***Salix caprea***, grey willow ***Salix cinerea***, rowan ***Sorbus aucuparia,*** wild cherry ***Prunus avium***, hawthorn, Irish whitebeam ***Sorbus hibernica***, sessile oak ***Quercus petraea*** and pedunculate oak ***Quercus robur*** for treelines) using a 'like-for-like' approach to replace lost hedgerows/treelines where possible.
- If planting a new hedgerow that will be topped, the species chosen must tolerate trimming, such as hawthorn and blackthorn.
- Plants must be of Irish Origin or Irish Provenance and purchased from Department of Agriculture, Fishing and the Marine (DAFM) registered professional operators[1].
- New planting will be undertaken in the appropriate season, with bareroot stock planted October to December (avoiding periods when the ground is waterlogged or frozen) unless on clay, when planting should be delayed until March due to risk of heave during heavy frost.
- Planting will not be undertaken until the first appropriate season post-construction to avoid damage to whips.
- Cultivate the ground prior to planting and add organic matter if required.
- To ensure new hedgerows are beneficial for biodiversity, there must be six plants per metre in a double-staggered row with >10 species per 30 m section. Overall, no one species will make up more than 70% of the total number of plants.
- If planting a new treeline, any mix of native hedgerow and tree species can be chosen, with one tree at every 15 m.
- Water during first year to assist with establishment. Frequency of watering to adapt to weather conditions.
- If planting new hedgerows in a grass or tillage field, they must be protected from livestock with an appropriate permanent fence, which can be moved out further as the hedgerow matures and expands.
- Trees will be left to mature without cutting and protected with a tree guard/shelter and fenced off from livestock if present.
- Cut hedgerows annually during establishment phase to encourage sideways growth and canopy closure. Some plants will not be cut / trimmed and allowed to grow into mature hedgerow trees.

[1] The GLAS specification provides the mailbox plantandpests@agriculture.gov.ie as the place to request this info from.

- Competing vegetation will be controlled, preferably via mulching with organic matter, and avoiding the of use of chemical herbicides.
- Failed or dead plants (identified during condition assessments) should be replaced the following planting season.
- Should any newly planted hedgerows require temporary removal to allow for maintenance works to the wind farm, they will be reinstated following the criteria mentioned above.

Objective 2.0 Enhancing existing poor-quality hedgerows/treelines

- Ensure all hedgerows/treelines within the red-line boundary are fenced to prevent (further) damage from livestock in areas where livestock are / could be present.
- Remove competing vegetation or alien invasive plant species following relevant guidance including that published online by the Department for Agriculture, Food and the Marine (DAFM, 2021) and the National Roads Authority (2010).
- Fill in gaps in poor-quality hedgerows/treelines following the relevant species and planting requirements set out for Objective 1.0.

Objective 3.0 Enhancing habitat linkages and continuity of habitats

- The locations of any new hedgerows/treelines to be planted as part of objective 1.0 will be chosen to maximise connectivity between woodland habitats within and outside of the red-line boundary (see Figure 1).

2.1.2 Measures of success

Success will be assessed by monitoring the condition of hedgerows/treelines throughout the establishment phase, and, at less frequent intervals, throughout the maintenance phases.

Hedgerows

- Newly created or enhanced hedgerows will be subject to condition assessment following the Hedgerow Appraisal System each year after planting for the first 5 years (the establishment phase), and then every 5 years until (and including) year 20 (the maintenance phase). This will help identify ongoing management actions, such as weed control, gapping up and where fence maintenance is required.
- By Year 5 after planting, hedgerows should meet the criteria for 'Favourable' under the Hedgerow Appraisal System.
- In addition to the condition assessment, the diversity of the tree / shrub / climber component (otherwise described in the Hedgerow Appraisal System as 'canopy' forming species) should be the same, or greater than, that at planting (>10 native species per 30 m length).

Treelines

- Newly planted trees forming treelines will be inspected each year after planting for the first 5 years, and then every 5 years until year 20. These inspections will inform the need or otherwise for weed control, replacement of failed trees, removal of tree guards (usually around Yr 3-5), and pruning.
- Success will be defined as >95% of trees established at Year 5, with at least 90% at Year 20 meeting the British Standard 5837: Trees in relation to design, demolition and construction – Recommendations (2012) criteria for Category A - Tree of High Quality'.

3.0 Species

The following sections set out measures to create habitats or otherwise enhance the Site for birds, mammals, amphibians and reptiles. These measures are independent of any compensation measures which may be required by wildlife licences potentially needed to allow construction work to progress.

3.1 Bats

3.1.1 Objective 4.0

Any works to roosts recorded during pre-construction checks of trees / bridges will be subject to NWPS licence conditions.

All hedgerows and treelines that will be lost due to construction will be replaced (as per Section 2.1) which will ensure there is no net loss of commuting routes for bats and the creation of mixed broadleaved woodland (as per Section 2.2) will provide foraging resources to bats in the medium and long-term.

3.2 Birds

3.2.1 Objective 5.0 and 6.0

The adoption of good practice measures will avoid damage/destruction of bird nests and disturbance / displacement of birds during construction (see Section 15.6.1 in EIAR chapter 15 for more details) would ensure no impacts to habitats used by birds in the wider area. However, to reduce or offset collision risk during operation, measures to dissuade sensitive species form nesting near to turbines will be implemented. Also, measures to reinforce local populations through provision of additional nesting habitat will be implemented. Enhancement measures further include provision of nesting/breeding habitat as set out below, and Objectives 1.0-3.0 (relating to creation of hedgerows and treelines) will also be of benefit to the local bird populations.

Figure 1 shows the indicative locations for proposed bird management measures.

Objective 5.0 Reduction in habitat suitability

The EIAR states that:

Mitigation to limit common kestrel foraging activity around turbines will be implemented. This will include the following measures to reduce prey availability in an area of 96 m to 103 m surrounding each turbine (this reflects the dimensions of the turbine permutations assessed):

- ***Creation of uniformly short vegetation heights via infrequent mowing or trimming of vegetation;***
- ***Removal of timber/brash from felling and chipping of tree stumps to ground level;***
- ***Spread and compaction of chipped wood and spoil to create a flat surface to prevent rapid colonisation of new vegetation; and***
- ***Piping/filling over of open field/forestry drains.***

Objective 6.0 Provision of bird nesting habitat

Additional measures to increase nesting habitat will be implemented as follows:

- Erection of one swift tower whose location will be agreed in conjunction with landowners and Planning Authority prior to the operation of the Proposed Development. An indicative location within the red-line boundary is shown in Figure 1.

3.2.2 Measures of Success

- Annual vegetation checks in Years 1-5 around turbines indicate that these areas are being maintained as unsuitable for common kestrel.
- Use of swift tower by relevant bird species as evidenced by annual breeding bird surveys / checks of nesting habitat (using methods that avoid disturbance).
- Bird surveys / checks every year during years 1-5 post-construction.

3.3 Hedgehogs

3.3.1 Objective 7.0

The adoption of good practice measures during construction will minimise direct and indirect impacts on hedgehogs ***Erinaceus europaeus***. Measures to enhance the Site for hedgehog during operation involve the creation of hibernacula and are set out below. Objectives have been developed using Gazzard and Baker (2022).

Figure 1 shows the indicative locations for proposed hedgehog management measures within the red-line boundary.

Objective 7.0 Provision of hibernacula for hedgehogs

- Eight no. hibernacula will be constructed for hedgehogs from logs arising from felled trees as shown in Figure 1;
- The hibernacula will be constructed in areas that are south facing, well-drained, undisturbed by humans/vehicles (e.g. paths and roads) adjacent to broad-leaved trees (to provide leaves for nest construction[2]) and act as transitions between habitats (e.g. between scrub and woodland etc);
- The logs will be laid in a hole 0.5 m deep, and at least 2 m wide and 4 m long, with turves of vegetation from the area excavated kept aside to be placed on top of the hibernacula. The hole will be filled to just below ground level with gravel or sand to facilitate drainage, with logs piled on top in a configuration that creates voids within the heap, with access gaps into these voids. Logs will be piled to a height of at least 1m. Soil arising from the hole and the salvaged turves of vegetation will be laid on top of the logs with the aim of establishing a cover of vegetation to provide insulation.
- The locations of the hibernacula will be agreed in conjunction with landowners and the Planning Authority prior to the operation of the Proposed Development.

3.3.2 Measures of success

- Annual checks in Years 1-5 indicate hibernacula are in suitable condition for use by hedgehogs.
- Evidence of use (droppings, nests) recorded within at least two hibernacula in the first 5 year after construction.
- All hedgehog records to be submitted to the Irish Hedgehog Survey online at Record sightings | Hedgehog Survey (irishhedgehogsurvey.com)

3.4 Reptiles and amphibians

3.4.1 Objectives 8.0 and 9.0

Best practice measures adopted during construction will prevent direct impacts to frogs and reptiles such as pre-works checks for spawning frogs and the use of herpetofauna fencing to prevent individuals from accessing potentially dangerous construction areas.

To increase the suitability of the site for reptiles and amphibians further enhancement measures are presented below based on guidance within the Reptile Habitat Management Handbook (Edgar et al., 2010) and the Amphibian Habitat Management Handbook (Baker et al, 2011).

Figure 1 shows the indicative locations for proposed reptile and amphibian management measures within the red-line boundary.

[2]Gazzard & Baker, 2022 found that the presence of supply of broad leaved leaves as a bedding material increased the likelihood of nest box occupancy.

Objective 8.0 Provision of reptile and amphibian hibernacula

- Eight no. hibernacula will be constructed for reptiles and amphibians from logs formed from felled trees (see Figure 1);
- The hibernacula will be created in addition to those for hedgehogs, but to the same specification.
- The hibernacula will be located in a sunny position, orientated such that a long side faces south and near to watercourses / drainage ditches, within rough grassland or scrub and avoiding areas of intensively managed / grazed land.

Objective 9.0 Management of new and existing drainage ditches to benefit amphibians

- Dredging to be undertaken of new and existing ditches within red-line boundary outside amphibian breeding period (February – July) and on rotation with not more than ¼ of ditch length dredged over a 3-year period.
- Dredging arisings to be left near to ditch.
- Ditch / marginal vegetation to be cut on rotation, with not more than ¼ of ditch length cut over a 3-year period, and to a minimum of 150 mm above ground level.
- Shading vegetation controlled to ensure ditch network does not become totally shaded. Not more than ¼ of shading vegetation cut over a 3-year period.
- Where possible in discrete sections ditches to be locally widened and deepened to encourage 'ponding' / retention of water during dry spells.

3.4.2 Measures of success

Reptile and amphibian species richness and abundance will be measured via physical checks to ensure hibernacula are still present and functional in years 1-5 post-construction, plus the ditch network will be checked against measures outlined in objective 9.0 .

3.5 Invertebrates

3.5.1 Objective 10.0

To increase the suitability of the site for pollinators. further enhancement measures are presented below based on guidance contained within the NBDC (2022) Protecting Farmland Pollinators Project report was used to inform proposed management measures for invertebrates.

Figure 1 shows the indicative locations for proposed invertebrate management measures.

Objective 10.0 Provision of invertebrate hibernacula

- Maintain 5 m rough grassland buffer along borrow pit to provide habitat for pollinators;
- Erect insect hotels in the first year of operation. Insect hotels or bee boxes can be created by drilling holes into fence posts or pieces of wood and positioning appropriately. These sites can be created along dry hedgerows, driveways and other field boundaries;
- Ensure insect hotels are maintained or replaced over the lifespan of the wind farm as required; and
- Locate both insect hotels in sunny, sheltered areas, ideally no more than 300 m from areas of food plants.

3.5.2 Measures of success

- At least three insect hotels per 35 ha;

- Maintenance checks to ensure grassland buffer habitats, and insect hotels still present and functional, to be carried out annually in Years 1-5 post-construction.

4.0 Invasive Species

Regarding plants, cherry laurel ***Prunus laurocerasus,*** fuchsia ***Fuchsia magellanica***, Himalayan honeysuckle ***Leycesteria formosa,*** Japanese knotweed ***Fallopia japonica***, Japanese rose ***Rosa rugosa***, red flowering currant ***Ribes sanguineum*** and snowberry ***Symphocarpos alba*** and have been recorded near to the Proposed Development by surveys. Canadian pondweed ***Elodea canadensis*** was also recorded by aquatic surveys.

Regarding animals, crayfish plague ***Aphanomyces astaci*** was recorded by aquatic surveys and greater white-toothed ***Crocidura russula*** shrew was recorded by terrestrial surveys. However, measures to minimise the risk of spreading crayfish plague are described in the EIAR chapter and the Proposed Development will not spread greater white-toothed shrew. Consequently, the below focuses on invasive alien plant species.

The distribution of the invasive alien plant species is presented in the EIAR Figure 15-4.

Table 4-1 below describes the location of the species in relation to the Proposed Development's footprint.

Table 4-1: IAS species recorded

Species	X (ITM)	Y (ITM)	Description of Baseline Conditions	Within Development Footprint? Y/N
Canadian pondweed	657171	696342	At aquatic survey site A15 (Stradbally River) downstream of grid connection route (GCR) option 2	N
	656510	679059	At aquatic survey site C7 (Clogh River) downstream of southern cluster	N
Cherry laurel	656558	684477	In forestry southern cluster	N
	656512	685618	Next to forestry track southern cluster	N
	656547	685164	In hedgerow southern cluster	Y
	651361	683683	In hedgerow along GCR option 1	Y
	650981	683665	In hedgerow along GCR option 1	Y
Fuchsia	656548	685171	In hedgerow southern cluster	Y
	657181	686671	In quarry borrow pit	Y
Himalayan honeysuckle	650765	683629	In hedgerow along GCR option 1	Y
Japanese knotweed	657170	686671	In quarry borrow pit	Y
	657178	686674	In quarry borrow pit	Y
	657178	686667	In quarry borrow pit	Y
	652375	683682	Near house along GCR option 2	N

Species	X (ITM)	Y (ITM)	Description of Baseline Conditions	Within Development Footprint? Y/N
Japanese rose	656552	685166	In hedgerow southern cluster	Y
Red flowering currant	651243	683673	In hedgerow along GCR option 1	Y
Snowberry	656548	685154	In hedgerow southern cluster	Y
	656553	685147	In hedgerow southern cluster	Y
	653612	690398	In hedgerow along GCR option 2	Y
	653418	685726	In hedgerow along GCR option 1	Y
	653424	685726	In hedgerow along GCR option 1	Y
	651283	683683	In hedgerow along GCR option 1	Y
	651034	683666	In hedgerow along GCR option 1	Y

4.1 Objective 11.0 Control of Invasive Alien Species

To eradicate and/or halt the spread of IAS via prevention, containment, treatment and eradication, the following management measures will be implemented with reference to best-practice guidance provided in relevant sections.

4.2 Details of proposed management measures

4.2.1 General prevention measures

- Supervision of control measures and treatment by appropriate qualified ecologist or invasive species specialist;
- Use of toolbox talks given by suitably qualified personnel as part of site introduction to workers, including what to look out for and procedures to follow if invasive species are observed;
- Only planning or sowing native species within the main wind farm site, and along the GCR and TDR.
- Where invasive species are physically removed, disturbed soil will be seeded or replanted with native plant species to prevent recolonisation of bare soil by non-natives;
- Unwanted material originating from the Site will be transported off-site by an appropriate licenced waste contractor and disposed of at a suitably licenced facility, or buried on-site following NRA (2010) guidelines;
- Signs will be used to warn workers of invasive species contamination;
- Good hygiene practices;
- Removal of build-up of soil on equipment;
- Keeping equipment clean;
- Washing vehicles existing the Site using a pressure washer to prevent the transport of seeds;
- Storing wastewater from washing facilities securely and treating to prevent spread of invasive species outside the Site; and
- Checking footwear and clothing of operatives working nearby invasive species for seeds, fruits or other viable material before leaving Site.

4.2.2 General containment measures

- A pre-construction survey will be used to confirm the findings of the EIAR during the growing season immediately prior to the construction phase. This will be used to physically mark out the extent of invasive plant species.
- A 1 m buffer (except for named species below) will be used to cordon off invasive species outside the works footprint.

4.2.3 Species-specific treatment measures

Japanese knotweed

Japanese knotweed code of practice

To help developers, consultants, and contractors to select the most appropriate treatment option, some excerpts from the Knotweed Code of Practice[3] are reproduced below. The code of practice has been developed by experts in the control of Japanese knotweed and is based on the successes and failures of a number of Japanese knotweed management plans in the United Kingdom. Therefore, it represents the best available guidance on the different treatment options.

- "***Unless an area of Japanese knotweed is likely to have a direct impact on the development, control it in its original location with herbicide over a suitable period of time, usually two to five years.***
- ***Only consider excavating Japanese knotweed as a last resort, and if so, keep the amount of knotweed excavated to a minimum.***
- ***Soil containing Japanese knotweed material may be buried on the site where it is produced to ensure that you completely kill it. Bury material at least 5m deep.***
- ***Where local conditions mean you cannot use burial as an option, it may be possible to create a Japanese knotweed bund. The purpose of the bund is to move the Japanese knotweed to an area of the site that is not used. This 'buys time' for treatment that would not be possible where the Japanese knotweed was originally located.***
- ***Due to timing, location, landfill is the only reliable option, but it should be treated as a last resort. Landfill can be expensive and would require haulage, which would increase the risk of Japanese knotweed spreading.***
- ***When transporting soil infested with Japanese knotweed to landfill, it is essential to carry out strict hygiene measures. If these standards are not followed, this may result in the spread of this invasive species. Japanese knotweed is a particular problem along transport routes/corridors, where it can interfere with the line of vision and can potentially result in traffic accidents***."

Information is also provided in the National Road Authority (NRA) (now Transport Infrastructure Ireland (TII))[4], and Invasive Species Ireland (ISI)[5] in relation to identification, control and eradication of Japanese knotweed.

Exclusion zone

Prior to the construction phase/excavations at the Site, the following bio-security measures will be in place at the site;

- A 7m exclusion zone, measured horizontally from the nearest visible Japanese knotweed plant, will be established around all areas infested by Japanese knotweed.

[3] UK Environment Agency (2013) The Knotweed Code of Practice: Managing Japanese Knotweed on development sites. Version 3. Published by the UK Environment Agency, Bristol. Available online at https://www.gov.uk/government/publications/japanese-knotweed-managing-on-development-sites (now withdrawn).

[4] https://www.tii.ie/technical-services/environment/construction/Management-of-Noxious-Weeds-and-Non-Native-Invasive-Plant-Species-on-National-Road-Schemes.pdf

[5] Invasive Species Northern Ireland – Invasive Species Northern Ireland (invasivespeciesni.co.uk)

- Where part of the exclusion zone encroaches onto an active public access, or beyond a site boundary, this section of the exclusion zone will be positioned as close as possible to the boundary.
- The exclusion zone will be delineated with a secure temporary construction fence, such as herras panels or timber post and netting, and be fitted with appropriate warning / advisory signage.
- Fencing will remain in place for the duration of construction works, and while the stand is being treated, allowing the rest of the fencing to be constructed. No fencing will be erected within this exclusion until treatment is completed and no new growth is detected.
- Signs will be placed on the fence to advise site personnel that the area contains Japanese knotweed material, and that bio-security measures are actively in force.

Chemical control

The desired option to treat Japanese knotweed generally is to control the infestation in-situ with a combination of physical and herbicide control over a period of time (typically 3-5 years, or until no new growth is observed). The control of Japanese Knotweed will require the use of herbicides, which can pose a risk to human health, to non-target plants or to wildlife. In order to ensure the safety of herbicide applicators and of other public users of the site, it is essential that a competent and qualified person carries out the herbicide treatment. A qualified and experienced contractor will be employed to carry out all treatment work. The contractor will follow the detailed recommendations of the following documents for the control of invasive species and noxious weeds:

- Chapter 7 and Appendix 3 of the TII Publication: The Management of Noxious Weeds and Non-Native Invasive Plant Species on National Roads (NRA, 2010)
- Best Practice Management Guidelines for Japanese Knotweed (Invasive Species Ireland, 2015)
- Circular Letter NPWS 2/08 Use of Herbicide Spray on Vegetated Road Verges (National Parks and Wildlife Service 2008)

A systemic herbicide (e.g. Picloram) and/or a bioactive formulation (i.e. glyphosate) may be sprayed on foliage during dry weather or injected directly into the stems of Japanese Knotweed plants identified within the proposed development site. Strong systemic herbicides are most effective at targeting the persistent roots of Japanese Knotweed, however it should be noted that they may also persist in the soil and/or kill surrounding vegetation. The length of treatment may vary depending on the type of herbicide used, i.e. highly persistent herbicides may eradicate a plant within one to two years, whereas non-persistent herbicides (such as glyphosate) may take over a period of at least three years to ensure the successful eradication of the plants.

Annual spot-checks will be conducted in May-June to identify and retreat any re-growth. Such a treatment can take up to five years to completely eradicate growth; therefore, further treatment may be required beyond the three years. This will be determined by the results of the monitoring. Japanese Knotweed does not produce viable seed in Ireland, and therefore seed germination in subsequent years will not be an issue. The optimal time period for treatment is May-June and September-October.

It should be noted that these herbicides can pose a general risk to non-target plants, to wildlife and/or human health. Chemical control using a bioactive formulation of glyphosate is the most appropriate herbicide for use in or near water (Environment Agency, 2010). To ensure the safety of herbicide applicators and of other public users of the site, a qualified and experienced contractor should be employed to carry out all work.

Cherry laurel

Four options for the treatment of cherry laurel have been proposed. Any one or a combination of these four options shall be used to eradicate cherry laurel from the site and avoid the spread of the species. However, the following general recommendations will be adhered to as part of the plan:

- No treatment measures to take place in these areas without supervision and agreement by appointed Cherry Laurel eradication specialist.
- The cherry laurel plant contains cyanide and as per good practice will only be handled with gloves. This plant will be disposed of via an appropriately licensed waste facility.
- Equipment, clothing and footwear is to be checked following treatment operations and cleared of fruits/seeds as necessary.

Option 1 – Cut to stump and dig out stump; bury onsite This method involves cutting the main stem of the plant down near ground level and digging out the stump and any visible roots. This option is not usually practical in areas where there are other invasive plants present as the disturbed soil can allow for the setting of seeds or the spread of rhizomes of adjacent species (ISI, 2008).

Option 2 – Cut to stump and treat stump with herbicide This method involves cutting the main stem of the plant down near ground level, and applying herbicide to the freshly cut wound. The herbicide concentrations used, and timings of applications vary according to which chemical is used. When treating many stems, vegetable dye added to herbicide is useful for highlighting the stems that have and haven't been treated. The use of a brush or other such applicator will provide an accurate application and prevent damaging adjacent non-target plants via spray drift. Please see table below for best treatment time (ISI, 2008). Since the 26th November 2015, only a DAFM-registered professional user can apply Plant Protection Products that are authorised for professional use. As such any application of herbicide must be carried out by a professional user. Since the 26th November 2016, it has been a requirement for sprayers to have passed a Pesticide Application Equipment Test before being used to apply professional use Plant Protection Products.

Option 3 – Cut to main stem and inject stem with herbicide This method involves the 'drill and drop' method where the main stem is cut, and a hole drilled into the cut. The main drawback to this technique is that the plant is left in place to rot, which can take a decade or more. Please see Table 5-1 below for best treatment time (ISI, 2008).

Option 4 - Cut back to stump and spray regrowth with herbicide This application involves cutting a main stem down near ground level and then treating the new stems with herbicide. This method is the least effective as some stems may be missed and not treated. Also, the application of herbicide is generally via spraying, which can result in adjacent non-target plants being killed off. Please see Table 5-1 below for the best treatment times(ISI, 2008)

Any reproductive plant material will be carefully disposed of following NRA (2010) Guidelines. Any equipment used will be inspected and thoroughly cleaned, as will the footwear and clothing of operatives removing invasive species material. Any material arising from cleaning of equipment and footwear will be disposed of in a manner which will not cause the spread of invasive species

Snowberry

The primary means of preventing spread of this species due to the works is predicted to be avoidance, as it is located in hedgerows along the two GCR options. In the event of interaction of works with snowberry, one option for the treatment of snowberry at the site has been proposed to avoid the spread of the species. The following general recommendations will be adhered to as part of the plan:

- Snowberry is spread both by seed, a buffer area of 1m will be left to prevent further contact with plants, possibly causing seeds to fall or become attached to machinery or people. Disturbed seeds may result in the propagation of a new snowberry population elsewhere.
- Staff shall be made aware of this buffer zone when working within areas of infestation.
- Areas of infestation will be fenced off from other works areas including a buffering distance of up to 1m to create exclusion zones.
- Construction works will not be allowed within exclusion zones until the species has been fully removed but may continue outside of these areas.
- No treatment measures to take place in these areas without supervision and agreement by appointed eradication specialist.
- All machinery and vehicles operating within areas of infestation to be thoroughly checked and if necessary cleaned prior to leaving the area to protect against further spreading of snowberry.
- No material shall be taken from areas of infestation, unless for disposal. All material will be either deep buried (2m) or transported by an appropriately licensed waste contractor and received by an appropriately licensed facility.
- All staff shall be made aware of nature of threat via toolbox talks as part of site inductions. Toolbox talks shall be undertaken with all personnel accessing the site to ensure that the details of the invasive species management plan are adhered to and to raise awareness of the potential treat of invasive species.

- Wheel washes shall be put in place at entry and exit points, if considered appropriate. Wastewater from these facilities will need to be stored and treated to avoid further outbreaks.
- If operating within an area of known infestation all machinery, vehicles, equipment, foot ware and clothing will need to be cleaned thoroughly (if necessary, using steam cleaners) in a contained area to avoid further contamination.

Option 1- Excavation of the entire root system is thought to be a very effective method of Snowberry control. This must be done before the plants' seeds ripen in autumn. Plant matter from this process can be disposed of using a licenced landfill site or may be buried to a depth of over 2m.

Any reproductive plant material will be carefully disposed of following NRA (2010) Guidelines. Any equipment used will be inspected and thoroughly cleaned, as will the footwear and clothing of operatives removing invasive species material. Any material arising from cleaning of equipment and footwear will be disposed of in a manner which will not cause the spread of invasive species.

Fuchsia, Himalayan honeysuckle, Japanese rose, flowering red currant

These species are unlikely to be affected by Proposed Development works and as such the primary means of prevention of spread is avoidance. If interaction with these species is unavoidable, any reproductive plant material will be carefully disposed of following NRA (2010) Guidelines. Any equipment used will be inspected and thoroughly cleaned, as will the footwear and clothing of operatives removing invasive species material. Any material arising from cleaning of equipment and footwear will be disposed of in a manner which will not cause the spread of invasive species.

4.3 Measures of success

- Continual monitoring of Site for signs of regrowth of all invasive species during operational phase – presence, distribution and extent of species will be used as an indicator of success with eradication representing complete success;
- Site to be monitored annually during operational phase years 1-5, 10, 15 and 20 during the growing season for signs of regrowth of all invasive species – presence, distribution and extent of species will be used as an indicator of success with eradication representing complete success.

5.0 Implementation

5.1 Roles and Responsibilities

The implementation of the HSMP will be overseen by a suitably qualified person or persons, typically an ecologist with the required experience and expertise, appointed by Coolglass Wind Farm Ltd.

All management tasks carried out under the HSMP will either be undertaken by the developer, operator or by suitably experienced contractors acting on their behalf, and all ecological monitoring will be undertaken by suitably qualified and experienced ecologists.

An ecologist or horticulturalist with experience of the identification and removal of IAS will be employed to carry out the manual removal of the IAS.

5.2 Management and Monitoring Schedule

The monitoring schedule is shown in Table 5-1 below.

Table 5-1: Monitoring Schedule

Ecological feature	Management works (summary)	Management schedule	Measures to be reported on	Reporting Schedule
Habitats	Hedgerow / treeline creation and enhancement: 938 m of hedgerow and 141 m of treeline	Operational year 1	Details of planting including species composition and locations	Operational year 1
	Hedgerow / treeline checking	Operational years 2-5, 10, 15 and 20	Details of dimensions / species composition of relevant hedgerows / treelines and any remedial actions required	Once a year for operational years 1-5, 10, 15 and 20
Birds	Maintenance of low vegetation height around turbines to deter kestrels	Throughout lifespan of Proposed Development	Height of vegetation and suitability for kestrel prey species	Once a year for operational years 1-5
	Checks to ensure areas around turbines unsuitable for kestrels	Once a year for operational years 1-5		
	Bird box erection: 1 no. swift tower	Operational year 1	Details of structures erected and locations of structures	Operational year 1
	Bird box checking (inspections of nest structures must be made outside of breeding season for relevant species)	Once a year for operational years 2-5	Presence/absence of birds, evidence of box/structure usage and whether box/structure needs repairing/replacing	Once a year for operational years 2-5
Hedgehogs	Creation of log piles: 8 no.	Operational year 1	Presence/absence of hibernacula,	

Ecological feature	Management works (summary)	Management schedule	Measures to be reported on	Reporting Schedule
	Checks for hedgehog hibernacula	Operational years 2-5	evidence of hedgehog usage and remedial measures required	Once a year for operational years 1-5
Reptiles and amphibians	Creation of log piles: 8 no. (separate to those for hedgehogs)	Operational year 1	Presence/absence of hibernacula, evidence of reptile/amphibian usage and remedial measures required	Once a year for operational years 1-5
	Checks for reptile hibernacula	Operational years 2-5		
Pollinating insects	Creation of 5 m rough grassland buffers	Operational year 1	Locations and details of measures implemented and any remedial measures required	Once a year for operational year 1
	Grassland buffer checking	Operational years 2-5		Once a year for operational years 2-5
	Insect hotel erection (3 insect hotels per 35 ha)	Operational year 1	Location and details of measures implemented	Once a year for operational year 1
	Insect hotel checking	Operational years 2-5	Evidence of usage by relevant invertebrates and whether any remedial measures are required	Once a year for operational years 1-5, 15 and 20
Invasive Species	Pre-construction survey	Prior to construction	IAS presence, distribution and extent	Prior to construction
	Invasive species management	Operational years 1-5, 10 and 15	IAS presence, distribution and extent, management measures undertaken if required	Operational years 1-5, 10, 15 and 10

5.3 Reporting and Reviewing

This HSMP has been developed using NatureScot (formerly SNH) guidance (SNH, 2016) and following the recommendations of this guidance monitoring is proposed to measure success of the management measures and to identify whether remedial measures are required if objectives are not being met.

Monitoring results will be reported on an annual basis (during years in which monitoring takes place) and if necessary (e.g. if stated objectives were not being met), recommendations made for reasonable changes to management prescriptions, as appropriate. Monitoring reports will be submitted to Planning Authority and any changes proposed to management prescriptions would be discussed with them in the first instance.

6.0 References

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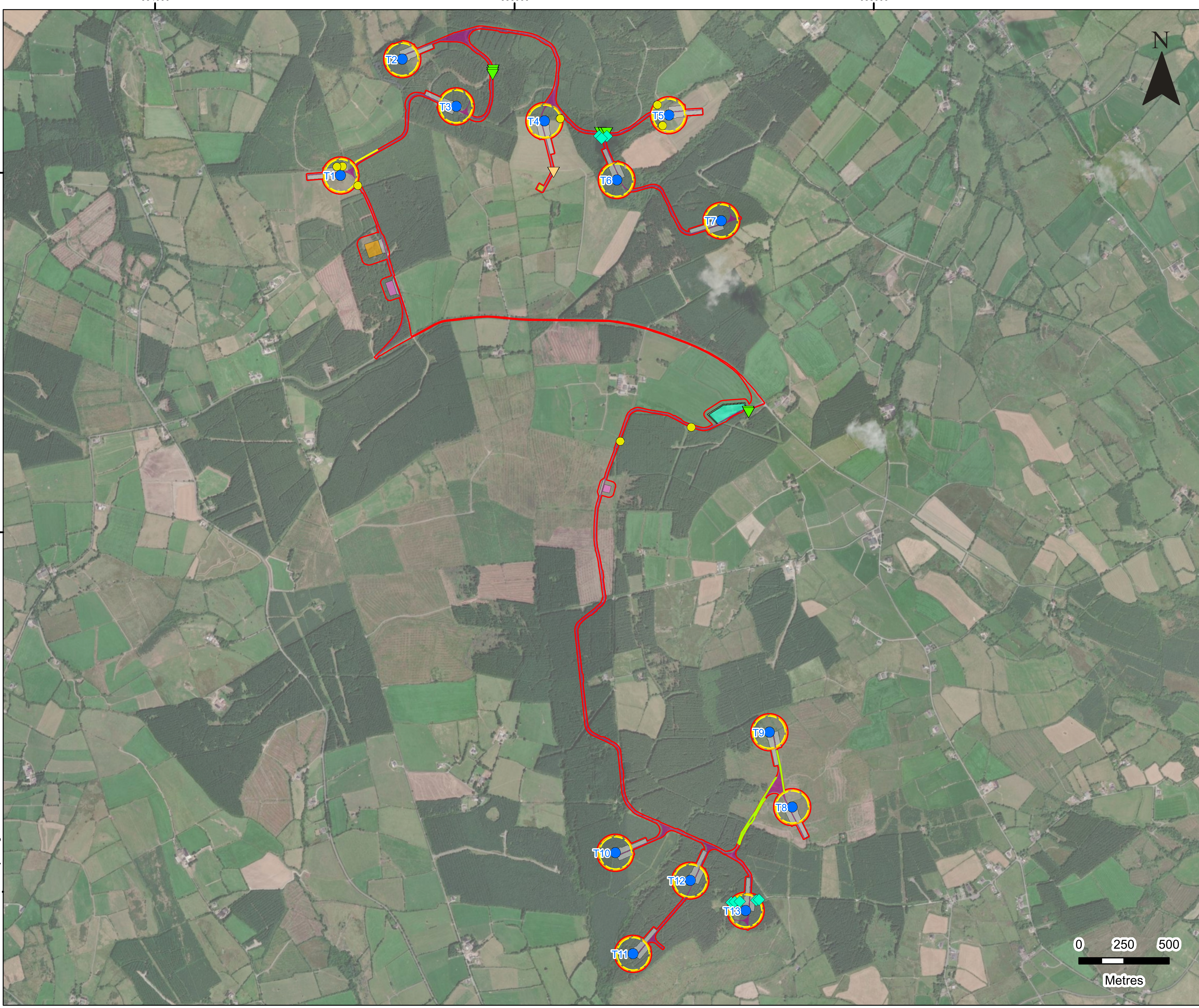
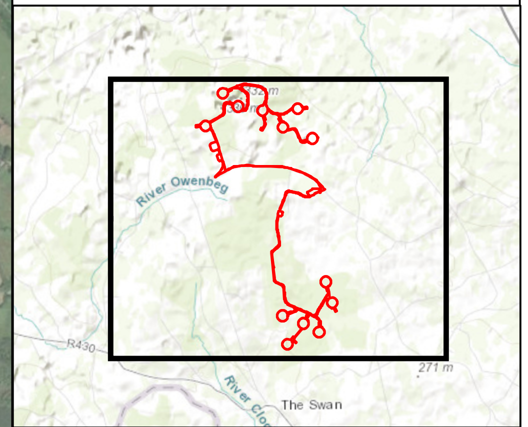
1.0 Figures



LEGEND

- Proposed Development Site Boundary
- Proposed Turbine Layout
- Proposed Substation Compound
- Proposed Temporary Construction Compound
- Proposed Borrow Pit
- Proposed Hardstanding
- Proposed Access Track
- Proposed Met Mast Hardstanding
- Proposed Swift Tower
- Proposed Insect Hotel
- Proposed Hedgehog Hibernacula
- Proposed Amphibian/Reptile Hibernacula
- Proposed Treeline Planting*
- Proposed Hedgerow Planting*
- Proposed Rough Grassland for Pollinators*

*See Habitat and Species Management Plan for details on species mix.



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COOLGLASS WIND FARM
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HABITAT AND SPECIES MANAGEMENT PLAN

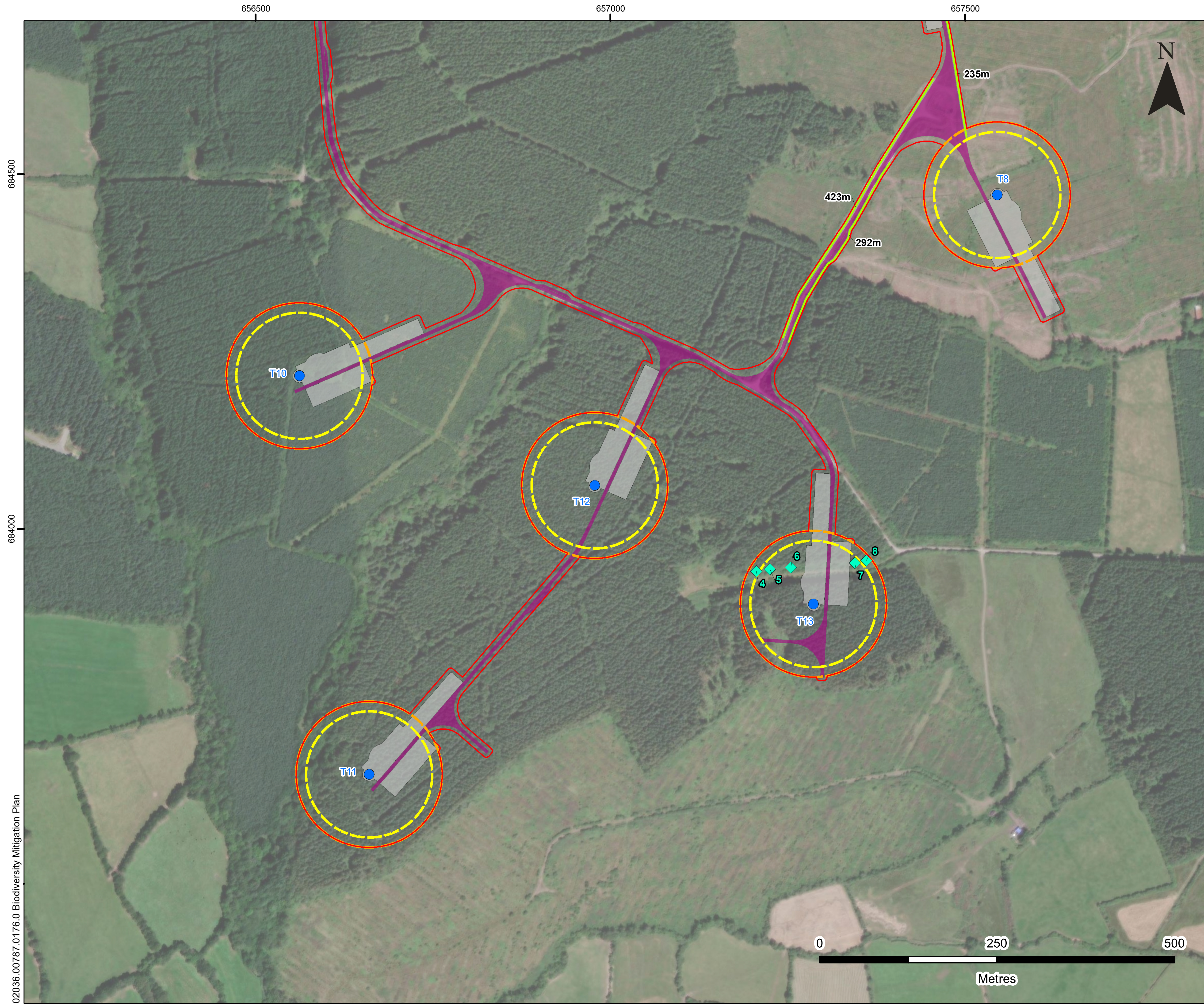
BIODIVERSITY MITIGATION PLAN

FIGURE 1-a

Scale	Date
1:20,000 @ A3	JULY 2023

02036.00787.0177.0 Biodiversity Mitigation Plan Overview

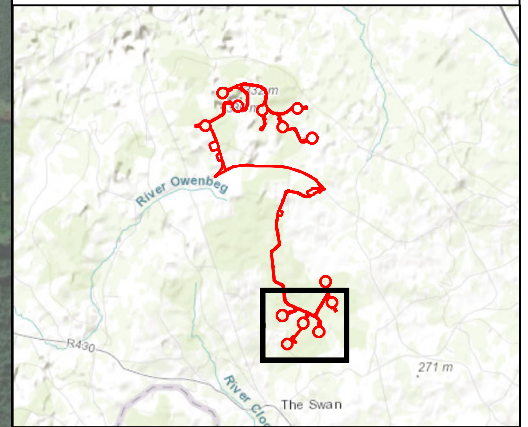
Aerial Imagery (2022): Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), (c) OpenStreetMap contributors, and the GIS User Community.Source: Esri, Maxar, Earthstar Geographics, and the GIS



LEGEND

- Proposed Development Site Boundary
- Proposed Turbine Layout
- Proposed Hardstanding
- Proposed Access Track
- Hedgerow Felling Buffer (89 m)
- Woodland and Treeline Felling Buffer (103 m)
- Proposed Hedgehog Hibernacula
- Proposed Hedgerow Planting*

*See Habitat and Species Management Plan for details on species mix.



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HABITAT AND SPECIES MANAGEMENT PLAN

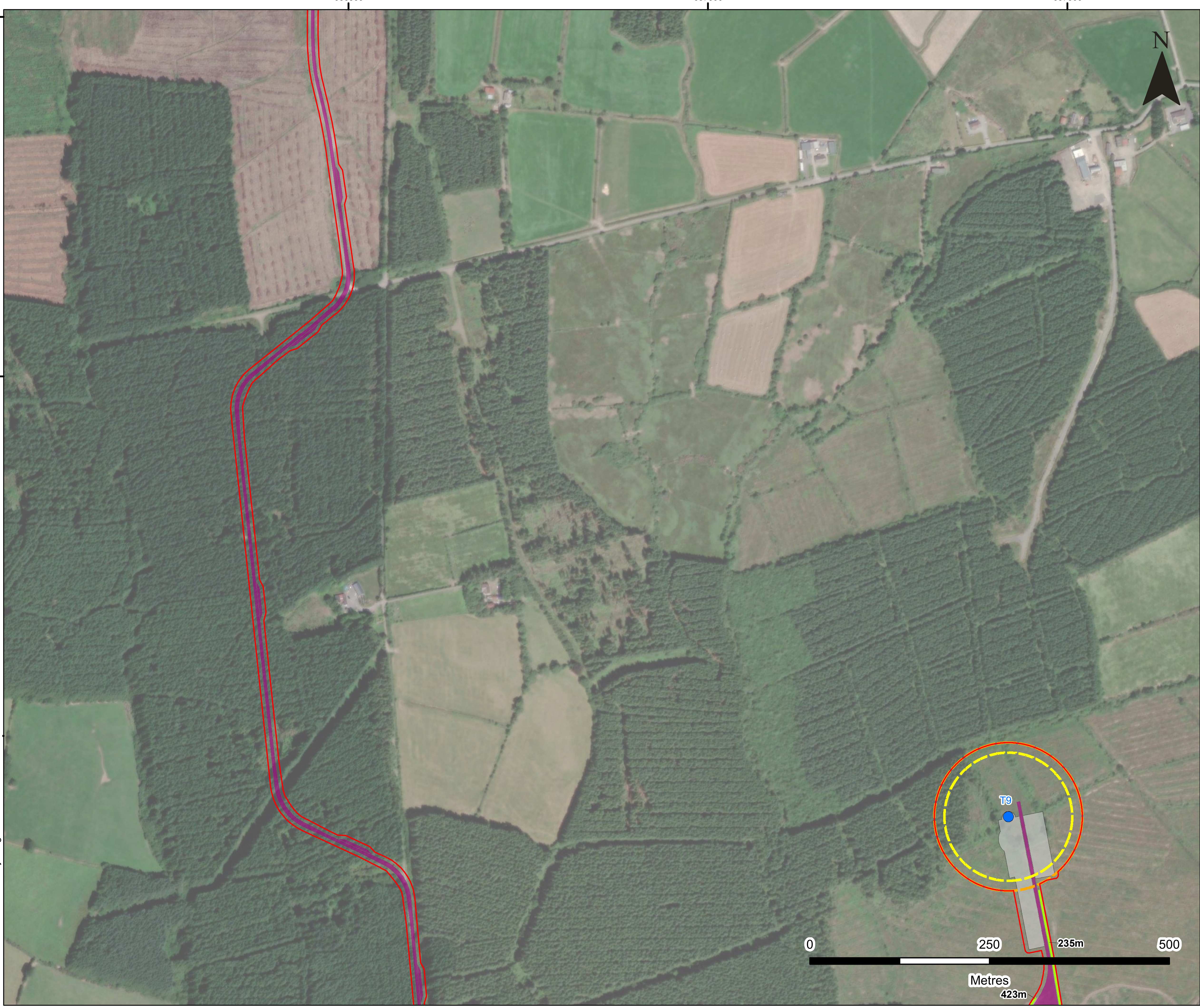
BIODIVERSITY MITIGATION PLAN

FIGURE 1-b

Scale	Date
1:5,000 @ A3	JULY 2023

02036.00787.0176.0 Biodiversity Mitigation Plan

Aerial Imagery (2022): Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), (c) OpenStreetMap contributors, and the GIS User Community.Source: Esri, Maxar, Earthstar Geographics, and the GIS



LEGEND

- Proposed Development Site Boundary
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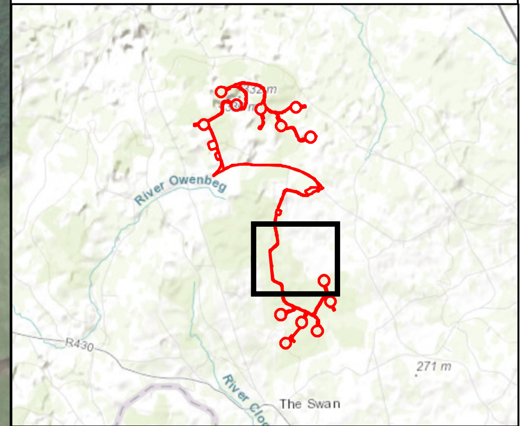
- Woodland and Treeline Felling Buffer (103 m)
- Proposed Hedgerow Planting*

*See Habitat and Species Management Plan for details on species mix.



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HABITAT AND SPECIES MANAGEMENT PLAN

BIODIVERSITY MITIGATION PLAN

FIGURE 1-c

Scale 1:5,000 @ A3

Date JULY 2023

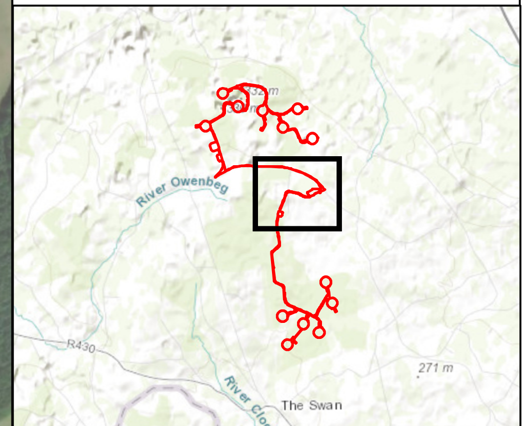
02036.00787.0176.0 Biodiversity Mitigation Plan

Aerial Imagery (2022): Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), (c) OpenStreetMap contributors, and the GIS User Community.Source: Esri, Maxar, Earthstar Geographics, and the GIS

LEGEND

- Proposed Development Site Boundary
- Proposed Temporary Construction Compound
- Proposed Borrow Pit
- Proposed Hardstanding
- Proposed Access Track
- Proposed Insect Hotel
- Proposed Amphibian/Reptile Hibernacula
- Proposed Rough Grassland for Pollinators*

*See Habitat and Species Management Plan for details on species mix.



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HABITAT AND SPECIES MANAGEMENT PLAN

BIODIVERSITY MITIGATION PLAN

FIGURE 1-d

Scale	Date
1:5,000 @ A3	JULY 2023

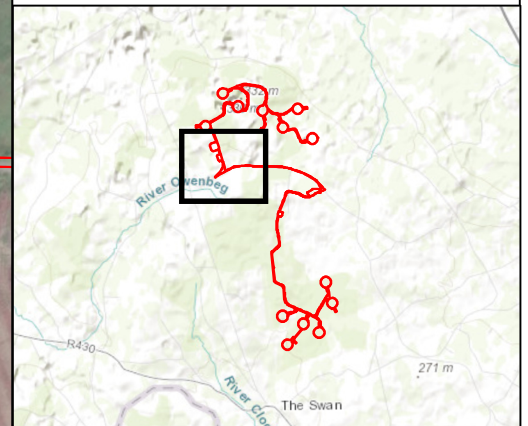
02036.00787.0176.0 Biodiversity Mitigation Plan

Aerial Imagery (2022): Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), (c) OpenStreetMap contributors, and the GIS User Community.Source: Esri, Maxar, Earthstar Geographics, and the GIS

LEGEND

- Proposed Development Site Boundary
- Proposed Substation Compound
- Proposed Temporary Construction Compound
- Proposed Hardstanding
- Proposed Access Track

*See Habitat and Species Management Plan for details on species mix.



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COOLGLASS WIND FARM
ENVIRONMENTAL IMPACT
ASSESSMENT REPORT

HABITAT AND SPECIES
MANAGEMENT PLAN

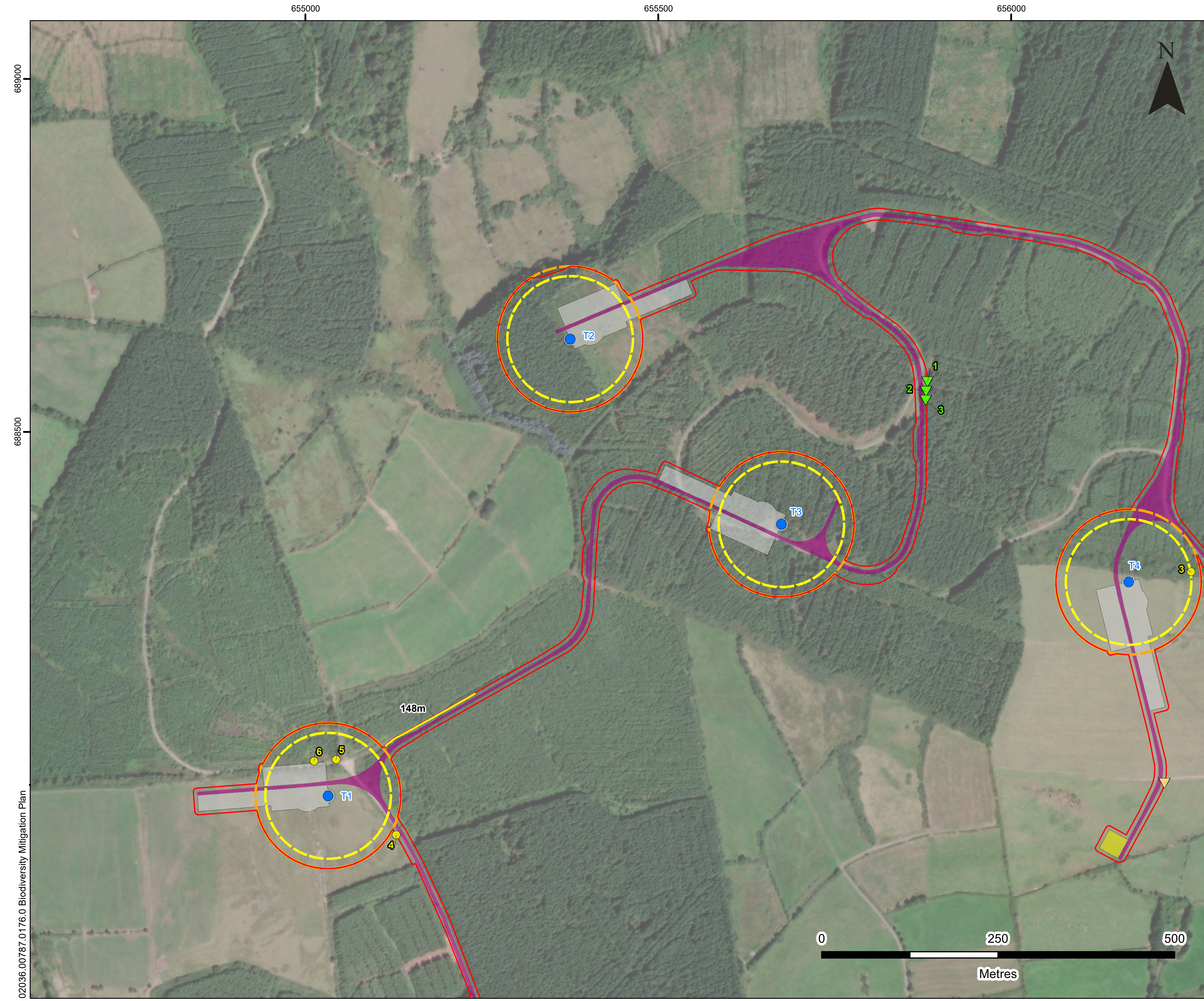
BIODIVERSITY MITIGATION PLAN

FIGURE 1-e

Scale	Date
1:5,000 @ A3	JULY 2023

02036.00787.0176.0 Biodiversity Mitigation Plan

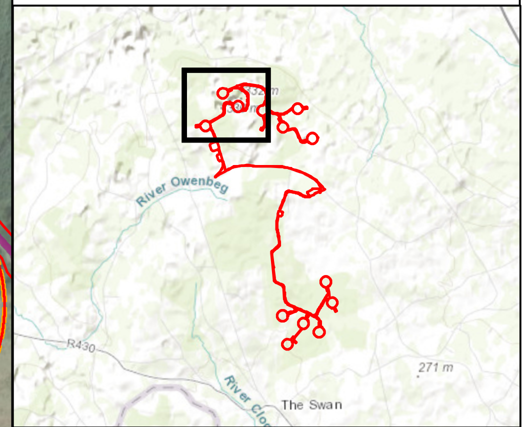
Aerial Imagery (2022): Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), (c) OpenStreetMap contributors, and the GIS User Community.Source: Esri, Maxar, Earthstar Geographics, and the GIS



LEGEND

- Proposed Development Site Boundary
- Proposed Turbine Layout
- Proposed Hardstanding
- Proposed Access Track
- Proposed Met Mast Hardstanding
- Hedgerow Felling Buffer (89 m)
- Woodland and Treeline Felling Buffer (103 m)
- Proposed Swift Tower
- Proposed Insect Hotel
- Proposed Amphibian/Reptile Hibernacula
- Proposed Treeline Planting*

*See Habitat and Species Management Plan for details on species mix.



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COOLGLASS WIND FARM
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HABITAT AND SPECIES MANAGEMENT PLAN

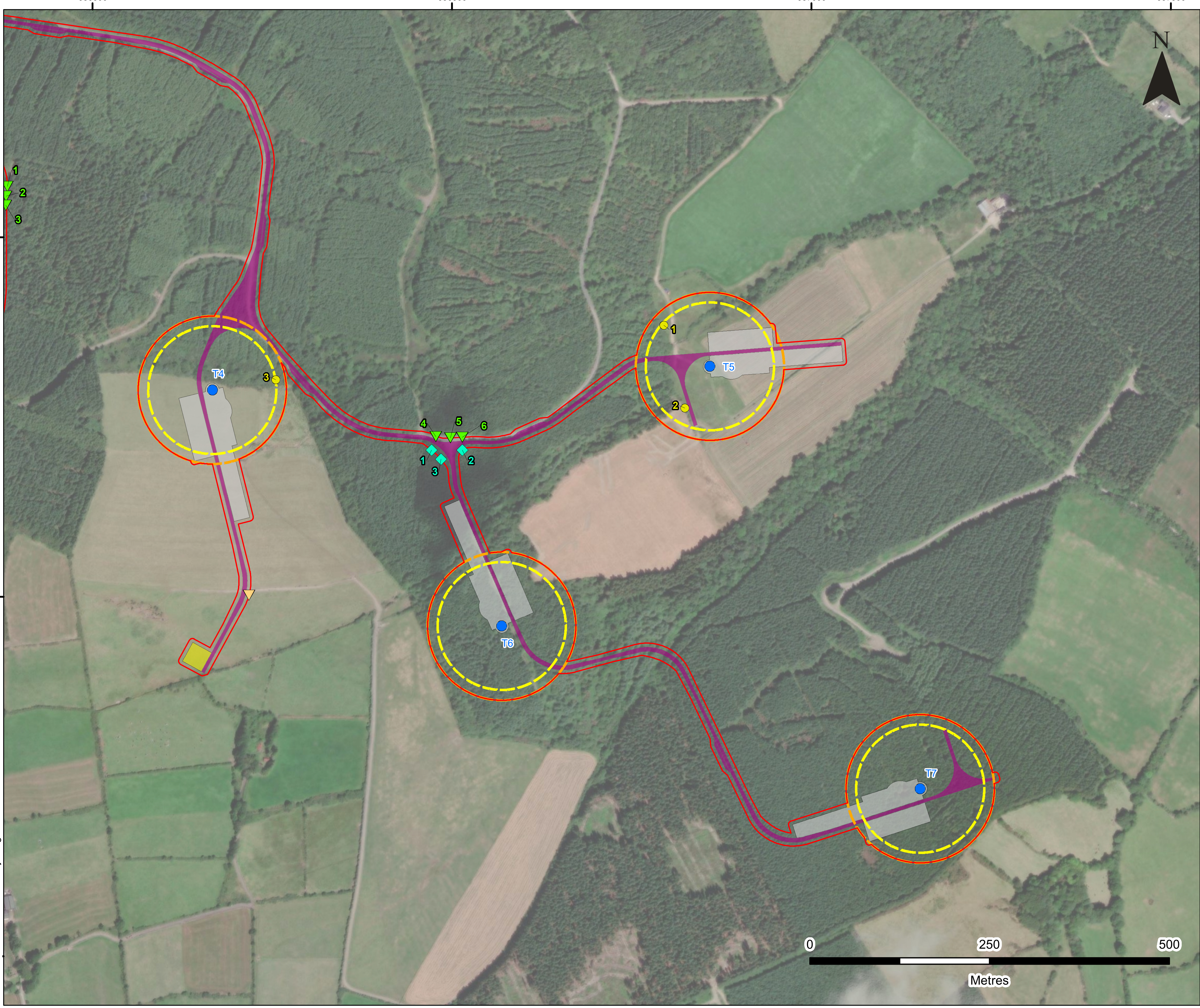
BIODIVERSITY MITIGATION PLAN

FIGURE 1-f

Scale	Date
1:5,000 @ A3	JULY 2023

02036.00787.0176.0 Biodiversity Mitigation Plan

Aerial Imagery (2022): Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), (c) OpenStreetMap contributors, and the GIS User Community.Source: Esri, Maxar, Earthstar Geographics, and the GIS



LEGEND

- Proposed Development Site Boundary
- Proposed Turbine Layout
- Proposed Hardstanding
- Proposed Access Track
- Proposed Met Mast Hardstanding
- Hedgerow Felling Buffer (89 m)
- Woodland and Treeline Felling Buffer (103 m)
- Proposed Swift Tower
- Proposed Insect Hotel
- Proposed Hedgehog Hibernacula
- Proposed Amphibian/Reptile Hibernacula

*See Habitat and Species Management Plan for details on species mix.

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COOLGLASS WIND FARM ENVIRONMENTAL IMPACT ASSESSMENT REPORT

HABITAT AND SPECIES MANAGEMENT PLAN

BIODIVERSITY MITIGATION PLAN

FIGURE 1-g

Scale 1:5,000 @ A3 | Date JULY 2023

02036.00787.0176.0 Biodiversity Mitigation Plan

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