Natura Impact Statement

Cush Wind Farm

Cush Wind Limited

Client Address

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Making Sustainability Happen

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1.0 Introduction

1.1 Project Overview

The project comprises the following main components:-

- 8 no. wind turbines with an overall tip height of 200m, and all associated ancillary infrastructure;
- All associated and ancillary site development, excavation, construction, landscaping and reinstatement works, including provision of site drainage infrastructure and forestry felling.
- Temporary alterations to the turbine component haul route; and,
- Construction of an electricity substation, Battery Electricity Storage System and installation of 5.6km of underground grid connection to facilitate connection of the proposed electricity substation to the existing 110kV substation at Clondallow, County Offaly;

Off-site and secondary elements of the project include:-,

- The planting of 23ha of forestry on lands in the townlands of Drumagelvin, Drumleek South, Lisdonny and Moy, County Monaghan.

A 10-year planning permission is being sought by the Developer for this project. That is, planning permission would remain valid for 10-years following the final grant. The operational lifespan of the project is proposed to be 35-years following the full commissioning of the wind farm.

A full description of the project is provided at **Sections 3.2.1 and 4.1.1** below

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 for 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 (EC) 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-ordinated the bird surveys associated with the project. 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.

Kathryn Robson - This NIS has been written by Kathryn Robson BSc Hons, MSc. Kathryn is a senior ecologist at SLR Consulting Ltd with 7 years of experience as a professional ecological consultant. Her project experience has primarily been in the renewable energy sector, mainly onshore wind farms, at all stages of the development process, from design to completion. Competent in undertaking most terrestrial ecology surveys, her survey experience has focussed on ornithology and bat surveys. Kathryn holds a MSc in Ecological Management and Conservation Biology and a BSc in Biological Sciences, both from Queen's University Belfast.

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, 2010a) 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 project on 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 project 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 project 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:

- Cush Wind Farm Ltd (2023) Cush Wind Farm Environmental Impact Assessment Report;
- SLR (2020) Cush – Bird Survey Report Breeding Season 2020 (**Appendix 2**);
- SLR (2022) Cush – Bird Survey Report Winter 2020-21 (**Appendix 2**);
- SLR (2022) Cush – Bird Survey Report Breeding Season 2021 and Winter 2021-22 (**Appendix 2)**;
- SLR (2022) Cush – Bird Survey Report Breeding Season 2022 (**Appendix 2)**;
- SLR (2023) Cush – Bird Survey Report Winter 2022-23 (**Appendix 2)**;
- Triturus (2022) Aquatic baseline report for Cush Wind Farm, Co. Offaly. Report prepared by Triturus Environmental Ltd. for SLR Consulting. November 2023 (**Appendix 3**);
- Triturus (2023). Fisheries assessment of Cush Wind Farm, Co. Offaly. Report prepared by Triturus Environmental Ltd. for SLR Consulting. November 2023 (**Appendix 3**);
- Ken Bond (2022) Cush Wind Farm – Marsh Fritillary Survey. June 2022; 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:

- Leabeg Wind Farm (2010)[2];
- Derrinlough Wind Farm Wind Farm Development (2020) Natura Impact Statement[3];
- Cloghan Wind Farm Wind Farm (2014) Natura Impact Statement[4];
- Cloghan Wind Farm – Amendments to Permitted Development (2019) Natura Impact Statement[5]
- Cloghan Wind Farm (2019) Appropriate Assessment Screening Report[6]
- Meenwaun Wind Farm Wind Farm (2015) Natura Impact Statement[7];
- Carrig and Skehanagh Wind Farm (2001);
- Carrig Renewables Wind Farm (2023) Natura Impact Statement[8];

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[1] https://www.npws.ie/protected-sites

[2] Gaelectric Developments ltd. (2010) Leabeg Wind Farm Development Environmental Impact Report

[3] MKO (2020) Derrinlough Wind Farm Development Natura Impact Statement

[4] Ecofact (2014) Cloghan Wind Farm, Natura Impact Statement

[5] SLR (2019) Cloghan Wind Farm – Amendments to Permitted Development, Natura Impact Statement

[6] SLR (2019) Cloghan Wind Farm Underground Electricity Line, Co, Offaly. Appropriate Assessment Screening Report.

[7] Fehily Timoney and Company (2015) Meenwaun Wind Farm Ltd. Natura Impact Statement

[8] MKO (2023) Carrig Renewables Energy Ltd. Natura Impact Statement

- Offaly County Development Plan 2021 - 2027[9];
- National Biodiversity Action Plan[10]; and
- Eastern & Midland Regional Assembly Regional Spatial and Economic Strategy 2020-2032 (RSES)[11].

2.4 Consultations

The scope for this assessment has also been informed by consultation with statutory consultees and other bodies with environmental responsibility.

Issues, matters and recommendations highlighted by the responses in relation to ecology are summarised in **Table 2-1** below.

Table 2-1: Response to consultation comments

Consultee	Date of Consultation	Consultee's Comments
An Taisce	02/06/2022	No response.
Bat Conservation Ireland	02/06/2022	BCI advised they don't comment on planning applications but asked that all best practice guidelines are followed.
Birdwatch Ireland	02/06/2022	No response.
Offaly County Council	02/06/2022	Noted the proximity of the project site to Rapemills River and Natura 2000 sites.
Department of Agriculture, Food and the Marine	02/06/2022	Felling licence to be acquired, and the EIA and appropriate assessment procedures to be followed.
Department of Environment, Climate and Communications	02/06/2022	No response.
Department of Housing, Local Government & Heritage	02/06/2022	No response.
Environmental Protection Agency	02/06/2022	No response.
Inland Fisheries Ireland	02/06/2022	No response.
Irish Peatland Conservation Council	02/06/2022	No response.
Irish Raptor Study Group	02/06/2022	No response.
Irish Wildlife Trust	02/06/2022	No response.
National Parks and Wildlife Service	02/06/2022	No response.
Office of Public Works	02/06/2022	The project site is located in lands that benefit from the Boolinaraig Drainage District. There may be a risk of flooding at this location. The

9 https://www.offaly.ie/stage-4-final-plan/

10 https://www.npws.ie/sites/default/files/publications/pdf/National%20Biodiversity%20Action%20Plan%20English.pdf

11 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.

Consultee	Date of Consultation	Consultee's Comments
		Local Authority and the developers should satisfy themselves that there is adequate level of protection against flooding at this location. • Datasets prepared by the Office of Public Works identifying land that might benefit from the implementation of Arterial (Major) Drainage Schemes (under the Arterial Drainage Act 1945) and indicating areas of land subject to flooding or poor drainage. • The channel in question [at the project Site] is not an OPW maintainable channel; however, it is good practise that a 10m wide strip be retained adjacent to the channel to permit access to the local authority for maintenance. Ideally, the strip should not be fenced, paved or landscaped in a manner that would prevent access by maintenance plant. Further to this, please note that for the construction, replacement or alteration of any bridge or culvert over any channel which appears on a 6-inch to 1 mile map, Prior Section 50 consent must be sought under Section 50 of the Arterial Drainage Act, 1945.
Eastern and Midland Regional Assembly	02/06/2022	No response
Sustainable Energy Authority of Ireland	02/06/2022	No response
The Heritage Council	02/06/2022	No response
Waterways Ireland	02/06/2022	No response

3.0 Stage 1: Screening

3.1 Step 1: Management of European Sites

The project includes the construction, operation and decommissioning of a wind farm. Therefore, it is not connected with, or necessary for, the management of any European site.

3.2 Step 2, Part 1: Brief Project Description

3.2.1 The Project

3.2.1.1 Turbines and Associated Infrastructure

The proposed Cush Wind Farm consists of the following elements:

- 8 no. wind turbines with a hub height of 114 meters (m), a rotor diameter of 172m, and an overall tip height of 200m;
- All associated turbine foundations and crane hardstand areas;

- Wind farm control building incorporating a medium voltage switchgear room;
- All underground internal electrical and communications cabling;
- Provision of new internal site access tracks and use of, and upgrades to, existing agricultural/forestry tracks;
- Upgrade of 2 no. site entrances from the N62 national route for use during the construction phase only;
- Upgrade of 2 no. site entrances from the L30033 and L300321 local roads, respectively, for the operation phase only;
- 1 no. guy-wired meteorological mast with an overall height of 30 metres;
- 2 no. temporary construction compounds;
- 3 no. dedicated spoil deposition areas for the storage, as required, of excavated material;
- Felling of up to 23 hectares (ha) of forestry to facilitate the construction and operation of wind farm infrastructure; and,
- All associated and ancillary site development, excavation, construction, landscaping and reinstatement works, including provision of site drainage infrastructure and environmental mitigation measures.
- Temporary alteration works to public roads along the turbine component haul route, including a vehicle turning area at the N52/N62 junction.
- A 110 kilovolt (kV) electrical substation and all associated electrical equipment, including a control building and battery electricity storage system;
- The installation of c. 5.6km of underground electricity cable to facilitate connection of the proposed electricity substation to the existing 110kV substation at Clondallow, County Offaly; and,
- The planting of 23ha of forestry on lands in the townlands of Drumagelvin, Drumleek South, Lisdonny and Moy, County Monaghan.

3.2.1.2 Turbine Component Haul Route

In order to facilitate the delivery of turbine components some temporary alterations will be required at various locations along the route. A total of 17 no. locations have been identified where alterations to the public road network will be required. Each of these 17 locations involve works of a temporary nature, including the temporary provision of hardcored surfacing, temporary road sign/traffic signal/street lighting removal, and/or the temporary removal, with replacement, of roadside/streetscape vegetation and trees.

3.2.1.3 Grid Connection

The existing Dallow 110kV electricity substation is the most likely point of connection to the national network.

The project includes; A 110 kilovolt (kV) electrical substation and all associated electrical equipment, including a control building and battery electricity storage system and the installation of c. 5.6km of underground electricity cable to facilitate connection of the proposed electricity substation to the existing ‘Dallow’ 110kV substation at Clondallow, County Offaly

3.2.1.4 Meteorological Mast

A temporary 80m meteorological mast is present within the project site at Irish Transverse Mercator (ITM) coordinates 607231, 710703, and is assessed as part of the in-combination effects in **Section 4.4**.

The permanent mast to be installed will be 30m in height and will consist of a guy-wired structure to which various measurement instruments will be attached. The purpose of the mast is to monitor wind speeds and climate conditions. Some ground works, including the construction of a concrete foundation and anchors, will be required to erect the proposed permanent mast.

3.2.2 The Project Site

3.2.2.1 Habitats

The dominant habitats within the project site are commercial forestry, private cutover raised bogs, agricultural grassland, mixed broadleaved/conifer woodland.

No annex I habitats were recorded within the project site.

No invasive plant species were recorded within the project site, the grid connection, or haul route.

3.2.2.2 Species (Annex I birds, SCIs of SPAs within 20 km radius and Annex II others)

A range of ecological surveys, following best practice guidelines, were undertaken between May 2020 and August 2023. Please refer to Table 4.4 for more detail.

Golden Plover *Pluvialis apricaria*

During flight activity surveys in the winter of 2022/23, a peak count of approximately 3,500 golden plover was observed within 500m of the project site boundary. County Offaly is outside the breeding range of golden plover and no breeding golden plover were recorded within the appropriate survey area.

Hen Harrier *Circus cyaneus*

Flight activity of hen harrier was at a very low level throughout the study period. All flight lines were recorded in winter, suggesting a few birds moving through the wider area while foraging. No hen harrier were recorded roosting during dedicated winter roost surveys. Furthermore, no breeding hen harrier were recorded during dedicated breeding raptor surveys.

Peregrine Falcon *Falco peregrinus*

During flight activity surveys a total of 13 peregrine flight lines comprising single birds were observed. During breeding raptor surveys, a single peregrine falcon was recorded in July 2021 hunting to the south of the project site, but no confirmed evidence of breeding was recorded within the 2km survey buffer. Peregrine falcon were recorded probably breeding within [redacted] c. 1.3 km from turbine T7.

Whooper Swan *Cygnus cygnus*

Whooper swan was occasionally observed commuting over the project site. A peak count of a flock of 12 birds was recorded during flight activity surveys in winter 2020/21. Whooper swan was not recorded during the dedicated swan and goose feeding distribution surveys.

Kingfisher *Alcedo atthis*

A single kingfisher was observed during habitat surveys in July 2022 flying west to east along the Rapemills River.

Wigeon

Wigeon were only recorded during flight activity surveys. Overall, flight activity by wigeon was low, with a single flight of 13 birds recorded.

Teal

Teal were only recorded during flight activity surveys during which a single long flight of 42 birds were recorded.

Lapwing

Lapwing was recorded during flight activity surveys. A maximum flock size of 27 was observed in winter 2021/22. In addition, a breeding pair was confirmed within 500m of the project site.

Black-headed gull

Black-headed gull was observed commuting over the project site. A peak flock size of 46 birds and 34 birds were recorded in the winter season 2021/22 and breeding season 2022, respectively.

Cormorant

Cormorant was observed during the baseline ornithological study. Specifically, a peak count of 2 birds was recorded during winter 2021/22 during flight activity surveys.

Otter *Lutra lutra*

Despite some good suitability at numerous survey locations, otter signs were only recorded at a total of 5 no. sites during the course of aquatic surveys undertaken in August 2022 (see **Appendix 3** for site locations). Regular otter spraint sites were recorded at sites on the Rapemills River (B1 & B3), River Brosna (D6) and Blackwater River (D7). An old otter spraint site (not regularly used) was also recorded on the Little Brosna River at site A3. Fresh otter prints were recorded alongside regular spraint sites at site D7 on the Blackwater River.

No breeding (holts) or resting (couch) areas were identified in the 150m vicinity of the survey sites in August 2022.

White-clawed crayfish *Austropotamobius pallipes*

Live white-clawed crayfish were recorded from sites on the Mullaghakaraun Bog Stream (B9) and Feeghroe River (B12) (see **Appendix 3** for site locations). Both sites supported low densities of juveniles only.

Crayfish remains were identified in otter spraint at sites on the Little Brosna River (site A3), Rapemills River (B1 & B3) and Blackwater River (D7). The remains on an adult crayfish (possibly preyed upon by otter) were also recorded at site B5 on the West Galros Stream, in addition to widespread crayfish burrows in sloping clay banks. Crayfish burrows were also visibly widespread at site B6 on the West Galros Stream.

Environmental DNA analysis detected white-clawed crayfish in the Little Brosna River (site A3) and Grand Canal (site D4).

Atlantic salmon *Salmo salar*

Atlantic salmon parr were recorded in low numbers on the Little Brosna River (A3) and the Silver River (E2) (see **Appendix 3** for site locations).

Lamprey *Lampetra sp.*

Lamprey ammocoetes (Lampetra sp., likely Brook lamprey (*L. planeri*) given known catchment barriers) were recorded from a total of 8 no. sites on the Rapemills River (B1, B3 & B4), Mullaghakaraun Bog Stream (B9), Little River (D5) and the Silver River (E1 & E2) (see **Appendix 3** for site locations).

Marsh fritillary *Euphydryas aurinia*

A marsh fritillary butterfly was recorded flying within the Project site in May 2021. However, no suitable habitat or larval webs were recorded within the site during targeted marsh fritillary habitat and larval web surveys in June 2022.

3.2.2.3 Ecological Connections

A population of a mobile species that is a qualifying interest of a European site could also use habitat within or in the vicinity of the Project site. If such a population is sometimes present within the Project site, it is connected to the relevant European site. For example, ecological connections may include populations of golden plover, whooper swan, hen harrier, migratory fish and otter that form the qualifying interest of a European site.

Other examples of potential ecological connections include habitat connections either directly or as 'stepping stones', Also, the Project site may support a population of the same species as within a connected European Site which occasionally exchange individuals. Furthermore, the Project site may support populations of species which are prey/ food or host to the qualifying interests of a European Site.

3.2.2.4 Hydrological and Hydrogeological Connections

Rapemills River flows through the southwestern section of the site for approximately 1.2km. While a tributary stream of Rapemills River, referred to as the West Galros by the EPA, emerges from foresty on the eastern portion of the Project site. The Rapemills River flows into the River Shannon and ultimately Lough Derg. There is potential hydrological connectivity between any European site located downstream of the Project site.

The Project is located within groundwater body IE_SH_G_040 (Banagher). There is potential hydrogeological connectivity between the Project and any European site located within this groundwater body.

3.3 Step 2, Part 2: Potential Impacts

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

- Loss of, or damage to, habitats and flora during the construction/removal of infrastructure;
- Loss of habitat and consequent reduction in home ranges of qualifying interest species;
- Displacement of qualifying interest species;
- Disturbance of Annex I bird species and otter 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) guidelines suggest that a 15km 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 (NatureScot 2016) 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.

According to NatureScot guidance (NatureScot 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 European sites within 20km from the Project were considered for source-receptor connectivity. This also aligns with the approach recommended within the Office of the Planning Regulator's Practice Note PN01.

In some cases, hydrological connectivity beyond 20km was also searched for using GIS to identify any European sites downstream of the Project connected via watercourses.

The project site is located within 20km of the designated sites detailed in **Table 3-1**. The locations of these sites are shown in **Figure 1**.

Table 3-1: Designated Sites Considered for Screening

Site name and code	Qualifying interests	Conservation objective in summary	Direct line distance to project site (km)	Connections (Source -Pathway – Receptor)	Considered further in screening (Y/N)
Ridge Road, SW of Rapemills SAC 000919	Semi-natural dry grasslands and scrubland facies on calcareous substrates (*Festuco-Brometalia*) [6210]	To maintain the favourable conservation condition of Semi-natural dry grasslands and scrubland facies on calcareous substrates.	0.26	**Hydrological & Hydrogeological** The qualifying interest is a terrestrial habitat and thus there is no connectivity. Ecological No ecological connectivity as the designated feature is a habitat which does not occur on the Project site, therefore, no pathway. However, due to the proximity of the SAC to the Project Site, pollution, such as dust generated during construction and vehicle emissions, may impact upon the habitat.	**Y**
All Saints Bog and Esker SAC 000566	Semi-natural dry grasslands and scrubland facies on calcareous substrates (*Festuco-Brometalia*) (* important orchid sites) [6210] Active raised bogs [7110] Degraded raised bogs still	To restore the favourable conservation condition of: • Semi-natural dry grasslands and scrubland facies on calcareous substrates • Active raised bogs • Bog woodland	2.22	**Hydrological and Hydrogeological** Raised bogs (and the associated depressions on peat substrates of the Rynchosporion) are typically rainwater fed, and so are not usually dependent on surface or groundwater from elsewhere. The	**N**

Site name and code	Qualifying interests	Conservation objective in summary	Direct line distance to project site (km)	Connections (Source -Pathway – Receptor)	Considered further in screening (Y/N)
	capable of natural regeneration [7120] Depressions on peat substrates of the Rhynchosporion [7150] Bog woodland [91D0]	• The long-term aim for degraded raised bogs still capable of natural regeneration is that its peat-forming capability is re-established; therefore, the conservation objective for this habitat is inherently linked to that of active raised bogs and a separate conservation objective has not been set. • Depressions on peat substrates of the Rhynchosporion is an integral part of good quality active raised bogs and thus a separate conservation objective has not been set.		other qualifying habitat features are terrestrial in nature. Therefore, no connectivity. Ecological No ecological connectivity as the designated features are habitats which do not occur on the Project site. Therefore, no pathway. .	
Ballyduff/Clonfinane Bog SAC 000641	Active raised bogs [7110] Degraded raised bogs still capable of natural regeneration [7120]	To restore the favourable conservation condition of active raised bogs. The long-term aim for degraded raised bogs still	5.26	**Hydrological & Hydrogeological** Raised bogs are typically rainwater fed, and so are not usually dependent on surface or groundwater from elsewhere.	**N**

Site name and code	Qualifying interests	Conservation objective in summary	Direct line distance to project site (km)	Connections (Source -Pathway – Receptor)	Considered further in screening (Y/N)
	Depressions on peat substrates of the *Rhynchosporion* [7150] Bog woodland [91D0]	capable of natural regeneration is that its peat-forming capability is re-established; therefore, the conservation objective for this habitat is inherently linked to that of active raised bogs and a separate conservation objective has not been set. • Depressions on peat substrates of the Rhynchosporion is an integral part of good quality active raised bogs and thus a separate conservation objective has not been set. • The status of Bog woodland as a qualifying Annex I habitat for Ballyduff/Clonfinane Bog SAC is currently under review.		Furthermore, although the SAC is mostly within the same groundwater body (Banagher; IE_SH_G_040) as the Project, it is a considerable distance from the Project site for hydrogeological links. A study of the watercourses revealed no hydrological connectivity as the SAC is situated upstream of the nearest potentially connected water course. Ecological No ecological connectivity as the designated features are habitats which do not occur on the Project site. Therefore, no pathway.	
River Shannon Callows SAC 000216	Molinia meadows on calcareous, peaty or	To restore the favourable conservation condition of:	6.23	**Hydrological and Hydrogeological**	**Y**

Site name and code	Qualifying interests	Conservation objective in summary	Direct line distance to project site (km)	Connections (Source -Pathway – Receptor)	Considered further in screening (Y/N)
	clayey-silt-laden soils (*Molinion caeruleae*) [6410] Lowland hay meadows (*Alopecurus pratensis*, *Sanguisorba officinalis*) [6510] Alkaline fens [7230] Limestone pavements [8240] Alluvial forests with *Alnus glutinosa* and *Fraxinus excelsior* (*Alno-Padion, Alnion incanae, Salicion albae*) [91E0] *Lutra lutra* (Otter) [1355]	• Molinia meadows on calcareous, peaty or clayey-silt-laden soils • Lowland hay meadows • To maintain the favourable conservation condition of: • Alkaline fens • Limestone pavements • Alluvial forests with Alnus glutinosa and Fraxinus excelsior • Otter		Construction/ decommissioning of wind farm - release of suspended solid (and other) pollution – (alkaline fens, alluvial forests with *Alnus glutinosa* and *Fraxinus excelsior* and otter) into Rapemills River which is upstream of the SAC. **Ecological** Construction/ decommissioning of wind farm - physical injury to otter, physical damage to otter breeding/ resting/ foraging sites, disturbance/ displacement or reduction in foraging opportunities for otter, which could be a population linked to that of the SAC.	
Lisduff Fen SAC 002147	Petrifying springs with tufa formation (*Cratoneurion*) [7220]	To maintain the favourable conservation condition of petrifying springs with tufa formation	6.59	**Hydrological and Hydrogeological** The SAC is located in a different groundwater body to the SAC. Therefore, no hydrogeological connectivity. A study of local water courses revealed no hydrological connectivity as the SAC is situated	**N**

Site name and code	Qualifying interests	Conservation objective in summary	Direct line distance to project site (km)	Connections (Source -Pathway – Receptor)	Considered further in screening (Y/N)
				upstream of the nearest potentially connected water course. Ecological No ecological connectivity as the designated feature is a habitat, which does not occur on the Project site. Therefore, no pathway	
Island Fen SAC 002236	Juniperus communis formations on heaths or calcareous grasslands [5130] Alkaline fens [7230]	To maintain the favourable conservation condition of: • Juniperus communis formations on heaths or calcareous grasslands • Alkaline fens	7.31	**Hydrological and Hydrogeological** The SAC is located in a different groundwater body to the SAC. Therefore, no hydrogeological connectivity. A study of the water courses revealed no hydrological connectivity as the SAC is situated upstream of the nearest potentially connected water course. Ecological No ecological connectivity as the designated features are habitats which do not occur on the Project site. Therefore, no pathway.	**N**

Site name and code	Qualifying interests	Conservation objective in summary	Direct line distance to project site (km)	Connections (Source -Pathway – Receptor)	Considered further in screening (Y/N)
Redwood Bog SAC 002353	Active raised bogs [7110] Degraded raised bogs still capable of natural regeneration [7120] Depressions on peat substrates of the Rhynchosporion [7150]	To restore the favourable conservation condition of active raised bogs. The long-term aim for degraded raised bogs still capable of natural regeneration is that its peat-forming capability is re-established; therefore, the conservation objective for this habitat is inherently linked to that of active raised bogs and a separate conservation objective has not been set. Depressions on peat substrates of the Rhynchosporion is an integral part of good quality active raised bogs and thus a separate conservation objective has not been set.	7.84	Hydrological and Hydrogeological Raised bogs are typically rainwater fed, and so are not usually dependent on surface or groundwater from elsewhere. Furthermore, Redwood Bog SAC is within a different sub-catchment to the Project and at a considerable distance from the Project site for hydrogeological links. A study of the watercourses revealed no hydrological connectivity. Ecological No ecological connectivity as the designated features are habitats which do not occur on the Project site. Therefore, no pathway.	**N**
Sharavogue Bog SAC 000585	Active raised bogs [7110] Degraded raised bogs still capable of natural regeneration [7120]	To restore the favourable conservation condition of active raised bogs The long-term aim for degraded raised bogs still	7.96	**Hydrological and Hydrogeological** Raised bogs are typically rainwater fed, and so are not usually	**N**

Site name and code	Qualifying interests	Conservation objective in summary	Direct line distance to project site (km)	Connections (Source -Pathway – Receptor)	Considered further in screening (Y/N)
	Depressions on peat substrates of the *Rhynchosporion* [7150]	capable of natural regeneration is that its peat-forming capability is re-established; therefore, the conservation objective for this habitat is inherently linked to that of active raised bogs and a separate conservation objective has not been set. • Depressions on peat substrates of the Rhynchosporion is an integral part of good quality active raised bogs and thus a separate conservation objective has not been set.		dependent on surface or groundwater from elsewhere. Furthermore, Sharavogue Bog SAC is within a different groundwater body to the Project and thus there is no link. A study of the water courses revealed no hydrological connectivity as the SAC is situated upstream of the nearest potentially connected water course. Ecological No ecological connectivity as the designated features are habitats which do not occur on the Project site. Therefore, no pathway.	
Arragh More (Derrybreen) Bog SAC 002207	Degraded raised bogs still capable of natural regeneration [7120]	To restore the favourable conservation condition of degraded raised bogs still capable of natural regeneration	8.56	**Hydrological and Hydrogeological** Raised bogs are typically rainwater fed, and so are not usually dependent on surface or groundwater from elsewhere. Furthermore, the SAC is within a different groundwater body to the	**N**

Site name and code	Qualifying interests	Conservation objective in summary	Direct line distance to project site (km)	Connections (Source -Pathway – Receptor)	Considered further in screening (Y/N)
				Project and thus there is no hydrogeological link. A study of the water courses revealed no hydrological connectivity as the SAC is situated upstream of the nearest potentially connected water course. **Ecological** No ecological connectivity as the designated feature is a habitat which does not occur on the Project site. Therefore, no pathway.	
Kilcarren-Firville Bog SAC 000647	Active raised bogs [7110] Degraded raised bogs still capable of natural regeneration [7120] Depressions on peat substrates of the *Rhynchosporion* [7150]	To restore the favourable conservation objectives of active raised bogs The long-term aim for degraded raised bogs still capable of natural regeneration is that its peat-forming capability is re-established; therefore, the conservation objective for this habitat is inherently linked to that of active raised bogs and a separate	9.26	**Hydrological and Hydrogeological** Raised bogs are typically rainwater fed, and so are not usually dependent on surface or groundwater from elsewhere. Furthermore, the SAC is within a different groundwater body to the Project and thus there is no hydrogeological link. A study of the water courses revealed no hydrological connectivity as the SAC is situated upstream of the	**N**

Site name and code	Qualifying interests	Conservation objective in summary	Direct line distance to project site (km)	Connections (Source -Pathway – Receptor)	Considered further in screening (Y/N)
		conservation objective has not been set. Depressions on peat substrates of the Rhynchosporion is an integral part of good quality active raised bogs and thus a separate conservation objective has not been set.		nearest potentially connected water course. **Ecological** No ecological connectivity as the designated features are habitats which do not occur on the Project site Therefore, no pathway.	
Liskeenan Fen SAC 001683	Calcareous fens with *Cladium mariscus* and species of the *Caricion davallianae* [7210]	To maintain the favourable conservation condition of calcareous fens with *Cladium mariscus* and species of the *Caricion davallianae*	12.03	**Hydrological and Hydrogeological** The SAC is within a different groundwater body to the Project and thus there is no hydrogeological link. A study of the water courses revealed no hydrological connectivity as the SAC is situated upstream of the nearest potentially connected water course. **Ecological** No ecological connectivity as the designated feature is a habitat which does not occur on the Project site. Therefore, no pathway	**N**

Site name and code	Qualifying interests	Conservation objective in summary	Direct line distance to project site (km)	Connections (Source -Pathway – Receptor)	Considered further in screening (Y/N)
Moyclare Bog SAC 000581	Active raised bogs [7110] Degraded raised bogs still capable of natural regeneration [7120] Depressions on peat substrates of the *Rhynchosporion* [7150]	To restore the conservation objectives for active raised bogs. The long-term aim for degraded raised bogs still capable of natural regeneration is that its peat-forming capability is re-established; therefore, the conservation objective for this habitat is inherently linked to that of active raised bogs and a separate conservation objective has not been set. Depressions on peat substrates of the Rhynchosporion is an integral part of good quality active raised bogs and thus a separate conservation objective has not been set.	12.34	**Hydrological and Hydrogeological** Raised bogs are typically rainwater fed, and so are not usually dependent on surface or groundwater from elsewhere. Furthermore, the SAC is within a different groundwater body to the Project and at a considerable distance from the Project site for hydrogeological links. A study of the water courses revealed no hydrological connectivity. **Ecological** No ecological connectivity as the designated features are habitats which do not occur on the Project site. Therefore, no pathway.	**N**
Slieve Bloom Mountains SAC 000412	Northern Atlantic wet heaths with Erica tetralix [4010] Blanket bogs (* if active bog) [7130]	To restore the favourable conservation condition of: • Northern Atlantic wet heaths with Erica tetralix	13.79	**Hydrological and Hydrogeological** The SAC is within a different groundwater body to the Project and thus there is no	**N**

Site name and code	Qualifying interests	Conservation objective in summary	Direct line distance to project site (km)	Connections (Source -Pathway – Receptor)	Considered further in screening (Y/N)
	Alluvial forests with *Alnus glutinosa* and *Fraxinus excelsior* (*Alno-Padion, Alnion incanae, Salicion albae*) [91E0]	• Blanket bogs • Alluvial forests with Alnus glutinosa and Fraxinus excelsior		hydrogeological link. A study of the water courses revealed no hydrological connectivity. Furthermore, blanket bog and upland wet heath are usually rainwater fed. **Ecological** No ecological connectivity as the designated features are habitats which do not occur on the Project site. Therefore, no pathway.	
Ferbane Bog SAC 000575	Active raised bogs [7110] Degraded raised bogs still capable of natural regeneration [7120] Depressions on peat substrates of the Rhynchosporion [7150	To restore the favourable conservation condition of Active raised bogs The long-term aim for degraded raised bogs still capable of natural regeneration is that its peat-forming capability is re-established; therefore, the conservation objective for this habitat is inherently linked to that of active raised bogs and a separate conservation objective has not been set.	14.48	**Hydrological and Hydrogeological** Raised bogs are typically rainwater fed, and so are not usually dependent on surface or groundwater from elsewhere. Furthermore, the SAC is within a different groundwater body to the Project and at a considerable distance from the Project site for hydrogeological links. A study of the water courses revealed no hydrological connectivity as the SAC is situated upstream of the	**N**

Site name and code	Qualifying interests	Conservation objective in summary	Direct line distance to project site (km)	Connections (Source -Pathway – Receptor)	Considered further in screening (Y/N)
		Depressions on peat substrates of the Rhynchosporion is an integral part of good quality active raised bogs and thus a separate conservation objective has not been set.		nearest potentially connected water course. **Ecological** No ecological connectivity as the designated features are habitats which do not occur on the Project site. Therefore, no pathway.	
Lough Derg, North-east Shore SAC 002241	Juniperus communis formations on heaths or calcareous grasslands [5130] Calcareous fens with *Cladium mariscus* and species of the *Caricion davallianae* [7210] Alkaline fens [7230] Limestone pavements [8240] Alluvial forests with *Alnus glutinosa* and *Fraxinus excelsior* (*Alno-Padion, Alnion incanae, Salicion albae*) [91E0] *Taxus baccata* woods of the British Isles [91J0]	To restore the favourable conservation condition of: • Juniperus communis formations on heaths or calcareous grasslands • Limestone pavements • Alluvial forests with *Alnus glutinosa* and *Fraxinus excelsior.* To maintain the favourable • conservation condition of: • Calcareous fens with Cladium mariscus and species of the Caricion davallianae • Alkaline fens	14.81	**Hydrological** Construction/ decommissioning of wind farm - release of suspended solid (and other) pollution via the Rapemills River and River Shannon which flows into Lough Derg SAC– (calcareous fens with *Cladium mariscus* and species of the *Caricion davallianae*, Alkaline fens, Alluvial forests with *Alnus glutinosa* and *Fraxinus excelsior*). **Hydrogeological** The SAC is within a different groundwater body to the Project and at a considerable distance from the Project site for hydrogeological links. **Ecological**	**Y**

Site name and code	Qualifying interests	Conservation objective in summary	Direct line distance to project site (km)	Connections (Source -Pathway – Receptor)	Considered further in screening (Y/N)
		• *Taxus baccata* woods of the British Isles		No ecological connectivity as the designated features are habitats which are at a remove from and do not occur on the Project site, therefore, no pathway.	
Clonaslee Eskers and Derry Bog SAC 000859	Petrifying springs with tufa formation (*Cratoneurion*) [7220] Alkaline fens [7230] *Vertigo geyeri* (Geyer's Whorl Snail) [1013]	To restore the favourable conservation condition of: • Alkaline fens • Geyer's whorl snail	15.33	**Hydrological and Hydrogeological** The SAC is within a different groundwater body to the Project and at a considerable distance from the Project site for hydrogeological links. A study of the water courses revealed no hydrological connectivity. **Ecological** No ecological connectivity as the distance between the SAC and Project site is too large (>15km) for Geyer's whorl snail to travel.	**N**
Scohaboy (Sopwell) Bog SAC 002206	Degraded raised bogs still capable of natural regeneration [7120]	To restore the favourable conservation condition of degraded raised bogs still	17.02	**Hydrological and Hydrogeological**	**N**

Site name and code	Qualifying interests	Conservation objective in summary	Direct line distance to project site (km)	Connections (Source -Pathway – Receptor)	Considered further in screening (Y/N)
		capable of natural regeneration		Raised bogs are typically rainwater fed, and so are not usually dependent on surface or groundwater from elsewhere. Furthermore, the SAC is within a different groundwater body to the Project and at a considerable distance from the Project site for hydrogeological links. A study of the water courses revealed no hydrological connectivity as the SAC is situated upstream of the nearest potentially connected water course. **Ecological** No ecological connectivity as the designated feature is a habitat which does not occur in the Project site, therefore, no pathway.	
Fin Lough (Offaly) SAC 000576	Alkaline fens [7230] *Vertigo geyeri* (Geyer's Whorl Snail) [1013]	To maintain the favourable condition of: • Alkaline fens • Geyer’s whorl snail	18.03	**Hydrological and Hydrogeological** The SAC is within a different groundwater body to the Project and at a considerable distance from the Project site for hydrogeological links. A study of the water courses revealed no	**N**

Site name and code	Qualifying interests	Conservation objective in summary	Direct line distance to project site (km)	Connections (Source -Pathway – Receptor)	Considered further in screening (Y/N)
				hydrological connectivity as the SAC is situated upstream of the nearest potentially connected water course. **Ecological** No ecological connectivity as the distance between the SAC and Project site is too large (>18km) for Geyer's whorl snail to travel.	
Mongan Bog SAC 000580	Active raised bogs [7110] Degraded raised bogs still capable of natural regeneration [7120] Depressions on peat substrates of the Rhynchosporion [7150]	To restore the favourable conservation condition of active raised bogs The long-term aim for degraded raised bogs still capable of natural regeneration is that its peat-forming capability is re-established; therefore, the conservation objective for this habitat is inherently linked to that of active raised bogs and a separate conservation objective has not been set. Depressions on peat substrates of the Rhynchosporion is an	19.42	**Hydrological and Hydrogeological** Raised bogs are typically rainwater fed, and so are not usually dependent on surface or groundwater from elsewhere. The SAC is within a different groundwater body to the Project and at a considerable distance from the Project site for hydrogeological links. A study of the water courses revealed no hydrological connectivity as the SAC is situated upstream of the nearest potentially connected water course. **Ecological**	**N**

Site name and code	Qualifying interests	Conservation objective in summary	Direct line distance to project site (km)	Connections (Source -Pathway – Receptor)	Considered further in screening (Y/N)
		integral part of good quality active raised bogs and thus a separate conservation objective has not been set.		No ecological connectivity as the designated features are habitats which do not occur in the Project site. Therefore, no pathway.	
Ardgraigue Bog SAC 002356	Active raised bogs [7110] Degraded raised bogs still capable of natural regeneration [7120] Depressions on peat substrates of the Rhynchosporion [7150]	To restore the favourable conservation objective of active raised bogs. The long-term aim for degraded raised bogs still capable of natural regeneration is that its peat-forming capability is re-established; therefore, the conservation objective for this habitat is inherently linked to that of active raised bogs and a separate conservation objective has not been set. Depressions on peat substrates of the Rhynchosporion is an integral part of good quality active raised bogs and thus a separate conservation objective has not been set.	19.65	**Hydrological and Hydrogeological** Raised bogs are typically rainwater fed, and so are not usually dependent on surface or groundwater from elsewhere. Ardgraigue Bog SAC is within a different groundwater body to the Project and at a considerable distance from the Project site for hydrogeological links. A study of the water courses revealed no hydrological connectivity. **Ecological** No ecological connectivity as the designated features are habitats which do not occur in the Project site. Therefore, no pathway.	**N**

Site name and code	Qualifying interests	Conservation objective in summary	Direct line distance to project site (km)	Connections (Source -Pathway – Receptor)	Considered further in screening (Y/N)
Dovegrove Callows SPA 004137	Greenland White-fronted Goose (*Anser albifrons flavirostris*) [A395]	To maintain or restore the favourable conservation condition of the bird species listed as Special Conservation Interests for this SPA.	0.001 from grid connection. 1.71 from wind farm site.	**Ecological** Greenland white-fronted goose was not recorded during the baseline ornithological study. However, due to the proximity of the grid connection to this SPA, the construction of the grid connection may cause disturbance and/or displacement of Greenland white-fronted geese.	**Y**
River Little Brosna Callows SPA 004086	Whooper Swan (*Cygnus cygnus*) [A038] Wigeon (*Anas penelope*) [A050] Teal (*Anas crecca*) [A052] Pintail (*Anas acuta*) [A054] Shoveler (*Anas clypeata*) [A056] Golden Plover (*Pluvialis apricaria*) [A140] Lapwing (*Vanellus vanellus*) [A142] Black-tailed Godwit (*Limosa limosa*) [A156]	To maintain or restore the favourable conservation condition of the bird species listed as Special Conservation Interests for this SPA. To maintain or restore the favourable conservation condition of the wetland habitat at River Little Brosna Callows SPA as a resource for the regularly-occurring migratory waterbirds that utilise it.	1.65	**Hydrological & Hydrogeological** The SPA is within the same groundwater body as the Project. Therefore, there is potential hydrogeological connectivity. A study of the water courses revealed no hydrological connectivity. **Ecological** Whooper swan, wigeon, teal, golden plover, lapwing and black-headed gull were recorded in flight within the Project site. Therefore, the potential ecological	**Y**

Site name and code	Qualifying interests	Conservation objective in summary	Direct line distance to project site (km)	Connections (Source -Pathway – Receptor)	Considered further in screening (Y/N)
	Black-headed Gull (*Chroicocephalus ridibundus*) [A179] Greenland White-fronted Goose (*Anser albifrons flavirostris*) [A395] Wetland and Waterbirds [A999]			connections for these species are as follows: Operation of the wind farm – collision risk – commuting birds. Construction/decommissioning and operation of the wind farm – disturbance/displacement of birds, including barrier effects to migration flyways. In addition, lapwing was recorded breeding within 500m of the Project site. Therefore, the potential ecological connection for this species is: Construction/decommissioning and operation of the wind farm – disturbance/displacement of lapwing. Greenland white-fronted goose was not recorded during the baseline ornithological study. However, the Greenland white-fronted goose population at Dovegrove Callows SPA, for which a potential pathway for disturbance/displacement has been identified, has also been	

Site name and code	Qualifying interests	Conservation objective in summary	Direct line distance to project site (km)	Connections (Source -Pathway – Receptor)	Considered further in screening (Y/N)
				recorded utilising this SPA. Therefore, an effect on Dovegrove Callows SPA also affects this SPA. Pintail and shoveler were not recorded during the baseline ornithological study. Therefore, no ecological connection.	
All Saints Bog SPA 004103	Greenland White-fronted Goose (*Anser albifrons flavirostris*) [A395]	To maintain or restore the favourable conservation condition of the bird species listed as Special Conservation Interests for this SPA.	2.23	Greenland white-fronted goose was not recorded during the baseline ornithological study. However, the Greenland white-fronted goose population at Dovegrove Callows SPA, for which a potential pathway for disturbance/displacement has been identified, has also been recorded utilising this SPA. Therefore, an effect on Dovegrove Callows SPA also affects this SPA.	Y
Middle Shannon Callows SPA 004096	Whooper Swan (*Cygnus cygnus*) [A038] Wigeon (*Anas penelope*) [A050] Corncrake (*Crex crex*) [A122]	To maintain the favourable conservation condition of: • Whooper swan • Golden plover • Wetlands	6.24	**Hydrological & Hydrogeological** There is hydrological connectivity between Middle Shannon Callows SPA and the Project site via the Rapemills River and River Shannon. The SPA is also present within the same groundwater body as the Project site and thus there is	**Y**

Site name and code	Qualifying interests	Conservation objective in summary	Direct line distance to project site (km)	Connections (Source -Pathway – Receptor)	Considered further in screening (Y/N)
	Golden Plover (*Pluvialis apricaria*) [A140] Lapwing (*Vanellus vanellus*) [A142] Black-tailed Godwit (*Limosa limosa*) [A156] Black-headed Gull (*Chroicocephalus ridibundus*) [A179] Wetland and Waterbirds [A999]	To restore the favourable conservation condition of: • Wigeon • Lapwing • Black-tailed godwit • Black-headed gull The status of corncrake as a Species of Conservation Interest for the Middle Shannon Callows SPA is currently under review.		potential hydrogeological connectivity. **Ecological** Whooper swan, wigeon, golden plover, lapwing and black-headed gull were recorded during flight activity surveys. Therefore, the potential ecological connections for these species are as follows: Operation of the wind farm – collision risk – commuting birds. Construction/decommissioning and operation of the wind farm – disturbance/displacement of birds, including barrier effects. In addition, lapwing was recorded breeding within 500m of the Project site. Therefore, the potential ecological connection for this species is: Construction/decommissioning and operation of the wind farm – disturbance/displacement of breeding lapwing. Corncrake and black-tailed godwit were not recorded during the	

Site name and code	Qualifying interests	Conservation objective in summary	Direct line distance to project site (km)	Connections (Source -Pathway – Receptor)	Considered further in screening (Y/N)
				baseline ornithological study. Therefore, no ecological connection.	
Slieve Bloom Mountains SPA 004160	Hen Harrier (*Circus cyaneus*) [A082]	To restore the favourable conservation condition of hen harrier	11.65	A total of four hen harrier flight lines were recorded during flight activity surveys. No breeding or wintering hen harriers were observed within the survey area. Therefore, the potential ecological connection is as follows: Operation of the wind farm – collision risk – commuting birds.	Y
Lough Derg (Shannon) SPA 004058	Cormorant (*Phalacrocorax carbo)* [A017] Tufted Duck (*Aythya fuligula*) [A061] Goldeneye (*Bucephala clangula*) [A067] Common Tern (*Sterna hirundo*) [A193] Wetland and Waterbirds [A999]	To maintain or restore the favourable conservation condition of the bird species listed as Special Conservation Interests for this SPA. To maintain or restore the favourable conservation condition of the wetland habitat at Lough Derg (Shannon) SPA as a resource for the regularly-occurring migratory waterbirds that utilise it.	15.07	**Hydrological & Hydrogeological** There is hydrological connectivity between Lough Derg (Shannon) SPA and the Project site via the Rapemills River and River Shannon. The SPA is within a different groundwater body to the Project site, and at a considerable distance from the Project site. Therefore, there is no hydrogeological connectivity. **Ecological**	**Y**

Site name and code	Qualifying interests	Conservation objective in summary	Direct line distance to project site (km)	Connections (Source -Pathway – Receptor)	Considered further in screening (Y/N)
				Cormorant was recorded during flight activity surveys with a peak count of two birds. Therefore, the potential ecological connections are as follows: Operation of the wind farm – collision risk – commuting birds. Construction/decommissioning and operation of the wind farm – disturbance/displacement of birds, including barrier effects. Tufted duck, goldeneye and common tern were not recorded during the baseline ornithological study. Therefore, there is no ecological connection for these species.	
River Suck Callows SPA 004097	Whooper Swan (*Cygnus cygnus*) [A038] Wigeon (*Anas penelope*) [A050] Golden Plover (*Pluvialis apricaria*) [A140] Lapwing (*Vanellus vanellus*) [A142]	To maintain the favourable conservation condition of: • Whooper swan • Wetlands To restore the favourable conservation condition of: • Wigeon • Golden plover	17.11	**Hydrological & Hydrogeological** River Suck Callows SPA is within a different groundwater body as the Project and at a considerable distance from the Project site for hydrogeological links. A study of the water courses revealed no hydrological connectivity as the SAC is situated upstream of the	Y

Site name and code	Qualifying interests	Conservation objective in summary	Direct line distance to project site (km)	Connections (Source -Pathway – Receptor)	Considered further in screening (Y/N)
	Greenland White-fronted Goose (*Answer albifrons flavirostris*) [A395] Wetland and Waterbirds [A999]	• Lapwing • Greenland white-fronted goose		nearest potentially connected water course. **Ecological** Whooper swan, wigeon, golden plover and lapwing were recorded during flight activity surveys. Therefore, the potential ecological connections for these species are as follows: Operation of the wind farm – collision risk – commuting birds. Construction/decommissioning and operation of the wind farm – disturbance/displacement of birds, including barrier effects. In addition, lapwing was recorded breeding within 500m of the Project site. Therefore, the potential ecological connection for this species is: Construction/decommissioning and operation of the wind farm – disturbance/displacement of breeding lapwing. Greenland white-fronted goose was not recorded during the	

Site name and code	Qualifying interests	Conservation objective in summary	Direct line distance to project site (km)	Connections (Source -Pathway – Receptor)	Considered further in screening (Y/N)
				baseline ornithological study. Therefore, there is no ecological connection for this species.	
Mongan Bog SPA 004017	Greenland Greenland White-fronted Goose	To maintain or restore the favourable conservation condition of the bird species listed as Special Conservation Interests for this SPA.	19.42	**Hydrological & Hydrogeological** The SPA is within a different groundwater body as the Project. Therefore, there is no hydrogeological connectivity. A study of the water courses revealed no hydrological connectivity. **Ecological** The project site is outside of the core foraging range for this species (i.e. 5-8km). Further, this species was not recorded during survey. Therefore, there is no ecological connectivity between the project and this SPA.	**N**

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 Project 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 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. Lesser horseshoe bat typically forages within 2.5km of its roost (NPWS 2018). 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). Therefore, Likely Significant Effects on SACs which only have Lesser horseshoe bat as a qualifying interest feature can be excluded.

The following SACs all have habitats only as qualifying interests; Ballyduff/Clonfinane Bog SAC, Lisduff Fen SAC, Island Fen SAC, Redwood Bog SAC, Sharavogue Bog SAC, Arragh More (Derrybreen) Bog SAC, Kilcarren-Firville Bog, Liskeenan Fen SAC, Moyclare Bog SAC, Slieve Bloom Mountains SAC, Ferbane Bog SAC, Scohaboy (Sopwell) Bog SAC, Fin Lough SAC, Mongan Bog SAC and Ardgraigue Bog SAC. For the all the aforementioned SACs, there is no hydrological or hydrogeological connectivity between the SAC and the Project site, the habitats, or similar habitats are not found within the Project site, or the habitat is terrestrial in nature. Furthermore, these SACs are too distant from the Project Site to be affected by pollution, for example, vehicle emissions, dust and light. Likely Significant Effects on qualifying interest features of these SACs can therefore be excluded at this stage without further assessment or mitigation.

However, due to the proximity of Ridge Road, SW of Rapemills SAC (0.26 km distant), the impacts due to dust and vehicle emissions generated during the construction of the Project may adversely affect the qualifying interest habitats and as such are further assessed. Furthermore, there is no hydrogeological or hydrological connection between Clonaslee Eskers and Derry Bog SAC and Fin Lough SAC. Furthermore, these SACs are too distant from the Project site to experience pollution (e.g. noise, light, emissions and dust). Therefore, Likely Significant Effects on habitat qualifying interests for these sites can also be excluded at this stage. Geyer's whorl snail is a qualifying interest of Clonaslee Eskers and Derry Bog SAC and Finn Lough (Offaly) SAC. However, there is no ecological connectivity as the distance between both of these European sites and the Project site is considered to be too large (a minimum of 15km) for this species to travel. Furthermore, this species was not found within the Project site and there is no suitable habitat within the Project site . Therefore, Likely

Significant Effects on Geyer's whorl snail, and the three SACs for which it is a Qualifying Interest, can be excluded at this stage without further assessment or mitigation.

There is direct hydrological connectivity between the Project site, and River Shannon Callows SAC and Lough Derg, North-east Shore SAC. The Project has the potential to affect these SACs in several ways.

Firstly, in the absence of mitigation, suspended solids, nutrients and other pollutants generated during the construction and decommissioning of the project could enter the SACs via run-off into connected watercourses. This could negatively affect qualifying interests which are sensitive to changes in water quality. Specifically, alkaline fens and alluvial forests with *Alnus glutinosa* and *Fraxinus excelsior* are qualifying interests sensitive to water quality changes within the River Shannon Callows SAC. In addition, the following qualifying interests of Lough Derg, North-east Shore SAC may be affected; calcareous fens with *Cladium mariscus* and species of the *Caricion davallianae,* alkaline fens and alluvial forests with *Alnus glutinosa* and *Fraxinus excelsior.*

Secondly, with regards to the River Shannon Callows SAC, activities undertaken during the construction/decommissioning of the project could result in physical injury to otters, disturbance, displacement, damage to holts/couches, and/or reduction in foraging opportunities for this species.

Dovegrove Callows SPA and All Saints Bog SPA are located 0.001km and 2.23km distance, respectively from the Project site. Both these SPAs are designated solely for Greenland white-fronted goose. Among other bird species, Greenland white-fronted goose is also a SCI of River Little Brosna SPA, located approximately 1.65km distant. Dovegrove Callows is an important feeding area for this species. It is of particular importance as it can support the entire Little Brosna flock. All Saints Bog SPA was formerly used by part of the internationally important Greenland white-fronted goose population based on the River Little Brosna. Therefore, a potential impact to this species at Dovegrove Callows also impacts the Greenland white-fronted goose population at All Saints Bog SPA and Little River Brosna Callows SPA. The grid connection infrastructure lies in close proximity to Dovegrove Callows SPA and, as such, its construction may cause disturbance/displacement to Greenland white-fronted geese within this SPA.

Greenland white-fronted goose was not recorded during flight activity surveys or dedicated winter feeding distribution surveys. Therefore, impacts such as collision, displacement and/or displacement as a result of the construction, operation and decommissioning of the wind farm itself can be excluded at this stage. River Little Brosna Callows SPA is located approximately 1.65km west of the Project. The Species of Conservation Interest (SCI) for this SPA are whooper swan, wigeon, teal, pintail, shoveler, golden plover, lapwing, black-tailed godwit, black-headed gull, wetland and waterbirds, and as previously mentioned, Greenland white-fronted goose. Of these species, whooper swan, wigeon, teal, golden plover, lapwing and black-headed gull were recorded during flight activity surveys. Furthermore, lapwing was recorded breeding within 500m of the Project site. Therefore, breeding lapwing are a risk of disturbance and/or displacement. However, pintail, shoveler, black-tailed godwit were not recorded during the baseline ornithological study. Therefore, Likely Significant Effects on these species can be excluded at this stage without further assessment or mitigation.

The operational phase of the Project may present a collision risk. Collision of a bird with turbine rotors is almost certain to result in the death of the bird. The frequency and likelihood of a collision occurring depends on several factors which include aspects of the size and behaviour of the bird (including their use of a site), the nature of the surrounding environment, and the structure and layout of the wind turbines.

Furthermore, individual turbines, or the wind farm as a whole, may present a barrier to the movement of birds, restricting or displacing birds from much larger areas. The effect this would have on a population, if affected, could be subtle, and may be difficult to predict. If birds must regularly fly over or around obstacles or are forced into suboptimal habitats, this may result in greater energy expenditure. By implication, this will reduce the efficiency with which they accumulate reserves, potentially affecting their survival or breeding success. However, logically, barrier effects can only be possible if birds are regularly flying through a site, or regularly using the habitats within a site.

The Project could also cause displacement of breeding lapwing due to disturbance during the construction and/or operational phase; this may be temporary or permanent. Disturbance effects during the operational phase may be less than during the construction phase, as species may become habituated to wind turbines and disturbance due to human activities would be considerably reduced.

With regards to waterbirds and wetland birds, the conservation objectives for this qualifying interest relates to the maintenance and restoration of the wetland habitat within the SPA. There is potential hydrogeological connectivity between the Project site and River Little Brosna Callows SPA. Therefore, Likely Significant Effects on this qualifying interest cannot be excluded and are assessed in further detail at Stage 2, below.

Middle Shannon Callows SPA, located approximately 6.24km distant, is designated for whooper swan, wigeon, corncrake, golden plover, lapwing, black-tailed godwit, black-headed gull, and wetlands. Corncrake, pintail, and black-tailed godwit were not recorded during the baseline ornithological study and there is no suitable habitat for these species within the Project site, consequently, Likely Significant Effects on these three species can be excluded. Whooper swan, golden plover, lapwing and black-headed gull were recorded in flight within at least 500m of the Project site. In addition, lapwing was recorded breeding within 500m of the Project site. As described above, the Project may present a collision risk, or even a barrier to the movement of birds. The Project could also cause displacement of breeding lapwing due to disturbance during the construction and/or operational phase.

There is hydrological connectivity between Middle Shannon Callows SPA and the Project site via the Rapemills River and River Shannon. Therefore, in the absence of mitigation, suspended solids, nutrients and other pollutants generated during the construction and decommissioning of the wind farm could enter the SPA via run-off into connected watercourses and negatively affect the wetland habitat. The SPA is also present within the same groundwater body as the Project site and thus there is potential hydrogeological connectivity. If the lowering of groundwater is required during the construction phase, for instance during excavation for turbine bases, this may impact upon groundwater dependant habitats.

The SCI for Lough Derg (Shannon) SPA, situated 15.07km distant, are cormorant, tufted duck, goldeneye, common tern, and wetland and waterbirds. Of these species only cormorant was recorded during the baseline ornithological study. Specifically, flight activity surveys recorded a peak count of two birds. As detailed above, the Project may present a collision risk, or even a barrier to the movement of this species. Likely Significant Effects on tufted duck, goldeneye and common tern can be excluded because these species were not recorded during the base ornithological study and there is no suitable habitat for them within the Project site.

Lough Derg (Shannon) SPA is hydrologically connected to the Project site via the Rapemills River and River Shannon. Thus, without mitigation, there is potential for suspended solids, nutrients and other pollutants generated during the construction and decommissioning of the wind farm to enter the SPA. This pollution could negatively affect the wetland habitat utilised by the wetland and waterbirds.

River Suck Callows SPA has the following SCI; whooper swan, wigeon, golden plover, lapwing, Greenland white-fronted goose, and wetland and waterbirds. As outlined in Table 3-1 Likely Significant Effects on this population of Greenland white-fronted goose can be excluded. Whooper swan, wigeon, golden plover and lapwing were recorded in flight within 500m of the Project site. Lapwing was also recorded breeding within 500m of the Project site.

Therefore, the Project may present a collision risk, or even a barrier to the movement of these species. Breeding lapwing may also be disturbed or displaced during the construction, operation and decommissioning phases of the Project.

River Suck Callows SPA is within a different groundwater body to the Project and at a considerable distance from the Project site for hydrogeological links. A study of the water courses revealed no hydrological connectivity as the SAC is situated upstream of the nearest potentially connected water course. Therefore, likely significant effects on the wetland habitat can be excluded at this stage without further assessment or mitigation.

Hen harrier is the only qualifying interest of Slieve Bloom Mountains SPA, located c. 11.65km east. A total of four flight lines of single hen harriers were recorded during flight activity surveys. All flight lines were observed in winter, suggesting a few birds moving through the wider area while foraging. No hen harrier were recorded roosting during dedicated winter roost surveys. Furthermore, no breeding hen harrier were recorded during dedicated breeding raptor surveys. The Project may present a collision risk to hen harrier and as such Likely Significant Effects cannot be excluded and further assessment has been undertaken at Stage 2.

3.5.2 For the Project 'In Combination'

Pathways for potential in-combination effects have been identified for the following European sites:

- Ridge Road, SW of Rapemills SAC,
- River Shannon Callows SAC,
- Lough Derg, North-east Shore SAC,
- Dovegrove Callows SPA,
- River Little Brosna Callows SPA,
- All Saints Bog SPA
- Middle Shannon Callows SPA,
- Slieve Bloom Mountains SPA,
- Lough Derg (Shannon) SPA, and
- River Suck Callows SPA.

There is the potential for other plans and projects, specifically any other land use changes, to also impact upon the designated features of these European sites. Therefore, Likely Significant Effects cannot be excluded for the European sites listed above 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 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 direct hydrological connectivity between the Project site and two SACs: River Shannon Callows SAC and Lough Derg, North-east Shore SAC. The Project has the potential to affect these SACs in several ways. Firstly, there is a risk of suspended solids, nutrients and other pollutants generated during the construction and decommissioning of the project entering the SACs. This could negatively affect qualifying interests which are sensitive to changes in water quality.

Secondly, with regards to the River Shannon Callows SAC, activities undertaken during the construction/decommissioning of the project could result in physical injury to otters, disturbance, displacement, damage to holts/couches, and/or reduction in foraging opportunities for this species.

The construction of the grid connection infrastructure has the potential to cause disturbance and/or displacement of Greenland white-fronted goose within Dovegrove Callows. The population of Greenland white-fronted goose in the following three SPA's are linked; River Little Brosna Callows SPA, Dovegrove Callows SPA and All Saints Bog SPA. Therefore, an impact to Greenland white-fronted goose in one these SPA's effects the population in all three of them.

The possibility cannot be excluded that the Project could negatively affect whooper swan, golden plover, lapwing, black-headed gull, cormorant and hen harrier, the combined SCI of River Little Brosna Callows SPA, Middle Shannon Callows SPA, Lough Derg (Shannon) SPA, River Suck Callows SPA and Slieve Bloom Mountains SPA, via disturbance, displacement and collision risk.

Furthermore, the wetland habitat of River Little Brosna Callows SPA, Middle Shannon SPA and Lough Derg (Shannon) SPA may be negatively impacted due to hydrogeological and/or hydrological connectivity with the Project site.

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 Project alone, and in combination with other plans or projects, on:

- Ridge Road, SW of Rapemills SAC,
- River Shannon Callows SAC,
- Lough Derg, North-east Shore SAC,
- River Little Brosna Callows SPA,
- Middle Shannon Callows SPA,
- Slieve Bloom Mountains SPA,
- Lough Derg (Shannon) SPA, and
- River Suck Callows 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 Project alone, and in combination with other plans or projects, on:

- All Saints Bog and Esker SAC
- Ballyduff/Clonfinane Bog SAC
- Lisduff Fen SAC,
- Island Fen SAC
- Redwood Bog SAC,
- Sharavogue Bog SAC,
- Arragh More (Derrybreen) Bog SAC,
- Kilcarren-Firville Bog SAC,
- Liskeenan Fen SAC,

- Moyclare Bog SAC,
- Slieve Bloom Mountains SAC,
- Ferbane Bog SAC,
- Clonaslee Eskers and Derry Bog SAC,
- Scohaboy (Sopwell) Bog SAC,
- Fin Lough SAC,
- Mongan Bog SAC,
- Ardgraigue Bog SAC,
- Dovegrove Callows SPA, and
- All Saints Bog SPA.
- Nor any other European sites in Ireland.

4.0 Stage 2: Appropriate Assessment

4.1 Step 1, Part 1: Information on the Project

4.1.1 Project Description

4.1.1.1 Turbines and Associated Infrastructure

The proposed Cush Wind Farm consists of the following elements:

- 8 no. wind turbines with a hub height of 114 meters (m), a rotor diameter of 172m, and an overall tip height of 200m;
- All associated turbine foundations and crane hardstand areas;
- Wind farm control building incorporating a medium voltage switchgear room;
- All underground internal electrical and communications cabling;
- Provision of new internal site access tracks and use of, and upgrades to, existing agricultural/forestry tracks;
- Upgrade of 2 no. site entrances from the N62 national route for use during the construction phase only;
- Upgrade of 2 no. site entrances from the L30033 and L300321 local roads, respectively, for the operation phase only;
- 1 no. guy-wired meteorological mast with an overall height of 30 metres;
- 2 no. temporary construction compounds;
- 3 no. dedicated spoil deposition areas for the storage, as required, of excavated material;
- Felling of up to 23 hectares (ha) of forestry to facilitate the construction and operation of wind farm infrastructure; and,
- All associated and ancillary site development, excavation, construction, landscaping and reinstatement works, including provision of site drainage infrastructure and environmental mitigation measures.
- Temporary alteration works to public roads along the turbine component haul route, including a vehicle turning area at the N52/N62 junction.
- A 110 kilovolt (kV) electrical substation and all associated electrical equipment, including a control building and battery electricity storage system;
- The installation of c. 5.6km of underground electricity cable to facilitate connection of the proposed electricity substation to the existing 110kV substation at Clondallow, County Offaly; and,
- The planting of 23ha of forestry on lands in the townlands of Drumagelvin, Drumleek South, Lisdonny and Moy, County Monaghan.

4.1.1.2 Turbine Component Haul Route

In order to facilitate the delivery of turbine components some temporary alterations will be required at various locations along the route. A total of 17 no. locations have been identified where alterations to the public road network will be required. Each of these 17 locations involve works of a temporary nature, including the temporary provision of hardcored surfacing, temporary road sign/traffic signal/street lighting removal, and/or the temporary removal, with replacement, of roadside/streetscape vegetation and trees.

4.1.1.3 Grid Connection

The existing Dallow 110kV electricity substation is the most likely point of connection to the national network.

The project includes; A 110 kilovolt (kV) electrical substation and all associated electrical equipment, including a control building and battery electricity storage system and the installation of c. 5.6km of underground electricity cable to facilitate connection of the proposed electricity substation to the existing 'Dallow' 110kV substation at Clondallow, County Offaly

4.1.1.4 Meteorological Mast

A temporary 80m meteorological mast is present within the Project site at Irish Transverse Mercator (ITM) coordinates 607231, 710703, and is assessed as part of the in-combination effects in **Section 4.4**.

The permanent mast to be installed will be 30m in height and will consist of a guy-wired structure to which various measurement instruments will be attached. The purpose of the mast is to monitor wind speeds and climate conditions. Some ground works, including the construction of a concrete foundation and anchors, will be required to erect the proposed permanent mast.

4.1.2 Site Location and Context

The project is located in rural County Offaly, approximately 4km north of the town of Birr and c. 28km south-west of Tullamore in the townlands of Cush, Galros West, Boolinarig Big, and Eglish. The proposed temporary haul route alteration works to the N52/562 junction are located in the townland of Ballindown, County Offaly. The project will have an overall site area of approximately 290 hectares (ha).

The N62 national secondary route bisects the project site and it is proposed to access the project from the N62 during the construction phase.

The project site and surrounding topography are typical of the midlands region and comprise a generally flat landscape with occasional gentle undulations, with ground elevations ranging between 47m and 63m OD (Ordnance Datum). The most elevated section of the project site is found along the eastern fringes where agricultural grassland rises up to 63m OD (met mast location). The ground slopes in a general westerly direction from this eastern section to the lowest point on the far west of the project site which follows the valley of the Rapemills River.

Current land use within the project site is made up of peat bogs, agricultural pasture and forestry, including commercial planting, woodland, and scrub. Areas to the north and northwest of the project site comprise cutover private bog; areas to the east and west of the N62 exhibit commercial forestry plantation and woodland; and areas to the south and southeast are predominantly agricultural pasture. The wider landscape is characterised by large tracts of industrial cutaway peatlands and agricultural scrub; however, improved agricultural pasture is dominant in areas bordering the east and west of the project site.

The primary drainage feature within the project site is the Rapemills River which flows in a westerly direction through the southwestern portion of the site for c. 1.2km. The Rapemills River is deep (approximately 2m) with steep banks and up to 5m in width.

A tributary stream of Rapemills River, referred to as the West Galros Stream by the EPA emerges from forestry on the eastern portion of the project site, crosses the N62 and then merges with the Rapemills River close to the western boundary of the project site.

The underground grid connection (c. 5.6km in length) follows public roads for c. 4.7km with an off-road section through private lands (off-road) for c. 0.65km. Approximately 200m of the route is located within the wind farm site. The off-road section of the grid connection is through rough grassland. The existing ESB owned Clondallow 110kV substation is located 1.7km to the southwest of the wind farm site.

Settlement patterns in the local area are typical of this part of Ireland, largely comprising dispersed rural dwellings often accompanied by attendant agricultural holdings and outbuildings.

4.1.3 Detailed Project Description

4.1.3.1 Wind Turbines

The coordinates of the proposed wind turbines are set out in **Table 4-1** below.

Table 4-1: Proposed wind turbine coordinates and existing ground levels.

ID	Easting*	Northing*	Overall tip height (m)	Approximate ground level (mAOD)
T1	606797	710446	200	46.9
T2	606312	709829	200	46.7
T3	607351	710753	200	48.3
T4	607060	710033	200	46.7
T5	607922	710465	200	46.7
T6	607844	709967	200	48.9
T7	608286	709735	200	51.9
T8	608427	710195	200	50.8

*Note: Coordinates provided In Irish Transverse Mercator (ITM)

**Note: Micrositing and any immaterial deviations to the proposed turbines within an overall development envelope (overall height or red line boundary) are fully assessed.

The proposed wind turbines will have an overall tip height of 200m. The rated output for each turbine, based on the proposed model selected, is 7.2 MW, resulting in a total rated output of 57.6 MW for the project.

The turbines will each consist of a three-bladed rotor attached to a nacelle (hub) which contains the mechanical drive train and electrical generation mechanisms, mounted on a steel/concrete tower of tubular construction. The blades will be constructed of glass reinforced plastic. The colour of the proposed turbines and blades will be white, off-white or light grey in accordance with the Wind Energy Development Guidelines for Planning Authorities 2006, or as otherwise determined by An Bord Pleanála.

The turbines will be geared to ensure that all turbines rotate in the same direction and will typically have a cut-in wind speed of 3 m/s and a cut-out speed of 25 m/s. At the cut-out speed, the turbine will automatically shut down.

Each turbine will utilise its own transformer, which will be located inside the nacelle. Transformers will either be oil-filled (and bunded to prevent spillage) or of a solid cast resin type, which is effectively non-polluting should a spillage occur. The transformers will increase the electrical voltage on site and on-site electrical cables will connect the turbines to the electrical control building located on the southwestern boundary of the Project site.

Details of the proposed turbine make, model and dimensions are provided in **Table 4-2** below.

Table 4-2: Proposed turbine model and dimensions

Turbine model	Output (mw)	Hub height (m)	Rotor diameter (m)	Overall tip height
Vestas V172-7.2MW	7.2	114	172	200

4.1.3.2 Turbine Foundation

Each turbine tower is secured to a steel ring foundation which can comprise either a reinforced concrete (gravity) foundation or a piled foundation. The precise type of foundation to be used for each turbine will depend upon the specific ground conditions at each location. This shall be established through detailed technical design and post-consent geotechnical investigations prior to construction, as is normal best practice in all construction projects.

The depth of excavation required for each wind turbine foundation will vary depending on precise ground conditions. The diameter of a standard gravity raft foundation will be c. 28.9m; whilst the diameter of a piled foundation would, if deemed to be required, be c. 22m. Foundation depths will range between 3m and 5m in depth depending on ground conditions at each turbine location. Excavations will be undertaken by conventional mechanical methods and no blasting will be required.

4.1.3.3 Turbine Hardstands

Hardstand areas shall be established adjacent to each turbine to facilitate crane operations for turbine erection; and, occasionally, for maintenance; and final decommissioning. Each hardstand area shall typically be 96 m x 45m for the construction phase and will consist of levelled and compacted (unsealed) hardcore.

The crane hardstands will be retained *in situ* during the operational phase of the project to accommodate any crane activities in the event of a major component change-out and during the decommissioning phase.

Temporary set down areas will be located immediately adjacent to each hardstand during the construction phase to accommodate the temporary storage of turbine components following their delivery to the project site, and crane components during crane assembly. Following the erection of the turbines, these set down areas will be reinstated with excavated material, re-seeded and allowed to revegetate.

4.1.3.4 On-site Access Tracks

A total of 6.8km of on-site (wind farm) access tracks will be required for construction purposes and for site access during the operational phase. The vast majority of these access tracks (c. 5.6km) shall be newly constructed; however, the alignment will generally follow routes which are regularly trafficked during current agricultural and forestry operations. Approximately 1.2km of existing agricultural/forestry access track shall also be upgraded (re-surfaced) to accommodate construction traffic.

The access tracks shall be similar to normal agricultural tracks but with a slightly wider typical running width of approximately 5m (wider at bends to accommodate turbine component delivery vehicles). Passing bays and turning heads shall also be provided along the access tracks to accommodate the turning of long loads and passing traffic, as required.

It is noted that the Rapemills River runs along the southwestern fringes of the site and that a section of proposed access track, between proposed Turbine T4 and T2, spans/crosses this section of the river. It is proposed to install an abutment on either side of the river, with associated albs, which will effectively span the river, negating the need for invasive culvert structures. This abutment type crossing is proposed for all crossings across the Project site. It is also noted that a number of drainage ditches and lower order watercourses/streams do exist across the site, including at areas to the northeast and east.

4.1.3.5 Meteorological Mast

A temporary meteorological (anemometry) mast currently exists within the project site for measuring wind speed and meteorological conditions. This mast is 80m in height and has recorded an average wind speed for the site of approximately 7.3 m/s at 14 m (adjusted).

Planning permission has been granted, pursuant to Offaly County Council Planning Register Reference PL2/22/444, for its extension to 100m in height. At the time of writing, the mast has not yet been extended but it is anticipated that these works will be undertaken later in 2023.

It is proposed that this mast will be removed and replaced with the permanent (permanent as per the lifespan of the wind farm) mast; the details of which are provided at **Table 4-3** below.

Table 4-3: Meteorological met mast details

ID	Easting*	Northing*	Overall Height (m)	Approximate Ground Level (mAOD)*
Permanent meteorological mast	608483	709506	30	53.0

***meters above ordnance datum

The permanent mast to be installed will be 30m in height and will consist of a guy-wired structure to which various measurement instruments will be attached. The purpose of the mast is to monitor wind speeds and climate conditions for the efficient operation of the project. The recorded data will also be utilised in the forecasting of electricity generation.

Some ground works, including the construction of a concrete foundation and anchors, will be required to erect the proposed permanent mast. Mast components will be brought to site by 4x4 vehicles which will utilise the proposed access tracks and site entrances.

4.1.3.6 Electrical/Communications Cabling and Site Control Building

All on-site electrical and communications cables will be placed underground and be of a solid polymeric construction with either aluminium or copper conductors. All electrical cables will follow the alignment of the on-site access tracks, insofar as is practical. Trenching will be by a mechanical digger. The proposed depth of the cable trench is 1m with a width of 0.5m. The excavated material from the cable trenches will be cast alongside the trench and reinstated following the laying of cable ducts.

An electrical site control building will be constructed within the Project site. The purpose of this control building is to act as a ‘node’ to where the underground electrical (and communications) cabling circuits from each wind turbine will converge. The control building will contain electrical apparatus and will transfer electricity from each individual circuit to a single circuit for its onward transmission to a 110kV ‘tail fed’ electricity substation.

The control building will measure 17.8m x 7.35m (gross floor area of 131 m2) and will have an overall height of c. 6m to ridge height. The control building will be constructed of blockwork and finished in sand and cement render, blue/black slate roof covering and galvanised steel doors. The control building will contain a control room, switchgear room, storeroom and welfare facilities for staff during the operational phase of development. The control building will include a dedicated mains water connection to provide for toilet facilities and hand washing. Wastewater from the control building will be stored in a sealed tank and will be tankered off-site as required by a local licensed waste collector.

4.1.3.7 Temporary Construction Compounds

During the construction period, 2 no. temporary construction compounds will be required. The compounds will be located along the proposed arterial access track, with 1 no. construction compound located on the eastern side of the N62 (approximate area of 0.1ha) and 1 no. located on the western side (approximate area of 0.9ha).

4.1.3.8 Turbine Component Delivery Route

Whilst the final turbine component haul route has not been selected and will be entirely dependent on the turbine supplier and the chosen port of entry, it has been determined that turbine components will, most likely, enter via the Port of Galway. It is envisaged that, from here, the turbines will then be transported by specialised HGVs for the transport of turbine components along the N6, M6, N52 and N62 before accessing the site via the proposed construction phase site entrances.

In order to facilitate the delivery of turbine components, however, some temporary works will be required at various locations along the above route. A total of 17 no. locations have been identified where works to the public road network will be required. Each of these 17 locations involve works of a temporary nature, including the temporary provision of hardcored surfacing, temporary road sign/traffic signal/street lighting removal, and/or the temporary removal, with replacement, of roadside/streetscape vegetation and trees.

4.1.3.9 Electricity Substation

The 110kV tail fed substation, to be located in the townland of Boolinarig Big, will comprise an electrical compound. The footprint of the substation (overall compound area) will measure 8,235m^2 and will be surrounded by a palisade fence, with associated gates, of 2.6m in height for safety and security reasons. The proposed substation will contain 2 no. control buildings, a battery energy storage system and all necessary electrical equipment and apparatus to facilitate the export of electricity to the national grid.

The proposed substation will be connected to the proposed wind farm via the proposed site control building and the associated underground electrical cabling, as described in section 4.1.4.6.

4.1.3.10 The proposed substation compound will contain 2 no. control buildings; one of which, the Independent Power Producer Building (the 'IPP) Building'), will be operated and maintained by the Developer, while the Transmission System Operator Control Building ('the EirGrid Building') will be operated and maintained by EirGrid. Underground Electrical Line

The proposed electricity substation will be connected to the Dallow 110kV substation via c. 5.6km of 110kV underground electricity line (UGL). From the proposed substation, the UGL will be located within the proposed access track to the south where it runs west along the L30033 local road. The UGL then enters private lands, to the north of Birr Golf Club, until it enters the R439 Regional Road (northward) for a short distance, before being placed along the L70151, L701521, and L70152 local road's to where it connects into the existing Dallow 110kV substation. The UGL will be installed within ducting in excavated trenches of 1.2m deep and 0.6m wide.

4.1.3.11 Tree Felling and Replanting

It is proposed to permanently remove up to 23 ha of woodland habitat in order to accommodate the construction of turbine foundations, access tracks, and other ancillary infrastructure; and to facilitate the physical operation of the wind turbines.

The Developer has identified potential replacement lands at Drumagelvin, Drumleek South, Lisdonny and Moy, Co. Monaghan. Whilst it is highly likely that the identified lands will be progressed through the felling licence consenting process, it is important to note that an alternative parcel of land may also be selected in due course.

4.1.4 Project Construction

4.1.4.1 Construction Environmental Management Plan (CEMP)

A detailed Construction & Environmental Management Plan (CEMP) will be prepared in advance of all construction activities and will incorporate all mitigation measures proposed. A Planning-Stage CEMP has been prepared and is provided at **Appendix 4**.

4.1.4.2 Construction Activities

The construction method for the project (wind farm) will consist of the following general sequence:-

- Preliminary traffic management and surface water protection measures to be implemented;
- Creation of the site entrances, to be commenced and completed, ensuring that adequate visibility splays are provided;
- Progressive installation of surface water protection measures;
- Establishment and continued management of spoil deposition areas;
- Progressive construction of internal on-site access tracks utilising material extracted from on-site, where possible, and imported from local quarries;
- Construction of the temporary construction compounds for offloading materials and equipment, and to accommodate temporary site offices;
- Construction of bunded areas for oil, fuel and lubricant storage tanks;
- As the internal access tracks progress to each turbine location, tree felling will be completed and foundation excavations for the turbines will commence, and foundations poured. The hardstand areas will be constructed as track construction advances;
- Temporary alteration works along the turbine component haul route will be commenced;
- Once the on-site access tracks are completed, the trenching and laying of underground cabling will begin;
- Site preparatory and groundworks associated with the wind farm control building, construction of the building followed by the installation of electrical and ancillary equipment;
- Installation of turbines will commence once the on-site access tracks, hardstands, foundations and drainage measures are in place and the road upgrade works are complete. It is anticipated that each turbine will take approximately one week to install. Two cranes will be used for this operation. As each turbine is completed, the electrical connections will be made;
- Decommissioning of the temporary meteorological mast and installation of the permanent meteorological mast will then take place; and,
- Progressive site reinstatement, restoration and landscaping including re-profiling of spoil deposition areas, removal of turbine storage areas; erection of post-and-wire fencing around turbines, access tracks and at site entrances; decommissioning of construction phase site entrances; establishment of operational site entrances; erection of gates and

vegetation at site entrances; and decommissioning of the temporary construction compounds.

The construction method for the proposed substation and grid connection will consist of the following general sequence (to be completed concurrently with wind farm construction):-

- Site preparatory and groundworks associated with the substation compound footprint including control buildings;
- Construction of the IPP and EirGrid buildings;
- Construction of bases or plinths for electrical apparatus, including battery energy storage system containers;
- Erection of palisade fencing around substation;
- Installation of internal and external electrical apparatus in control buildings and within compound area;
- Installation of underground electricity cables (including joint bays and communication chambers,) between substation and Dallow 110kV electricity substation;
- Connection of underground electricity cables to the respective substations;
- Commissioning of electrical apparatus and underground electricity cables; and
- Progressive site reinstatement, restoration, landscaping and planting proposals including the installation of stockproof fencing and the erection of gates.

4.1.4.3 Site Entrances

A total of 4 no. site entrances will be required to facilitate access to the Project site; comprising 2 no. construction phase site entrances, to be used during the construction phase of works only, and 2 no. operational phase site entrances, to be used during the operational phase of the project. The 2 no. proposed construction phase entrances will involve the upgrade of 2 no. existing agricultural/forestry entrances, whilst the 2 no. proposed operational entrances will require the upgrade of 2 no. existing agricultural entrances.

Following the delivery of turbine components, the scale of the wind farm (construction phase) site entrances will be reduced and gated but will be reinstated such that they remain capable of accommodating abnormal loads in the event of a major component change-out during the operational phase of development. The reinstatement of the site entrances will comprise the erection of post and rail fencing, gates and the planting of hedgerows.

4.1.4.4 Hardstanding Areas and On-site Access Tracks

The areas of hardstanding for crane operations and on-site access tracks will generally be constructed as follows:

- Topsoil and subsoil will be removed and stored in separate mounds in appropriate areas adjacent to the crane site/access tracks;
- Rock/stone, where encountered, will be laid on a geo-textile mat (where required) and compacted in layers to an appropriate depth. The sub-layers of the hardstanding areas and access tracks will be constructed of imported rock/stone, with the upper layer comprising capping material imported from a local quarry (quarries). All such areas of hardstanding will be permeable to avoid significant volumes of surface water run-off;
- Where access tracks are required to cross drainage ditches, these will be piped or spanned with an appropriate bridging structure. Where access tracks cross a watercourse, bottomless culverts will be installed (where possible) to prevent any interference with the hydraulic capacity of the watercourse; and,
- Areas of temporary hardstanding (for turbine component storage and crane assembly) will be reinstated following the construction phase by removing aggregates, replacing the excavated spoil and reseeding. The crane hardstandings and on-site access tracks

will be retained during the operational phase to facilitate access for maintenance personnel and in the event of a major component change-out.

4.1.4.5 Temporary Construction Compounds

Topsoil will be removed from the required area and side cast for temporary storage adjacent to the compound areas. The compound base will be made up of well graded aggregates, compacted as necessary. A designated waste management area and fuels and chemicals storage area will be provided along with site offices, parking, staff welfare facilities and equipment storage areas for each compound area. The compounds will be fenced with temporary security fencing to restrict access. Following the completion of the construction phase, the temporary construction compounds will be fully removed and the compounds will be reinstated with excavated material and reseeded.

4.1.4.6 Chemical Storage and Refuelling

Storage areas for oils, chemicals and fuels will comprise bunded areas of hardstand of sufficient capacity within the temporary construction compounds. Bunds will have a watertight roof structure and will be supplied by a licensed manufacturer to enable adequate safe storage for the quantities of material required. An adequate supply of spill kits will be readily available in order to clean up any minor spillages should they occur. A hydrocarbon interceptor will be installed within the surface water drainage system during the construction phase to trap any hydrocarbons that may be present. As part of the design process, a 50m buffer has been observed around all surface water features and no fuel/chemicals shall be handled or stored within this zone.

From the construction compounds, fuel will be transported to works area by a 4x4 in a double skinned bowser with drip trays under a strict protocol and carried out by suitably trained personnel. The bowser/4x4 will be fully stocked with spill kits and absorbent material, with delivery personnel being fully trained to deal with any accidental spills. The bowser will be bunded appropriately for its carrying capacity. As above, a 50m buffer will be observed around all surface water features and no refuelling will be permitted within this zone.

4.1.4.7 Construction Waste Management

Waste will be generated during the construction phase and the main items of anticipated construction waste are as follows:

- Hardcore, stone, gravel, concrete, plaster, topsoil, subsoil, timber, concrete blocks and miscellaneous building materials;
- Waste from chemical portaloo toilets;
- Plastics; and
- Oils and chemicals.

Waste disposal measures proposed include:

- On-site segregation of all waste materials into appropriate categories including, for example, topsoil, bedrock, concrete, bricks, tiles, oils /diesels, metals, dry recyclables e.g. cardboard, plastic, timber;
- All waste materials will be stored in skips or other suitable and sealed receptacles in a designated area of the construction compound;
- Wherever possible, left over materials (e.g. timber off-cuts) and any suitable demolition materials shall be re-used on-site;

- Uncontaminated excavated material (rock, topsoil, sub-soil, etc.) will be re-used on-site in preference to importation of clean inert fill;
- Bedrock may be encountered during foundation excavation. If bedrock is encountered it will be utilised for infill during construction;
- All waste leaving the site will be transported by permitted contractors and taken to suitably licensed or permitted facilities and will be recycled, recovered or reused, where possible; and
- All waste leaving the site will be recorded in accordance with legal requirements and copies of relevant documentation maintained.

4.1.4.8 Construction Traffic

Vehicular traffic required for the construction phase is likely to include:

- Articulated trucks (HGVs) to bring initial equipment onto site and later to bring the turbine components, electrical cables, steel reinforcement for foundations, anemometer mast, and ancillary equipment;
- Tipper trucks and excavation plant involved in site development and excavation works;
- Cranes to erect the turbines;
- Miscellaneous vehicles and handling equipment, including vehicles associated with construction workforce.

Effects from construction traffic could include temporarily increased local traffic levels and traffic noise. Construction traffic on the local road network will be managed in accordance with a Traffic Management Plan and the requirements of the Planning Authority (Authorities). This may include the installation of temporary road signage and traffic lights, as appropriate. Noise arising from construction traffic would be localised, temporary and of a short-term duration.

Deliveries of turbine components will take place at times to avoid peak traffic periods, and are likely to occur during night-time hours. All abnormal loads will be accompanied by an advance escort vehicle.

Once the turbines are operational, the traffic movements will be greatly reduced to, on average, once/twice per week by a light commercial vehicle for maintenance purposes. There may be an occasional need to replace some turbine components but these are unlikely to be frequent.

4.1.5 Operational Phase

The proposed operational phase of the development is 35-years from the date of commissioning. During this period, the wind turbines will be operational and, other than routine maintenance and monitoring, there will be no other activities on site and agricultural activities will continue as normal. On average, the project will be serviced once/twice per week by a light commercial vehicle for maintenance purposes. In exceptional circumstances there may be an occasional need to replace some major turbine components, but these will be very infrequent.

Waste will be generated during the operation phase including, for example, cooling oils, lubricating oils and packaging from spare parts or equipment. All waste will be removed from site and reused, recycled or disposed of in accordance with best-practice and all regulations in a licensed facility.

4.1.6 Decommissioning

The proposed operational phase of the development is 35-years. At the end of this period, several options will exist:

- Continued operation of the existing turbines;
- Refurbishment/replacement of the turbines and continued operation; and
- Decommissioning of the wind farm.

Any further operation beyond 35-years would be subject to a further planning application. In its scope, this report assumes full decommissioning of the Project will take place after 35-years. All structures above ground level shall be demolished and removed from the site for reuse/recycling; however, access tracks are likely to be retained for continued use by landowners for agricultural purposes.

A Decommissioning Management Plan will be agreed with the Planning Authority in advance of decommissioning works.

4.1.6.1 Wind Turbines

The internal components of the turbine will be removed prior to the dismantling of the turbines using cranes in a similar manner to the construction but in reverse. The turbine will be removed to approximately ground level and the components will be transported off site for re-use or recycling.

4.1.6.2 Turbine Foundations

Wind turbine foundations shall be grubbed up to a depth of 1m below ground level using conventional mechanical diggers. Exposed rebar and holding down bolts shall be burned off and removed off site to an approved waste handling facility for recycling or disposal. Excavations shall be backfilled with excavated material, soiled over and seeded out.

4.1.6.3 Hardstands and Access Tracks

Hardstands shall be grubbed up to a depth of 0.5m below ground level and the excavated material shall be used to regrade the hardstand area to match existing ground contours and profile. Once the area has been profiled to match the surrounding ground, 200-300mm of topsoil shall be spread over the reinstated area. This area shall then be seeded out.

If it is decided not to retain the access tracks on site for agriculture purposes, then these shall be removed using a similar methodology.

4.1.6.4 Transformers and Cables

The decommissioning of transformers will depend entirely on any future use of the wind turbines. If the turbines are to be used elsewhere, the transformer will be removed from site for refurbishment and future use. If the turbines are to be scrapped, the transformer will be removed to an approved waste handling/recycling facility and stripped of any useable parts with the remainder being recycling.

Excavations shall be carried out to expose any cables buried in trenches to a depth of 1m below ground level and the cable removed. The majority of cables used in wind farm construction contain a core of either copper or aluminium. Both of these materials can be recycled. Any cable off-cuts shall be removed off site to an approved waste handling facility where the cores shall be recycled and the remaining material shall be disposed of at an approved facility. Excavations carried out to expose cables shall be backfilled with excavated material, soiled over and seeded out.

4.1.6.5 Electrical Substation and Grid Connection

The electricity substation and grid connection will, once operational, be 'taken-in-charge' by ESB Networks, who will operate and maintain the infrastructure as part of the national electricity network. As a result, the substation and grid connection do not have a specified operational period and may continue to be operated following the decommissioning of the proposed wind farm (i.e. after its 35-year operational period). However, for the purposes of this report, full decommissioning of the substation and grid connection have been assumed.

The decommissioning of the substation will involve the strip-out and demolition. Foundations and building services shall be grubbed up to a depth of 1m below ground level. Decommissioning of the grid connection will involve the removal of the UGL ducting and cable.

4.1.6.6 Meteorological Mast

The decommissioning of the meteorological mast will involve the removal of wind measuring equipment, the separation of the lattice mast sections and their removal from site for re-use in other projects or for recycling. The mast foundations shall be grubbed up to a depth of 1m below ground level and the excavated material shall be used to re-grade the area to match existing ground contours and profile. Excavations shall be backfilled with excavated material, soiled over and seeded out.

4.1.6.7 Monitoring

A monitoring period of 2-years immediately following the decommissioning and restoration activities will be implemented. The monitoring period allows for the subject site to experience seasonal changes and to determine if additional restoration works are required. If, during this time, any failure of works or reinstatements carried out were to occur, they shall be made good using similar methods as described above, or as agreed with the Planning Authority.

4.1.7 Ecology Baseline

4.1.7.1 Ecology Surveys

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

Table 4-4: Summary of ecology surveys

Survey	Brief description	Timing
Site walkover	An initial walkover of the site was undertaken to identify any major constraints.	11th May 2022
Habitats	Survey to determine habitats present within the main wind farm site, grid-connection route, and substation.	18th – 21st July 2022 23rd and 26th August 2022. 31st August 2023.
Annex I habitats	A survey to determine if areas identified as bog woodland (Fossitt code WN7) correspond with Annex I habitat 91D0.	24th – 25th August 2022
Invasive species	Recording non-native invasive species observed during habitat surveys, and on an ad-hoc basis during other surveys. The location and area covered by invasive plant species (i.e. area	11th May 2022 and 18th – 21st July 2022.

Survey	Brief description	Timing
	or length (m^2)/(m)) of plant species was also noted.	
Aquatic surveys	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, freshwater pearl mussel (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 vicinity of the project. Full details of the survey methodology are included in section 2 of the aquatic survey report in **Appendix 3**.	23rd – 25th August 2022
Marsh fritillary	Habitat assessment to determine potential and suitability for marsh fritillary.	13th – 14th June 2022
Bird surveys	Vantage point (VP) surveys covering each turbine locations plus a 500m radius around the same. Two VPs x 36 hours/VP/season (minimum) over two years.	Breeding season 2020: 6th May 2020 - 8th September 2020.
		Non-breeding season 2020/21: 6th October 2020 - 12th March 2021.
		Breeding season 2021: 29th April 2021 - 15th September 2021.
		Non-breeding season 2021/22: 13th October 2021 - 16th March 2022.
	Breeding wader surveys within the site plus a 500m buffer zone.	Breeding season 2020: 5th and 29th May and 26th June 2020.
		Breeding season 2021: 13th May, 1st and 17th June 2021.
		Breeding season 2022: 9th and 17th May, and 8th June 2022.
	Breeding raptor surveys within the site plus a 2km buffer zone.	Breeding season 2020: 5th and 29th May, 26th June and 8th July 2020.
		Breeding season 2021:

Survey	Brief description	Timing
		13th May, 1st and 16th June, and 18th and 20th July 2021.
		Breeding season 2022: 9th and 17th of May, 7th of June, 14th of July and 2nd of August 2022.
	Winter swan and goose feeding distribution surveys within the site plus at least a 500m buffer zone.	Non-breeding season 2020/21: fortnightly from 4th November 2020 to 12th March 2021.
		Non-breeding season 2021/22: fortnightly from 13th October 2021 to 16th March 2022.
		Non-breeding season 2022/23: fortnightly from 5th October 2022 to 13th March 2023.
	Winter hen harrier roost surveys at suitable habitat within the site plus a 2km buffer zone.	Non-breeding season 2021/22: 18th January, 16th February and 2nd March 2022.
	Nocturnal golden plover surveys at suitable habitat within the site.	Non-breeding season 2022/23: 3rd January and 13th March 2023.
Terrestrial mammals (excluding bats)	Survey carried out within 50m of site infrastructure. Surveys for otter also extended 150m upstream/downstream of water crossings (300m total).	11th May 2022 18th – 21st July 2022 22nd – 24th August 2022
Bats	Preliminary ecological appraisal of project site to determine presence of potential commuting, foraging, and roosting habitat.	11th May 2022
	Preliminary roost assessment	06th - 08th April 2022
	Ground-level static detector	Spring: 11th May – 23rd May 2022 Summer: 12th July – 23rd July 2022 Autumn: 28th September – 11th October 2022
	Static detector at height	Spring: 18th May – 08th June 2022 Summer: 01st July – 04th September 2022 Autumn: 28th September – 18th October 2022
	Transects	Spring: 18th May 2022 Summer: 1st July 2022

Survey	Brief description	Timing
		Autumn: 27th September 2022
	Survey of trees along grid connection routes	18th-21st July 2022 23rd and 26th August 2022

4.1.7.2 Habitats (Annex I)

No Annex I habitats were recorded within the Project site.

4.1.7.3 Species (Annex I birds, bird species of interest and Annex II others)

Whooper swan

Whooper swan, a SCI of River Little Brosna Callows SPA, Middle Shannon Callows SPA and River Suck Callows SPA, was observed commuting over the Project site, with a peak count of a flock of 12 birds recorded in winter 2020/21. However, this species was not recorded during the dedicated swan and goose feeding distribution surveys.

Wigeon

Flight activity by wigeon was low, with a single flight of 13 birds recorded. Wigeon is a SCI of the following three SPAs River Little Brosna Callows SPA, Middle Shannon Callows SPA and River Suck Callows SPA. Suitable habitat for this specie is limited in the wider area, and thus it is likely that the birds observed within the Site are part of the SPA populations.

Teal

Flight activity by teal, a SCI of River Little Brosna Callows SPA, was low, with a single long flight of 42 birds recorded. Due to the proximity of this SPA to the Project site (approximately 1.65 km) it is likely that the birds recorded within the Site are part of the SPA population.

Golden plover

During flight activity surveys in the winter of 2021/22, a peak count of approximately 2,000 golden plover were observed within 500m of the Project site boundary. This species is a SCI of River Little Brosna Callows SPA, Middle Shannon Callows SPA and River Suck Callows SPA. Due to the proximity of the SPAs with the Project site it is assumed that these birds are part of the SPA population. However, it is worth noting that this species occurs widely on farmland during the winter months and thus these birds may not be associated with an SPA.

Lapwing

Lapwing, a SCI of the following three SPAs: River Little Brosna Callows SPA, Middle Shannon Callows SPA and River Suck Callows SPA, was recorded during flight activity surveys. A maximum flock size of 27 was observed in winter 2021/22. In addition, a breeding pair was confirmed within 500m of the Project site. Due to the proximity of the SPAs with the Project site it is assumed that these birds are part of the SPA population. However, it is worth noting that this species occurs widely on farmland during the winter months and thus these birds may not be associated with an SPA.

Black-headed gull

Black-headed gull was observed in commuting over the Project site. A peak flock size of 46 birds and 14 birds were recorded in the winter season and breeding season, respectively. As previously mentioned, due to the proximity of the SPA with the Project site it is assumed that these birds form part of the SPA population. Black-headed gull is a SCI of River Little Brosna Callows SPA.

Cormorant

Cormorant is a SCI of Lough Derg (Shannon) SPA and was observed during the baseline ornithological study. Specifically, a peak count of 2 birds was recorded during winter 2021/22 during flight activity surveys.

Hen harrier

The SCI for Slieve Bloom Mountains SPA is hen harrier. Within the study area, very low levels of hen harrier flight activity was recorded (4 flight lines of single birds). All flight lines were recorded in winter, suggesting a few birds moving through the wider area while foraging. Hen harrier were not recorded breeding or roosting (either singly or communally) within the survey area. Hen harrier is a rare breeding bird in Ireland with most pairs associated with an SPA making it likely that these form part of the Slieve Bloom Mountains SPA population.

Otter

Despite some good suitability at numerous survey locations, otter signs were only recorded at a total of 5 no. sites. Regular otter spraint sites were recorded at sites on the Rapemills River (B1 & B3), River Brosna (D6) and Blackwater River (D7). An old otter spraint site (not regularly used) was also recorded on the Little Brosna River at site A3. Fresh otter prints were recorded alongside regular spraint sites at site D7 on the Blackwater River. No breeding (holts) or resting (couch) areas were identified. Otter is a designated feature of the River Shannon Callows SAC situated approximately 6.23km west of the Project site. There is hydrological connectivity between the SAC and Project site.

4.1.7.4 Ecological Connections

Potential ecological connectivity between the Project site and the following European sites has been identified due to mobile bird species; River Shannon Callows SAC, Dovegrove Callows SPA, River Little Brosna Callows SPA, Middle Shannon Callows SPA, Slieve Bloom Mountains SPA, Lough Derg (Shannon) SPA and River Suck Callows SPA.

4.1.7.5 Hydrological and Hydrogeological Connections

There is direct hydrological connectivity between the Project site and the following two SACs: River Shannon Callows SAC and Lough Derg, North-east Shore SAC. Rapemills River flows through the Project site westward where it drains to the River Shannon. It is via the River Shannon, and its tributaries, that the Project site is connected to these SACs.

The Project is located within the same groundwater body (Banagher; IE_SH_G_040) as River Little Brosna Callows SPA and Middle Shannon Callows SPA, and therefore there is potential hydrogeological connectivity between the Project site and these two SPAs.

4.2 Step 1, Part 2 Information on European Sites

The conservation objectives for the European Sites for which a pathway to impact has been identified are summarised below. Only the qualifying interests for which a potential impact has been identified are included in the summary.

4.2.1 Ridge Road, SW of Rapemills SAC

Ridge Road, SW of Rapemills SAC has site specific conservation objectives (NPWS 2018) These provide clarity on the definition of favourable conservation condition for the qualifying interests of the SAC, and state whether the qualifying interests are favourable or unfavourable. These are summarised in **Table 4-5**.

Table 4-5: Ridge Road, SW of Rapemills SAC

Qualifying interest	Attributes defining conservation condition	Conservation condition and objective
Semi-natural dry grasslands and scrubland facies on calcareous substrates (*Festuco-Brometalia*) (* important orchid sites)	Habitat area Habitat distribution Vegetation composition: positive indicator species Vegetation composition: negative indicator species Vegetation composition: nonnative species Vegetation composition: woody species and bracken Vegetation structure: broadleaf herb: grass ratio Vegetation structure: sward height Vegetation structure: litter Physical structure: bare soil Physical structure: disturbance	M/F*

*F=favourable, M=maintain, R =Restore, U = Unfavourable

4.2.2 River Shannon Callows SAC

River Shannon Callows SAC has site specific conservation objectives (NPWS 2022). These provide clarity on the definition of favourable conservation condition for the qualifying interests of the SAC, and state whether the qualifying interests are favourable or unfavourable. These are summarised in **Table 4-6**.

Table 4-6: Conservation objectives for the qualifying interests of River Shannon Callows SAC

Qualifying interest	Attributes defining conservation condition	Conservation condition and objective
Alkaline fens	Habitat area Habitat distribution Ecosystem function: soil nutrients Ecosystem function: peat formation Ecosystem function: hydrology - groundwater levels Ecosystem function: hydrology - surface water flow Ecosystem function: water quality Vegetation composition: community diversity Vegetation composition: typical brown mosses Vegetation composition: typical vascular plants	M/F*

Qualifying interest	Attributes defining conservation condition	Conservation condition and objective
	Vegetation composition: native negative indicator species Vegetation composition: non-native species Vegetation composition: native trees and shrubs Vegetation composition: algal cover Vegetation structure: vegetation height Physical structure: disturbed bare ground Physical structure: tufa formations Indicators of local distinctiveness Transitional areas between fen and adjacent habitats	
Alluvial forests with *Alnus glutinosa* and *Fraxinus excelsior* (*Alno-Padion, Alnion incanae, Salicion albae*)	Habitat area Habitat distribution Woodland size Woodland structure: cover and height Woodland structure: community diversity and extent Woodland structure: natural regeneration Hydrological regime: flooding depth/height of water table Woodland structure: dead wood Woodland structure: veteran trees Woodland structure: indicators of local distinctiveness Woodland structure: indicators of overgrazing Vegetation composition: native tree cover Vegetation composition: typical species Vegetation composition: negative indicator species Vegetation composition: problematic native species	M/F
Otter	Distribution Extent of terrestrial habitat Extent of freshwater (river) habitat Couching sites and holts Fish biomass available Barriers to connectivity	M/F

*F=favourable, M=maintain

4.2.3 Lough Derg, North-east Shore SAC

Lough Derg, North-east Shore SAC has site specific conservation objectives (NPWS 2019). These provide clarity on the definition of favourable conservation condition for the qualifying interests of the SAC, and state whether the qualifying interests are favourable or unfavourable. These are summarised in **Table 4-7.**

Table 4-7: Conservation objectives for the qualifying interests of Lough Derg, North-east Shore SAC

Qualifying interest	Attributes defining conservation condition	Conservation condition and objective
Calcareous fens with *Cladium mariscus* and species of the *Caricion davallianae*	Habitat area Habitat distribution Ecosystem function: peat formation Ecosystem function: hydrology - groundwater levels Ecosystem function: hydrology - surface water flow Ecosystem function: water quality Vegetation composition: typical species Vegetation composition: native negative indicator species Vegetation composition: non-native species Vegetation composition: trees and shrubs Physical structure: disturbed bare ground Indicators of local distinctiveness	M/F*
Alkaline fen	Habitat area Habitat distribution Ecosystem function: soil nutrients Ecosystem function: peat formation Ecosystem function: hydrology - groundwater levels Ecosystem function: hydrology - surface water flow Ecosystem function: water quality Community diversity Vegetation composition: brown mosses Vegetation composition: typical vascular plants Vegetation composition: native negative indicator species Vegetation composition: non-native species	M/F

Qualifying interest	Attributes defining conservation condition	Conservation condition and objective
	Vegetation composition: native trees and shrubs Vegetation composition: soft rush and common reed cover Vegetation structure: litter Physical structure: disturbed bare ground Physical structure: tufa formations Indicators of local distinctiveness	
Alluvial forests with Alnus glutinosa and *Fraxinus excelsior* (*Alno-Padion, Alnion incanae, Salicion albae*)	Habitat area Habitat distribution Woodland size Woodland structure: cover and height Woodland structure: community diversity and extent Woodland structure: natural regeneration Hydrological regime: flooding depth/height of water table Woodland structure: dead wood Woodland structure: veteran trees Woodland structure: indicators of local distinctiveness Woodland structure: indicators of overgrazing Vegetation composition: native tree cover Vegetation composition: typical species Vegetation composition: negative indicator species Vegetation composition: problematic native species	R/U

F=favourable, M=maintain, R =Restore, U = Unfavourable

4.2.4 Dovegrove Callows SPA

The conservation objectives for Dovegrove Callows SPA are generic ((NPWS 2022)

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

In the case of Dovegrove Callows SPA, the bird species considered to have ecological connectivity with the Project site is:

- Greenland white-fronted goose

Greenland white-fronted goose is considered to be in an unfavourable condition as the mean peak count in winter between 2016/17 and 2020/21 (111) is lower than the baseline reference value (mean peak between 1994/95 to 1998/99) cited in the site synopsis (537).

4.2.5 River Little Brosna Callows SPA

The conservation objectives for River Little Brosna Callows SPA are generic (NPWS 2022) :

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

In the case of River Little Brosna Callows SPA, the bird species considered to have ecological connectivity with the Project site are:

- whooper swan,
- wigeon,
- teal,
- golden plover,
- lapwing,
- black-headed gull, and
- Greenland white-fronted goose.

Whooper swan is considered to be in a favourable condition as the mean peak count between 2016/17 and 2020/21 (303) is higher than the baseline reference value (122; 1995/96 – 1999/2000) cited in the synopsis. The remaining species, wigeon, teal, golden plover, lapwing, black-headed gull, and Greenland white-fronted goose are considered to be in an unfavourable condition as the mean peak counts between 2016/17 and 2020/21 are considerably lower than the baseline reference values (mean peaks between 1995/96 and 1999/2000) cited in the site synopsis. Specifically, wigeon numbers have fallen from 8,116 to 4,281, teal from 2,683 to 1,899, golden plover from 10,577 to 5,110, lapwing numbers from 6,552 to 3,258, black-headed gull numbers from 1,939 to 101 and Greenland white-fronted goose numbers from 537 in 1994/95 to 111 in 2020/21.

To acknowledge the importance of Ireland's wetlands to wintering waterbirds, 'Wetland and Waterbirds' may be included as a Special Conservation Interest for some SPAs that have been designated for wintering waterbirds and that contain a wetland site of significant importance to one or more of the species of Special Conservation Interest. Thus, a second objective is included for River Little Brosna Callows SPA as follows:

To maintain or restore the favourable conservation condition of the wetland habitat at River Little Brosna Callows SPA as a resource for the regularly occurring migratory waterbirds that utilise it.

Under the precautionary principle, the assumption is that habitat is unfavourable, and the conservation objective is to restore (U/R).

4.2.6 All Saints Bog SPA

The conservation objectives for All Saints Bog SPA are generic ((NPWS 2022)

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

In the case of All Saints Bog SPA, the bird species considered to have ecological connectivity with the Project site is:

- Greenland white-fronted goose

Greenland white-fronted goose is considered to be in an unfavourable condition.

All Saints Bog was formerly used by part of the internationally important Greenland White-fronted Goose population based on the River Little Brosna. In recent years, however, there has been little or no use of All Saints by the geese following a general trend of less usage of raised bogs in favour of grassland sites. The last record of Greenland White-fronted Goose within the site was 75 individuals in 1993/94.

4.2.7 Middle Shannon Callows SPA

Middle Shannon Callows SPA has site specific conservation objectives (NPWS 2022). These provide clarity on the definition of favourable conservation condition for the SCI of the SPA, and state whether the SCI are favourable or unfavourable. The conservation objectives for the SCI for which there is considered to be an ecological connection are summarised in **Table 4-8**.

Table 4-8: Conservation objectives for the SCI of Middle Shannon Callows SPA

<table>
<tr><th>Species of conservation interest</th><th>Attributes defining conservation condition</th><th>Conservation condition and objective</th></tr>
<tr><td>Whooper swan</td><td rowspan="5">Winter population trend
Winter spatial distribution
Disturbance at wintering site
Barriers to connectivity and site use
Forage spatial distribution, extent and abundance
Roost spatial distribution and extent
Supporting habitat: area and quality</td><td>M/F</td></tr>
<tr><td>Golden plover</td><td>M/F</td></tr>
<tr><td>Lapwing</td><td rowspan="2">R/U</td></tr>
<tr><td>Wigeon</td></tr>
<tr><td>Black-headed gull</td><td>R/U</td></tr>
<tr><td>Wetlands</td><td></td><td>M/F</td></tr>
</table>

F=favourable, M=maintain, R=restore, U = Unfavourable

4.2.8 Slieve Bloom Mountains SPA

Slieve Bloom Mountains SPA has site specific conservation objectives (NPWS 2022). These provide clarity on the definition of favourable conservation condition for hen harrier, and states whether this SCI is in a favourable or unfavourable condition. This information is summarised in **Table 4-9**.

Table 4-9: Conservation objectives for Slieve Bloom Mountains SPA

Species of conservation interest	Attributes defining conservation condition	Conservation condition and objective
Hen harrier	Population size Productivity rate Spatial utilisation by breeding pairs Extent and condition of heath and bog and associated habitats	R/U

Species of conservation interest	Attributes defining conservation condition	Conservation condition and objective
	Extent and condition of low intensity managed grasslands and associated habitats Extent and condition of hedgerows Age structure of forest estate Disturbance to breeding sites	

F=favourable, M=maintain R=restore, U = Unfavourable

4.2.9 Lough Derg (Shannon) SPA

The conservation objectives for Lough Derg (Shannon) SPA are generic (NPWS 2022):

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

In the case of Lough Derg (Shannon) SPA, the bird species considered to have ecological connectivity with the Project site is:

- Cormorant.

Cormorant is considered to be in an unfavourable condition as the mean peak count in winter between 2016/17 and 2020/21 (71) is lower than the baseline reference value (mean peak between 1995/96 and 1999/2000) cited in the site synopsis (90). There is also a breeding colony here, which supported 167 breeding pairs when the SPA was designated. The current breeding population size is not known.

To acknowledge the importance of Ireland's wetlands to wintering waterbirds, 'Wetland and Waterbirds' may be included as a Special Conservation Interest for some SPAs that have been designated for wintering waterbirds and that contain a wetland site of significant importance to one or more of the species of Special Conservation Interest. Thus, a second objective is included for Lough Derg (Shannon) SPA as follows:

To maintain or restore the favourable conservation condition of the wetland habitat at Lough Derg (Shannon) SPA as a resource for the regularly-occurring migratory waterbirds that utilise it.

Under the precautionary principle, the assumption is that habitat is unfavourable and the conservation objective is to restore (U/R).

4.2.10 River Suck Callows SPA

River Suck Callows SPA has site specific conservation objectives (NPWS 2022). These provide clarity on the definition of favourable conservation condition for the SCI of the SPA, and state whether the SCI are favourable or unfavourable. The conservation objectives for the SCI, for which there is considered to be an ecological connection, are summarised in **Table 4-10.**

Table 4-10: Conservation objectives for the SCI of River Suck Callows SPA

Species of conservation interest	Attributes defining conservation condition	Conservation condition and objective
Whooper swan	Winter population trend Winter spatial distribution Disturbance at wintering site Barriers to connectivity and site use Forage spatial distribution, extent and abundance Roost spatial distribution and extent Supporting habitat: area and quality	M/F
Wigeon Golden plover Lapwing	Winter population trend Winter spatial distribution Disturbance at wintering site Barriers to connectivity and site use Forage spatial distribution, extent and abundance Roost spatial distribution and extent Supporting habitat: area and quality	R/U

F=favourable, M=maintain, R=restore, U = Unfavourable

4.3 Step 2, Part 1: Effects on the Integrity of European Sites 'Alone'

4.3.1 Ridge Road, SW of Rapemills SAC

Due to the proximity of Ridge Road, SW of Rapemills SAC to the Project Site (approximately 0.26km distant) pollution generated during the construction phase, such as dust and vehicle emissions, may impact upon the qualifying interest habitat (Semi-natural dry grasslands and scrubland facies on calcareous substrates (*Festuco-Brometalia*) [6210]).

4.3.2 River Shannon Callows SAC and Lough Derg, North-east Shore SAC

4.3.2.1 Hydrological and Hydrogeological Connectivity

There is direct hydrological connectivity between the Project site and the following two SACs: River Shannon Callows SAC and Lough Derg, North-east Shore SAC. Rapemills River flows through the Project site westward where it drains to the River Shannon. It is via the River Shannon, and its tributaries, that the Project site is connected to these SACs.

Water quality

During construction, decommissioning, and to a lesser extent, during operation (in the form of routine maintenance) of the Project there is potential for the release of:

- suspended solids,
- nutrients, and
- other pollutants, (such as hydrocarbons, contaminated waste-water, and cement-based products).

All identified pathways outlined above have the potential to impact upon the aquatic habitat interest features of these SACs (River Shannon Callows SAC: alkaline fens and alluvial forests with *Alnus glutinosa* and *Fraxinus excelsior,* and Lough Derg, North-east Shore SAC: calcareous fens with *Cladium mariscus* and species of the *Caricion davallianae*, alkaline fens and alluvial forests with *Alnus glutinosa* and *Fraxinus excelsior*).

Suspended solids could reduce water clarity lowering the ability of plants to photosynthesize, resulting in die back. The increased availability of nutrients can lead to algal blooms (eutrophication) which can also limit light penetration, reducing growth and causing the death of plants in littoral zones. Hydrocarbon pollution affects leaf biochemistry, leading to decline in productivity and die back of vegetation (Arellano 2015).

However, the quantities of suspended solids, nutrients and other pollutants that could be released at the Project site are likely to be very small and subject to high levels of dilution in the river system. Moreover, the period for potential release of suspended solids is likely to be temporary, occurring only during the construction and/or decommissioning works.

Water quantity

Temporary lowering of groundwater levels may be required during the construction of the turbine bases. If the lowering of ground water levels is required, the impact will be localised and short-term, and very unlikely to be significant beyond 50m of any excavation. Therefore, impacts upon the following aquatic habitats, which are qualifying interests of River Shannon Callows SAC and Lough Derg, North-east Shore SAC, with conservation objectives related to groundwater levels can be excluded from further assessment; alkaline fens, alluvial forests with *Alnus glutinosa* and *Fraxinus excelsior* and calcareous fens with *Cladium mariscus* and species of the *Caricion davallianae.*

4.3.2.2 Ecological Connectivity (River Shannon Callows SAC, only)

Otter

Otter signs were recorded on the Rapemills River, River Brosna and Blackwater River (See **Appendix 3** for locations). The Rapemills River flows through the southwestern section of the site for 1.2km. Furthermore, West Galros Stream, a tributary stream of Rapemills River, emerges from forestry on the eastern portion of the Project site. West Galros Stream has is approximately 1m deep with a high-water level that's close to ground level. These watercourses are considered suitable for otters, and thus this species could utilise aquatic and terrestrial habitat within the Project site. 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.

4.3.3 Dovegrove Callows SPA, All Saints Bog SPA and River Little Brosna Callows (Greenland white-fronted goose only)

Dovegrove Callows SPA and All Saints Bog SPA are located 0.001km and 2.23km distant, respectively from the Project site. Both these SPA are designated solely for Greenland white-fronted goose. Among other bird species, Greenland white-fronted goose is also a SCI of River Little Brosna SPA, located approximately 1.65km distant. Dovegrove Callows is an important feeding area for this species. It is of particular importance as it can support the entire Little Brosna flock. All Saints Bog SPA was formerly used by part of the internationally important Greenland white-fronted goose population based on the River Little Brosna. Therefore, a potential impact to this species at Dovegrove Callows also impacts the Greenland white-fronted goose population at All Saints Bog SPA and Little River Brosna Callows SPA. The proposed grid connection lies in close proximity to Dovegrove Callows SPA and as such the construction of the grid connection may cause disturbance/displacement to Greenland white-fronted geese within this SPA.

Greenland white-fronted goose was not recorded during the flight activity surveys or dedicated winter goose feeding distribution surveys. Therefore, the construction/ decommissioning or operation of the wind farm itself will not impact upon this species. Furthermore, all three of these SPA's are located west of the Project site and therefore the Project will not impede upon the movement of Greenland white-fronted goose between these SPA's.

4.3.4 River Little Brosna Callows SPA

4.3.4.1 Hydrological and Hydrogeological Connectivity

River Little Brosna Callows SPA is within the same groundwater body (Banagher; IE_SH_G_040) as the Project site. Therefore, there is potential hydrogeological connectivity. Temporary lowering of groundwater levels may be required during the construction of the turbine bases. This may indirectly negatively impact the wetland habitat within the SPA which is utilised by regularly-occurring migratory waterbirds.

However, it should be noted that the impact will be localised and short-term and very unlikely to be significant beyond 50m of any excavation. Therefore, impacts to the wetland habitat, located 1.65km distant, can be excluded from further assessment.

4.3.4.2 Ecological Connectivity

River Little Brosna Callows SPA is located approximately 1.65km west of the Project site. The SCI for this SPA, for which there is ecological connectivity, are whooper swan, wigeon, teal, golden plover, lapwing, and black-headed gull.

Whooper swan

Whooper swan was recorded making occasional flights through the Project site. A peak count of a flock of 12 birds was recorded during flight activity surveys in winter 2020/21. Using the data from the surveys, collision risk modelling (CRM) has been completed which indicates that the wind farm could result in 0.097 collisions per year, or 1 bird every 10.3 years. The latest five year IWeBS mean count for River Little Brosna Callows is 303 whooper swan. The predicted increase in annual mortality (taking into account the current level) on that size of population is 0.16%.

The small numbers of turbines means that the energetic costs for the whooper swan of avoiding the wind from is negligible.

Wigeon

Flight activity by wigeon was low, with a single flight of 13 birds recorded. CRM indicated an annual mortality rate of 0.025. The latest five year IWeBS mean count for the River Little Brosna Callows is 4,281. The predicted increase in annual mortality on that size of population is 0.001%.

Teal

Flight activity by teal was low, with a single long flight of 42 birds recorded. CRM predicted an annual mortality of 1.566. However, this considered to be an over-estimate, given the low level of observed flight activity over three years of survey. The latest five year IWeBS mean count is 1,899 birds and therefore the predicted increase in annual mortality is 0.175%.

Golden plover

Golden plover were also observed during flight activity surveys. Flight activity was very low, with only 16 flight lines recorded across the three years of surveys. Although, two very large flocks (2,000 birds in January 2022 and 3,500 birds in November 2022) were observed in transit and not using the Project site. It is therefore likely that collision risk estimate, which includes these flocks, has been hugely overestimated.

Assuming a 98% avoidance rate (SNH 2018), there was a mean annual collision rate of 77.358 collisions (approximately one collision every 0.01 years) predicted. The latest five year IWeBS mean count for golden plover at River Little Brosna Callows is 5,110. The predicted increase in annual mortality (taking into account the current level) on that size of population is 5.61%.

In addition to the SNH (2018) 98% default avoidance rate, there has been recent research that shows that for 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[12]. Consequently, we have presented the results using the two avoidance rates to show the range of possible collision estimates.

Using the 99.8% avoidance rate, there would be an estimated 7.736 collisions per year and an annual mortality increase of 0.56%

Furthermore, as mentioned before, the collision risk estimate is likely to be hugely overestimated due to the presence of two exceptionally large flocks moving through the area, which is thought to represent an outlier. The realised effects of collision with the project are likely to be much lower, as evidenced by the low number of golden plover killed at European and Irish wind farms (Durr 2022).

[12] https://www.ballivorwindfarmplanning.ie/wp-content/uploads/sites/38/2023/04/Appendix_7-6_Collision_Risk_Assessment.pdf

Lapwing

Lapwing were recorded flying through the Project site. Using the data from the surveys, CRM has been completed which indicates that the wind farm could result in 4.977 collisions per year, or 1 bird every 0.2 years. The latest five-year IWeBS mean count is 3,258 lapwing. The predicted increase in annual mortality (taking into account the current level) on that size of population is 0.52%.

A single pair was recorded breeding in an area of recolonised cutover bog within the Project site. A buffer of at least 108m is required to avoid disturbance (Hötker 2006). The project has been designed to ensure there is a 400m buffer distance between the known northern lapwing breeding area and closest piece of site infrastructure. There are other areas of recolonising bog within the Project site, so it is possible that they could breed in another location within the Project site prior to development. However, the buffer means that the known breeding pair would not be displaced from its current territory.

Black-headed gull

Black-headed gull are also at risk of collision with the turbines. Based on flight data, 25 black-headed gull flight lines were recorded at potential collision height (PCH) within the collision risk zone (CRZ). Assuming a 98% avoidance rate, there was a mean annual collision rate of 1.146 (approximately one collision every 0.87 years) predicted. Based on the site synopsis population of 1,939 birds, the predicted increase in annual mortality is 0.59%. The site synopsis population has been used for this species rather than the latest IWeBS count as the recording of gulls during the IWeBS counts is optional and thus are likely under recorded.

Greenland white-fronted goose

Please refer to **section 4.3.3** for more information.

4.3.5 Middle Shannon Callows SPA

4.3.5.1 Hydrological and Hydrogeological Connectivity

One of the conservation objectives for the Middle Shannon Callows SPA is to maintain the favourable conservation condition of the wetlands present within it. As previously discussed, there is hydrological and hydrogeological connectivity between this SPA and the Project site. Therefore, suspended solids, nutrients and other pollutants, generated during the construction and/or decommissioning of the wind farm, could enter SPA watercourses, which could negatively affect the wetland habitat.

Middle Shannon Callows SPA is within the same groundwater body (Banagher; IE_SH_G_040) as the Project site. Therefore, temporary lowering of groundwater levels during the construction of the turbine bases may negatively impacts the wetland habitat within the SPA. However, it should be noted that the impact will be localised and short-term and unlikely to occur beyond 50m of any excavation. Therefore, impacts to the wetland habitat, located 6.24km distant, are excluded for the Project alone.

4.3.5.2 Ecological Connectivity

The Middle Shannon Callows SPA, situated approximately 6.24km north-west of the Project site, has the following SCI for which there is considered to be ecological connectivity; whooper swan, wigeon, golden plover, lapwing and black-headed gull.

As discussed in section 4.3.2.2, all of these bird species were observed flying through the Project site and as such as are at risk of collision with the proposed turbines. CRM has been undertaken for each of these four species using data collected from flight activity surveys.

Whooper swan

For whooper swan, the wind farm could result in 0.097 collisions per year, or 1 bird every 10.3 years. The latest five year IWeBS mean count for the Shannon Callows (corresponding Irish Wetland Birds Survey (I-WeBS) site) is 100 whooper swan. The predicted increase in annual mortality (taking into account the current level) on that size of population is 0.49%.

The small numbers of turbines means that the energetic costs for the whooper swan of avoiding the wind from is negligible.

Wigeon

Flight activity by wigeon was low, with a single flight of 13 birds recorded. CRM indicated an annual mortality rate of 0.025. The current SPA population is 370 birds. The predicted increase in annual mortality on that size of population is 0.03%.

Golden plover

With regards to golden plover, CRM results, calculated based on a 98% avoidance rate, indicated a mean annual collision rate of 77.358 collisions, or approximately one collision every 0.01 years). Based on the site synopsis population of 13,240, the estimated increase in annual mortality is 2.17%. However, it should be noted that the collision risk estimate is likely to be hugely overestimated due to the presence of two exceptionally large flocks moving through the area, which is thought to represent an outlier. The realised effects of collision with the project are likely to be much lower, as evidenced by the low number of golden plover killed at European and Irish wind farms (Durr 2022).

However, CRM was also conducted using a 99.8% avoidance rate, as recent research has shown that this may be more appropriate (see section 4.3.2.2. for more information). Using a 99.8% avoidance rate there would be an estimated 7.736 collisions per year and an annual mortality increase of 0.22%.

Furthermore, the collision risk estimate is likely to be hugely overestimated due to the presence of twp exceptionally large flocks (c. 3,500 and 2,000 birds) moving through the area, which is thought to represent an outlier. The realized effects of collision with the project are likely to be much lower, as evidenced by the low number of golden plover killed at European and Irish wind farms (Durr 2022).

Lapwing

For lapwing, the wind farm could cause 4.977 collisions per year, or 1 bird every 0.2 years. Based on the site synopsis population of 13,240 wintering birds and 126 breeding birds. The predicted increase in mortality (taking into account the current level) on that size of population is 0.13% and 13.39% respectively.

A single pair of lapwing were recorded breeding within the Project site and therefore breeding lapwing are at risk of disturbance and/or displacement. A buffer of at least 108m is required to avoid disturbance (Hötker 2006) The Project site was designed to ensure a 400m buffer distance between the known breeding territory and nearest infrastructure. However, it is possible that this species could breed elsewhere within the Project site prior to construction.

Black-headed gull

Based on black-headed gull flight data, a mean annual collision rate of 1.146 (approximately one every 2.5 years) was predicted for this species.

Based on the site synopsis population of 1,209 birds, the predicted increase in annual mortality is 0.95%. The site synopsis population has been used for this species rather than the latest

IWeBS count as the recording of gulls during the IWeBS counts is optional and thus are likely under recorded.

4.3.6 Slieve Bloom Mountains SPA

4.3.6.1 Ecological Connectivity

The qualifying feature of Slieve Bloom Mountains SPA, situated approximately 11.65km south-east, is hen harrier. A total of 7 flight lines of single hen harrier were observed during flight activity surveys. All flights were recorded in winter, suggesting a few birds foraging in the wider area. According to the NatureScot guidance (2016), hen harrier has a maximum foraging distance of 10km during the breeding season, with a core foraging range of 2km. However, satellite tracing studies in Ireland and Britain have shown that hen harrier will travel up to 20km from roost sites during the day to forage, especially in the winter. Even, during the breeding season males have been recorded foraging up to 11km from the nest according to data from GPS tagged birds ((Arroyo 2006), (Irwin 2012), (B. L. Arroyo 2014)). Therefore, taking a precautionary approach, it is assumed that the recorded hen harrier form part of the Slieve Bloom Mountains SPA population. Therefore, the wind farm may present a collision risk to this population.

Collision risk analysis has been carried out on hen harrier flight activity data. Assuming a 99% avoidance rate, there was a mean annual collision rate of 0.009 (approximately one collision every 108.17 years) predicted. The current hen harrier population within the SPA is estimated to be 20 birds (Hen Harrier Project 2021). This results in an estimated 0.24% increase in mortality.

4.3.7 Lough Derg (Shannon) SPA

4.3.7.1 Hydrological Connectivity

One of the conservation objectives of this SPA is to restore the favourable conservation condition of the wetland habitat at Lough Derg (Shannon) SPA as a resource for the regularly-occurring migratory waterbirds that utilise it. There is hydrological connectivity between Lough Derg (Shannon) SPA and the Project site via the Rapemills River and River Shannon. Therefore, suspended solids, nutrients and other pollutants, generated during the construction and/or decommissioning of the wind farm, could enter the SPA and negatively affect the wetland habitat. Overall, without mitigation, the risk is considered to be low.

4.3.7.2 Ecological Connectivity

Lough Derg (Shannon) SPA, situated approximately 15.07km south-west of the Project site, is designated for a number of wetland and waterbirds species. Of these species, only cormorant is considered to have ecological connectivity. Flight activity was at a low level throughout the study period, with a peak count of 2 birds was recorded during flight activity surveys during winter 2021/22. There was a mean annual collision rate of 0.096 (approximately one collision every 10.37 years) predicted. The latest IWeBS five-year mean count for cormorant is 71. This results in an estimated 0.11% increase in mortality.

Regarding the breeding population, the recent status of this species is not known. However, using the baseline reference value of 2,176 birds there would be an estimated increase in mortality of 1.13%.

4.3.8 River Suck Callows SPA

4.3.8.1 Ecological Connectivity

River Suck Callows is located approximately 17.11km north-west of the Project site. The SCI for this SPA, for which potential ecological connectivity has been identified, are whooper swan, wigeon, golden plover and lapwing. All three of these species were recorded during flight activity surveys and are therefore at risk of collision with the proposed turbines. **Section 4.3.2.2**. above provides more information on the recorded flight activity of these species. CRM has been conducted for whooper swan, golden plover and lapwing, and the results are summarised below in the context of River Suck Callows SPA.

Whooper swan

With regards to whooper swan, the wind farm could result in 0.097 collisions per year, or 1 bird every 10.29 years. The current population is 209 (mean peak count last 5 years 2016/17 to 2021/22 from IWeBS site River Suck). The predicted increase in annual mortality is 0.23%. Therefore, impacts on whooper swan as a result of collision risk are negligible.

The small numbers of turbines means that the energetic costs for the whooper swan of avoiding the wind from is negligible.

Wigeon

Flight activity by wigeon was low, with a single flight of 13 birds recorded. CRM indicated an annual mortality rate of 0.025. The current SPA population is 1,355 (mean peak count last 5 years 2016/17 to 2021/22 from IWeBS site River Suck). The predicted increase in annual mortality on that size of population is 0.003%.

Golden plover

For golden plover, based on an avoidance rate of 98%, a result of 77.358 collisions per year, or approximately one collision every 0.01 years was calculated. The current population is 1,043 (mean peak count last 5 years 2016/17 to 2021/22 from IWeBS site River Suck). This results in an estimated 27.48% increase in mortality.

However, CRM was also conducted using a 99.8% avoidance rate, as recent research has shown that this may be more appropriate (see section 4.3.2.2. for more information). Using a 99.8% avoidance rate there would be an estimated 7.736 collisions per year and an annual mortality increase of 2.75%.

Furthermore, the collision risk estimate is likely to be hugely overestimated due to the presence of on exceptionally large flock (c. 2,000 birds) moving through the area, which is thought to represent an outlier. The realized effects of collision with the project are likely to be much lower, as evidenced by the low number of golden plover killed at European and Irish wind farms (Durr 2022).

Lapwing

Regarding wintering lapwing, the wind farm could cause 4.977 collisions per year, or 1 bird every 0.2 years. The current population is 1,778 (mean peak count last 5 years 2016/17 to 2021/22 from IWeBS site River Suck). The predicted increase in annual mortality is 0.95%.

As previously discussed, a pair of lapwing were observed breeding within the Project site. Although there is a 400m buffer between the recorded breeding territory and the nearest infrastructure, it should be noted that suitable habitat for breeding lapwing is present elsewhere within the Project site and it is possible that lapwing could breed in another location within prior to construction.

4.4 Step 2, Part 2: Effects on the integrity of European Sites 'In Combination'

4.4.1 Projects

A desktop-based planning search spanning 10 years within a 20 km radius of each of the European Sites under assessment was undertaken. Sources consulted included the EIA portal, An Bord Pleanála, Offaly County Council, Tipperary County Council, Laois County Council and Galway County Council planning lists.

The list of planning applications focussed on:

- All wind farms and grid connection 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.

The wind farms returned from the desktop search are summarised in **Table 4-11** below.

Table 4-11: Other projects considered for 'in-combination' effects

Development name	Description	Planning reference
Meenwaun Wind Farm	Operational wind farm consisting of 4 turbines.	Offaly County Council ref: 15/44
Derrinlough Wind Farm	A ten-year permission for a wind farm consisting of 21 wind turbines and all associated site works	ABP ref: PA19.306706
Cloghan Wind Farm	Operational wind farm consisting of 9 turbines	Offaly County Council Planning ref: 14/188 ABP ref: PL 19.244053
	10-year planning permission for amendments to the development permitted under ABP reference PL19.244053 (OCC ref PL2/14/188) to provide changes including an increase in the overall wind turbine height from 150 m to 169 m, and the re-siting of wind turbines T1, T2, T4, T6, T7 and T9 by up to 19 m.	Offaly County Council Planning ref: 19/404
	The installation of approximately 8 km of underground electricity line with a capacity of up to 38KV from the permitted (wind farm) substation to the permitted Derrycarney electricity substation.	Offaly County Council Planning ref: 19/555
	The construction of a 33KV substation compound with associated electrical infrastructure including transformer and grid connection into the permitted Derrycarey 110KV substation.	Offaly County Council Planning ref: 20/389
Leabeg Wind Farm	Operational wind farm consisting of 2 turbines with a 30 year operational life.	Offaly County Council ref: 20/70 ABP ref: PL 19.244053
Carrig and Skehanagh Wind Farm	Operational wind farm consisting of 3 and 5 turbines in each cluster, respectively.	
Carrig Renewables Wind Farm	Proposed wind farm consisting of 7 turbines.	Tipperary County Council ref: 23/60763
Monaincha Wind Farm	Operational wind farm consisting of 15 turbines	Tipperary County Council ref: 11510103
Mountlucas Wind Farm	Operational wind farm consisting of 28 turbines	Offaly County Council ref: 09/453 ABP ref: PL19.237263
Bruckana Wind Farm	Operational wind farm consisting of 8 turbines	Kilkenny County Council ref: 10145

Development name	Description	Planning reference
Skrine Wind Farm	Operational wind farm consisting of 2 turbines	Roscommon County Council ref: 04103

4.4.2 Plans

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

- Eastern and Midlands Regional Spatial and Economic Strategy 2020-2032 (RSES),
- Offaly County Development Plan 2021 – 2027,
- Tipperary County Development Plan 2022 – 2028,
- Laois Couty Development Plan 2021 – 2027; and
- Galway County Development Plan 2022 – 2028.
- National Biodiversity Action Plan.

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 4-12.**

Table 4-12: Assessment of relevant plans

Plan	Policies for the protection of European Sites	Development allocations with potential for in combination effects
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.
Offaly County Development Plan 2021-2027	**NHP-01**: It is Council policy to prohibit any development that would be harmful to or that would result in a significant deterioration of habitats and/or disturbance of species in a Special Protection Area (SPA), Special Area of Conservation (SAC) and candidate Special Area of Conservation (cSAC), Natural Heritage Area (NHA) and Proposed Natural Heritage Area (pNHA) **NHP-08**: It is Council policy to protect, conserve and enhance the county's biodiversity and natural heritage including wildlife (flora and fauna), habitats, landscapes and/or landscape features of importance to wildlife or which play a key role in the conservation and management of natural resources such as water. **NHP-11:** It is Council policy to conserve, protect and enhance where possible wildlife habitats such as rivers, streams, canals, lakes, and associated wetlands including reed-beds and swamps, ponds, springs, bogs, fens, trees, woodlands and scrub, hedgerows and other boundary types such as stone walls and ditches which occur outside of designated areas providing a network of habitats and corridors essential for wildlife to flourish. **NHP-12**: It is Council policy to ensure that peatland areas, which are designated for protection under international and national legislation, are conserved and managed appropriately to conserve their ecological, archaeological, cultural and educational significance. **NHP-12:** It is Council policy to ensure that peatland areas, which are designated for protection under international and national legislation, are conserved and managed appropriately to conserve their ecological, archaeological, cultural and educational significance.	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
	NHP-22: It is Council policy to encourage, pursuant to Article 10 of the Habitats Directive, the management of features of the landscape, such as traditional field boundaries, important for the ecological coherence of the Natura 2000 site(s) network and essential for the migration, dispersal and genetic exchange of wild species. **NHP-24:** It is Council policy to protect, conserve and enhance the county's biodiversity and natural heritage including wildlife (flora and fauna), habitats, landscapes and / or landscape features of importance to wildlife or which play a key role in the conservation and management of natural resources such as water. **NHO-01**: It is an objective of the Council to ensure that any development proposal in the vicinity of, or affecting a designated site, complies with the provisions relating Appropriate Assessment and SEA requirements and the Council will consult with the appropriate statutory environmental authority in this regard. **NHO-02:** It is an objective of the Council to conserve and protect the natural heritage of the county and to conserve and protect European and National designated sites within the county including Special Protection Areas (SPAs), Special Areas of Conservation (SACs), candidate Special Areas of Conservation (cSACs), Natural Heritage Areas (NHAs), Proposed Natural Heritage Areas (pNHAs), Ramsar Sites, Statutory Nature Reserves, Biogenetic Reserves and Wildfowl Sanctuaries.	
Tipperary County Development Plan 2022-2028	It is the policy of the Council to: **11 – 1:** In 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	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
	and Projects, Guidelines for Planning Authorities', (DEHLG 2009) or any amendment thereof and relevant Environmental Protection Agency (EPA) and European Commission guidance documents.	
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 Natura 2000 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 Natura 2000 network and essential for the migration, dispersal and genetic exchange of wild species. **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.	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
Galway County Development Plan 2022 - 2028	**NHB 1: Natural Heritage and Biodiversity of Designated Sites, Habitats and Species** Protect and where possible enhance the natural heritage sites designated under EU Legislation and National Legislation (Habitats Directive, Birds Directive, European Communities (Birds and Natural Habitats) Regulations 2011 and Wildlife Acts) and extend to any additions or alterations to sites that may occur during the lifetime of this plan. Protect and, where possible, enhance the plant and animal species and their habitats that have been identified under European legislation (Habitats and Birds Directive) and protected under national Legislation (European Communities (Birds and Natural Habitats) Regulations 2011 (SI 477 of 2011), Wildlife Acts 1976-2010 and the Flora Protection Order (SI 94 of 1999). Support the protection, conservation and enhancement of natural heritage and biodiversity, including the protection of the integrity of European sites, that form part of the Natura 2000 network, the protection of Natural Heritage Areas, proposed Natural Heritage Areas, Ramsar Sites, Nature Reserves, Wild Fowl Sanctuaries (and other designated sites including any future designations) and the promotion of the development of a green/ ecological network. **NHB 2: European Sites and Appropriate Assessment** To implement Article 6 of the Habitats Directive and to ensure that Appropriate Assessment is carried out in relation to works, plans and projects likely to impact on European sites (SACs and SPAs), whether directly or indirectly or in combination with any other plan(s) or project(s). All assessments must be in compliance with the European Communities (Birds and Natural Habitats) Regulations 2011. All such projects and plans will also be required to comply with statutory Environmental Impact Assessment requirements where relevant. **NHB 3: Protection of European Sites** No plans, programmes, or projects etc. 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	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
	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.* **NHB 4: Ecological Appraisal of Biodiversity** Ensure, where appropriate, the protection and conservation of areas, sites, species and ecological/networks of biodiversity value outside designated sites. Where appropriate require an ecological appraisal, for development not directly connected with or necessary to the management of European sites, or a proposed European site and which are likely to have significant effects on that site either individually or cumulatively.	

4.4.3 Ridge Road, SW of Rapemills SAC

Pollution, such as dust and vehicle emissions, generated during the construction of the Project could adversely affect the qualifying interest habitat, Semi-natural dry grasslands and scrubland facies on calcareous substrates (Festuco-Brometalia) [6210], of Ridge Road, SW of Rapemills SAC. This may occur due to the close proximity of the Project site to the SAC (approximately 0.26km distant). Any construction projects that are located in close proximity to the SAC has 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, or in series.

There are no other proposed wind farms, infrastructure, quarries, strategic infrastructure or strategic housing developments within a 2 km radius of the SAC.

4.4.4 River Shannon Callows SAC and Lough Derg, North-east Shore SAC

The primary identified pathway that could effect River Shannon Callows SAC and Lough Derg, North-east Shore SAC, is through a reduction in water quality, due to the aquatic habitats that are designated features of these SACs. Any construction projects that are located within the same catchment as these SACs have the potential to have an in-combination effect with the Project, if they also have a negative effect on water quality. 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.

Furthermore, with regards to River Shannon Callows only, activities undertaken during the construction/ decommissioning of the wind farm could result in disturbance to otter. Other projects in the vicinity of the Project site, if timed to be constructed and/or decommissioned while this Project is constructed and/or decommissioned, could result in an in-combination effect.

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 4-13.**

The wind farms within 20 km of the River Shannon Callows SAC are Skehanagh and Carrig Wind Farm, Meenwaun Wind Farm and Leabeg Wind Farm. Only Skehanagh and Carrig Wind Farm was returned from the search within 20 km of Lough Derg, North-east Shore SAC.

4.4.5 Dovegrove Callows SPA, All Saints Bog SPA, and River Little Brosna Callows SPA (Greenland-white fronted goose only).

The construction of the grid connection may result in the disturbance/ displacement of Greenland white-fronted goose within Dovegrove Callows SPA. This flock of Greenland white-fronted goose has also been recorded utilising habitat within All Saints Bog SPA and River Little Brosna Callows SPA. Therefore, an impact to the flock of geese within one SPA subsequently impacts the other two SPA’s.

The construction and/or operation of other wind farms, infrastructure, quarries, strategic infrastructure or strategic housing developments could result in in-combination effects.

All such projects within a precautionary 2 km radius of these SPA’s have been searched for. The search returned no projects. Therefore, there is no risk as result of in-combination effects.

4.4.6 River Little Brosna Callows SPA

The Project could result in collisions with whooper swan, wigeon, teal, golden plover, lapwing and black-headed gull, which may be a part of the SPA population. The Project may also result in disturbance or displacement of breeding lapwing. The Project will not present a barrier to migration on it's own. However, there are three wind farms within 5km of the Project site and therefore collectively they may present a barrier to migration.

Other wind farms or single wind turbines located within 20km of River Little Brosna SPA have the potential to have an in-combination effect with the Project. 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 4-13**. The following five wind farms were returned within 20 km of River Little Brosna Callows SPA: Meenwaun Wind Farm, Derrinlough Wind Farm, Cloghan Wind Farm, Carrig Renewables Wind Farm and Carrig and Skehanagh Wind Farm.

4.4.7 Middle Shannon Callows SPA

The Project could result in collisions with whooper swan, wigeon, golden plover, lapwing and black-headed gull, which may be a part of the SPA population. The Project may also result in disturbance or displacement of breeding lapwing. The Project will not present a barrier to migration on its own. However, there are three wind farms within 5km of the Project site and therefore collectively they may present a barrier to migration.

Other wind farms or single wind turbines located within 20km of Middle Shannon Callows SPA have the potential to have an in-combination effect with the Project. 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 4-13**. The wind farms within 20 km of Middle Shannon Callows SPA are Meenwaun Wind Farm, Derrinlough Wind Farm, Cloghan Wind Farm, Leabeg Wind Farm, Carrig Renewables Wind Farm and Carrig and Skehanagh Wind Farm.

There is hydrological connectivity between Middle Shannon Callows SPA and the Project site via the Rapemills River and River Shannon. In the absence of mitigation, suspended solids, nutrients and other pollutants generated during the construction and decommissioning of the Project could cause a reduction in water quality within the SPA. Any construction projects within the same catchment (25 B Lower Shannon) as the SAC have the potential to have an in-combination effect with the Project, if they also negatively impact water quality. This impact could arise if other projects are scheduled to be constructed or decommissioned at the same time as this Project, resulting in a decline in water quality, or in series, producing a continuing reduction in water quality.

4.4.8 Slieve Bloom Mountains SPA

Hen harrier is the qualifying feature of Slieve Bloom Mountains SPA. The Project presents a collision risk to this species. Other wind farms, or single wind turbines, located within 20km of this SPA have the potential to have an in-combination effect with the Project. 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 4-13. There are a total of nine wind farms within a 20km radius of Slieve Bloom Mountains SPA, namely; Meenwaun Wind Farm, Derrinlough Wind Farm, Cloghan Wind Farm, Leabeg Wind Farm, Carrig Renewables Wind Farm, Carrig and Skehanagh Wind Farm, Monaincha Wind Farm, Mountlucas (1) Wind Farm and Bruckana Wind Farm

4.4.9 Lough Derg (Shannon) SPA.

4.4.9.1 Hydrological Connectivity

The Project could result in collisions with cormorant. Other wind farms or single wind turbines located within 20km of Lough Derg (Shannon) SPA have the potential to have an in-combination effect with the Project. 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 4-13**. There are a total of three wind farms within a 20 km radius of Lough Derg (Shannon) SPA, namely; Meenwaun Wind Farm, Carrig Renewables Wind Farm and Carrig and Skehanagh Wind Farm.

Hydrological connectivity between the Project site and Lough Derg (Shannon) SPA, via the Rapemills River and River Shannon, provides a pathway for suspended solids, nutrients and other pollutants generated during the construction/ decommissioning of the Project to enter the SPA and lead to deterioration in water quality. In-combination effect with the Project is possible with any other construction projects within the same catchment as the SPA (25B Lower Shannon), they also negatively impact water quality. Such effects could arise if the other projects are timed to be constructed or decommissioned at the same time as this Project, resulting in a decline in water quality, or in succession, with an ongoing reduction in water quality.

4.4.10 River Suck Callows SPA

The SCI for this SPA, for which potential ecological connectivity has been identified are; whooper swan, wigeon, golden plover and lapwing. All of these species were recorded during flight activity surveys, and are therefore at risk of collision with the proposed turbines. Other wind farms, or single wind turbines, located within 20km of this SPA have the potential to have an in-combination effect with the Project. 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 4-14**.

Skrine Wind Farm, Leabeg Wind Farm, Meenwaun Wind Farm, Derrinlough Wind Farm and Cloghan Wind Farm were returned from the 20 km search radius around River Suck Callows SPA.

Table 4-13: Summary of NIS conclusions and mitigation for the other identified projects

Project	NIS conclusions	Mitigation measures summary	Source
Meenwaun Wind Farm	With the implementation of the detailed mitigation measures there is no scientific doubt remaining as to the absence of potential adverse effects.	• Mitigation measures during the construction phase • In advance of any works taking place, a method statement for protecting watercourses on the proposed Meenwaun Wind Farm site (Mullaghakaraun Bog Stream and Milltown Stream) and along the grid connection (Rapemills River, Woodfield Stream), will be drawn up • AN SDMP will be prepared in advance of works. The works programme for the site will incorporate erosion and sediment control to be detailed in the SDMP including the installation of drainage and runoff controls; minimisation of the area of exposed ground; preventing runoff entering the site from adjacent ground; provision of appropriate control and containment measures on site; monitoring and maintenance of erosion and sediment controls throughout the project; and establishing vegetation as soon as practical on all areas of exposed soil. • The design of all silt and erosion control measures on site will be based on the peak flood flows. • The access track will be designed to minimise excavation on the site and reduce the risk of sediment runoff. • Swales for turbine based and hard standings will be constructed. • All infrastructure will be set back 50m from all streams within the site, except for the main crossings. • Cross-drains of 450mm diameter will be provided to prevent risk of clogging for drainage crossings and conveying flows from agricultural drains and forestry drains across the access roads • The structure at the stream crossing will be sized in accordance with CIRIA C689. • In the event that HDD is used a biodegradable fluid will be used and a contingency and resource protection plan will be prepared.	Element Power Ireland Ltd (2014) Natura Impact Statement Meenwaun Wind Farm

Project	NIS conclusions	Mitigation measures summary	Source
		• The excavated subsoil material will be removed to the designated material storage area which will be monitored to manage any potential loss of suspended solids to surface waters. • The proposed drainage of the material storage area includes a stilling pond and silt fencing, where necessary. • An Emergency Silt Control and Spillage Response Procedure will be included in the SDMP. • A designated area for concrete washdown will be located at the temporary site compounds. A lined settlement lagoon will be provided. • Standing water, which could arise in excavations, as the potential to contain an increased concentration of suspended solids. The excavations for turbines will be pumped in the site drainage system. • Wheel washing facilities will be provided at the site entrance draining to silt traps. Additional silt fencing will be kept on site in case of an emergency break out of silt laden run-off. • Sanitary waste will be removed from site via a licenced waste disposal contractor. • Any diesel or fuel oils stored at the temporary site compound will be bunded. The bund capacity will be sufficient to contain 110% of the tank's maximum capacity. • Refuelling of plant machinery during construction will only be carried out at designated refuelling station locations on site a minimum of 100m from any watercourse. • Appropriate preventative measures will be details within the CEMP to ensure that non-native aquatic/riparian species are not introduced into the site. • A monitoring programme will be established to ensure that the water quality is maintained. • For off-line cabling methods where a temporary diversion of a watercourse may be required silt curtains and floating booms will	

Project	NIS conclusions	Mitigation measures summary	Source
		be used. The use of construction machinery in-stream will be minimised as much as practical. • Stilling ponds will be put in place in advance as construction progresses across the site. • Where haul roads pass close to watercourses silt fencing will be used to protect the streams. Silt traps will be provided at outfalls from roadside swales to existing drains. • During the construction period an emergency facility will be provided to control the discharge from the stilling ponds. • Roads will be capped as soon as practical. • Tree felling will be undertaken in accordance with the Forest Service Forestry and Water Quality Guidelines (2000) and Forest Harvesting and Environmental Guidelines. • Mitigation measures during the operational phase • During the operational phase, oils will be required for cooling the transformers giving rise to the potential for oil spill within the site. However, the transformers will be bunded to over 110% of the volumes of oil within them. • Weekly inspection of the erosion and sediment control measures on site will be carried out, followed by fortnightly inspections until the risk of erosion or siltation has declined following the successful establishment of vegetation. • The conceptual drainage management system has been designed to operate effectively during the operational period. The stilling ponds will be a permanent feature. During the operation period the swales will have vegetated and will serve to attenuate flows and remove any suspended solids from the run-off. • Bird diverters shall be placed on guy wires for the permanent met mast on site and will be maintained over the lifetime of the project. • Mitigation measures during the decommissioning phase	

Project	NIS conclusions	Mitigation measures summary	Source
		• As in the construction phase silt protection controls will again be put in place. The drainage system will remain operational during the decommissioning phase. • Additional mitigation • A monitoring programme will be established to ensure that the water quality is maintained and to ensure the effectiveness of designed control and other mitigation measures.	
Derrinlough Wind Farm	Following an examination, evaluation and analysis, in light of best scientific knowledge and the conservation objectives of the site, and, on the basis of objective information, having taken into account the relevant mitigation measures, it can be concluded that the project will not have an adverse impact on any European sites], either alone or in combination with other plans or projects.	**Deterioration of water quality** The pathway that would allow potential impacts to occur was considered in the design of the project. The environmental management framework to be adhered to during the construction phase of the development including comprehensive detail regarding site set up, pollution prevention and hydrocarbon management and incorporates the mitigating principles to ensure no adverse impact on the integrity of European sites as outlined in Chapter 9 of the EIAR and in the CEMP for the proposed. Extensive mitigation measures for the protection of water quality will be adhered to during the construction phase of the development. **Bird disturbance** - Mitigation by design The project design has followed the basic principles outlined below to eliminate the potential for significant effects on avian receptors: • The project has been deliberately designed to avoid the most sensitive areas for birds within the study area. This includes the Drinagh Wetlands. (Note: the amenity pathway in this area follows the route of an existing track). • Sensitive hydrological features will be avoided where possible, by application of suitable buffer zones (i.e. 50m to main watercourses, and 10m to main drains). All of the key project areas are located significantly away from the delineated 50m watercourse buffer zones with the exception of the upgrading of the existing watercourse crossing, new drain crossing and upgrades to existing site access tracks.	MKO (2020) Natura Impact Statement Derrinlough Wind Farm

Project	NIS conclusions	Mitigation measures summary	Source
		• Hard standing areas have been designed to the minimum size necessary to accommodate the turbine model that is selected. • The proposed substation and associated grid connection route will be located entirely within the development site boundary. The proposed wind farm would be connected to the national electricity grid through the existing Dallow/Portlaoise/Shannonbridge 110kV line which traverses the north-eastern section of the site. These areas have been subjected to detailed bird surveys across the two-year survey period. - Mitigation During Construction, Operation and Decommissioning • The following measures are proposed for the construction phase: • A Construction and Environmental Management Plan (CEMP) has been prepared. The CEMP will be in place prior to the start of the construction phase. • During the construction phase, noise limits, noise control measures, hours of operation (i.e. dusk and dawn is high faunal activity time) and selection of plant items will be considered in relation to disturbance of birds. • Plant machinery will be turned off when not in use. • All plant and equipment for use will comply with the Construction Plant and Equipment Permissible Noise Levels Regulations 1996 (SI 359/1996) and other relevant legislation. An Ecological Clerk of Works (ECoW) will be appointed. Duties will include: ○ Undertake a pre-construction transect/walkover bird survey to ensure that significant effects on breeding birds will be avoided. ○ Inform and educate on-site personnel of the ornithological and ecological sensitivities within the Project site. ○ Oversee management of ornithological and ecological issues during the construction period and advise on ornithological issues as they arise. ○ Provide guidance to contractors to ensure legal compliance with respect to protected species onsite. o Liaise with officers	

Project	NIS conclusions	Mitigation measures summary	Source
		of consenting authorities and other relevant bodies with regular updates in relation to construction progress. ○ The following measures are proposed for the decommissioning phase: • During the decommissioning phase, disturbance limitation measures will be as per the construction phase. • Plant machinery will be turned off when not in use. • All plant and equipment for use will comply with the Construction Plant and the European Communities (Noise Emission by Equipment for Use Outdoors) Regulations 2001 (S.I. No. 632 of 2001).	
Cloghan Wind Farm	Taking account of mitigation measures proposed for the avoidance and reduction of adverse effects on the qualifying interests and conservation objectives of the designated Natura 2000 sites within the study area it is concluded the proposed Cloghan Wind Farm will not result in direct, indirect or cumulative impacts which would have the potential to adversely affect any Natura 2000 site.	Construction phase mitigation measures - Water quality • In advance of works commencing on site, the contractor will be required to prepare a detailed Environmental Management System (EMS) include of a Construction Method Statement for the works. The following measures will be included in the EMS: ○ The storage of hydrocarbons and chemicals will be minimised at the site and will only take place when absolutely necessary. ○ Storage tanks will be secured within a bund capable of holding 120% of the total storage volume. ○ Any leaks or spills will be immediately removed, treated and disposed of correctly. ○ All storage tanks will be located so as to minimise the risk of damage from vehicle of machinery impact. ○ Refuelling of site machinery will only take place on designated hard-standing areas surrounded by interceptor drains. Absorbent mats will be placed and maintained in these areas ○ Regular inspection, and repair as necessary, of the hard-standing areas will take place .	Ecofact (2014) Cloghan Wind Farm Natura Impact Statement to Inform the Appropriate Assessment process

Project	NIS conclusions	Mitigation measures summary	Source
		○ All vehicles and site machinery will be kept in good working order at all times. Any defective machinery will be removed from site immediately. ○ Parking of vehicles and machinery when the site is not operational will only take place on hard-standing areas surrounded by interceptor drains. ○ All valves and mechanisms on fixed and mobile plant, vehicles and storage tanks will be kept securely locked when not in use. ○ An emergency response spill management plan that will be implemented in the event of accidental leaks or spills will be made available to all site construction staff. ○ All site personnel will be fully briefed on best construction practices and on the procedures in place to minimise the risk of impact to water quality. ○ To minimise the risk of concrete wash water run-off, concrete delivered in ready-mix trucks will be used. ○ Where necessary, any discharge water will be pumped to tankers and removed off site for appropriate, licensed disposal. ○ A detailed Waste Management Plan for all phases of the project will be included in the EMS. - Avifauna • The seasonality of the proposed works is identified as a key mitigation measure. Turbines will be erected over the summer period and will be in place when birds arrive on their wintering ground in October. • A Site Environmental Management Plan (SEMP) is required during the construction and operational phases of the development in order to avoid any preventable impacts on the ornithological resource of the study area. • All site workers, including sub-contractors will be made aware of the SEMP through an environmental induction. • Operational phase mitigation	

Project	NIS conclusions	Mitigation measures summary	Source
		• As a precautionary measure to avoid impacts affecting migratory bird species, particularly swans and geese, an Avian Monitory System will be installed. This will monitor bird flights through the wind farm for the lifetime of the installation and will also serve as an anti-collision mechanism.	
Leabeg Wind Farm	The screening report, based on the available scientific information and project details, has demonstrated that the project does not pose a risk of likely significant effects on Natura 2000 sites and concludes that Offaly County Council can determine that appropriate assessment is not required, as the proposed works, individually or in combination with other plans or projects, will not have a significant effect on an European (Natura 2000) sites.	No mitigation measures required.	Columb Kane (2020) Planning and Environmental Report
Carrig and Skehanagh Wind Farm	No NIS for Carrig and Skehanagh Wind Farm, or any documents relevant to biodiversity, were available in an online search.	n/a	n/a
Carrig Renewables Wind Farm	It can be objectively concluded that the Project, individually or in combination with other plans or projects, will not adversely affect the integrity of any European Site	Wind Farm Site The key mitigation measure during the construction phase is the avoidance of sensitive aquatic areas where possible, by application of suitable buffer zones (i.e. 50m to main watercourses). All of the key development components within the wind farm site are located significantly away from the delineated 50m watercourse buffer zones with the exception of 2 no. new watercourse crossing locations. Spoil and peat management areas for removed soil/subsoil will be localised to spoil and peat repository areas outside of these buffer zones and will be designed and constructed with the minimal amount of surface area exposed. In these spoil and peat management areas, the vegetative top-soil layer will be removed and re-instated or	MKO (2023) Carrig Renewables Wind Farm. Appropriate Assessment Screening Report and Natura Impact Statement.

Project	NIS conclusions	Mitigation measures summary	Source
		reseeded directly after construction, allowing for re-vegetation which will mitigate against erosion. Additional control measures, which are outlined further on in this section, will be undertaken at the proposed watercourse crossing locations. It should be noted that an extensive network of agricultural, forestry and bog drains already exist, and these will be integrated and enhanced as required and used within the wind farm site drainage system. The integration of the existing drainage network and the wind farm site network is relatively simple. The key elements being the upgrading and improvements to water treatment elements, such as in line controls and treatment systems, including silt traps, settlement ponds and buffered outfalls. The main elements of interaction with existing drains will be as follows: • Apart from interceptor drains, which will convey clean runoff water to the downstream drainage system there will be no direct discharge (without treatment for sediment reduction, and attenuation for flow management) of runoff from the wind farm site drainage into the existing site drainage network where possible. This will reduce the potential for any increased risk of downstream flooding or sediment transport/erosion; • Silt traps will be placed in the existing drains upstream of any streams where construction works / tree felling is taking place, and these will be diverted into proposed interceptor drains, or culverted under/across the works area; • Buffered outfalls which will be numerous over the wind farm site which will promote percolation of drainage waters across vegetation and close to the point at which the additional runoff is generated, rather than direct discharge to the existing drains; and, • Drains running parallel to the existing roads requiring widening will be upgraded. Velocity and silt control measures such as check dams, sand bags, oyster bags, straw bales, flow limiters, weirs, baffles, silt fences will be used during the upgrade construction	

Project	NIS conclusions	Mitigation measures summary	Source
		works. Regular buffered outfalls will also be added to these drains to protect downstream surface waters. Grid route The vast majority of the underground electrical cabling connection route options are >50m from any nearby watercourse. Sections of the grid route which are within 50m of a watercourse are confined to existing watercourse crossings at bridges. It is proposed to limit works in any areas located within 50m of any watercourse/waterbody including the stockpiling of excavated soils and subsoils. There are a total of 4 no. watercourse crossings and 2 no. drain crossings along the grid connection and all the crossings are existing bridges and culverts along the public road. No in-stream works are required at any of these crossings, however due to the proximity of the streams to the construction work at the crossing locations, there is a potential for surface water quality impacts during trench excavation work. Mitigation measures are outlined below. A constraint/buffer zone will be maintained for all crossing locations, whereby all watercourses will be fenced off. In addition, measures which are outlined below will be implemented to ensure that silt laden or contaminated surface water runoff from the excavation work does not discharge directly to the watercourse. The large setback distance from sensitive hydrological features means that adequate room is maintained for the proposed drainage mitigation measures (discussed below) to be properly installed and operate effectively. The proposed buffer zone will: • Avoid physical damage to watercourses, and associated release of sediment; • Avoid excavations within close proximity to surface watercourses; • Avoid the entry of suspended sediment from earthworks into watercourses; and,	

Project	NIS conclusions	Mitigation measures summary	Source
		• Avoid the entry of suspended sediment from the construction phase drainage system into watercourses, achieved in part by ending drain discharge outside the buffer zone and allowing percolation across the vegetation of the buffer zone.	
Monaincha Wind Farm	No NIS for Monaincha Wind Farm was available online. However, the Ecological Impact Assessment concluded; 'Th loss of habitat caused by the turbines and roadway is unlikely to be significant for any of the bird species'. 'The day-to-day operation of the wind farm and associated low level human activity would minimally impact on most bird species'. 'The day-today operation of the wind farm is unlikely to have a major impact on the mammal fauna present. it would be expected that they would become accustomed to the movement and noise of the blades' Furthermore, with regards to bird strike 'Skylark, meadow pipit, snipe and woodcock all may suffer bird strike. However, since these are common species, and the risk of collision low, the potential loss to their population would not be significant.'	Bird strike • The possibility of bird strike can be mitigated by building the turbines of solid structure rather than the alternative lattice design. This serves to restrict perching sites for raptors. This also means that vantage points for potential plunder of small bird's nests are not available for crows and ravens. Disturbance • Construction work will occur over as short a time frame as possible. If feasible, disturbance will be minimised during the breeding season of resident bird and mammal populations. • After construction, human activity will be confined to roadways and occasionally the wind turbines to minimise human disturbance factor. General • The risk of pollution arising from construction of the wind farm can be reduced by adopting the following preventative measures: - off-site washing of concrete and cement carrying vehicles, - off-site disposal of excess concrete, used oils and other chemicals (temporary on-site storage to be restricted to bunded areas).	Ryan, C. (2008) Monaincha Wind Farm. Ecological Impact Assessment.
Mountlucas Wind Farm	No NIS for Mountlucas Wind Farm was available online.	Mitigation measures outlined in the ecology chapter of the EIAR are summarised below.	Fehily Timoney and Company (2009)

Project	NIS conclusions	Mitigation measures summary	Source
	However, the ecology chapter of the EIAR concluded that 'With the successful application of mitigation measures and best practice construction techniques the construction of Mountlucs Wind Farm will not have any significant long term, negative impacts on the habitats or locally occurring wildlife on the site. The successful application of mitigation measures will ensure that the residual post construction impacts will be negligible. The conclusion of the Soils, Geology & Water chapter is as follows: 'The proposed wind farm development is not likely to have any significant impacts on surrounding water quality. The most significant impact on the environment is from sediment release; however, this will be appropriately managed and mitigated so that the residual risk is minor.	• No disturbance to habitats ot flora outside the site boundary will occur. All works and temporary storage of material will be restricted to within the site boundary. • The proposed wind farm will be located at least 50 m from the Bog Woodland, Marshes, mosaic of Broadleaved Woodland & Scrub and Raised Bog at the northern boundary in order to ensure that these habitats are protected from the development. The proposed site configuration achieves this. • Where possible any peat areas cleared (e.g. areas of scrub) but not developed as hard-standing areas will be allowed to re-vegetate naturally. If these areas fail to re-vegetate naturally, then the situation will be assessed by a suitably qualified expert who will make recommendations to promote natural re-vegetation. • A walkover of the site will be undertaken prior to construction in order to survey the mammals and birds in the area earmarked for habitat removal. This will ensure that any site-specific issues in relation to wildlife will be highlighted before construction. • Should any Badger setts be discovered within the site during construction works, the NPWS will be informed, and Badger sett removal will take place under the advice and licensing regulations of the NPWS and under the guidelines of the National Roads Authority. • The majority of vegetation removal will be undertaken outside of the main period of bird breeding season to minimise disturbance to nesting birds during this period. Mitigation measures outlined in the Soils, Geology & Water chapter of the EIAR are summarised below. • Spoil heaps will be covered and surrounded by silt fences to minimise any increase in suspended solids in the surface water run-off. Swales outside the silt fences will carry the filtered run-off to the nearest outfall.	Environmental Impact Statement for a proposed wind farm at Mountlucas, Daigean, Co. Offaly.

Project	NIS conclusions	Mitigation measures summary	Source
		• Excavations will be pumped into temporary settlement basins which will be lined and which will drain into the existing drainage channels on site. • A preliminary drainage system has been designed and will be connected directly or diverted into the existing drainage system on site. As a result, no increased sediment loading in the watercourse is anticipated during the construction or operation of the proposed wind farm.	
Bruckana Wind Farm	No NIS for Bruckana Wind Farm, or any documents relevant to biodiversity, were available in an online search.	n/a	n/a
Skrine Wind Farm	No NIS for Skrine Wind Farm was available online. However the 'Ecology' chapter for the Environmental Report concluded: 'The number of bird mortalities would not be so great as to cause adverse affects to the local population as a whole' 'There will be no significant impacts on the fauna that inhabit the site through loss of habitat due to the construction of the proposed wind turbines'	Reduce collision impacts • Use solid rather than lattice turbine design • Make the turbine blades as visible as possible • Use intermittent rather than continuous navigating lighting, if applicable Reducing disturbance impacts • Minimize the number of access roads and avoid unnecessary human activity on site Reducing habitat impacts • Minimise the number of new access roads created • Avoid the most ecologically sensitive parts of the site (i.e. limestone pavement and scrub)	proVento Ireland (2004) Environmental Report. Proposed Wind Farm Development at Skrine/ Knockmeane, Athleague, Co. Roscommon.

For all the identified projects where an NIS/environmental reporting was available, the projects incorporated significant mitigation to prevent adverse impacts on the designated features of Natura 2000 sites.

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

4.5.1 Ridge Road, SW of Rapemills SAC

The unmitigated risks for the Project to undermine the draft conservation objectives of Ridge Road, SW of Rapemills SAC are set out below in **Table 4-14.**

Table 4-14: Unmitigated risk of undermining the conservation objectives of Ridge Road, SW of Rapemills SAC

Conservation objective (summary)	For the Project Alone	For the Project in combination with other plans and projects
Maintain the: • habitat area, and • habitat distribution of Semi-natural dry grasslands and scrubland facies on calcareous substrates (Festuco-Brometalia) (* important orchid sites)	No risk: There are no works proposed within the SAC and the closest known location of this habitat is approximately 0.26km away from the Project site boundary.	No risk
Maintain the: • vegetation composition: positive indicator species, • vegetation composition: negative indicator species, • vegetation composition: non-native species, and • vegetation composition: woody species and bracken of Semi-natural dry grasslands and scrubland facies on calcareous substrates (Festuco-Brometalia) (* important orchid sites)	Low risk: Unmitigated, the Project could release pollutants, such as dust and vehicle emissions, resulting in increased air pollution and dust deposition on plants. In turn this may affect photosynthesis, respiration and allow the penetration of toxic gaseous pollutants resulting in decreased plant productivity and subsequent alteration in the vegetation composition.	Low, but slightly increased, risk of other construction and/or decommissioning works at other project sites adding to the risk for the Project alone.
Maintain the: • vegetation structure: broadleaf herb:grass ratio • vegetation structure: sward height • vegetation structure: litter • physical structure: bare soil • physical structure: disturbance of Semi-natural dry grasslands and scrubland facies on calcareous substrates (Festuco-	Low risk: Unmitigated, the Project could release pollutants, such as dust and vehicle emissions, resulting in increased air pollution and dust deposition on plants. In turn this may affect photosynthesis, respiration and allow the penetration of toxic gaseous pollutants resulting in decreased plant productivity and subsequent alternation in vegetation structure.	Low, but slightly increased, risk construction and/or decommissioning works at other project sites adding to the risk for the Project alone.

Conservation objective (summary)	For the Project Alone	For the Project in combination with other plans and projects
Brometalia) (* important orchid sites)		

4.5.2 River Shannon Callows SAC

The unmitigated risks for the Project to undermine the draft conservation objectives of River Shannon Callows SAC are set out below in **Table 4-15**.

Table 4-15: Unmitigated risk of undermining the conservation objectives of River Shannon Callows SAC

Conservation objective (summary)	For the Project Alone	For the Project in combination with other plans and projects
Maintain the: • habitat area, and • habitat distribution of alkaline fen	No risk: There are no works proposed within the SAC and the closest known location of this habitat is approximately 20.5km away from the Project site boundary.	No risk
Maintain the: • ecosystem function: soil nutrients, • ecosystem function: peat formation, • Ecosystem function: hydrology - groundwater levels, • ecosystem function: hydrology - surface water flow, and • ecosystem function: water quality of alkaline fen	Low risk: Unmitigated, the Project could release suspended sediment, nutrients and other pollutants into water courses hydrologically connected with the SAC resulting in a deterioration of water quality and increase in soil nutrients. Due to the distance between the SAC and Project site there is considered to be no risk of increase in surface water flow due to run-off from surfaced and hard stand areas within the Project site.	Low, but slightly increased, risk of other construction and/or decommissioning works at other project sites adding to the risk for the Project alone.
Maintain the: • vegetation composition: community diversity, • vegetation composition: typical brown mosses, • vegetation composition: typical vascular plants, • vegetation composition: native negative indicator species, • vegetation composition: non-native species, • vegetation composition: native trees and shrubs,	No risk: There are no works proposed within the SAC and the closest known location of this habitat is approximately 20.5km away from the Project site boundary. Therefore, there will be no direct impact to vegetation composition. No invasive non-native plant species were recorded within the Project site.	No risk

Conservation objective (summary)	For the Project Alone	For the Project in combination with other plans and projects
• vegetation composition: algal cover, and • vegetation structure: vegetation height of alkaline fen		
Maintain the: • physical structure: disturbed bare ground, and • physical structure: tufa formations of alkaline fen	No risk: There are no works proposed within the SAC and the closest known location of this habitat is approximately 20.5km away from the Project site boundary.	No risk
Maintain the: • indicators of local distinctiveness, and • transitional areas between fen and adjacent habitats of alkaline fen	No risk: There are no works proposed within the SAC and the closest known location of this habitat is approximately 20.5km away from the Project site boundary.	No risk
Maintain the: • habitat area, and • habitat distribution of alluvial forests with Alnus glutinosa and Fraxinus excelsior (*Alno-Padion, Alnion incanae, Salicion albae*)	No risk: There are no works proposed within the SAC and the nearest known location of this habitat is approximately 9.5km distant from the Project site boundary. Therefore, there will be no loss of this habitat.	No risk
Maintain the: • woodland size, • woodland structure: cover and height, • woodland structure: community diversity and extent, • woodland structure: natural regeneration, • woodland structure: dead wood, • woodland structure: veteran trees, • woodland structure: indicators or local distinctiveness, and • woodland structure: indicators of overgrazing of alluvial forests with *Alnus glutinosa* and *Fraxinus excelsior* (*Alno-Padion, Alnion incanae, Salicion albae*)	No risk: There are no works proposed within the SAC and the nearest known location of this habitat is approximately 9.5km distant from the Project site boundary. There will be no works within this habitat and therefore no changes to the structure of alluvial woodlands as a result of the Project.	No risk

Conservation objective (summary)	For the Project Alone	For the Project in combination with other plans and projects
Maintain the: • hydrological regime: flooding depth/height of water table of alluvial forests with *Alnus glutinosa* and *Fraxinus excelsior* (Alno-*Padion, Alnion incanae, Salicion albae*)	No risk: There are no works proposed within the SAC and the nearest known location of this habitat is approximately 9.5km distant from the Project site boundary. Risks as a result of the temporary lowering of groundwater levels during turbine base construction was ruled out as impacts will be localised and very unlikely to be perceptible beyond 50m of the excavation.	No risk
Maintain the: • vegetation composition: native tree cover, • vegetation composition: typical species, • vegetation composition: negative indicator species, and • vegetation composition: problematic native species of alluvial forests with *Alnus glutinosa* and *Fraxinus excelsior* (*Alno-Padion, Alnion incanae, Salicion albae*)	No risk: There are no works proposed within the SAC and the nearest known location of this habitat is approximately 9.5km distant from the Project site boundary. There will be no works within this habitat and therefore no changes to the structure of alluvial woodlands as a result of the Project.	No risk
To maintain: • distribution, • extent of terrestrial habitat, • extent of freshwater (river) habitat, • couching sites and holts, and, • barriers to connectivity of otter	Low risk: There will be no works within the SAC. However, the Project site is hydrologically connected with the SAC via West Galros Stream and Rapemills River. Both these watercourses are suitable for otter. Regular otter spraint sites were recorded on the Rapemills River. Activities undertaken during the construction/ decommissioning of the wind farm could result in disturbance and displacement of otter associated with the SAC. However, this species is not very sensitive to disturbance (Chanin 2003).	Low, but slightly increased, risk, of other construction and/or decommissioning works at other project sites adding to the risk for the Project alone.
To maintain: • fish biomass available for otter	Low risk: Water pollution via suspended sediment could negatively affect fish spawning gravels, vegetation or	Low, but slightly increased, risk, of other construction and/or decommissioning works at other

Conservation objective (summary)	For the Project Alone	For the Project in combination with other plans and projects
	invertebrates that fish forage upon.	project sites adding to the risk for the Project alone.

4.5.3 Lough Derg, North-east Shore SAC

The unmitigated risks for the Project to undermine the draft conservation objectives of Lough Derg, North-east Shore SAC are set out below in **Table 4-16**.

Table 4-16: Unmitigated risk of undermining the conservation objectives of Lough Derg, North-east Shore SAC

Conservation objective (summary)	For the Project Alone	For the Project in combination with other plans and projects
To maintain: • habitat area, and • habitat distribution of calcareous fens with *Cladium mariscus* and species of the *Caricion davallianae*	No risk: There are no works proposed within the SAC and the SAC is approximately 14.8km distant from the Project site.	No risk
To maintain: • ecosystem function: peat formation habitat distribution, • ecosystem function: hydrology - groundwater levels, • ecosystem function: hydrology - surface water flow, • ecosystem function: water quality of calcareous fens with *Cladium mariscus* and species of the *Caricion davallianae*	Low risk: Unmitigated, the Project could release suspended sediment, nutrients and other pollutants into water courses hydrologically connected with the SAC resulting in a deterioration of water quality and increase in soil nutrients. Due to the distance between the SAC and Project site there is considered to be no risk of increase in surface water flow due to run-off from surfaced and hard stand areas within the Project site.	Elevated but low risk of other construction and/or decommissioning works at other project sites adding to the risk for the Project alone.
To maintain: • vegetation composition: typical species, • vegetation composition: native negative indicator species ecosystem function: hydrology - surface water flow, • vegetation composition: non-native species, and • vegetation composition: trees and shrubs of calcareous fens with *Cladium mariscus* and species of the *Caricion davallianae*	No risk: There are no works proposed within the SAC and the closest known location of this habitat is approximately 20.5km away from the Project site boundary. Therefore, there will be no direct impacts to vegetation composition . No invasive non-native species were recorded within the Project site.	No risk

Conservation objective (summary)	For the Project Alone	For the Project in combination with other plans and projects
To maintain: • physical structure: disturbed bare ground, and • indicators of local distinctiveness of calcareous fens with *Cladium mariscus* and species of the *Caricion davallianae*	No risk: There are no works proposed within the SAC and the SAC is approximately 14.8km distant from the Project site.	No risk
Maintain the: • habitat area, and • habitat distribution of alkaline fen	No risk: There are no works proposed within the SAC and the SAC is approximately 14.8km distant from the Project site.	No risk
Maintain the: • ecosystem function: soil nutrients, • ecosystem function: peat formation, • Ecosystem function: hydrology - groundwater levels, • ecosystem function: hydrology - surface water flow, and • ecosystem function: water quality of alkaline fen	Low risk: Unmitigated, the Project could release suspended sediment, nutrients and other pollutants into water courses hydrologically connected with the SAC resulting in a deterioration of water quality and increase in soil nutrients. Due to the distance between the SAC and Project site there is considered to be no risk of increase in surface water flow due to run-off from surfaced and hard stand areas within the Project site.	Elevated but low risk of other construction and/or decommissioning works at other project sites adding to the risk for the Project alone.
Maintain the: • vegetation composition: community diversity, • vegetation composition: typical brown mosses, • vegetation composition: typical vascular plants, • vegetation composition: native negative indicator species, • vegetation composition: non-native species, • vegetation composition: native trees and shrubs, and • vegetation composition: soft rush and common reed cover of alkaline fen	No risk: There are no works proposed within the SAC and the SAC is approximately 14.8km distant from the Project site. Therefore, there will be no direct impacts to vegetation composition within this habitat. No invasive non-native species were recorded within the Project site.	No risk
Maintain the: • physical structure: litter	No risk: There are no works proposed within the SAC and the SAC is approximately	No risk

Conservation objective (summary)	For the Project Alone	For the Project in combination with other plans and projects
• physical structure: disturbed bare ground, • physical structure: tufa formations, and • indicators of local distinctiveness of alkaline fen	14.8km distant from the Project site.	
Maintain the: • habitat area, and • habitat distribution of alluvial forests with Alnus glutinosa and Fraxinus excelsior (Alno-Padion, Alnion incanae, Salicion albae)	No risk: There are no works proposed within the SAC and the SAC is approximately 14.8km distant from the Project site Therefore, there will be no loss of this habitat.	No risk
Maintain the: • woodland size, • woodland structure: cover and height, • woodland structure: community diversity and extent, • woodland structure: natural regeneration, • woodland structure: dead wood, • woodland structure: veteran trees, • woodland structure: indicators or local distinctiveness, and • woodland structure: indicators of overgrazing of alluvial forests with *Alnus glutinosa* and *Fraxinus excelsior* (*Alno-Padion, Alnion incanae, Salicion albae*)	No risk: There are no works proposed within the SAC and the SAC is approximately 14.8km distant from the Project site. There will be no works within this habitat and therefore no changes to the structure of alluvial woodlands as a result of the Project.	No risk
Maintain the: • hydrological regime: flooding depth/height of water table of alluvial forests with *Alnus glutinosa* and *Fraxinus excelsior* (*Alno-Padion, Alnion incanae, Salicion albae*)	No risk: There are no works proposed within the SAC and the SAC is approximately 14.8km distant from the Project site. Risks as a result of the temporary lowering of groundwater levels during turbine base construction was ruled out as impacts will be localised and very unlikely to be significant beyond 50m of the excavation.	No risk

Conservation objective (summary)	For the Project Alone	For the Project in combination with other plans and projects
Maintain the: • vegetation composition: native tree cover, • vegetation composition: typical species, • vegetation composition: negative indicator species, and • vegetation composition: problematic native species of alluvial forests with *Alnus glutinosa* and *Fraxinus excelsior* (*Alno-Padion, Alnion incanae, Salicion albae*)	No risk: There are no works proposed within the SAC and the SAC is approximately 14.8km distant from the Project site. Therefore, there will be no direct impacts to vegetation composition within this habitat. No invasive non-native species were recorded within the Project site.	No risk

4.5.4 Dovegrove Callows SPA, All Saints Bog SPA and Little River Brosna Callows SPA

The Project may present a disturbance/displacement risk to Greenland white-fronted geese within Dovegrove Callows SPA due to the close proximity of the proposed grid connection to the SPA. The flock of geese that utilises Dovegrove Callows SPA for feeding has also been recorded within All Saints Bog SPA and Little River Brosna Callows SPA. Therefore, an adverse impact to the geese within one of the SPA's has the potential to undermine the conservation objectives of all three SPA's. Overall, the risk of undermining the conservation objectives is considered to be low.

Regarding in-combination effects, no wind farms, infrastructure developments, quarries, strategic infrastructure or strategic housing developments were found within a precautionary 2 km radius of these SPA's. Therefore, there is no risk of in-combination effects.

4.5.5 Little River Brosna Callows SPA

The Project may present a collision risk to whooper swan, wigeon, teal, golden plover, lapwing and black-headed gull.

Whooper swan

The data confirms that whooper swan makes occasional flights through the Project site. Using the data from the surveys, CRM was completed which indicates that the Project could result in 0.097 collisions per year.

CRM for whooper swan was conducted for Derrinlough Wind Farm and Carig Renewables Wind Farm at 0.21 and 0.326 collisions per year, respectively. A qualitative assessment was undertaken at Meenwaun Wind Farm which both concluded no collision effects as no whooper swan were recorded within the CRZ. With regards to Cloghan Wind Farm, whooper swan was not deemed to be at sufficient collision risk for CRM to be conducted. No documents relevant to ornithology for Carrig and Skehanagh Wind Farm were available in an online search and therefore no quantitative assessment of in-combination effects for this project is possible.

Therefore, for whooper swan, the in-combination collision risk is 0.633 and based on the most recent population estimated for whooper swan at River Little Brosna Callows SPA (303) the predicted annual increase in mortality is 1.05%

Overall, the rate of mortality attributable to the project is low and therefore the risk of undermining the conservation objectives to maintain the population is low.

Wigeon

CRM indicated that the Project could result in an annual mortality rate of 0.025. CRM for this species was not conducted for any of the wind farms under consideration in this in-combination assessment as no wigeon were recorded or the flight activity was considered too low to warrant CRM. Therefore, overall the in-combination collision risk is 0.025 which is very low. With regards to the most recent population estimate for wigeon at River Little Brosna Callows SPA (4,281 birds), the predicted increase in annual mortality is unchanged and remains at 0.001%. The population of this species at River Little Brosna Callows SPA is in an unfavorable condition, being about half what it was when the site was designated. This is probably part of a wider decline of this species, which is occurring across Ireland and Britain, the reasons for which are unclear. The rate of mortality attributable to the wind farm is so low that the risk of undermining the conservation objective to restore the population is negligible.

Teal

CRM indicated that the Project could result in an annual mortality rate of 1.566. However, the CRM is based on a single long flight of 42 birds and the predicted mortality is considered to be an over-estimate given the low level of observed flight activity over three years of survey. CRM for this species was not conducted for any of the wind farm under consideration in this in-combination assessment. Therefore, overall the in-combination collision risk is 1.566 and the predicted increase in annual mortality remains at 0.18%. As for wigeon, the population is unfavourable, with the population being about two thirds of what it was, with unclear reasons. Based on the CRM, the risk that the wind farm would hinder restoration of the population and therefore undermine the conservation objectives is low.

Golden plover

With regards to golden plover, a collision risk of 77.36 collisions per year (98% avoidance rate) or 7.736 (99.8% avoidance rate) was estimated. However, it should be noted that the collision risk estimate is likely to be hugely overestimated due to the presence of two exceptionally large flocks moving through the area, which are thought to be outliers. The realised effects of collision with the project are likely to be much lower, as evidenced by the low number of golden plover killed at European and Irish wind farms (Durr 2022).

For Derrinlough Wind Farm 14.191 collisions per year were projected. Based on a 99.8% avoidance rate, 2.345 collisions per year were projected at Carrig Renewables Wind Farm. A qualitative assessment of collision risk was undertaken at Meenwaun Wind Farm which determined that as low numbers of golden plover flights were recorded the impact is very low to low. For Cloghan Wind farm, the collision risk was not judged to be sufficient to warrant CRM. No documents relevant to ornithology for Carrig and Skehanagh Wind Farm were available in an online search and therefore no quantitative assessment of in-combination effects for this project is possible.

Therefore, the in-combination collision risk for golden plover is between 24.272 and 93.896 collisions per year. In light of the most recent population estimate for golden plover at River Little Brosna Callows SPA (5,100), the predicted increase in annual mortality remains between 1.76% and 6.81%. Taking into consideration the two outlying large flocks, which is only assumed to be part of an SPA population, the risk of undermining the conservation objective to restore the SPA population is low-moderate.

Lapwing

Regarding lapwing, the Project could cause 4.977 collisions per year.

CRM for lapwing was conducted for Derrinlough Wind Farm and Cloghan Wind farm with results of 1.875 and 0.71 collisions per year, respectively. With regards to Carrig Renewables

Wind Farm 2.941 collisions per year were predicted. For Meenwaun Wind Farm the flight activity of this species was considered to be too low to warrant qualitative assessment. No documents relevant to ornithology for Carrig and Skehanagh Wind Farm were available in an online search and therefore no quantitative assessment of in-combination effects for this project is possible.

Therefore, the in-combination collision risk for lapwing is 10.503 collisions per year and the predicted annual mortality based on the latest population of lapwing at Little River Brosna Callows SPA (3,258) is 1.09%. Overall, the risk of undermining the conservation objective to restore the population is low.

A pair of lapwing were recorded breeding within the Project site, and therefore breeding lapwing are at risk of disturbance/displacement. The SPA is designated for its wintering population of lapwing, and this pair and its progeny may be part of that population. Therefore an effect on this pair could have a marginal effect on the wintering population which currently stands at 3,258.

However, given the separation distances between the Project site and other wind farms, in-combination the risk of undermining the conservation objectives is low.

Black-headed gull

Black-headed gull are also at risk of collision with the turbines. Based on flight data, there was a mean annual collision rate of 1.146 predicted.

In terms of in-combination effects, a collision rate of 1.832 and 0.745 collisions per year were calculated for Derrinlough Wind Farm[13] and Carrig Renewables Wind Farm, respectively. CRM for this species was not conducted at Meenwaun Wind Farm and Cloghan Wind Farm due to no/low levels of recorded flight activity. No documents relevant to ornithology for Carrig and Skehanagh Wind Farm were available in an online search and therefore no quantitative assessment of in-combination effects for this project is possible.

Hence, the in-combination collision risk for black-headed gull is 3.723 collisions per year. Based on the site synopsis population of 1,939 birds, the predicted increase in annual mortality is 1.92%.

Based on the rate of mortality attributable to the wind farm the risk of undermining the conservation objective to restore the population is low.

Barrier effect

Given the distances between the Project site and these wind farm there is no realistic potential for barrier effects that would have an adverse effect on the integrity of River Little Brosna Callows SPA.

4.5.6 Middle Shannon Callows SPA

The unmitigated risks for the Project to undermine the conservation objectives of Middle Shannon Callows SAC are set out below in **Table 4-17.**

There are a total of five consented wind farms within 20km of Middle Shannon Callows SPA, namely Meenwaun Wind Farm, Derrinlough Wind Farm, Cloghan Wind Farm, Leabeg Wind Farm and Carrig and Skehanagh Wind Farm, and one currently with awaiting an outcome, Carrig Renewables Wind Farm.

[13] https://www.derrinloughwindfarmplanning.ie/Appendices/Appendix%207.6%20-%20Collision%20Risk%20Assessment.pdf

Table 4-17: Unmitigated risk of undermining the conservation objectives of Middle Shannon Callows SPA

Conservation objective (summary)	For the Project Alone	For the Project in combination with other plans and projects
To maintain the: • winter population trend, • winter spatial distribution, • disturbance at wintering site • barriers to connectivity and site use, • forage spatial distribution, extent and abundance, • roost spatial distribution and extent, and • supporting habitat: area and quality of whooper swan	The Project could result in 0.097 collisions per year.	Meenwaun Wind Farm: qualitative assessment concluded no collision effects. Derrinlough Wind Farm: 0.21 collisions per year Cloghan Wind Farm and Leabeg Wind Farm: whooper swan was not deemed to be at sufficient collision risk for CRM to be conducted. Carig Renewables Wind Farm: 0.326 collisions per year Carrig and Skehanagh: no documents relevant to ornithology available. The in-combination collision risk is 0.6333 collisions per year, which equates to a predicted annual increase in mortality of 3.18% Overall, the rate of mortality attributable to the project is low and therefore the risk of undermining the conservation objectives to maintain the population is low. Given the distances between the Project site and these wind farms there is no realistic potential for barrier effects that would have an adverse effect on the integrity of the SPA. Overall, based on the rate of mortality the risk of undermining the conservation objectives is low.
To restore the: • winter population trend, • winter spatial distribution, • disturbance at wintering site • barriers to connectivity and site use, • forage spatial distribution, extent and abundance, • roost spatial distribution and extent, and	The Project could result in 0.025 collisions per year.	CRM for this species was not conducted for any of the wind farms under consideration in this in-combination assessment. Therefore, overall the in-combination collision risk is 0.025 and the predicted increase in annual mortality is unchanged and remains at 0.03% Overall, based on the rate of mortality the risk of undermining

Conservation objective (summary)	For the Project Alone	For the Project in combination with other plans and projects
• supporting habitat: area and quality of wigeon		the conservation objectives is low.
To maintain the: • winter population trend, • winter spatial distribution, • disturbance at wintering site • barriers to connectivity and site use, • forage spatial distribution, extent and abundance, • roost spatial distribution and extent, and • supporting habitat: area and quality of golden plover	The Project could result in between 7.736 and 77.358 collisions per year. However, it should be noted that the collision risk estimate is likely to be hugely overestimated due to the presence of two large flocks moving through the area, which is thought to represent an outlier. The 112ealized effects of collision within the Project are likely to be much lower, as evidenced by the low number of golden plover killed at European and Irish wind farms (Durr 2022).	Meenwaun Wind Farm: qualitative assessment determined very low – low impact. Derrinlough Wind Farm: and 14.191 collision per year were projected. Cloghan Wind Farm: collision risk not judged to be sufficient to warrant CRM. Leabeg Wind Farm: No golden plover recorded. Carrig Renewables Wind Farm: 2.345 collision per year (based on a 99.8% avoidance rate) Carrig and Skehanagh: no documents relevant to ornithology available. Given the separation distances and that both turbine clusters contain only low numbers of turbines each, significant in-combination effects are very unlikely. Therefore, the in-combination collision risk for golden plover is between 24.272 and 93.896 collisions per year. The predicted increase in annual mortality remains between 17.87% and 69.2% Given the distances between the Project site and these wind farms there is no realistic potential for barrier effects that would have an adverse effect on the integrity of the SPA. Taking into consideration the large outlier flocks and two avoidance rates, overall, the risk of undermining the conservation objectives is considered to be low – moderate.
To restore the: • winter population trend, • winter spatial distribution, • disturbance at wintering site	The Project could cause 4.977 collisions per year.	Meenwaun Wind Farm: flight activity considered too low to warrant qualitative assessment.

Conservation objective (summary)	For the Project Alone	For the Project in combination with other plans and projects
• barriers to connectivity and site use, • forage spatial distribution, extent and abundance, • roost spatial distribution and extent, and • supporting habitat: area and quality of lapwing		Derrinlough Wind Farm: 1.875 collisions per year Cloghan Wind Farm: 0.71 collisions per year. Leabeg Wind Farm: No lapwing were recorded in flight. Carrig Renewables Wind Farm: 2.941 collisions per year Carrig and Skehanagh: no documents relevant to ornithology available. Given the separation distances and that both turbine clusters contain only low numbers of turbines each, significant in-combination effects are very unlikely. Therefore, the in-combination collision risk for lapwing is 10.503 collisions per year and the predicted annual mortality based on the latest population of lapwing at Middle Shannon Callows SPA (507) is 7.02%. Overall, the risk of undermining the conservation objective to restore the population is low-moderate.Given the distances between the Project site and these wind farms there is no realistic potential for barrier effects that would have an adverse effect on the integrity of the SPA A pair of lapwing were recorded breeding within the Project site, and therefore breeding lapwing are at risk of disturbance/ displacement.
To restore the: • winter population trend, • winter spatial distribution, • disturbance at wintering site • barriers to connectivity and site use, • forage spatial distribution, extent and abundance, • roost spatial distribution and extent, and • supporting habitat: area and quality	The Project could cause 1.146 collisions per year.	Meenwaun Wind Farm, Cloghan Wind Farm and Leabeg Wind Farm: CRM not conducted due to no/low levels of flight activity Derrinlough Wind Farm: 1.832 collisions per year Carrig Renewables Wind Farm: 0.745 collisions per year Carrig and Skehanagh: no documents relevant to ornithology available. Given the separation distances and that both turbine clusters contain

Conservation objective (summary)	For the Project Alone	For the Project in combination with other plans and projects
of black-headed gull		only low numbers of turbines each, significant in-combination effects are very unlikely. The in-combination collision risk for black-headed gull is 3,723 and the predicted annual mortality rate based on the SPA population (1,209) is 3.08%. Given the distances between the Project site and these wind farms there is no realistic potential for barrier effects that would have an adverse effect on the integrity of the SPA. Overall, the risk of undermining the conservation objectives is low.
To maintain: • wetland habitat area; and • wetland habitat quality and functioning of wetlands	There is hydrological and hydrogeological connectivity between this SPA and the Project site. Therefore, suspended solids, nutrients and other pollutants, generated during the construction and/or decommissioning of the wind farm, could enter SPA watercourses, which could negatively affect the wetland habitat and undermine the conservation objectives. Low risk.	In combination, the risk is low but elevated as other projects could also release pollution into connected watercourses.

4.5.7 Slieve Bloom Mountains SPA

The unmitigated risks for the Project to undermine the draft conservation objectives of Slieve Bloom Mountains SPA are set out below in **Table 4-18.**

Table 4-18: Unmitigated risk of undermining the conservation objectives of Slieve Bloom Mountains SPA

Conservation objective (summary)	For the Project Alone	For the Project in combination with other plans and projects
To maintain: • the population size, • productivity rate, and • disturbance to breeding sites of hen harrier	Very low risk: For the project, 0.009 collisions per year were predicted	Meenwaun Wind Farm: CRM not conducted due to no/low flight activity. Derrinlough Wind Farm: 0.005 collisions per year Cloghan Wind Farm: 0.006 collisions per year

Conservation objective (summary)	For the Project Alone	For the Project in combination with other plans and projects
		Leabeg Wind Farm: no flights recorded within collision risk zone, so no collision risk. Carrig Renewables Wind Farm: 0.005 collisions per year Carrig and Skehanagh Wind Farm and Bruckana Wind Farm: no documents relevant to ornithology available. Monaincha Wind Farm: vantage point surveys were not conducted. Therefore, collision risk modelling was not carried out. Mountlucas (1) Wind Farm: vantage point surveys were not conducted. Hence, collision risk modelling was not carried out. In-combination collision risk for hen harrier is a minimum of 0.025 collisions per year, which equates to 0.66% annual mortality rate based on the SPA hen harrier population. Therefore, based on the rate of mortality the risk of undermining the conservation objectives is considered to be very low.
To maintain: • spatial utilisation of breeding pairs • extent and condition of heath and bog and associated habitats, • extent and condition of low intensity managed grasslands and associated habitats, • extent and condition of hedgerows, • age structure of forest estate of hen harrier	No risk: There are no works proposed within the SPA and the SPA is approximately 13.79km distant from the Project site. Furthermore, there is limited suitable habitat within the Project site.	No risk

4.5.8 Lough Derg (Shannon) SPA

Cormorant was recorded during flight activity surveys with a peak count of two birds. Flight activity by cormorant involved birds commuting to/ from waterbodies off site. The results from CRM indicate 0.096 collisions per year.

Regarding in-combination effects, three wind farms were returned within the 20 km search radius around Lough Derg (Shannon) SPA, namely, Meenwaun Wind Farm, Carrig Renewables Wind Farm and Carrig and Skehanagh Wind Farm. For Meenwaun Wind Farm, CRM for cormorant was not conducted due to no/low recorded flight activity for this species. Regarding, Carrig Renewables Wind Farm 0.047 collisions per year were predicted. No documents relevant to ornithology for Carrig and Skehanagh Wind Farm were available in an online search and therefore no quantitative assessment of in-combination effects for this project is possible. Given the separation distances and given that both turbine clusters contain only low numbers of turbines each, significant in-combination effects are very unlikely.

Therefore, the in-combination collision risk for cormorant is 0.143 collisions per year. Based on the most recent population figures the estimated increase in mortality during the winter and breeding seasons are 1.68% and 0.05%, respectively. Based on the predicted mortality rate, the risk of undermining the conservation objectives is very low.

Hydrological connectivity between the Project site and Lough Derg (Shannon) SPA, via the Rapemills River and River Shannon, provides a pathway for suspended solids, nutrients and other pollutants generated during the construction/ decommissioning of the Project to enter the SPA and lead to deterioration in water quality. In-combination effect with the Project is possible with any other construction projects within the same catchment as the SPA (25B Lower Shannon), that also negatively impact water quality. Such effects could arise if the other projects are timed to be constructed or decommissioned at the same time as this Project, resulting in a decline in water quality, or in succession, with an ongoing reduction in water quality.

In combination, the risk is low but elevated as other projects could also release pollution into connected watercourses.

4.5.9 River Suck Callows SPA

The unmitigated risks for the Project to undermine the draft conservation objectives of River Suck Callows SAC are set out below in **Table 4-19.** Skrine Wind Farm, Leabeg Wind Farm and Meenwaun Wind Farm, Derrinlough Wind Farm and Cloghan Wind Farm were returned from the 20 km search radius around River Suck Callows SPA.

Table 4-19: Unmitigated risk of undermining the conservation objectives of River Suck Callows SPA

Conservation objective (summary)	For the Project Alone	For the Project in combination with other plans and projects
To maintain the: • winter population trend, • winter spatial distribution, • disturbance at wintering site • barriers to connectivity and site use, • forage spatial distribution, extent and abundance, • roost spatial distribution and extent, and • supporting habitat: area and quality of whooper swan	The Project could result in 0.097 collisions per year.	Skrine Wind Farm: vantage point surveys were not conducted. Hence, collision risk modelling was not carried out. Meenwaun Wind Farm: qualitative assessment concluded no collision effects. Derrinlough Wind Farm: 0.21 collisions per year Cloghan Wind Farm and Leabeg Wind Farm: whooper swan was not deemed to be at sufficient collision risk for CRM to be conducted. Overall, the in-combination collision risk is 0.307. In light of the most recent population estimate for the SPA (209) the predicted increase in annual mortality is 0.74%. Based on the estimated mortality rate, the risk of undermining the conservation objectives is low. Given the distances between the Project site and these wind farms there is no realistic potential for barrier effects that would have an adverse effect on the integrity of the SPA. Overall, the risk of undermining the conservation objectives is very low.
To restore the: • winter population trend, • winter spatial distribution, • disturbance at wintering site • barriers to connectivity and site use, • forage spatial distribution, extent and abundance, • roost spatial distribution and extent, and • supporting habitat: area and quality	The Project could result in 0.025 collisions per year.	CRM for this species was not conducted for any of the wind farm under consideration in this in-combination assessment. Therefore, overall the in-combination collision risk is 0.025 and the predicted increase in annual mortality remains as 0.004%. Based on the estimated mortality rate, the risk of undermining the conservation objectives is negligible.

Conservation objective (summary)	For the Project Alone	For the Project in combination with other plans and projects
of wigeon		
To restore the: • winter population trend, • winter spatial distribution, • disturbance at wintering site • barriers to connectivity and site use, • forage spatial distribution, extent and abundance, • roost spatial distribution and extent, and • supporting habitat: area and quality of golden plover	The Project could result in between 7.736 and 77.358 collisions per year. However, it should be noted that the collision risk estimate is likely to be hugely overestimated due to the presence of two exceptionally large flock moving through the area, which is thought to represent an outlier. The realised effects of collision within the Project are likely to be much lower, as evidenced by the low number of golden plover killed at European and Irish wind farms (Durr 2022).	Skrine Wind Farm: vantage point surveys were not conducted. Hence, collision risk modelling was not carried out. Leabeg Wind Farm: No golden plover recorded. Meenwaun Wind Farm: qualitative assessment determined very low – low impact. Derrinlough Wind Farm: and 14.191 collision per year were projected. Cloghan Wind Farm: collision risk not judged to be sufficient to warrant CRM. The in-combination collision risk for golden plover is between 21.927 and 91.549 collisions per year. In light of the most recent population estimate for the River Suck SPA, the predicted increase in annual mortality is between 7.30% and 30.50%. . Given the distances between the Project site and these wind farms there is no realistic potential for barrier effects that would have an adverse effect on the integrity of the SPA. Taking into consideration the large outlier flock and two avoidance rates, overall, the risk of having an adverse effect on site integrity is considered to be low – moderate.
To restore the: • winter population trend, • winter spatial distribution, • disturbance at wintering site • barriers to connectivity and site use, • forage spatial distribution, extent and abundance, • roost spatial distribution and extent, and	The Project could cause 4.977 collisions per year.	Skrine Wind Farm: vantage point surveys were not conducted. Hence, collision risk modelling was not carried out. Leabeg Wind Farm: No lapwing were recorded in flight Meenwaun Wind Farm: flight activity considered too low to warrant qualitative assessment. Derrinlough Wind Farm: 1.875 collisions per year

Conservation objective (summary)	For the Project Alone	For the Project in combination with other plans and projects
• supporting habitat: area and quality of lapwing		Cloghan Wind Farm: 0.71 collisions per year The in-combination collision risk for golden plover is 7.562. In light of the most recent population estimate (1,764) the predicted annual mortality remains as 1.45%. Based on the predicted mortality rate the risk of undermining the conservation objectives in low. Given the distances between the Project site and these wind farms there is no realistic potential for barrier effects that would have an adverse effect on the integrity of the SPA A pair of lapwing were recorded breeding within the Project site, and therefore breeding lapwing are at risk of disturbance/ displacement. Overall, in-combination the risk of undermining the conservation objectives is considered to be low.

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

4.6.1 Ridge Road, SW of Rapemills SAC

In the absence of mitigation, there is a low risk of having an adverse effect on the integrity of the Ridge Road, SW of Rapemills SAC as a result of the release of pollutants, such as dust and vehicle emissions, during the construction and/or decommissioning of the Project.

4.6.2 River Shannon Callows SAC

Without mitigation, overall there is a low risk of having an adverse effect on the integrity of the River Shannon Callows SAC during construction and/or decommissioning works as a result of the release of suspended solids and/or other water pollutants and spread of non-native invasive species.

Furthermore, construction/ decommissioning activities could result in disturbance and displacement of otter. There is a low risk having an adverse effect on the integrity of the River Shannon Callows SAC.

4.6.3 Lough Derg, North-east Shore SAC

In the absence of mitigation, there is a low risk of undermining the conservation objectives and therefore having an adverse effect on the integrity of the Lough Derg, North-east SAC during construction and/or decommissioning works as a result of the release of suspended solids and/or other water pollutants and spread of non-native invasive species.

4.6.4 Dovegrove Callows SPA, All Saints Bog SPA and River Little Brosna Callows SPA (Greenland white-fronted geese only)

Disturbance and/or displacement of Greenland white-fronted geese within Dovegrove Callows SPA may occur due to the construction of the grid connection in close proximity to the SPA. The flock of geese within Dovegrove Callows SPA has been recorded utilising habitat within All Saints Bog SPA and River Little Brosna Callows SPA. Overall, the risk of having an adverse effect on the integrity of these SPA's is considered to be low.

4.6.5 River Little Brosna Callows SPA

Collision with the turbines is considered to present a negligible risk of undermining the conservation objectives for whooper swan, wigeon, a low risk for teal, black-headed gull and lapwing, and a low – moderate risk for golden plover. There is negligible risk from barrier effects. Furthermore, the risk of disturbance/displacement to breeding lapwing is considered to have a low risk of undermining the conservation objectives. Therefore, without mitigation there could be an adverse effect on the integrity of the River Little Brosna Callows SPA.

4.6.6 Middle Shannon Callows SPA

Whooper swan, wigeon and black-headed gull have a low collision risk, and lapwing and golden plover have a low-moderate collision risk. There is negligible risks from barrier effects. Disturbance/ displacement of breeding lapwing is considered to present a low risk. Therefore in the absence of mitigation there could be an adverse effect on the integrity of the SPA.

Without mitigation, there is a low risk of undermining the conservation objectives and therefore having an adverse effect on the wetland habitat during construction and/or decommissioning works as a result of the release of suspended solids and/or other water pollutants.

4.6.7 Slieve Bloom Mountains SPA

Overall, hen harrier has a very low collision risk with imperceptible effects on the population, and therefore, without mitigation, there will be no adverse effect on site integrity.

4.6.8 Lough Derg (Shannon) SPA

Cormorant had a very low collision risk, and therefore there is a very low risk of having an adverse effect on site integrity, in the absence of mitigation.

Hydrological connectivity between the Project site and Lough Derg (Shannon) SPA, via the Rapemills River and River Shannon, provides a pathway for pollutants to enter the SPA and deteriorate the water quality of the wetland habitat. However, in the absence of mitigation, the risk is considered to be low and hence the conservation objectives will not be undermined.

4.6.9 River Suck Callows SPA

Wigeon has a negligible collision risk, whooper swan and lapwing have a low collision risk and golden plover has a low-moderate collision risk, and therefore, without mitigation, there will be no adverse effect on site integrity. There is negligible risk from barrier effects. Disturbance/ displacement of breeding lapwing is considered to present a low risk.

4.7 Step 4: Mitigation Measures

4.7.1 Construction

4.7.1.1 Site Drainage Plan, Surface Water Management Plan and Water Quality Monitoring Plan

Prior to the commencement of development, a detailed Site Drainage Plan and Surface Water Management Plan (SWMP) will be prepared to detail the siting and composition of the surface water management measures. The respective plans, which will form part of a detailed Construction Environmental Management Plan (CEMP), will be prepared prior to the commencement of development. The SWMP will incorporate the principles of Sustainable Drainage Systems (SuDS) through an arrangement of surface water drainage infrastructure.

The CEMP will also include a detailed Water Quality Monitoring Plan (WQMP) for the monitoring of surface waters in the vicinity of the construction site by a designated Environmental Manager. The monitoring programme will comprise field testing and laboratory analysis of a range of agreed parameters.

4.7.1.2 Buffer zone

A buffer distance of 50m will be imposed, between watercourses and any proposed infrastructure. Other than some sections of access tracks, watercourse crossings (4 no.), part of the crane hardstanding of turbine T7, the southern end of the main construction compound and the northern end of the spoil deposition area at turbine T5; the majority of the proposed wind farm infrastructure (including all turbine locations) is located outside of areas that have been assessed to be hydrologically sensitive. Additional mitigation in the form of double silt fencing will be placed around all infrastructure that encroaches the 50m buffer zone.

The hydrological buffer will create setback distances and ensure that the drainage mitigation/management measures (discussed below) can be installed up-gradient of primary drainage features within sub-catchments to facilitate appropriate, efficient and effective attenuation and treatment of surface water runoff.

4.7.1.3 Source, In-line and Treatment controls

Measures will be put in place to ensure that surface water features are protected from the release of silt or sediment and to ensure that all surface water runoff is fully treated and attenuated to avoid the discharge of dirty water.

Source controls to limit the likelihood for ‘dirty water’ to occur include:

- Interceptor drains, vee-drains, diversion drains, flume pipes, erosion and velocity control measures such as use of sand bags, oyster bags filled with clean washed gravel, filter fabrics, and other similar/equivalent or appropriate systems;
- Small working areas, covering stockpiles, weathering off stockpiles, cessation of works in certain areas due to, for instance, forecasted heavy rain (i.e. 20mm – 30mm rainfall in 6 hrs or less), or other similar/equivalent or appropriate measures.

In-Line controls to ensure appropriate management of silt laden water:

- Interceptor drains, vee-drains, oversized swales, erosion and velocity control measures such as check dams, sandbags, oyster bags, straw bales, flow limiters, weirs, baffles, silt bags, silt fences, sedimats, filter fabrics, and collection sumps, temporary sumps/attenuation lagoons, sediment traps, pumping systems, settlement ponds, temporary pumping chambers, or other similar/equivalent or appropriate systems.

Treatment systems to fully attenuate silt laden waters prior to discharge:

Temporary sumps and attenuation ponds, temporary storage lagoons, sediment traps, and settlement ponds, and proprietary settlement systems such as Siltbuster, and/or other similar/equivalent or appropriate systems. It should be noted that an extensive network of bog and forestry drains already exists, and these will be integrated and enhanced as required and used within the wind farm drainage system.

4.7.1.4 Clear Felling

Mitigation measures which will reduce the risk of entrainment of suspended solids and nutrient release in surface watercourses comprise best practice methods, as follows:

- Machine combinations (i.e. handheld or mechanical) will be chosen which are most suitable for ground conditions and which will minimise soils disturbance;
- Checking and maintenance of tracks and culverts will be ongoing through any felling operation. No tracking of vehicles through watercourses will occur. Where possible, existing drains will not be disturbed during felling works;
- Ditches which drain from the areas to be felled towards existing surface watercourses will be blocked, and temporary silt traps will be constructed. No direct discharge of such ditches to watercourses will occur. Drains and sediment traps will be installed during ground preparation. Collector drains will be excavated at an acute angle to the contour (~0.3%-3% gradient), to minimise flow velocities. Main drains to take the discharge from collector drains will include water drops and rock armour, as required, where there are steep gradients, and avoid being placed at right angles to the contour;
- Sediment traps will be sited in drains downstream of felling areas. Machine access will be maintained to enable the accumulated sediment to be excavated. Sediment will be carefully disposed of in the spoil disposal areas. All new silt traps will be constructed on even ground and not on sloping ground;
- In areas particularly sensitive to erosion or where felling inside the 50m buffer is required, it will be necessary to install double or triple sediment traps;
- All drainage channels will taper out before entering the 50m buffer zone. This ensures that discharged water gently fans out over the buffer zone before entering the aquatic zone, with sediment filtered out from the flow by ground vegetation within the zone. On erodible soils, silt traps will be installed at the end of the drainage channels, to the outside of the buffer zone;
- Drains and silt traps will be maintained throughout all felling works, ensuring that they are clear of sediment build-up and are not severely eroded. Correct drain alignment, spacing and depth will ensure that erosion and sediment build-up are minimized and controlled;
- Brash or bog mats will be used to support vehicles on soft ground, reducing topsoil and mineral soils erosion and avoiding the formation of rutted areas, in which surface water ponding can occur. Brash mat renewal will take place before they become heavily used and worn. Provision will be made for brash mats along all off-road routes, to protect the soil from compaction and rutting. Where there is risk of severe erosion occurring, extraction will be suspended during periods of high rainfall;
- Timber will be stacked in dry areas, and outside the 50m watercourse buffer. Straw bales and check dams will be emplaced on the down gradient side of timber storage/processing sites;
- Works will be carried out during periods of no, or low, rainfall in order to minimise entrainment of exposed sediment in surface water run-off;

- Checking and maintenance of roads/tracks and culverts will be ongoing through the felling operation;
- Refuelling or maintenance of machinery will not occur within 50m of a watercourse. Mobile bowser, drip kits, qualified personnel will be used where refuelling is required;
- A permit to refuel system will be adopted:
- Branches, logs or debris will not be allowed to build up in aquatic zones. All such material will be removed when harvesting operations have been completed, but care will be taken to avoid removing natural debris deflectors;
- Trees will be cut manually from along streams and using machinery to extract whole trees; and
- Travel will only be permitted perpendicular to and away from surface water features.

4.7.1.5 Weather

The works programme for the initial construction stage of the development will also take account of weather forecasts, and predicted rainfall in particular. Large excavations and movements of soil/subsoil or vegetation stripping will be suspended or scaled back if prolonged or intense rain is forecast. The extent to which works will be scaled back or suspended will relate directly to the amount of rainfall forecast.

The construction of the site drainage system will be carried out, at the respective locations, prior to other activities being commenced. The construction of the drainage system will only be carried out during periods of, where possible, no rainfall, therefore avoiding runoff.

4.7.1.6 Hydrocarbons

Mitigation measures proposed to avoid release of hydrocarbons at the site are as follows:

- The volume of fuels or oils stored on site will be minimised. All fuel and oil will be stored in an appropriately bunded area within the temporary construction compound. Only an appropriate volume of fuel will be stored at any given time. The bunded area will be roofed to avoid the ingress of rainfall and will be fitted with a storm drainage system and an appropriate oil interceptor;
- All bunded areas will have 110% capacity of the volume to be stored;
- On site refuelling of machinery will be carried out using a mobile double skinned fuel bowser. The fuel bowser, a double-axel custom-built refuelling trailer will be re-filled at the temporary compound and will be towed around the site by a 4x4 jeep to where plant and machinery is located. No refuelling will be permitted at works locations within the 50m hydrological buffer. The 4x4 jeep will also be fully stocked with fuel absorbent material and pads in the event of any accidental spillages. The fuel bowser will be parked on a level area in the construction compound when not in use and only designated trained and competent operatives will be authorised to refuel plant on site. Mobile measures such as drip trays and fuel absorbent mats will be used during all refuelling operations to avoid any accidental leakages;
- All plant and machinery used during construction will be regularly inspected for leaks and fitness for purpose;
- Spill kits will be readily available to deal with and accidental spillages;
- All waste tar material arising from road cuttings (from trenching or other works in public roads) will be removed off-site and taken to a licensed waste facility; and

- An outline emergency plan for the construction phase to deal with accidental spillages will be contained within the CEMP.

4.7.1.7 Wastewater

Measures to avoid contamination of ground and surface waters by wastewaters will comprise:

- Self-contained port-a-loos (chemical toilets) with an integrated waste holding tank will be installed at the site compound, maintained by the providing contractor, and removed from site on completion of the construction works;
- Water supply for the site office and other sanitation will be brought to site and removed after use to be discharged at a suitable off-site treatment location; and,
- No water will be sourced on the site, nor will any wastewater be discharged to the site.

4.7.1.8 Cement

The following mitigation measures are proposed to ensure that the release of cement-based products is avoided:

- No batching of wet-cement products will occur on site. Ready-mixed concrete will be brought to site as required and, where possible, emplacement of pre-cast products will be utilised;
- All watercourse crossings will utilise pre-cast products and the use of wet-cement products within the hydrological buffer will be avoided;
- Where concrete is delivered on site, only the chute will be cleaned, using the smallest volume of water practicable. Chute cleaning will be undertaken at lined cement washout ponds with waters being stored in the temporary construction compound, removed off site and disposed of at an approved licensed facility. No discharge of cement contaminated waters to the construction phase drainage system or directly to any artificial drain or watercourse will be allowed;
- Weather forecasting will be used to ensure that prolonged or intense rainfall is not predicted during concrete pouring activities; and,
- The concrete pour site will be kept free of standing water and plastic covers will be ready in case of sudden rainfall event.

4.7.1.9 Bird monitoring

To avoid widespread disturbance to birds, access will be restricted to the footprint of the proposed works corridor.

The following will be implemented to reduce the possibility of damage and destruction (and disturbance to sensitive species) to occupied bird nests:

- clearance of woodlands and uncultivated vegetation i.e. trees and hedgerows (including vegetation removal for creation/maintenance of bat mitigation buffers), will be undertaken outside the main breeding season from March to September inclusive;
- if other site clearance and construction activities are required to take place during the main breeding bird season, pre-commencement survey work will be undertaken to ensure that nest destruction and disturbance is avoided;
- once vegetation has been removed from the works corridor, these areas will be retained in a condition that limits suitability for nesting birds for the remainder of the construction phase e.g. cover for ground nesting species will be made unsuitable for cutting vegetation or tracking over with an excavator; and

- a suitably experienced Ecologist will be employed for the duration of the construction period to make contractors aware of the ornithological sensitivities of the Project and to undertake surveys for nesting birds throughout the construction period, enforcing exclusion areas as required.

Construction of the grid connection will not be undertaken during the winter season to ensure that disturbance / displacement of Greenland white-fronted goose is avoided.

Based on current best-practice guidelines (SNH, 2009), a targeted range of flight activity surveys and collision monitoring (carcass searching) will be undertaken during the breeding and non-breeding seasons in years 1, 2 and 3 post construction, to monitor the rate of avian turbine collisions and identify any significant unforeseen adverse effects. Thereafter, if the rate of turbine strikes is as low as predicted by the CRM (which is highly precautionary), the monitoring should no longer be required. If monitoring indicates potentially significant levels of collision mortality for SCI birds, potential mitigation measures will be developed and implemented (including turbine curtailment), and further monitoring will also be identified, to ensure there are no significant effects on any SCI birds. Proposed mitigation and monitoring measures will be agreed with the planning authority prior to implementation.

In addition, turbine curtailment for birds may be implemented depending on the results of the proposed monitoring programme.

- Curtailment will be implemented via a system of adaptive management. Thus, if bird carcasses are recorded during post-construction monitoring, curtailment will be implemented where appropriate during ‘at-risk’ time periods and as discussed and agreed with NPWS.

4.7.1.10 Otters

A pre-construction walkover survey of the project will be undertaken. This will search for otter holts/couches, which could change over time. If any are identified, then appropriate exclusion zone(s) will be implemented and construction activities timed to avoid sensitive periods, such as the breeding season.

The following will be implemented to reduce the possibility of direct and indirect effects on otters:

- limiting constructions works to daylight hours;
- providing exit points for any excavations (e.g. escape planks or spoil runs) so otters do not become trapped; and
- a suitably qualified Ecologist will be employed for the duration of the construction period to make contractors aware of the otter sensitivities of the project and to undertake surveys for breeding or resting otters throughout the construction period, enforcing exclusion areas (150 m) as required. If in the unlikely event that exclusion zones cannot be implemented, advice will be sought from NPWS, and appropriate mitigation and compensation measures will be put in place and an application will be made to NPWS for a derogation licence if required.

4.7.2 Decommissioning

As in the construction phase, temporary surface runoff control measures will again be put in place during decommissioning works. The drainage system will remain operational during the decommissioning phase and will serve to treat any sediment laden surface water run-off due to a renewed disturbance of soils. Following decommissioning, re-vegetation will be implemented as soon as practicable and monitored to ensure vegetation is established.

5.0 Conclusion

This NIS contains information which the competent authority may consider in making its own 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. The potential impacts that could arise from the Project during the construction, operational and decommissioning phases are set out in this report and a proposed mitigation scheme for the construction, operational and decommissioning phases is described with all mitigation measures being implemented in full.

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.

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Making Sustainability Happen

Appendix A Figures

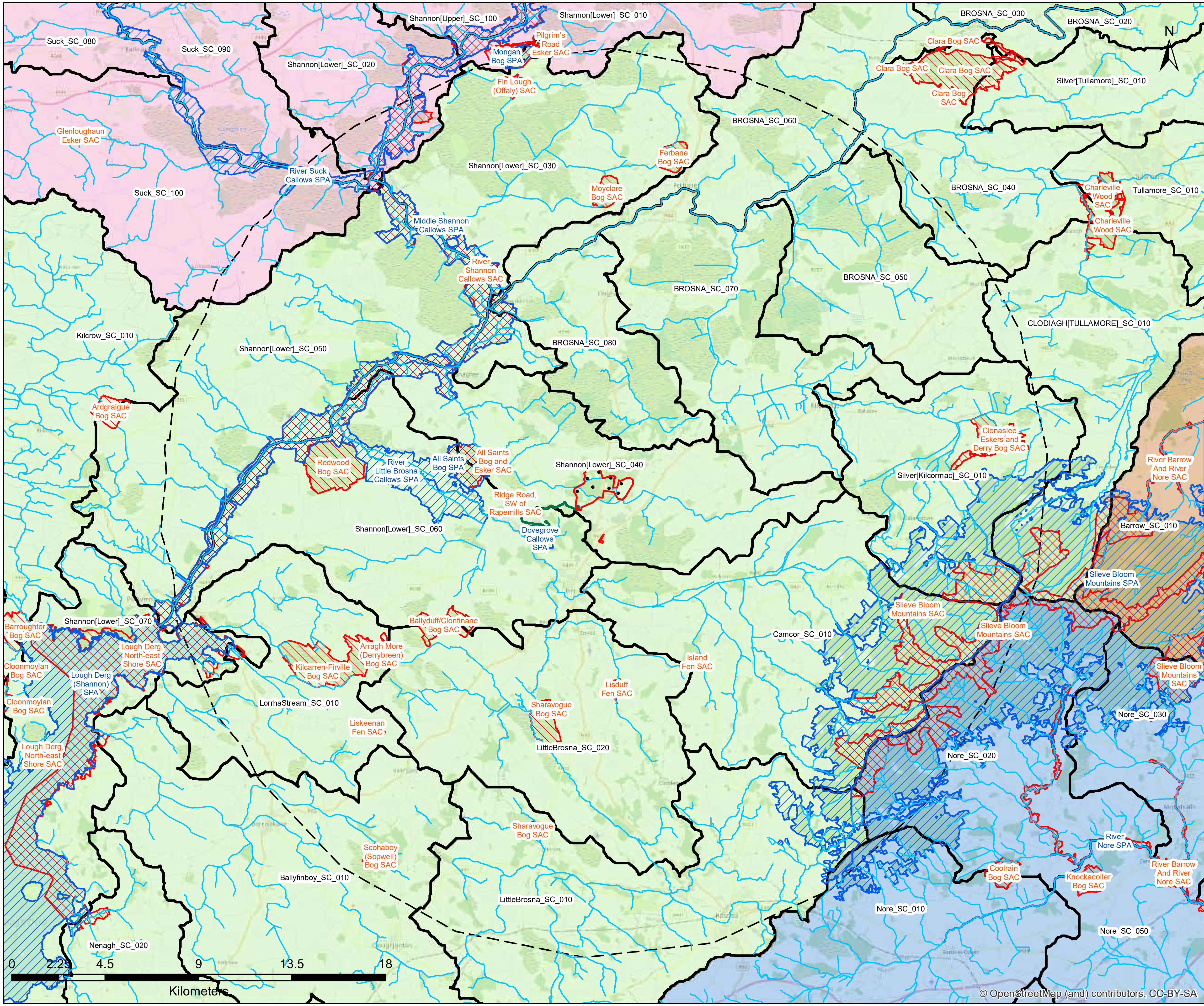
Natura Impact Statement

Cush Wind Farm

Cush Wind Limited

SLR Project No.: 501.00581.00005

17 December 2023



LEGEND

- Proposed Project Site Boundary
- Grid Connection Route
- Proposed Turbine Layout
- Watercourses
- Special Protection Area (SPA)
- Special Area of Conservation (SAC)
- Proposed Project Site Boundary and Grid Connection 20km Buffer
- Sub-Catchment (Labelled with Sub-Catchment Name)

Catchments

- Barrow
- Lower Shannon
- Nore
- Upper Shannon

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CUSH WIND FARM

NIS

CATCHMENTS AND NATURA 2000 SITES WITHIN 20KM OF THE PROPOSED PROJECT SITE STUDY AREA

FIGURE 1

Scale	Date
1:174,000 @ A3	NOVEMBER 2023

Appendix B   Bird Survey Reports

Natura Impact Statement

Cush Wind Farm

Cush Wind Limited

SLR Project No.: 501.00581.00005

17 December 2023

BIRD SURVEY REPORT

BREEDING SEASON 2020

Cush Wind Farm

Prepared for: Galetech Energy Developments

SLR Ref: 501.00495.00012
Version No: Final
April 2021

BASIS OF REPORT

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APPENDICES

Appendix I: Survey Dates, Times and Observers

Appendix II: Weather Data

Appendix III: Flight Activity Survey Data

1.0 Introduction

SLR Consulting Ireland (SLR) was commissioned by Galetech Energy Developments in April 2020 to carry out a breeding bird survey programme for a proposed wind farm site at Cush, Co. Offaly during the breeding season in 2020.

1.1 Site Description and Project Background

The proposed wind farm development site is located in the townland of Cush approximately 4 km north of Birr, Co. Offaly. The habitats within the proposed development site include conifer plantations of varying age classes, cutaway bog and agricultural grasslands (Figure 1).

There are two first order streams (West Galros and Elish), and one second order stream (Rapemills), which flow through the proposed site. The West Galros Stream and the Eglish Stream both rise in the eastern section of the proposed site and both are tributaries of the Rapemills Stream. The West Galros flows in a westerly direction through the northern section of the site for 2.5km to its confluence with the Rapemills Stream, while the Eglish flows in a south-westerly direction for 1.1km to meet the Rapemills Stream. The Rapemills Stream flows along the southern boundary of the proposed site in a west / northwest direction increasing in size to a third order river before it enters the Middle Shannon Callows SPA (Site Code: 004096), approximately 8.8km downstream. The Rapemills River travels for a further 1.7km to enter the River Shannon at the town of Banagher, approximately 10.5km downstream of the proposed site.

The proposed Cush Wind Farm site includes a linear area that was previously surveyed for a proposed overhead line (SLR, 2018). Flight activity surveys were carried out at two vantage point locations along the proposed overhead line route corridor during breeding season 2018.

1.2 Scope of Work

The scope of work addressed in this baseline ornithology report is as follows:

- Breeding Bird Surveys – 2020 season which includes:
    - Vantage Point (VP) Watches at 2 VP locations.
    - Breeding Wader Surveys.
    - Breeding Raptor Searches (2 km).
- Maps of flight-lines and other relevant bird data prepared using GIS.

1.3 Purpose of the Report

The aim of this report is to provide robust baseline ornithological survey data for the breeding period 2020 at the proposed wind farm at Cush, Co. Offaly. These data will be used to inform the ecological impact assessment and appropriate assessment for the proposed wind farm. The assessment of potential impacts is beyond the scope of this report.

2.0 Methods

2.1 Desk-Based Review

The desk review collated any available information to date on the breeding bird movements around the proposed wind farm development site.

As previously mentioned in Section 1.1, flight activity surveys were undertaken during the breeding season of 2018 from two vantage points overlooking an overhead power line route which was proposed to pass through the proposed Cush Wind Farm site. The following report resulting from that bird survey was reviewed:

- SLR (2018) Cloghan Wind Farm and Long Oak Wind Farm Breeding Bird Survey Report 2018. Prepared for Galetech Energy Services Ltd.

The websites of the National Parks and Wildlife Service (NPWS) www.npws.ie and the National Biodiversity Data Centre (NBDC) http://maps.biodiversityireland.ie/#/Map were accessed for information on sites designated for nature conservation.

2.2 Field Surveys

The scope of breeding bird surveys for the proposed wind farm, as set out in Section 1.2, is based on recommendations given in NatureScot (formerly Scottish Natural Heritage (SNH)) 2017[1]. This survey methods guidance is recognised as standard best practice guidance through the UK and Ireland for surveying birds to inform impact assessment of onshore wind farms.

2.2.1 Field Survey Team: Evidence of Technical Competence and Experience

Sarah Ingham (SI) BSc (Hons) MSc ACIEEM – Project Manager and Lead Ornithologist

Sarah Ingham is currently a Senior Ecologist with SLR Consulting (Ireland) and holds a BSc in Zoology from Anglia Ruskin University, Cambridge, UK and an MSc in Biodiversity and Conservation from Trinity College Dublin. She is an Associate member of the Chartered Institute of Ecology and Environmental Management (CIEEM). Sarah is a highly skilled and experienced bird surveyor with 11 years' post graduate experience as a professional consultant ecologist/ornithologist. She has extensive experience as a Project Manager/Ecology Lead on many wind farm developments throughout Ireland. Her role also involves advising the clients on best practice regarding the protection of ecological receptors during the construction activities, particularly wind farm construction.

Sarah managed this project through liaison with the client, coordination of the survey team, supervision of the health and safety of the team, carrying out various bird surveys onsite throughout the survey season, collating, quality controlling and assessing the survey data and writing this report.

Jason Cahill (JC) BSc (Hons) – Bird Surveyor

Jason joined SLR in February 2020 as a Graduate Ecologist. Jason holds a BSc (Hons) in Field Biology with Wildlife Tourism from Institute of Technology Tralee. He has gained experience in various methods of bird surveys, including vantage point and transect surveys, and is also involved in data input and the drafting of bird survey reports.
Supervised by Sarah Ingham, Jason carried out the majority of the bird surveys at Cush Wind Farm during the 2020 bird breeding season.

[1] SNH (2017) *Recommended bird survey methods to inform impact assessment of onshore wind farms*. Version 2.

Daniel Hulmes (DH) – Bird Surveyor

Daniel is a Senior Field Ornithologist and Terrestrial Ecologist. He has worked on a wide range of projects involving the survey and monitoring of birds in the UK, Ireland and internationally. Furthermore, as part of his previous work as an Ecologist, he gained experiencing in managing projects which included a large amount of report writing, survey planning and client interaction.

Supervised by Sarah Ingham, Daniel assisted with breeding bird surveys at Cush Wind Farm in June 2020.

2.2.2 Flight Activity Surveys

A total of two vantage point (VP) locations were identified during a desk-based viewshed analysis using a bespoke GIS tool for calculating the visible area from each VP. The Zones of Theoretical Visibility (ZTV) from each VP were calculated using ArcMAP 10.5.1 Spatial Analyst. The ZTVs were calculated with a surface offset of 30m and from a viewing height of 1.8m above ground level. The terrain model was derived from EU-DEM data with a vertical accuracy of ± 7m. The adequacy of these VPs was checked through a ground-truthing site visit prior to the commencement of breeding bird surveys in May 2020 to ensure that they were appropriate for collecting flight activity data during surveys. VP locations and 2km viewing arcs are shown in Figure 1 and VP viewsheds are shown in Figure 2.

Ideally, breeding bird flight activity surveys should be undertaken monthly from April - September inclusive in line with the bird breeding season. However, due to the onset of Covid 19 travel restrictions across Ireland in March 2020, surveys in April were postponed until May. A total of 36 hours of watches were undertaken at each of the two VP locations during the breeding season (monthly visits May - September inclusive). This equates to a total of six hours per VP per month, with the exception of nine hours at VP1 in May and July and 12 hours at VP2 in May. The VP survey effort undertaken during the breeding season of 2020 is outlined below in Table 2-1.

Table 2-1: Flight activity survey effort undertaken at the proposed Cush Wind Farm site from May to September 2020 (hrs:mins).

Month	VP1	VP2
May	9:00	12:00
June	6:00	6:00
July	9:00	6:00
August	6:00	6:00
September	6:00	6:00
Total hrs	36:00	36:00
VP ITM Coordinates (**Figure 1**)	664276 E 644585 N	661361 N 646428 N

It is good practice to ensure that where possible each monthly six-hour survey period should be split over more than a single day and spread across the day. As such, the six-hour survey periods were divided into three-hour blocks, the times of which were alternated across consecutive days e.g., on day 1, VP1 would be completed in the morning and VP2 would be completed in the afternoon and on day 2, VP2 would be completed in the morning and VP1 in the afternoon. In this way, it was possible to glean a clear picture of bird movements from each VP across the diurnal period.

It is recommended that there should be suitable breaks of at least 30 minutes between watches to minimise observer fatigue (SNH, 2017). Watches can be suspended and then resumed to take account of changes in visibility, e.g., fluctuations in the cloud base, passing rain shower or for the observer to rest. At SLR, we recommend that a combination of more than six hours VP watches should not be carried out by the same observer(s) over the course of a single 24-hour period.

Details of survey dates, times and observers are provided in Appendix I and a record of weather conditions during surveys is provided in Appendix II.

VP surveys aimed to quantify the flight activity of primary and secondary target species (as defined in Section 2.2.2.1) 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;
- Number of birds observed;
- 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 based on turbine specifications allowing for the maximum rotor tip height of 150m and the lowest rotor swept height of 50m. Flight heights were therefore attributed to four distinct height bands as follows:

- 1 = < 25m (below the likely rotor swept area);
- 2 = 25m to 50m (below the likely rotor swept area);
- 3 = 50m to 150m (within the rotor swept area);
- 4 = > 150m (above the likely rotor swept area).

In addition, a summary of observations of secondary target species (see Section 2.2.2.1) 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 site, in accordance with current SNH guidance. Data collected on secondary species included:

- The five-minute period start and end time;
- Species;
- Number of birds observed;
- If flying, the height band in which birds were observed flying;
- Whether birds were observed on site, in the 500m buffer or beyond;
- Flight behaviour; and
- Notes on observation.

2.2.2.1 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 SNH Guidance (2017).

Primary Target Species

The list of primary target species was limited to species upon which effects are most likely to be potentially significant in EIA terms, thereby enabling recording to focus on the species of greatest importance.

Primary target species were specifically limited to species upon which effects are most likely to be potentially significant in EIA terms, e.g., breeding species forming qualifying features for nearby SPAs or species listed on Annex I of the Birds Directive. 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 for these VP surveys included the following bird species:

- all Annex 1 raptor/owl species;
- lapwing *Vanellus vanellus;*
- golden plover *Pluvialis apricaria;*
- curlew *Numenius arquata;*
- black-headed gull *Chroicocephalus ridibundus*; and
- herring gull *Larus argentatus.*

Although lapwing, curlew, black-headed gull and herring gull are not listed under Annex I of the Birds Directive, the breeding populations of these species are Red-listed in Ireland under the Birds of Conservation Concern 2014-2019 (Colhoun and Cummins, 2013) as numbers of breeding pairs within the Irish landscape have suffered a serious decline in recent years. As these species are the only Red listed species likely to occur in this area which are potentially vulnerable to impacts, any observations of these four species were also recorded as primary target species during the summer months.

Secondary Target Species

Local circumstances may indicate that survey information should also be acquired on other species, especially those of regional conservation concern (SNH, 2017). Such species are termed secondary target species. Recording of secondary species is subsidiary to recording of primary target species.

Secondary target species included:

- Any other wildfowl, wader and gull species;
- Buzzard *Buteo buteo;*
- Sparrowhawk *Accipiter nisus*;
- Kestrel *Falco tinnunculus;*
- Raven *Corvus corax*;
- Grey heron *Ardea cinerea;* and
- Cormorant *Phalacrocorax carbo.*

2.2.3 Breeding Wader Surveys

Breeding wader surveys followed the lowland wet grassland survey methodology described in O'Brien and Smith (1992). The survey involved a walked transect to which covered all habitat potentially suitable for breeding waders within the wind farm site. The same transect was surveyed three times across the 2020 breeding season on 5 May, 29 May and 26 June.

As shown in Figure 4, there are large plantations of mature conifer forestry in the central, western, and southern areas of the site. These habitats not suitable for breeding waders and so were excluded from the survey. In addition, some fields adjacent to the forestry plantations were dominated by areas of cutover bog which are not suitable habitats for breeding waders and were also excluded from the survey. As such, transects were undertaken in the western, eastern and northern sections of the site where semi-natural and wet grassland fields are present, habitats which are more attractive for breeding waders.

The location, movement and behaviour of all wader species were to be recorded onto field maps using standard BTO species codes. The following criteria was to be recorded for each species:

- Lapwing – the total numbers of birds seen from the transect;
- 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/two), displaying birds, nests or broods and other single birds not in flocks).

Please see Figure 4 for an outline of the walked transect routes and Appendices I and II for metadata relating to these surveys.

2.2.4 Breeding Raptor Surveys

The survey methodology for breeding raptors used a driven transect with regular stops, to carry out watches of suitable habitat from appropriate viewpoints to identify potential nesting territories. A total of two stops were made along the driven transect around both wind farm sites overlooking potentially suitable breeding habitat. The outline of the driven survey route and associated viewpoints and the results of the surveys are presented in Figure 4.

A driven survey was used due to limitations to access to third party land within the 2 km buffer zone and the availability of a good road network in the vicinity of the site. It is also noted that suitable breeding habitat for Annex I raptors within the sites and 2 km buffer is very limited and visibility from the survey route was sufficient to cover the vast majority of potentially suitable breeding habitat within the survey area.

Suitable breeding habitat differs for each raptor species (Hardey *et al*., 2013) and was limited within the survey area. Table 2-2 provides a summary of the potentially suitable raptor habitats within the 2km buffer zone of the sites and the approximate locations of these in relation to the viewpoints used during the survey.

Table 2-2: Potentially suitable habitats for breeding raptors within the study area, the viewpoints the habitats can be seen from and the target raptor species which could be expected within these habitats

Raptor Viewpoint No. (RVP)	Habitat type	Target raptor species
RVP1	Mature forestry plantation, mixed deciduous woodland, wet grassland with dense rush and bracken cover and a quarry.	Buzzard, sparrowhawk, kestrel, hen harrier and peregrine falcon
RVP2	Quarry ([redacted])	Peregrine falcon and kestrel

Survey timings followed those in Hardey *et al*. (2013), as per SNH guidelines. This survey was repeated along the same routes on 5 May, 29 May, 26 June and 8 July. Please see Appendices I and II for metadata relating to these surveys.

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

2.3 Survey Limitations

Most of the flight activity surveys were undertaken in optimal weather conditions with nine hours out of the total of 72 during which the visibility was recorded as moderate i.e., 1-3km. This comprises 12.5% of the total survey season and in most cases all of the relevant 2km viewing arc was visible. As such, this does not significantly affect the validity of the data collected.

Due to the onset of Covid 19 travel restrictions across Ireland in March 2020, surveys in April were postponed until May. Given that extra hours of survey effort were undertaken at each vantage point and two breeding wader and raptor surveys were also undertaken in May, it is deemed that the conclusions of the study have not been affected.

3.0 Results

3.1 Desk-Based Review

The proposed wind farm site is not within or immediately adjacent to any Special Protection Area (SPA). However, there are a total of five SPAs within a 15km radius of the proposed development site.

The five SPAs within 15km are shown in Table 3-1, which also shows the species of special conservation interest (SSCI) for each site. The majority of SSCIs for which these sites are designated are wintering species. As such, for the purposes of this report**,** which deals specifically with breeding birds, SSCI which are only present during the wintering season have been excluded from Table 3-1.

The two closest SPAs to the proposed development site are Dovegrove Callows SPA (Site Code: 004137) and All Saints Bog SPA (Site Code: 004103) at distances of 1.9km and 3.1km, respectively. Both of these sites are designated for the protection of Greenland white-fronted geese *Anser albifrons flavirostris* and as such, are not relevant to this breeding season report. River Little Brosna Callows SPA (Site Code: 004086) is located 4.1km to the west and is designated for a number of breeding wildfowl species.

Corncrake *Crex crex* is a SSCI of the Middle Shannon Callows SPA. Upon their arrival to suitable breeding habitat in Ireland following migration from sub-Saharan Africa, corncrake, a site faithful species, then become sedentary, rarely if ever, moving from the habitat they have chosen for breeding once they find a mate (Duffy, 2018). As such, given that the Middle Shannon Callows SPA is at a distance of 7.2km from the proposed wind farm site, dedicated corncrake surveys were not deemed necessary. There is also a lack of suitable habitat for corncrake (hay meadows) within the proposed wind farm site.

Hen Harrier *Circus cyaneus* is the sole SSCI of the Slieve Bloom Mountains SPA (Site Code: 004160). Typically, male hen harriers travel up to 9km from nests but have a home-range size that averages only 8 km^2, while the average home-range size for females is 4.5 km^2 (Arroyo *et al*., 2014). As such, given the distance of 12km between the SPA and the proposed development site, it is unlikely that the proposed site will be used as a hunting ground by the Slieve Bloom Mountains SPA hen harrier population.

Table 3-1: SPAs within 15km of the proposed Cush Wind Farm site and their qualifying interests (species present during the breeding season only)

Site Name	Site Code	Distance/ Direction from Site Boundary	Species of Special Conservation Interest
Dovegrove Callows SPA	004137	1.9km south-west	• Wetland and Waterbirds
All Saints Bog SPA	004103	3.1km west	• Wetland and Waterbirds
River Little Brosna Callows SPA	004086	4.1km west	• Wigeon *Anas penelope* • Teal *Anas crecca* • Pintail *Anas acuta* • Shoveler *Anas clypeata* • Lapwing *Vanellus vanellus* • Black-tailed Godwit *Limosa limosa* • Black-headed Gull *Chroicocephalus ridibundus* • Wetland and Waterbirds

Site Name	Site Code	Distance/ Direction from Site Boundary	Species of Special Conservation Interest
Middle Shannon Callows SPA	004096	7.2km north west	• Corncrake *Crex crex* • Lapwing *Vanellus vanellus* • Black-tailed Godwit *Limosa limosa* • Black-headed Gull *Chroicocephalus ridibundus* • Wetland and Waterbirds
Slieve Bloom Mountains SPA	004160	12km east	• Hen Harrier *Circus cyaneus*

3.2 Field Surveys

3.2.1 Flight Activity Surveys

3.2.1.1 Primary Target Species

Flight lines of primary target species recorded at during the 2020 breeding season are mapped in Figures 3.

Lapwing was the only primary target species recorded during the flight activity surveys at the proposed Cush Wind Farm site throughout the 2020 breeding season. There were two sightings of this species which occurred during a single survey period in July and were observed 16 minutes apart. As such, it is possible that these were two sightings of the same individual. Both sightings were observed within the 500m buffer zone and below the likely rotor swept area.

3.2.1.2 Secondary Target Species

A total of five secondary target species were recorded during the flight activity surveys at the proposed Cush Wind Farm site throughout the 2020 breeding season. Summary details of these are presented in Table 3-2.

Buzzard was the most frequently recorded secondary target species with 42 observations (n=52). Approximately 75% of buzzards recorded were flying either above or below the likely rotor swept area in height bands 1, 2 or 4. During the June surveys at VP1, there were five sightings in a single survey period of a buzzard entering and leaving an area of mixed deciduous woodland within the 500m buffer zone of the site. There is a possibility that this may have been a nest site, however, as there was no definitive evidence of breeding observed during these sightings, such as carrying prey or courtship display, breeding could not be confirmed.

Raven was the second most frequently recorded secondary species with 12 observations (n=13). A total of eight of the 13 birds observed were recorded flying within the likely rotor swept area.

The only other raptor species recorded during flight activity surveys was kestrel, of which there were five observations of single individuals. Three of these individuals were observed flying within the likely rotor swept area and two observed below.

Lesser black-backed gull *Larus fuscus* was the only species of gull recorded on site, with a single observation of two individuals flying above the likely rotor swept height.

There were two observations of jay *Garrulus glandarius* recorded during the same survey period passing through the site below the likely rotor swept height.

Table 3-2: Secondary target species and flights recorded at the proposed Cush Wind Farm site – May to September 2020

Target Species	Total number of birds recorded	Total number of flights recorded
Buzzard	52	42
Kestrel	5	5
Raven	13	12
Jay	2	2
Lesser black-backed gull	2	1
Total	**74**	**62**

3.2.2 Breeding Wader Surveys

There were no waders recorded during the targeted breeding wader surveys throughout the breeding season.

3.2.3 Breeding Raptor Surveys

There was one species of raptor were recorded during the targeted breeding raptor surveys, namely buzzard, of which there was one sighting across the four surveys during the season.

The survey undertaken in early May (in place of the postposed April survey) yielded a sighting a single buzzard, flying north-westerly direction in the south-western section of the site.

As mentioned previously in Section 3.2.1, there was an observation of a possible buzzard breeding territory which was observed during the flight activity surveys. However, as definitive evidence of breeding behaviour was not observed, breeding could not be confirmed.

There were no further observations of any raptor species during the May, June or July surveys. Please see Figure 5 for transect route and locations of recorded sightings.

4.0 Summary and Conclusions

The aim of this report is to provide robust baseline ornithological survey data for the 2020 breeding season at the proposed wind farm site at Cush, Co. Offaly. These data will be used to inform the ecological impact assessment and appropriate assessment for the proposed wind farm. The assessment of potential effects of the proposed wind farm is beyond the scope of this report.

The proposed Cush Wind Farm site is set within a landscape of lowland intensive agriculture. Habitats onsite are a mosaic of improved agricultural grassland fields, cutover bog and mature conifer forestry plantation. There are two small streams in the vicinity of the proposed site (the West Galros and the Eglish), both of which rise in the east of the proposed site and flow in a westerly direction. These two streams are tributaries of a third stream, Rapemills Stream, which flows along the southern extents of the development site. The Rapemills Steam becomes the Rapemills River and flows in a north-westerly direction for approximately 10km meeting the River Shannon in the town of Banagher, Co. Offaly.

The proposed development site is not situated within any area designated for nature conservation, however, there are five SPAs within a 15km radius of the proposed site. The key species associated with these SPAs during the breeding season are corncrake, lapwing, black-tailed godwit, black-headed gull, wigeon, teal, pintail, shoveler and hen harrier.

The breeding bird survey methods employed during the 2020 survey season are based on recommendations given in NatureScot (formerly Scottish Natural Heritage (SNH)) 2017. This survey methods guidance is recognised as standard best practice guidance through the UK and Ireland for surveying birds to inform impact assessment of onshore wind farms. Breeding season surveys usually begin in April, however, due to the onset of Covid 19 restrictions in late March 2020, the April surveys were postponed until May. To account for this postponement, the survey effort in May was doubled at VP2 and an extra three hours were undertaken at VP1 in May and July. Surveys then ran until September.

There were three survey types undertaken on and around the proposed development site, namely flight activity, targeted breeding wader, and targeted breeding raptor. Flight activity surveys were undertaken from two vantage points overlooking the site. These vantage points were visited for six hours per month, with the exception, as mentioned above, of the extra survey hours undertaken in May and July. This resulted in a total survey effort of 36 hours per vantage point throughout the season.

Breeding wader surveys followed methodology described in O'Brien and Smith (1992). The survey involved a walked transect which covered all habitat potentially suitable for breeding waders within the wind farm site. The same transect was repeated three times across the 2020 breeding season, twice in May and once in June.

Breeding raptor surveys were repeated four times across the season, twice in May, once in June and once in July. The survey methodology for breeding raptors used a driven transect with regular stops, to carry out watches of suitable habitat from appropriate viewpoints to identify potential nesting territories. A total of two stops were made along the driven transect around the wind farm site overlooking potentially suitable breeding habitat.

This is the first season of bird surveys to be undertaken at this green-field site for this proposed project. However, flight activity surveys were undertaken during the breeding season of 2018 from two vantage points overlooking an overhead power line route which was proposed to pass through the proposed Cush Wind Farm site.

Results of flight activity surveys yielded two records of a single primary target species at the proposed Cush Wind Farm site during the breeding season 2020, namely lapwing. Both sightings of lapwing were recorded during the same survey period in July flying within the 500m buffer below the likely rotor swept area.

A total of five secondary target species were recorded during flight activity surveys, namely buzzard, kestrel, raven, jay, and lesser black-backed gull. Buzzard was the most frequently observed secondary target species (n = 52) followed by raven (n = 13). The majority of buzzard flights were recorded outside the likely rotor swept area. The only other raptor species recorded during flight activity surveys was kestrel, of which there were five observations of single individuals. Three of these individuals were observed flying within the likely rotor swept area and two observed below. Lesser black-backed gull and jay were recorded once and twice respectively, with none recorded within the likely rotor swept area.

The targeted breeding wader and raptor surveys yielded similarly low observation rates throughout the season, with no waders recorded during the breeding wader surveys and a single buzzard recorded during the breeding raptor surveys in May. There were no observations of raptors during this survey type in June and July. There was no evidence of confirmed breeding raptors observed throughout the season. However, during flight activity surveys in June, a possible nest site was observed in the east of the site (see Figure 5).

These results are comparable with the results of surveys carried out in the vicinity of the proposed wind farm site during the breeding season of 2018, with lapwing recorded twice in both years. Although there are some differences also. In 2018, three raptor species (buzzard, kestrel, sparrowhawk) and two species of wader (lapwing, snipe) were observed. Numbers of buzzard recorded in 2018 (n=25) were half of those recorded in 2020 (n=52), whilst over three times the number of kestrel were recorded in 2018 (n=16) compared with 2020 (n=5). Sparrowhawk and snipe were not recorded in 2020.

In conclusion, the results of this study show that there are no regular flight paths of bird species of special conservation interest or conservation concern within the site proposed for the Cush Wind Farm development. That said, this is the first of two breeding season surveys to be carried out at the proposed wind farm site. As such, further surveys which will be carried out during the 2021 breeding season, will provide a more robust baseline representation of site usage by bird species.

5.0 References

Arroyo, B., Leckie, F., Amar, A., McCluskie, A and Redpath, S. (2014) *Ranging behaviour of Hen Harriers breeding in Special Protection Areas in Scotland*. Bird Study 61: 1 – 8

Colhoun, K. and Cummins, S (2013) *Birds of Conservation Concern in Ireland 2014–2019*. Irish Birds 9: 523-544

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

Scottish Natural Heritage (2017) *Recommended bird survey methods to inform impact assessment of onshore wind farms. Version 2.* SNH Guidance. NatureScot, Battleby

SLR (2018) *Cloghan Wind Farm and Long Oak Wind Farm Breeding Bird Survey Report 2018*. Prepared for Galetech Energy Services Ltd.

6.0 Figures

Figure 1: Cush Wind Farm Breeding Season 2020 Bird Report – Vantage Points and Viewing Arcs
Figure 2: Cush Wind Farm Breeding Season 2020 Bird Report – Viewshed Analysis
Figure 3: Cush Wind Farm Breeding Season 2020 Bird Report – Lapwing Flight Lines
Figure 4: Cush Wind Farm Breeding Season 2020 Bird Report – Breeding Wader Transect Route and Survey Results
Figure 5: Cush Wind Farm Breeding Season 2020 Bird Report – Breeding Raptor Transect Route and Survey Results

LEGEND

- Site Infrastructure
- Turbines
- Site Infrastructure 500m Buffer
- Vantage Point
- Vantage Point Viewing

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BREEDING SEASONS 2020
BIRD SURVEY REPORT

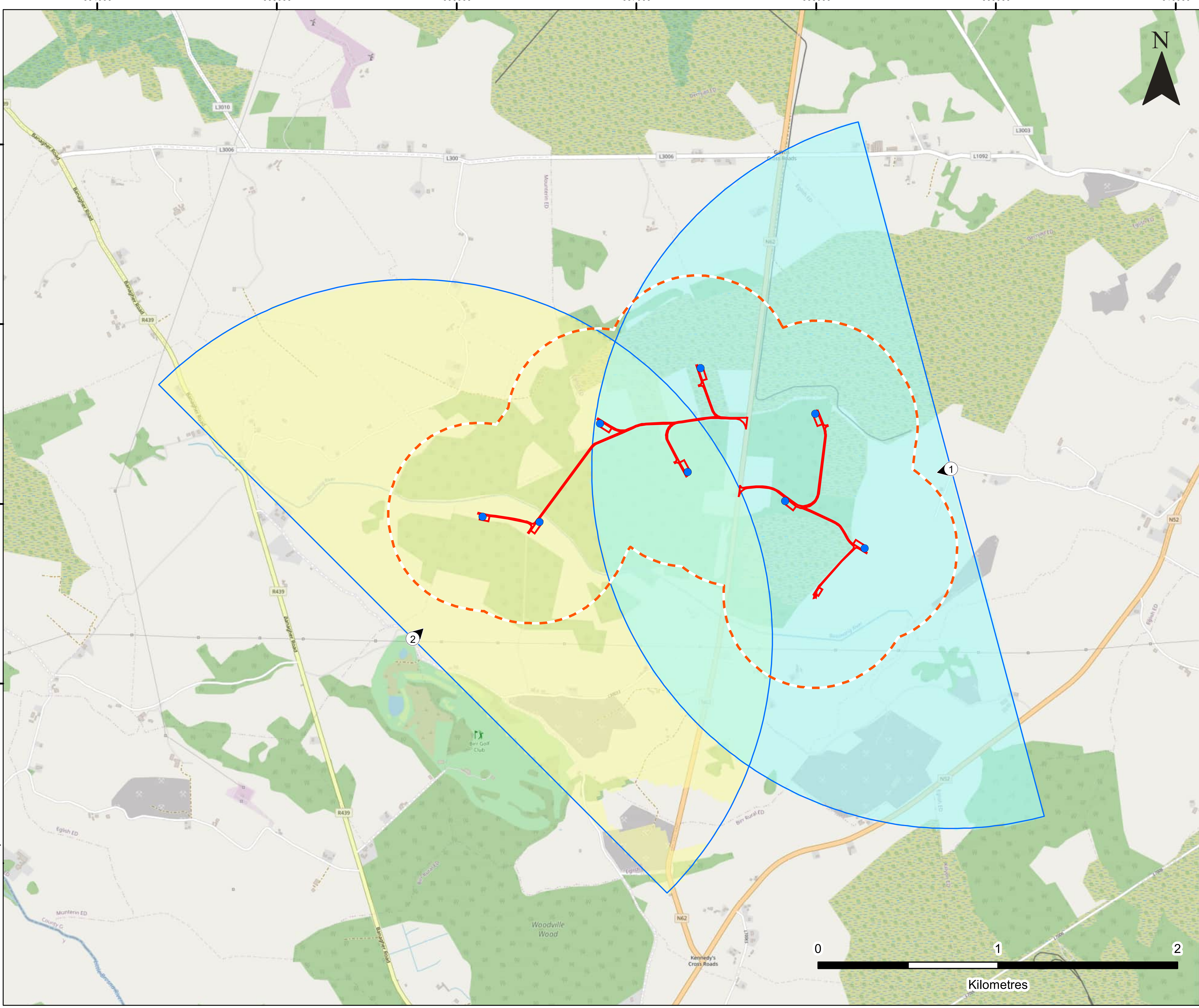
VANTAGE POINTS AND VIEWING ARCS

FIGURE 1

Scale 1:20,000 @ A3

Date FEBRUARY 2021

02036.00633.0002.0 Vantage Points and Viewing Arcs



LEGEND

- Site Infrastructure
- Turbines
- Site Infrastructure 500m Buffer
- Vantage Point
- Vantage Point Viewing
- Area Visible from Vantage Point 1
- Area Visible from Vantage Point 2

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BIRD SURVEY REPORT

VIEWSHED ANALYSIS

FIGURE 2

Scale 1:20,000 @ A3

Date FEBRUARY 2021

02036.00633.0003.0 Viewshed Analysis

LEGEND

- Site Infrastructure
- Turbines
- Site Infrastructure 500m Buffer
- Vantage Point
- Vantage Point Viewing
- Lapwing
- Flight Line

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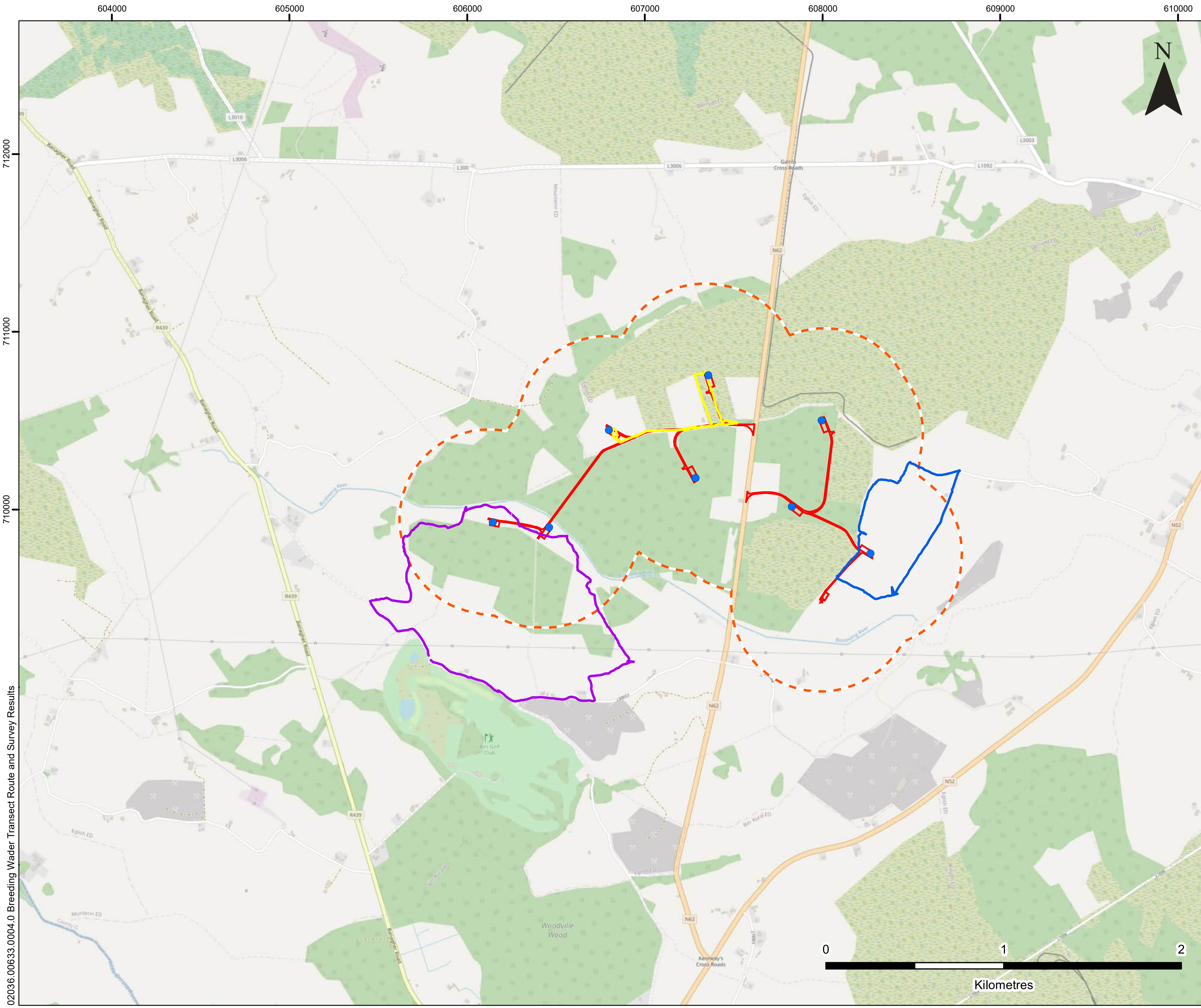
LAPWING FLIGHT LINES

FIGURE 3

Scale 1:20,000 @ A3

Date FEBRUARY 2021

02036.00633.0006.0 Lapwing Flight Lines



LEGEND

- Site Infrastructure
- Turbines
- Site Infrastructure 500m Buffer
- Breeding Wader Transect Route - North
- Breeding Wader Transect Route - East
- Breeding Wader Transect Route - West

No Waders recorded during these surveys.

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BREEDING SEASONS 2020
BIRD SURVEY REPORT

BREEDING WADER TRANSECT ROUTE AND SURVEY RESULTS

FIGURE 4

Scale 1:20,000 @ A3

Date FEBRUARY 2021

02036.00633.0004.0 Breeding Wader Transect Route and Survey Results

603000
604000
605000
606000
607000
608000
609000
610000
611000
612000
714000
713000
712000
711000
710000
LEGEND
Site Infrastructure
Turbines
Site Infrastructure 2km Buffer
Breeding Raptor Transect Route
Raptor Viewpoint
Species
Buzzard
Kestrel
Flight Line
Possible BZ nest location – not confirmed
Meenwaun Wind Farm
Woodville Wood
N62
L3003
L3010
R438
R439
Banagher Road
N
0
1
2
Kilometres
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BREEDING SEASONS 2020
BIRD SURVEY REPORT
BREEDING RAPTOR TRANSECT ROUTE AND SURVEY RESULTS
FIGURE 5
Scale 1:30,000 @ A3
Date FEBRUARY 2021
02036.00633.0005.0 Breeding Raptor Transect Route and Survey Results

APPENDIX I

Survey dates, times and observers

Table AI-1: Details of VP surveys undertaken from Vantage Point 1

Date	Surveyor	Start	End	Survey Duration
06/05/20	SI	11:45	14:45	3
07/05/20	JC	09:40	12:40	3
14/05/20	JC	09:20	12:20	3
11/06/20	DH	13:20	16:20	3
25/06/20	DH	14:00	17:00	3
07/07/20	SI	08:45	11:45	3
08/07/20	JC	09:50	12:50	3
21/07/20	JC	08:55	11:55	3
17/08/20	JC	10:50	13:50	3
18/08/20	JC	13:30	16:30	3
07/09/20	JC	10:30	13:30	3
08/09/20	JC	11:55	14:55	3
Total Hours				**36**

Table AI-2: Details of VP surveys undertaken from Vantage Point 2

Date	Surveyor	Start	End	Survey Duration
06/05/20	SI	15:15	15:15	3
07/05/20	JC	13:10	16:10	3
14/05/20	JC	13:50	16:50	3
15/05/20	JC	09:30	12:30	3
11/06/20	DH	10:00	13:00	3
25/06/20	DH	10:00	13:00	3
07/07/20	SI	12:15	15:15	3
21/07/20	JC	12:25	15:25	3
17/08/20	JC	14:20	17:20	3
18/08/20	JC	10:00	13:00	3
07/09/20	JC	14:00	17:00	3
08/09/20	JC	08:25	11:25	3
Total Hours				**36**

Table AI-3: Details of breeding wader surveys undertaken during the 2020 bird breeding season

Date	Surveyor	Start	End	Survey Duration
05/0520	SI	09:00	13:00	4
29/05/20	SI	08:00	12:00	4
26/06/20	DH	08:30	12:30	4
Total Hours				**12**

Table AI-4: Details of breeding raptor surveys undertaken during the 2020 bird breeding season

Date	Surveyor	Start	End	Survey Duration
05/0520	SI	14:15	18:15	4
29/05/20	SI	13:00	17:00	4
26/06/20	DH	13:00	17:00	4
08/07/20	SI	10:00	14:00	4
Total Hours				**16**

APPENDIX II

Weather Data

Table AII-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)
06/05/2020	SI	11:45	14:45	1	2	SE	0	3	2	2	0	0	16
06/05/2020	SI	11:45	14:45	2	2	SE	0	2	2	2	0	0	17
06/05/2020	SI	11:45	14:45	3	2	SE	0	1	2	2	0	0	17
07/05/2020	JC	09:40	12:40	1	3	SE	2	7	2	2	0	0	11
07/05/2020	JC	09:40	12:40	2	4	E	0	8	2	2	0	0	13
07/05/2020	JC	09:40	12:40	3	5	E	0	8	2	2	0	0	13
14/05/2020	JC	09:20	12:20	1	1	N	0	0	2	2	0	0	6
14/05/2020	JC	09:20	12:20	2	1	N	0	0	2	2	0	0	6
14/05/2020	JC	09:20	12:20	3	1	N	0	1	2	2	0	0	6
11/06/2020	DH	13:20	16:20	1	5	NW	0	8	2	2	0	0	16
11/06/2020	DH	13:20	16:20	2	5	NW	0	8	2	2	0	0	16
11/06/2020	DH	13:20	16:20	3	5	NW	0	8	2	2	0	0	16
25/06/2020	DH	14:00	17:00	1	3	W	0	8	2	2	0	0	24
25/06/2020	DH	14:00	17:00	2	4	W	0	7	2	2	0	0	25
25/06/2020	DH	14:00	17:00	3	4	W	2	8	2	2	0	0	24
07/07/2020	SI	08:45	11:45	1	1	S	3	8	1	1	0	0	11
07/07/2020	SI	08:45	11:45	2	1	S	3	8	1	1	0	0	11
07/07/2020	SI	08:45	11:45	3	1	S	3	8	1	1	0	0	12

Date	Surveyor	Start	End	Survey Hour	Wind Speed	Wind Direction	Rain	Cloud Cover	Cloud Height	Visibility	Snow	Frost	Temp (°c)
08/07/2020	JC	09:50	12:50	1	2	NE	0	2	2	2	0	0	13
08/07/2020	JC	09:50	12:50	2	2	NE	0	2	2	2	0	0	13
08/07/2020	JC	09:50	12:50	3	2	SE	1	2	2	2	0	0	13
21/07/2020	JC	08:55	11:55	1	1	SW	0	4	2	2	0	0	11
21/07/2020	JC	08:55	11:55	2	2	SW	0	3	2	2	0	0	13
21/07/2020	JC	08:55	11:55	3	1	SW	0	4	2	2	0	0	14
17/08/2020	JC	10:50	13:50	1	2	NE	0	8	2	2	0	0	17
17/08/2020	JC	10:50	13:50	2	2	NE	2	8	2	2	0	0	17
17/08/2020	JC	10:50	13:50	3	2	NE	2	8	2	2	0	0	18
18/08/2020	JC	13:30	16:30	1	2	SW	0	6	2	2	0	0	21
18/08/2020	JC	13:30	16:30	2	2	SW	0	6	2	2	0	0	21
18/08/2020	JC	13:30	16:30	3	3	SW	0	5	2	2	0	0	22
07/09/2020	JC	10:30	13:30	1	3	SW	0	8	2	2	0	0	14
07/09/2020	JC	10:30	13:30	2	4	SW	1	8	1	1	0	0	15
07/09/2020	JC	10:30	13:30	3	4	SW	0	8	1	1	0	0	16
08/09/2020	JC	11:55	14:55	1	3	SW	0	8	2	2	0	0	18
08/09/2020	JC	11:55	14:55	2	3	SW	0	7	2	2	0	0	19
08/09/2020	JC	11:55	14:55	3	3	SW	0	7	2	2	0	0	19

Date	Surveyor	Start	End	Survey Hour	Wind Speed	Wind Direction	Rain	Cloud Cover	Cloud Height	Visibility	Snow	Frost	Temp (°c)

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 AII-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)
06/05/2020	SI	15:15	18:15	1	2	SE	0	4	2	2	0	0	18
06/05/2020	SI	15:15	18:15	2	2	SE	0	5	2	2	0	0	16
06/05/2020	SI	15:15	18:15	3	2	SE	0	7	2	2	0	0	15
07/05/2020	JC	13:10	16:10	1	4	S	0	8	2	2	0	0	15
07/05/2020	JC	13:10	16:10	2	3	S	0	7	2	2	0	0	15
07/05/2020	JC	13:10	16:10	3	0	N/A	0	5	2	2	0	0	17
14/05/2020	JC	13:50	16:50	1	2	N	0	1	2	2	0	0	12
14/05/2020	JC	13:50	16:50	2	2	N	0	0	2	2	0	0	13
14/05/2020	JC	13:50	16:50	3	2	N	0	0	2	2	0	0	14
15/05/2020	JC	09:30	12:30	1	2	NW	0	8	2	2	0	0	8
15/05/2020	JC	09:30	12:30	2	2	NW	0	8	2	2	0	0	8
15/05/2020	JC	09:30	12:30	3	2	NW	0	8	2	2	0	0	11
11/06/2020	DH	10:00	13:00	1	4	S	0	2	2	2	0	0	18
11/06/2020	DH	10:00	13:00	2	4	SW	0	4	2	2	0	0	19
11/06/2020	DH	10:00	13:00	3	4	SW	0	5	2	2	0	0	19
25/06/2020	DH	10:00	13:00	1	3	W	0	6	2	2	0	0	21
25/06/2020	DH	10:00	13:00	2	3	W	0	5	2	2	0	0	23
25/06/2020	DH	10:00	13:00	3	3	W	0	6	2	2	0	0	24
07/07/2020	SI	12:15	15:15	1	0	N/A	1	8	1	1	0	0	12

Date	Surveyor	Start	End	Survey Hour	Wind Speed	Wind Direction	Rain	Cloud Cover	Cloud Height	Visibility	Snow	Frost	Temp (°c)
07/07/2020	SI	12:15	15:15	2	0	N/A	1	8	1	1	0	0	12
07/07/2020	SI	12:15	15:15	3	0	N/A	1	8	1	1	0	0	12
21/07/2020	JC	12:25	15:25	1	2	SW	0	6	2	2	0	0	17
21/07/2020	JC	12:25	15:25	2	1	SW	0	6	2	2	0	0	18
21/07/2020	JC	12:25	15:25	3	1	SW	0	6	2	2	0	0	18
17/08/2020	JC	14:20	17:20	1	2	NE	0	8	2	2	0	0	18
17/08/2020	JC	14:20	17:20	2	2	NE	1	8	2	2	0	0	18
17/08/2020	JC	14:20	17:20	3	2	NE	2	8	2	2	0	0	17
18/08/2020	JC	10:00	13:00	1	1	SW	0	7	2	2	0	0	16
18/08/2020	JC	10:00	13:00	2	1	SW	0	5	2	2	0	0	17
18/08/2020	JC	10:00	13:00	3	1	SW	0	5	2	2	0	0	18
07/09/2020	JC	14:00	17:00	1	3	SW	1	8	1	1	0	0	17
07/09/2020	JC	14:00	17:00	2	3	SW	0	8	2	2	0	0	18
07/09/2020	JC	14:00	17:00	3	3	SW	0	8	2	2	0	0	19
08/09/2020	JC	08:25	11:25	1	3	SW	0	8	1	2	0	0	17
08/09/2020	JC	08:25	11:25	2	2	SW	0	8	2	2	0	0	18
08/09/2020	JC	08:25	11:25	3	2	SW	1	8	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)

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

Table AII-3: Weather data collected during the breeding wader surveys undertaken during the 2020 breeding season

Date	Surveyor	Start	End	Survey Hour	Wind Speed	Wind Direction	Rain	Cloud Cover	Cloud Height	Visibility	Snow	Frost	Temp (°c)
05/0520	SI	09:00	13:00	1	1	W	0	5	2	2	0	0	12
05/0520	SI	09:00	13:00	2	1	W	0	5	2	2	0	0	14
05/0520	SI	09:00	13:00	3	1	W	0	5	2	2	0	0	16
05/0520	SI	09:00	13:00	4	1	W	0	5	2	2	0	0	16
29/05/20	SI	08:00	12:00	1	3	SE	0	1	2	2	0	0	17
29/05/20	SI	08:00	12:00	2	3	SE	0	1	2	2	0	0	19
29/05/20	SI	08:00	12:00	3	3	SE	0	1	2	2	0	0	21
29/05/20	SI	08:00	12:00	4	3	SE	0	1	2	2	0	0	21
26/06/20	DH	08:30	12:30	1	3	NW	0	1	2	2	0	0	23
26/06/20	DH	08:30	12:30	2	3	NW	0	5	2	2	0	0	19
26/06/20	DH	08:30	12:30	3	3	NW	0	4	2	2	0	0	19
26/06/20	DH	08:30	12:30	4	3	NW	0	1	2	2	0	0	20

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 AII-4: Weather data collected during the breeding raptor surveys undertaken during the 2020 breeding season

Date	Surveyor	Start	End	Survey Hour	Wind Speed	Wind Direction	Rain	Cloud Cover	Cloud Height	Visibility	Snow	Frost	Temp (°c)
05/05/20	SI	14:15	18:15	1	1	SW	0	7	2	2	0	0	17
05/05/20	SI	14:15	18:15	2	1	SW	0	6	2	2	0	0	18
05/05/20	SI	14:15	18:15	3	1	SW	0	3	2	2	0	0	19
05/05/20	SI	14:15	18:15	4	1	SW	0	7	2	2	0	0	119
29/05/20	SI	13:00	17:00	1	3	SE	0	1	2	2	0	0	21
29/05/20	SI	13:00	17:00	2	3	SE	0	1	2	2	0	0	23
29/05/20	SI	13:00	17:00	3	3	SE	0	1	2	2	0	0	24
29/05/20	SI	13:00	17:00	4	3	SE	0	1	2	2	0	0	24
26/06/20	DH	13:00	17:00	1	3	NW	0	1	2	2	0	0	23
26/06/20	DH	13:00	17:00	2	3	NW	0	5	2	2	0	0	23
26/06/20	DH	13:00	17:00	3	4	NW	0	4	2	2	0	0	23
26/06/20	DH	13:00	17:00	4	4	NW	0	1	2	2	0	0	23
08/07/20	SI	10:00	14:00	1	2	S	1	8	2	2	0	0	15
08/07/20	SI	10:00	14:00	2	2	S	0	8	2	2	0	0	15
08/07/20	SI	10:00	14:00	3	2	S	0	7	2	2	0	0	16
08/07/20	SI	10:00	14:00	4	2	S	1	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	

APPENDIX III

Flight activity survey data

Primary Target Species

Table AIII-1: Primary target species recorded during flight activity surveys undertaken at VP1

Date	Surveyor	Flight ID	Species	Num. Birds	M/F	Age	Obs. Time	Flight time (s)	Likely Rotor Swept Height (Y/N)
08/07/2020	JC	1	L	1	U	Ad	11:28	75	N
08/07/2020	JC	2	L	1	U	Ad	11:44	30	N

There were no primary target species recorded at VP2 of the proposed Cush Wind Farm site during the 2020 breeding season.

Secondary Target Species

Table AIII-1a: Secondary target species recorded during flight activity surveys undertaken at VP1

Date	Survey Start	Survey End	Species	Count	5 Min Period	Likely Rotor Swept Height (Y/N)
06/05/2020	11:45	14:45	BZ	1	12:10-12:15	Y
06/05/2020	11:45	14:45	BZ	1	12:20-12:25	Y
06/05/2020	11:45	14:45	BZ	1	12:45-12:50	N
06/05/2020	11:45	14:45	BZ	1	13:20-13:25	N
06/05/2020	11:45	14:45	BZ	1	13:45-13:50	Y
07/05/2020	09:40	12:40	BZ	1	10:25-10:30	N
07/05/2020	09:40	12:40	RN	1	11:20-11:25	N
14/05/2020	09:20	12:20	BZ	2	10:10-10:15	N
14/05/2020	09:20	12:20	BZ	2	10:15-10:20	N
14/05/2020	09:20	12:20	BZ	2	10:30-10:35	N
14/05/2020	09:20	12:20	BZ	1	11:20-11:25	N
11/06/2020	13:20	16:20	BZ	1	14:15-14:20	N
11/06/2020	13:20	16:20	BZ	1	14:30-14:35	N
25/06/2020	14:00	17:00	RN	1	14:05-14:10	N
25/06/2020	14:00	17:00	LB	2	14:35-14:40	N
25/06/2020	14:00	17:00	BZ	1	16:40-16:45	Y
21/07/2020	08:55	11:55	RN	1	9:40-9:45	N
21/07/2020	08:55	11:55	BZ	1	11:35-11:40	N
17/08/2020	10:50	13:50	K	1	11:30-11:35	Y
07/09/2020	10:30	13:30	RN	1	13:15-13:20	Y
08/09/2020	11:55	14:55	BZ	1	12:25-12:30	Y
08/09/2020	11:55	14:55	BZ	1	12:50-12:55	N
08/09/2020	11:55	14:55	BZ	1	13:10-13:15	Y
08/09/2020	11:55	14:55	BZ	1	14:30-14:35	Y

Table AIII-1b: Secondary target species recorded during flight activity surveys undertaken at VP2

Date	Survey Start	Survey End	Species	Count	5 Min Period	Likely Rotor Swept Height (Y/N)
06/05/2020	15:15	18:15	BZ	1	16:50-16:55	N
06/05/2020	15:15	18:15	RN	1	16:55-17:00	N
07/05/2020	13:10	16:10	BZ	1	14:25-14:30	N
07/05/2020	13:10	16:10	BZ	1	14:55-15:00	N
07/05/2020	13:10	16:10	BZ	2	15:45-15:50	N
14/05/2020	13:50	16:50	K	1	14:10-14:15	Y
14/05/2020	13:50	16:50	BZ	1	14:25-12:30	N
14/05/2020	13:50	16:50	BZ	1	15:20-15:25	Y
14/05/2020	13:50	16:50	BZ	1	15:25-15:30	Y
14/05/2020	13:50	16:50	BZ	1	15:40-15:45	N
14/05/2020	13:50	16:50	BZ	1	16:05-16:10	N
14/05/2020	13:50	16:50	BZ	2	16:30-16:35	N
15/05/2020	09:30	12:30	J	1	09:45-9:50	N
15/05/2020	09:30	12:30	BZ	1	9:55-10:00	N
15/05/2020	09:30	12:30	J	1	10:05-10:10	N
15/05/2020	09:30	12:30	BZ	1	11:00-11:05	N
15/05/2020	09:30	12:30	RN	1	12:20-12:25	Y
11/06/2020	10:00	13:00	BZ	1	10:20-10:25	N
11/06/2020	10:00	13:00	RN	1	10:45-10:50	N
11/06/2020	10:00	13:00	BZ	1	11:15-11:20	N
11/06/2020	10:00	13:00	BZ	3	11:35-11:40	N
11/06/2020	10:00	13:00	BZ	1	12:05-12:10	N
21/07/2020	12:25	15:25	K	1	13:50-13:55	Y
21/07/2020	12:25	15:25	BZ	1	13:55-14:00	N
21/07/2020	12:25	15:25	BZ	3	14:30-14:35	N
21/07/2020	12:25	15:25	BZ	1	14:55-15:00	N
17/08/2020	14:20	17:20	BZ	2	15:05-15:10	N
18/08/2020	10:00	13:00	RN	2	10:15-10:20	Y
18/08/2020	10:00	13:00	RN	1	12:25-12:30	Y
07/09/2020	14:00	17:00	RN	1	14:10-14:15	Y
07/09/2020	14:00	17:00	RN	1	15:20-15:25	Y
08/09/2020	08:25	11:25	BZ	1	8:40-8:45	N
08/09/2020	08:25	11:25	K	1	10:25-10:30	N

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BIRD SURVEY REPORT WINTER SEASON 2020-2021

Cush Wind Farm

Development Location

Prepared for: Galetech Energy Developments

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1.0 Introduction

SLR Consulting Ireland (SLR) was commissioned by Galetech Energy Developments to carry out a full suite of winter bird surveys for the proposed wind farm site at Cush, Co. Offaly during the winter season that spanned October 2020 to March 2021.

1.1 Site description and project background

The proposed wind farm development site is located in the townland of Cush approximately 4 km north of Birr, Co. Offaly. The habitats within the proposed development site include conifer plantations of varying age classes (c.327 ha), cutaway bog (c.102 ha) and agricultural grasslands (ca. 327 ha; refer to Appendix 1 Figure 1).

The proposed Cush Wind Farm site includes a linear area that was previously surveyed for a proposed overhead line[1]. Flight activity surveys were carried out at two vantage point locations along the proposed overhead line route corridor during the breeding season 2018.

1.2 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[2]. The scope of survey work undertaken during the 2020/21 non-breeding season is provided in Table 1-1. Due to the proximity of designated sites that included Greenland white-fronted goose (*Anser albifrons flavirostris*) and whooper swan (*Cygnus cygnus*), feeding and distribution surveys were undertaken as recommended by NS guidelines.

Table 1-1
Scope of ornithological survey work, non-breeding season 2020/21

Survey Type	Summary Methodology (see Section 2 for further details)
Vantage Point (VP) surveys	Based on 6 hours of survey per month between October 2020 and March 2021 inclusive, from each of two VPs. Following modelling of areas of potential visibility, two VPs were considered to provide sufficient coverage of possible turbine locations under consideration at the time of survey (i.e. the area within the site boundary), plus appropriate buffer zones.
Feeding and distribution surveys	Feeding distribution surveys were carried out on a twice monthly basis to establish if swans and/or geese were using the fields for foraging within 500 m of the wind farm boundary.

[1] SLR (2018) *Cloghan Wind Farm and Long Oak Wind Farm Breeding Bird Survey Report 2018*. Prepared for Galetech Energy Services Ltd

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

1.3 Purpose of this report

This report outlines the surveys undertaken and methods used. It then summarises the survey data obtained and provides descriptions of the legal and conservation status of the species recorded.

The assessment of impacts resulting from the proposed development and the development of mitigation measures, if required, are beyond the scope of this report and will be covered in a separate Environmental Impact Assessment (EIA) Report in due course.

1.4 Target species

Primary target species

Primary target species were specifically 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 SPAs or species listed on Annex I of the Birds Directive[3]. The relevant SPAs are listed in Section 3.1 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:

- All Annex 1 raptor/owl species;
- Qualifying interest species for nearby SPAs:
  - Greenland white fronted goose;
  - Whooper swan;
  - Wigeon *Mareca penelope*;
  - Teal *Anas crecca*;
  - Pintail *Anas acuta*;
  - Shoveler *Anas clypeata*;
  - Golden plover *Pluvialis apricaria*;
  - Lapwing *Vanellus vanellus*;
  - Black tailed godwit *Limosa limosa*; and
  - Black headed gull *Chroicocephalus ridibundus*.

Secondary target 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 target species. Recording of secondary species is subsidiary to recording of primary target species.

Secondary target species included:

- Any other wildfowl, wader and gull species;

[3] Annex 1 of The Birds Directive (Directive 2009/147/EC).

- Buzzard *Buteo buteo;*
- Sparrowhawk *Accipiter nisus*;
- Raven *Corvus corax*;
- Grey heron *Ardea cinerea;*
- Cormorant *Phalacrocorax carbo*;
- Kestrel *Falco tinnunculus*; and
- Snipe *Gallinago gallinago.*

Note that kestrel and snipe were recorded as secondary target species at the time of the surveys, but since have been red-listed under the Birds of Conservation Concern in Ireland (BoCCI) 4: 2020-2026[4] scheme, as numbers within the Irish landscape have suffered a serious decline in recent years. As such, they have been included as primary target species for all subsequent and ongoing survey work.

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

2.0 Survey methodology

2.1 Desk-based review

The desk review collated any available information to date on the wintering bird movements around the proposed wind farm development site.

As previously mentioned in Section 1.2, flight activity surveys were undertaken previously from two vantage points overlooking an overhead power line route which was proposed to pass through the proposed Cush Wind Farm site. The following reports resulting from previous breeding bird surveys were reviewed for any relevant information that could be used to inform winter bird surveys:

- SLR (2018) Cloghan Wind Farm and Long Oak Wind Farm Breeding Bird Survey Report 2018. Prepared for Galetech Energy Services Ltd.
- SLR (2020) Cush Wind Farm Breeding Bird Survey Report 2020.

The websites of the National Parks and Wildlife Service (NPWS) www.npws.ie and the National Biodiversity Data Centre (NBDC) http://maps.biodiversityireland.ie/#/Map were accessed for information on sites designated for nature conservation.

2.2 Survey dates and personnel

Surveys were undertaken by Jason Cahill (JC) BSc (Hons) and Aisling Kinsella (AK) BSc (Hons), MSc.

Details of survey dates and times are provided in Appendix 2 and a record of weather conditions during surveys is provided in Appendix 3.

2.3 Feeding distribution surveys

Whooper swan and Greenland white–fronted goose are features of interest of several Special Protection Areas (SPAs) within 15 km of the site boundary (refer to Table 3-1). A buffer of 500 m around the wind farm site was used for these surveys which were undertaken by driven transect twice per month, stopping on a regular basis to check all fields for goose and swan feeding activity. The transect route is shown in Appendix 1, survey dates in Appendix 2, weather conditions in Appendix 3 and survey results are shown in Appendix 4.

2.4 Flight activity surveys

VP locations and 2km viewing arcs are shown in Appendix 1 Figure 1 and VP viewsheds are shown in Figure 2.

A total of 72.5 hours of flight activity surveys were conducted from both VP locations during the 2020-21 non-breeding season (6 October 2020 to 12 March 2021 inclusive), as summarised in Table 2-1. The VP locations are shown in Appendix 1 along with their associated areas of visibility (the viewsheds) at 18 m above ground level, i.e. the lowest likely rotor swept height.

In order to avoid possible complications during any subsequent collision risk modelling, VP watches were timed such that surveys were not undertaken simultaneously from both VPs. This avoids double-counting birds and ensures that no disturbance is made to birds within viewsheds from presence of the observer.

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

Table 2-1
Summary of VP surveys undertaken, non-breeding season 2020-2021

VP Number	Co-ordinates (ITM)	Hours of Survey Completed						
		Oct	**Nov**	**Dec**	**Jan**	**Feb**	**Mar**	**Total**
1	664276 E 644585 N	6	6	6	6	6	6.5	36.5
2	661361 N 646428 N	6	6	6	6	6	6	36

2.5 Survey limitations

With regard to viewshed coverage of the 500 m site infrastructure buffer, some gaps are apparent due to the steepness of the terrain; however these are relatively small and most lie within the buffer rather than within the site itself (refer to Appendix 1 Figure 1). Overall, it is considered that the vantage point data will be representative of the site as a whole and sufficient to inform a robust assessment of the proposed development.

Feeding distribution surveys were not undertaken in October. This represents an oversight. However, surveys were undertaken for five out of six winter months and a full suite of feeding distribution surveys is currently being undertaken for the winter of 2021/22. Therefore, it is considered feeding distribution data are sufficient to inform a robust assessment of the proposed development.

There were intermittent periods of poor visibility during some surveys (specifically 11 March 2021). However, these conditions were not persistent through the affected surveys and target species were still recorded. Therefore, these conditions are not considered to be significant limitations to the survey data obtained.

3.0 Results

3.1 Desk based results

The proposed wind farm site is not within or immediately adjacent to any SPA. However, there are a total of eight SPAs within a 20km[5] radius of the proposed development site.

The five SPAs within 20km are shown in Table 3-1, which also shows the species of special conservation interest (SSCI) for each site. The majority of SSCIs for which these sites are designated are wintering species.

The two closest SPAs to the proposed development site are Dovegrove Callows SPA (Site Code: 004137) and All Saints Bog SPA (Site Code: 004103) at distances of 1.9km and 3.1km, respectively. Both of these sites are designated for the protection of Greenland white-fronted geese*.* River Little Brosna Callows SPA (Site Code: 004086) is located 4.1km to the west and is designated for a number of wildfowl species.

The Middle Shannon Callows SPA (Site Code: 004096), River Suck Callows SPA (Site Code: 004097), Lough Derg (Shannon) SPA (Site Code: 004058) and Mongan Bog SPA (Site Code: 00417) are designated for a number of wildfowl species.

Hen harrier *Circus cyaneus* is the sole SSCI of the Slieve Bloom Mountains SPA (Site Code: 004160). Hen harriers are likely to use the Slieve Bloom Mountain habitat more in the breeding season and travel more widely in winter. It was considered that the beginning and end of the season were times when hen harriers were more likely to be recorded. This species is also listed on Annex 1 and therefore is a primary target species.

Table 3-1
SPAs within 15km of the proposed Cush Wind Farm site and their qualifying interests (species present during the non-breeding season)

Site Name	Site Code	Distance/ Direction from Site Boundary	Species of Special Conservation Interest
Dovegrove Callows SPA	004137	1.9km south-west	• Greenland white-fronted goose
All Saints Bog SPA	004103	3.1km west	• Greenland white-fronted goose
River Little Brosna Callows SPA	004086	4.1km west	• Whooper swan • Wigeon • Teal • Pintail • Shoveler • Lapwing • Golden plover • Black-tailed godwit • Black-headed gull • Greenland white-fronted goose • Wetland and waterbirds
Middle Shannon Callows	004096	7.2km north west	• Whooper swan • Wigeon

[5] A 20km search radius was used as this represents the maximum core foraging distance used by Qualifying Interest species of SPAs in the UK and Ireland

Site Name	Site Code	Distance/ Direction from Site Boundary	Species of Special Conservation Interest
SPA			• Golden plover • Lapwing • Black-tailed godwit • Black-headed gull • Wetland and waterbirds
Slieve Bloom Mountains SPA	004160	12km east	• Hen harrier
River Suck Callows SPA	004097	17km northwest	• Whooper swan • Wigeon • Golden plover • Lapwing • Greenland white-fronted goose
Lough Derg (Shannon) SPA	004058	17.5km south west	• Cormorant • Tufted duck • Goldeneye • Common tern
Mongan Bog SPA	004017	19.2km north	• Greenland white-fronted goose

3.2 Field survey results

3.2.1 Feeding distribution surveys

The feeding distribution surveys did not record aggregations of swans or geese, only registering one mute swan (*Cygnus olor)* in December (17/12/20) to the south (Figure 6).

Peregrine falcon (*Falco peregrinus*), snipe and little egret (*Egretta garzetta*) were recorded as incidental species during the feeding distribution surveys but were not recorded during the flight activity surveys.

3.2.2 Flight activity surveys

Flight activity recorded from VP1 and VP2 combined by primary target species is summarised in Table 3-2. Primary target species flights from both VPs are shown in Appendix 1 Figures 3 to 5. Flight activity data are provided in more detail in Appendix 4 with full data retained in GIS and excel format for subsequent collision risk modelling, if required.

Table 3-2
Number of primary target species flights from VP1 and VP2 combined, October 2020 – March 2021

Species	Total number of flights							Total number of flights potentially at risk height*	Total number of birds recorded in flight
	October	November	December	January	February	March	**Total**		
Whooper swan	0	0	3	0	0	0	**3**	3	20
Lapwing	0	0	0	1	0	0	**1**	1	13
Hen harrier	0	0	0	0	0	2	**2**	2	1
*Precautionary risk height assumed to be between 15m-200m									

3.2.3 Species accounts

A total of 6 flights by primary target species were recorded between October 2020 and March 2021. A summary description of flight activity by each species is presented below.

Whooper swan

Whooper swan flights were observed on three occasions in December from vantage point one, each flight comprised of a flock of between six and eight individuals. Two flights flew went from west to east and the third from east to west and the birds were in passage. The height was recorded as below 25m.

Lapwing

A single lapwing flight was observed in January from vantage point two, this comprised a flock of 13 individuals. The flight went from north to south at a height of between 50-100m for 30 seconds and 25-50m for 60 seconds.

Hen harrier

Two female hen harrier flights were recorded in March 2021 one each from either vantage point. In both instances the flight was classified as circling, occurred between 25-50m and was located above woodland to the north of the vantage point.

3.2.4 Secondary target species

Six secondary species were recorded, as follows (in order of frequency). A monthly breakdown is provided in

Table 3-3.

- Buzzard: Recorded in every month, frequently two birds observed at any one time. Most frequently seen circling.
- Raven: Recorded in every month, frequently undertaking passage flights, often two birds observed flying together.
- Kestrel: Recorded singularly in most months, excluding October and February. Flight behaviours were predominately hunting with occasional passage flights.
- Grey heron: One observation of a single bird in February.

- Sparrowhawk: One observation of a single bird in January.
- Mallard: One observation of a single bird in February.

Table 3-3
Number of Secondary Target Species from VP1 and VP2 Combined, September 2020 – March 2021

Species	Number of 5-minute periods recorded by month							Maximum number of birds recorded in any one 50-minute period by month						
	October	November	December	January	February	March	**Total**	October	November	December	January	February	March	**Max**
Buzzard	5	5	2	10	19	22	**63**	2	2	1	2	2	3	**3**
Raven	3	6	5	2	6	2	**24**	2	2	2	2	2	1	**2**
Kestrel	0	1	1	4	0	3	**9**	0	1	1	1	0	1	**1**
Grey heron	0	0	0	0	1	0	**1**	0	0	0	0	1	0	**1**
Sparrowhawk	0	0	0	1	0	0	**1**	0	0	0	1	0	0	**1**
Mallard	0	0	0	0	1	0	**1**	0	0	0	0	1	0	**1**

4.0 Summary and conclusions

Flight activity surveys (VPs) and feeding distribution surveys for geese and swans, specifically Greenland white fronted geese and whooper swan, were carried out at the proposed Cush wind farm during the winter season. The winter season spanned from October 2020-March 2021 inclusive for the flight activity surveys and November 2020 to March 2021 for the foraging distribution surveys.

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

- Whooper swan;
- Hen harrier; and
- Lapwing.

The most frequent flight activity was by whooper swan (3 flights recorded), with other primary target species activity even less. However, whooper swan flights did comprise of larger flocks (between six and eight individuals in each flight), as did lapwing (13 individuals in the one flight recorded).

Six secondary target species were recorded: buzzard, raven, kestrel, grey heron, sparrowhawk and mallard.

4.1 Legal and Conservation Status of Target Species Recorded

Table 4-1 summarises the legal and conservation status of the target species recorded during the flight activity surveys.

Table 4-1
Legal and conservation status of primary and secondary target species

Species	Legal and Conservation status om Ireland
Whooper swan	WA, Annex 1, BoCCI4 Amber
Lapwing	WA, BoCCI4 Red
Hen harrier	WA, Annex 1, BoCCI4 Amber
Peregrine falcon*	WA, Annex 1, BoCCI4 Green
Key	WA - the species is afforded general protection by the Wildlife Acts 2000 (as amended); 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. * only recorded in feeding distribution surveys.

Appendix 01

Figures

LEGEND

- Site Infrastructure
- Turbine Location
- Vantage Point
- Vantage Point Viewing Area

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BIRD SURVEY REPORT
WINTER SEASON 2020/21

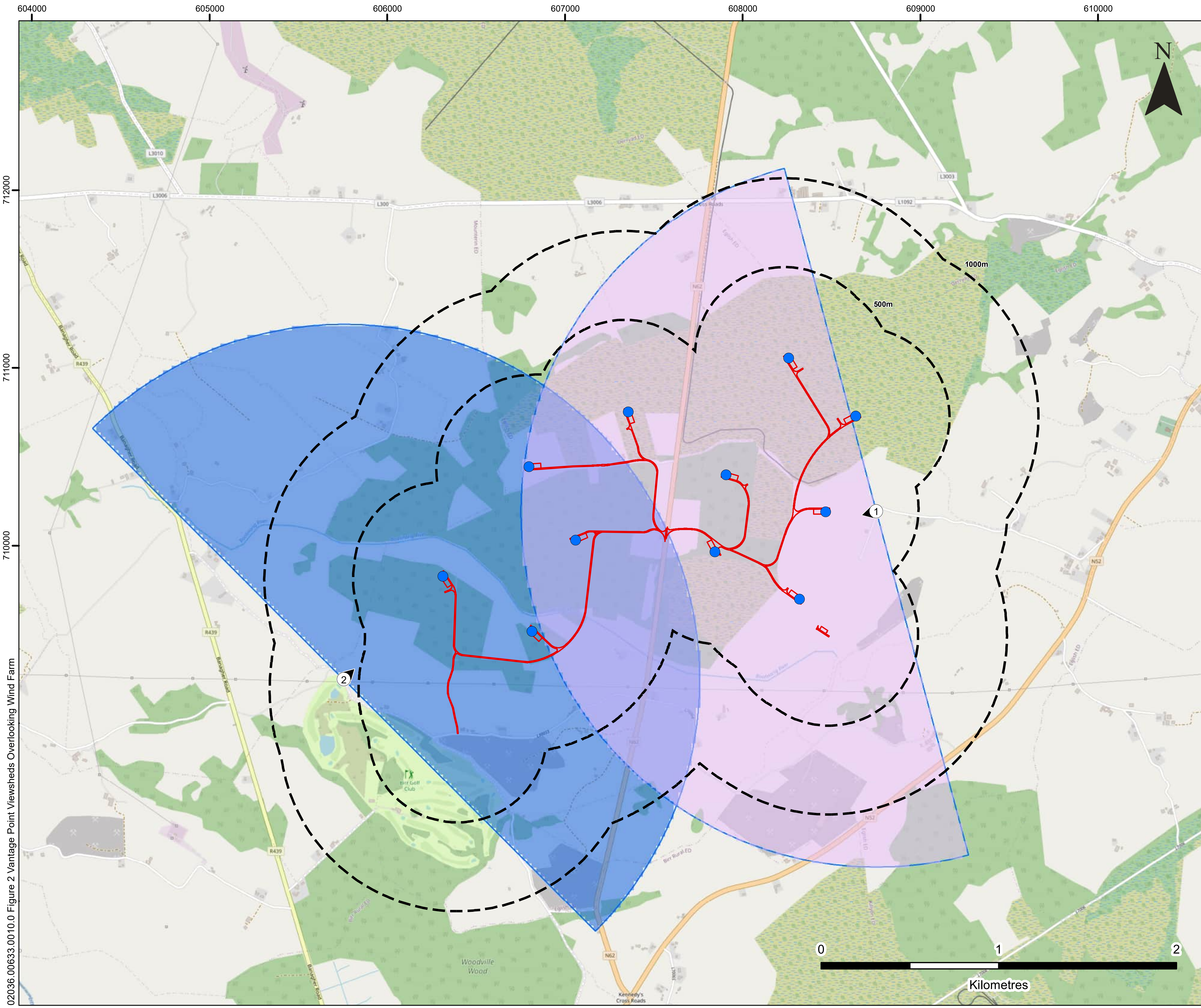
VANTAGE POINTS AND VIEWING ARCS

FIGURE 1

Scale 1:20,000 @ A3

Date DECEMBER 2021

02036.00633.0009.0 Figure 1 Site Layout and Vantage Point Locations



LEGEND

Site Infrastructure

Site Infastructure 1000m & 500m Buffer

Turbine Location

Vantage Point

Vantage Point Viewing Area

Theoretical Visibility from Wind Farm VP1

Theoretical Visibility from Wind Farm VP2

1. The Zones of Theoretical Visibility (ZTV) was calculated using ArcMAP 10.5.1 Spatial Analyst. The ZTV is calculated with a surface offset 18m & 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.

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BIRD SURVEY REPORT
WINTER SEASON 2020/21

VANTAGE POINT VIEWSHEDS OVERLOOKING WIND FARM

FIGURE 2

Scale 1:20,000 @ A3

Date DECEMBER 2021

02036.00633.0010.0 Figure 2 Vantage Point Viewsheds Overlooking Wind Farm

LEGEND

Site Infrastructure

Site Infrastructure 500m Buffer

Turbine Location

Vantage Point

Flight Lines

Whooper Swan

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BIRD SURVEY REPORT
WINTER SEASON 2020/21

FLIGHT LINES: WHOOPER SWAN

FIGURE 3

Scale 1:15,000 @ A3

Date DECEMBER 2021

02036.00633.0011.0 Figure 3-5 Flightline

LEGEND
Site Infrastructure
Site Infrastructure 500m Buffer
Turbine Location
Vantage Point
Flight Lines
Lapwing
N
605000
606000
607000
608000
609000
712000
711000
710000
Kilometres
0
0.25
0.5
0.75
1
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FLIGHT LINES: LAPWING
FIGURE 4
Scale 1:15,000 @ A3
Date DECEMBER 2021
02036.00633.0011.0 Figure 3-5 Flightline

LEGEND

Site Infrastructure

Site Infrastructure 500m Buffer

Turbine Location

Vantage Point

Flight Lines

Hen Harrier

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WINTER SEASON 2020/21

FLIGHT LINES: HEN HARRIER

FIGURE 5

Scale	Date
1:15,000 @ A3	DECEMBER 2021

02036.00633.0011.0 Figure 3-5 Flightline

LEGEND

- Site Infrastructure
- Site Infrastructure 500m Buffer
- Turbine Location
- Transect Route

Swan and Goose Registrations (Colour Denotes Survey Date)

- 17/12/2020

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WINTER SEASON 2020/21

SWAN AND GOOSE FEEDING DISTRIBUTION SURVEY – TRANSECT ROUTE AND PEAK COUNTS

FIGURE 6

Scale 1:30,000 @ A3 | Date DECEMBER 2021

02036.00633.0013.0 Figure 4 Swan and Goose Feeding Distribution Survey

Appendix 02

Survey dates times and observers

Table A2-1
Details of VP surveys undertaken from Vantage Point 1

Date	Surveyor	Start time	End time	No. Hours
06/10/2020	JC	10:00	13:00	03:00
08/10/2020	JC	13:00	16:00	03:00
05/11/2020	JC	13:00	16:00	03:00
25/11/2020	JC	09:40	12:40	03:00
08/12/2020	JC	09:25	12:25	03:00
09/12/2020	JC	12:45	15:45	03:00
20/01/2021	JC	10:20	13:20	03:00
22/01/2021	JC	11:10	14:10	03:00
09/02/2021	JC	10:20	13:20	03:00
11/02/2021	JC	11:30	14:30	03:00
11/03/2021	AK	13:30	16:30	03:00
12/03/2021	AK	09:30	13:00	03:30
Total hours				**36.5**

Table A2-2
Details of VP surveys undertaken from Vantage Point 2

Date	Surveyor	Start time	End time	No. Hours
06/10/2020	JC	13:30	16:30	03:00
08/10/2020	JC	09:30	12:30	03:00
05/11/2020	JC	09:30	12:30	03:00
25/11/2020	JC	13:15	16:15	03:00
08/12/2020	JC	12:55	15:55	03:00
09/12/2020	JC	09:15	12:15	03:00
20/01/2021	JC	13:50	16:50	03:00
21/01/2021	JC	09:30	12:30	03:00
09/02/2021	JC	13:55	16:55	03:00
10/02/2021	JC	09:00	12:00	03:00
10/03/2021	AK	13:00	16:00	03:00
11/03/2021	AK	09:45	12:45	03:00
Total hours				**36**

Table A2-3
Details of feeding distribution surveys

Date	Start time	Surveyor
04/11/2020	13:45	JC
13/11/2020	13:00	JC
10/12/2020	09:30	JC
17/12/2020	10:25	JC
06/01/2020	12:55	JC
21/01/2021	13:00	JC
05/02/2021	09:15	JC
11/02/2021	15:00	JC
05/03/2021	12:15	JC
12/03/2021	13:15	AK

Appendix 03

Weather data

Table A3-1
Weather data collected during flight activity surveys undertaken from VP 1

Date	Survey Start	Survey End	Hr	Wind Speed	Wind Direction	Rain	Cloud Cover	Cloud Height	Visibility	Snow	Frost	Temp (°c)	Notes
06/10/2020	10:00	13:00	1	3	W	0	8	2	2	0	0	11	
06/10/2020	10:00	13:00	2	3	SW	1	8	2	2	0	0	12	
06/10/2020	10:00	13:00	3	3	W	1	8	2	2	0	0	13	
08/10/2020	13:00	16:00	1	3	NW	0	3	2	2	0	0	12	
08/10/2020	13:00	16:00	2	3	NW	0	4	2	2	0	0	13	
08/10/2020	13:00	16:00	3	3	NW	0	4	2	2	0	0	13	
05/11/2020	13:00	16:00	1	1	SW	0	7	2	2	0	0	9	
05/11/2020	13:00	16:00	2	1	SW	0	8	2	2	0	0	12	
05/11/2020	13:00	16:00	3	1	SW	0	7	2	2	0	0	12	
25/11/2020	09:40	12:40	1	1	NW	0	2	2	2	0	1	2	
25/11/2020	09:40	12:40	2	2	NW	0	1	2	2	0	0	4	
25/11/2020	09:40	12:40	3	2	NW	0	2	2	2	0	0	5	
08/12/2020	09:25	12:25	1	3	SW	0	4	2	2	0	1	2	
08/12/2020	09:25	12:25	2	3	SW	0	3	2	2	0	0	4	
08/12/2020	09:25	12:25	3	4	W	0	6	2	2	0	0	5	
09/12/2020	12:45	15:45	1	4	SE	3	8	1	1	0	0	6	
09/12/2020	12:45	15:45	2	5	SE	3	8	1	1	0	0	6	
09/12/2020	12:45	15:45	3	5	SE	3	8	1	1	0	0	7	
20/01/2021	10:20	13:20	1	2	NW	1	8	2	2	0	0	3	
20/01/2021	10:20	13:20	2	2	NW	0	7	2	2	0	0	4	

Date	Survey Start	Survey End	Hr	Wind Speed	Wind Direction	Rain	Cloud Cover	Cloud Height	Visibility	Snow	Frost	Temp (°c)	Notes
20/01/2021	10:20	13:20	3	2	NW	0	7	2	2	0	0	4	
22/01/2021	11:10	14:10	1	2	N	0	3	2	2	0	0	3	
22/01/2021	11:10	14:10	2	3	N	0	2	2	2	0	0	3	
22/01/2021	11:10	14:10	3	3	N	0	2	2	2	0	0	4	
09/02/2021	10:20	13:20	1	4	E	2	8	1	1	1	0	2	Snow (no rain)
09/02/2021	10:20	13:20	2	4	E	2	8	1	1	1	0	2	Snow (no rain)
09/02/2021	10:20	13:20	3	3	E	0	6	2	2	0	0	3	
11/02/2021	11:30	14:30	1	5	E	0	7	2	2	0	0	2	
11/02/2021	11:30	14:30	2	5	E	0	8	2	2	0	0	2	Light snow at 13:00
11/02/2021	11:30	14:30	3	6	SE	2	8	1	1	0	0	2	Snow
11/03/2021	13:30	16:30	1	3	N	0	5	2	2	0	0	6	Heavy showers & increased wind 13:50
11/03/2021	13:30	16:30	2	4	NW	0	5	2	2	0	0	6	
11/03/2021	13:30	16:30	3	3	NW	0	3	2	2	0	0	6	
12/03/2021	09:30	13:00	1	3	E	0	7	2	2	0	0	6	
12/03/2021	09:30	13:00	2	3	E	0	5	2	2	0	0	6	
12/03/2021	09:30	13:00	3	3	E	0	7	2	1	0	0	6	Heavy shower 11:45-12:20

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 0 150-500m 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 A3-2
Weather data collected during flight activity surveys undertaken from VP 2

Date	Survey Start	Survey End	Hr	Wind Speed	Wind Direction	Rain	Cloud Cover	Cloud Height	Visibility	Snow	Frost	Temp (°c)	Notes
06/10/2020	13:30	16:30	1	3	W	1	8	2	2	0	0	13	
06/10/2020	13:30	16:30	2	3	W	0	5	2	2	0	0	14	
06/10/2020	13:30	16:30	3	4	NW	1	5	2	2	0	0	14	
08/10/2020	09:30	12:30	1	3	NW	0	8	2	2	0	0	9	
08/10/2020	09:30	12:30	2	3	NW	0	7	2	2	0	0	9	
08/10/2020	09:30	12:30	3	3	NW	0	5	2	2	0	0	9	
05/11/2020	09:30	12:30	1	1	SW	0	8	2	2	0	0	5	
05/11/2020	09:30	12:30	2	1	SW	0	6	2	2	0	0	7	
05/11/2020	09:30	12:30	3	1	SW	0	6	2	2	0	0	8	
25/11/2020	13:15	16:15	1	2	NW	0	2	2	2	0	0	7	
25/11/2020	13:15	16:15	2	2	N	1	4	2	2	0	0	8	
25/11/2020	13:15	16:15	3	2	N	0	4	2	2	0	0	9	
08/12/2020	12:55	15:55	1	4	W	0	3	2	2	0	0	6	
08/12/2020	12:55	15:55	2	4	NW	0	4	2	2	0	0	7	
08/12/2020	12:55	15:55	3	5	NW	0	4	2	2	0	0	6	
09/12/2020	09:15	12:15	1	3	S	0	8	2	2	0	0	3	
09/12/2020	09:15	12:15	2	3	S	2	8	2	2	0	0	5	
09/12/2020	09:15	12:15	3	2	S	2	8	1	1	0	0	6	
20/01/2021	13:50	16:50	1	2	NW	0	8	2	2	0	0	5	
20/01/2021	13:50	16:50	2	2	NW	0	8	2	2	0	0	5	
20/01/2021	13:50	16:50	3	2	NW	0	7	2	2	0	0	6	

Date	Survey Start	Survey End	Hr	Wind Speed	Wind Direction	Rain	Cloud Cover	Cloud Height	Visibility	Snow	Frost	Temp (°c)	Notes
21/01/2021	09:30	12:30	1	3	NE	0	3	2	2	0	0	3	
21/01/2021	09:30	12:30	2	3	NE	0	3	2	2	0	0	4	
21/01/2021	09:30	12:30	3	3	NE	0	4	2	2	0	0	4	
09/02/2021	13:55	16:55	1	4	E	0	5	2	2	0	0	3	
09/02/2021	13:55	16:55	2	5	NE	0	7	2	2	0	0	4	
09/02/2021	13:55	16:55	3	5	NE	0	5	2	2	0	0	4	
10/02/2021	09:00	12:00	1	2	NE	2	3	2	2	0	0	-2	Very light snow
10/02/2021	09:00	12:00	2	2	NE	0	3	2	2	0	0	-2	-1°C by 10:15
10/02/2021	09:00	12:00	3	2	NE	0	2	2	2	0	0	1	
10/03/2021	13:00	16:00	1	3	N	0	8	2	2	0	0	11	
10/03/2021	13:00	16:00	2	4	N	0	8	2	2	0	0	11	
10/03/2021	13:00	16:00	3	4	N	1	8	1	0	0	0	10	Heavy rain for 15 mins 15:15-15:30
11/03/2021	09:45	12:45	1	3	N	3	8	2	1	0	0	6	
11/03/2021	09:45	12:45	2	3	N	0	4	2	2	0	0	7	Heavy shower & poor visibility at 11:40
11/03/2021	09:45	12:45	3	2	N	1	6	2	2	0	0	7	

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 A3-3
Weather during feeding and distribution surveys

Date	Start	Precipitation	Wind	Wind direction	Cloud cover	Visibility	Temperature (C^0)
04/11/2020	13:45	0	0	NW	3	2	11
13/11/2020	13:00	0	4		5	2	8
10/12/2020	09:30	0	2	SW	6	2	7
17/12/2020	10:25	0	2	SW	3	?	6
06/01/2020	12:55	0	1	SW	1	2	0
21/01/2021	13:00	0	2	NE	4	2	6
05/02/2021	09:15	0	2	W	6	2	4
11/02/2021	15:00	2	5	SE	8	1	4
05/03/2021	12:15	2	3	N	6	2	9
12/03/2021	13:15	?	?		?	?	?

Rain/ Precipitation	**Cloud Cover**	**Visibility**
None 0 Drizzle 1 Light showers/snow 2 Heavy showers/snow 3 Heavy rain/snow 4	Expressed in oktas (n/8)	Poor (<1km) 0 Moderate (1-3km) 1 Good (>3km) 2

Appendix 04

Flight activity survey data

Table A4-1
Flight activity survey data primary target species

Date	VP	Surveyor	Flight ID	Species	No.	Age (AD-adult U-unknown)	M/F/U M-Male F-female U-Unknown	StartTime (hr:min)	Flight duration (s)
08/12/2020	1	JC	1.CU011.1.1	WS	6	Ad	U	09:54	45
08/12/2020	1	JC	1.CU011.2.1	WS	8	Ad	U	10:02	45
08/12/2020	1	JC	1.CU011.3.1	WS	6	Ad	U	11:12	30
21/01/2021	2	JC	2.CU019.1.1	L.	13	U	U	11:55	90
11/03/2021	2	AK	2.CU033.1.1	HH	1	U	F	10:45	30
12/03/2021	1	AK	1.CU034.1.1	HH	1	U	F	11:31	30

Table A4- 3
Flight Activity secondary target species

Date	VP	Survey start	Survey end	5 min period start time	5 min period end time	Species	Count Max	Location (on site, in buffer, or beyond)
06/10/2020	1	10:00	13:00	11:20	11:25	RN	1	Buffer
06/10/2020	1	10:00	13:00	12:20	12:35	BZ	2	Buffer
06/10/2020	1	10:00	13:00	12:45	12:50	BZ	2	Buffer
06/10/2020	2	13:30	16:10	13:40	13:45	BZ	1	Buffer
06/10/2020	2	13:30	16:10	14:40	14:45	BZ	2	Buffer
06/10/2020	2	13:30	16:10	14:50	14:55	BZ	2	Buffer
06/10/2020	2	13:30	16:10	16:10	16:15	RN	2	Buffer
06/10/2020	2	13:30	16:10	16:10	16:15	RN	2	Buffer
05/11/2020	2	09:30	12:30	09:50	09:55	BZ	2	Buffer
05/11/2020	2	09:30	12:30	11:10	11:15	RN	1	Buffer
05/11/2020	1	13:00	16:00	13:20	13:25	RN	1	Beyond
25/11/2020	2	09:40	12:40	09:40	09:45	K.	1	Beyond
25/11/2020	2	09:40	12:40	10:50	10:55	RN	1	Buffer
25/11/2020	2	09:40	12:40	11:05	11:10	RN	2	Buffer
25/11/2020	2	09:40	12:40	11:30	11:35	BZ	1	Buffer
25/11/2020	1	13:15	16:15	14:25	14:30	BZ	1	Buffer
25/11/2020	1	13:15	16:15	14:25	14:30	BZ	2	Buffer
25/11/2020	1	13:15	16:15	14:35	14:40	BZ	2	Buffer
25/11/2020	1	13:15	16:15	15:05	15:10	RN	1	Buffer
25/11/2020	1	13:15	16:15	15:20	15:25	RN	1	Buffer

Date	VP	Survey start	Survey end	5 min period start time	5 min period end time	Species	Count Max	Location (on site, in buffer, or beyond)
08/12/2020	1	09:25	12:25	12:00	12:05	BZ	1	Buffer
08/12/2020	1	09:25	12:25	12:55	13:00	K.	1	Buffer
08/12/2020	2	12:55	15:55	13:00	13:05	RN	1	Buffer
08/12/2020	2	12:55	15:55	13:10	13:15	RN	1	Buffer
08/12/2020	2	12:55	15:55	14:55	15:00	RN	1	Buffer
09/12/2020	1	12:45	15:45	11:05	11:10	K.	1	Buffer
09/12/2020	1	12:45	15:45	14:40	14:45	RN	2	Buffer
09/12/2020	1	12:45	15:45	14:50	14:55	RN	2	Beyond
09/12/2020	1	12:45	15:45	15:05	15:10	BZ	1	Buffer
20/01/2021	1	10:20	13:20	10:20	10:25	RN	2	Buffer
20/01/2021	1	10:20	13:20	10:20	10:25	K.	1	Buffer
20/01/2021	1	10:20	13:20	10:35	10:40	RN	2	Beyond
20/01/2021	1	10:20	13:20	11:20	11:25	BZ	2	Buffer
20/01/2021	1	10:20	13:20	11.55	12:00	K.	1	Beyond
20/01/2021	1	10:20	13:20	12:30	12:35	BZ	1	Buffer
20/01/2021	1	10:20	13:20	12:35	12:40	BZ	2	Buffer
20/01/2021	1	10:20	13:20	13:05	13:10	BZ	2	Buffer
20/01/2021	2	13:50	16:50	14:30	14:35	BZ	1	Buffer
20/01/2021	2	13:50	16:50	15:10	15:15	SH	1	Buffer
20/01/2021	2	13:50	16:50	15:30	15:35	BZ	2	Buffer
20/01/2021	2	13:50	16:50	15:55	16:00	BZ	2	Buffer
20/01/2021	2	13:50	16:50	16:20	16:25	BZ	2	Buffer

Date	VP	Survey start	Survey end	5 min period start time	5 min period end time	Species	Count Max	Location (on site, in buffer, or beyond)
21/01/2021	2	09:30	12:30	10:25	10:30	K.	1	Buffer
21/01/2021	2	09:30	12:30	10:35	10:40	K.	1	Buffer
21/01/2021	2	09:30	12:30	11:00	11:05	BZ	2	Buffer
21/01/2021	2	09:30	12:30	11:10	11:15	BZ	2	Buffer
09/02/2021	1	10:20	13:20	12:00	12:05	RN	2	Buffer, Beyond
09/02/2021	1	10:20	13:20	12:15	12:20	RN	1	Buffer
09/02/2021	1	10:20	13:20	12:20	12:25	BZ	1	Buffer
09/02/2021	1	10:20	13:20	13:15	13:20	RN	1	Buffer
09/02/2021	1	10:20	13:20	13:15	13:20	BZ	2	Buffer
09/02/2021	2	13:55	16:55	14:25	14:30	H.	1	Buffer
09/02/2021	2	13:55	16:55	14:55	15:00	RN	1	Buffer
09/02/2021	2	13:55	16:55	15:45	15:50	BZ	2	Buffer
09/02/2021	2	13:55	16:55	16:00	16:05	BZ	1	Buffer
10/02/2021	2	09:00	12:00	10:10	10:15	MA	1	Buffer, Beyond
10/02/2021	2	09:00	12:00	10:35	10:40	RN	1	Buffer
11/02/2021	1	11:30	14:30	11:25	11:30	BZ	1	Buffer
11/02/2021	1	11:30	14:30	11:25	11:30	BZ	2	Buffer
11/02/2021	1	11:30	14:30	11:30	11:35	BZ	2	Buffer
11/02/2021	1	11:30	14:30	12:05	12:10	RN	1	Buffer, Beyond
11/02/2021	1	11:30	14:30	12:25	12:30	BZ	1	Buffer
10/03/2021	2	13:00	16:00	13:20	13:25	BZ	1	Beyond
10/03/2021	2	13:00	16:00	13:35	13:40	BZ	1	Beyond

Date	VP	Survey start	Survey end	5 min period start time	5 min period end time	Species	Count Max	Location (on site, in buffer, or beyond)
10/03/2021	2	13:00	16:00	14:30	14:35	BZ	1	Beyond
10/03/2021	2	13:00	16:00	14:35	14:40	K.	1	Buffer
10/03/2021	2	13:00	16:00	15:05	15:10	BZ	1	Buffer
10/03/2021	2	13:00	16:00	15:15	15:20	K.	1	Buffer
11/03/2021	1	13:30	16:30	13:40	13:45	BZ	1	On site, buffer
11/03/2021	1	13:30	16:30	13:45	13:50	BZ	2	On site
11/03/2021	1	13:30	16:30	14:00	14:05	BZ	2	On site
11/03/2021	1	13:30	16:30	14:10	14:15	BZ	1	Buffer
11/03/2021	1	13:30	16:30	15:00	15:05	BZ	1	Buffer
11/03/2021	1	13:30	16:30	15:10	15:15	BZ	1	Buffer
11/03/2021	1	13:30	16:30	15:30	15:35	BZ	2	On site, buffer
11/03/2021	1	13:30	16:30	15:40	15:45	BZ	3	Buffer
11/03/2021	1	13:30	16:30	15:45	15:50	BZ	3	Buffer
11/03/2021	1	13:30	16:30	16:10	16:15	BZ	2	Buffer
11/03/2021	2	09:45	12:45	10:30	10:35	BZ	1	Buffer, beyond
11/03/2021	2	09:45	12:45	10:40	10:45	BZ	1	Buffer
11/03/2021	2	09:45	12:45	11:00	11:05	RN	1	Beyond
11/03/2021	2	09:45	12:45	11:00	11:05	BZ	2	On site, buffer
11/03/2021	2	09:45	12:45	12:00	12:05	RN	1	Beyond
12/03/2021	1	09:30	13:00	10:20	10:25	K.	1	Beyond
12/03/2021	1	09:30	13:00	10:45	10:50	BZ	1	Beyond
12/03/2021	1	09:30	13:00	10:50	10:55	BZ	1	On site, buffer

Date	VP	Survey start	Survey end	5 min period start time	5 min period end time	Species	Count Max	Location (on site, in buffer, or beyond)
12/03/2021	1	09:30	13:00	11:35	11:40	BZ	1	On site, buffer
12/03/2021	1	09:30	13:00	12:30	12:35	BZ	1	Buffer
12/03/2021	1	09:30	13:00	12:35	12:40	BZ	2	On site, buffer

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BIRD SURVEY REPORT

BREEDING 2021 AND NON-BREEDING 2021/22

Cush Wind Farm

Prepared for: Galetech Energy Developments

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APPENDICES

Appendix 01: Figures
Appendix 02: Survey dates times and observers
Appendix 03: Weather data
Appendix 04: Flight activity survey data

1.0 Introduction

Bird surveys have been previously undertaken at the proposed wind farm development site at Cush, Co. Offaly (hereafter 'the Project Site') by SLR Consulting Ireland (SLR) for the breeding 2020 and non-breeding 2020/21 seasons. The Project Site also includes a linear area that was previously surveyed for a proposed overhead line[1]. Flight activity surveys were carried out at two vantage point locations along the proposed overhead line route corridor during the breeding season in 2018.

SLR was commissioned by Galetech Energy Developments to carry out a bird survey programme for the proposed wind farm at Cush, Co. Offaly (hereafter 'the Project') during the breeding season in 2021 and non-breeding season in 2021/22.

1.1 Background to the Commission

No previous planning permission has been sought on the application site for the development of wind farms by Galetech Energy Developments or any other party.

1.2 Site Description

The Project site located in the townland of Cush approximately 4 km north of Birr, Co. Offaly. The habitats within the proposed development site are dominated by conifer plantations of varying age classes (c.327 ha), cutaway bog (c.102 ha) and agricultural grasslands (ca. 327 ha; refer to Appendix 01 **Figure 1**).

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[2], with details provided in **Table 1-1**. Due to the proximity of designated sites that support Greenland white-fronted goose (*Anser albifrons flavirostris*) and whooper swan (*Cygnus cygnus*), feeding distribution surveys were undertaken as recommended by NS guidelines. Hen harrier *Circus cyaneus* winter roost surveys were added to the scope of work following a few sightings of foraging harriers in the non-breeding season. Further details are provided in Sections 2.2 to 2.7

Table 1-1
Scope of Ornithological Survey Work April 2021 to March 2022

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 two VPs between April 2021 and March 2022 inclusive.
Breeding wader surveys	Three breeding wader surveys were carried out from May to June 2021 to search for lowland waders breeding within the Project Site.

[1] SLR (2018) *Cloghan Wind Farm and Long Oak Wind Farm Breeding Bird Survey Report 2018*. Prepared for Galetech Energy Services Ltd

[2] 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	Five breeding raptor surveys were carried out from May to July to search for any raptors breeding within 2 km of the Project Site.
Feeding distribution surveys	Feeding distribution surveys were carried out on a twice-monthly basis during the period October 2021 to March 2022 to search for swans and/or geese using the fields for foraging within 500 m of the Project Site.
Hen harrier winter roost surveys	Three monthly surveys were undertaken between January to March 2022 from a VP that provided coverage of possible roosting habitat within the NE of 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[3]. 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[4]; and
- Other raptors, waders or wildfowl red-listed on the latest Birds of Conservation Concern in Ireland (BoCCI)[5] 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;

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

- Common buzzard *Buteo buteo;*
- Eurasian sparrowhawk *Accipiter nisus*;
- Northern raven *Corvus corax*;
- Grey heron *Ardea cinerea;*
- Great cormorant *Phalacrocorax carbo;* and
- Gulls *Larus 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 i.e. the total number of flights for all surveys in a given season added together. It does not equate to the total number of unique individuals and should not be used to infer abundance.

1.6 Purpose of this Report

This report outlines the surveys undertaken and methods used. It then summarises the survey data obtained and provides descriptions of the legal and conservation status of the species recorded.

The assessment of impacts resulting from the proposed development and the development of mitigation measures, if required, are beyond the scope of this report and will be covered in a separate Environmental Impact Assessment (EIA) Report in due course.

2.0 Methods

2.1 Desk-Based Review

The desk review collated any available information to date on the breeding and non-breeding bird populations and movements around the Project site.

The following reports resulting from previous breeding and non-breeding bird surveys were reviewed for any relevant information that could be used to inform the current bird surveys:

- SLR (2020) Cush Wind Farm Breeding Bird Survey Report 2020.
- SLR (2022) Cush Wind Farm Winter Bird Survey Report 2020-2021.
- SLR (2018) Cloghan Wind Farm and Long Oak Wind Farm Breeding Bird Survey Report 2018

The websites of the National Parks and Wildlife Service (NPWS)[6], the UK and Ireland Bird Atlas 2007-2011[7] and the National Biodiversity Data Centre (NBDC)[8] were accessed for information on sites designated for nature conservation and notable bird species in the vicinity of the Project Site.

2.2 Field Survey Dates and Personnel

Surveys were undertaken by Jason Cahill (JC) BSc (Hons), Aisling Kinsella (AK) BSc (Hons) MSc and Faolan Linnane (FL) BSc (Hons) MSc.

Details of survey dates and times are provided in Appendix 02 and a record of weather conditions during surveys is provided in Appendix 03.

2.3 Flight Activity Surveys

VP locations, 2 km viewing arcs and viewsheds are shown in Appendix 01 **Figure 1**.

A total of 144 hours of flight activity surveys were conducted from both VP locations combined during the 2021 breeding season and 2021/2022 winter season, as summarised in **Table 2-1**.

In order to avoid possible complications during any subsequent collision risk modelling, VP watches were timed such that surveys were not undertaken simultaneously from both VPs. This avoids double-counting birds and ensures that no disturbance is made to birds within viewsheds from presence of the observer.

VP watches 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 Project Site;
- The relative use by birds of different parts of the Project Site;

[6] www.npws.ie Accessed 16/10/2022
[7] https://app.bto.org/mapstore/StoreServlet Accessed 16/10/2022
[8] http://maps.biodiversityireland.ie/#/Map Accessed 16/10/2022

- 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);
- Number of birds observed;
- 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. For the breeding season, height bands were determined based on turbine specifications allowing for the maximum rotor tip height of 150 m and the lowest rotor swept height of 50 m. Following the completion of breeding season, additional information was made available on the likely turbine dimensions. Height bands were updated allowing for the maximum rotor tip height of 200 m and a lowest rotor swept height of 28 m. The relation of the height bands to the latest turbine specification is shown below.

Flight heights were attributed to four distinct height bands for the breeding season as follows:

- 1 = <25 m (below the likely rotor swept area);
- 2 = 25 m to 50 m (potentially within the likely rotor swept area, at least in part);
- 3 = 50 m to 150 m (within the likely rotor swept area); and
- 4 = >150 m (potentially within the likely rotor swept area, at least in part).

Flight heights were therefore attributed to four distinct height bands for the non-breeding season as follows:

- 1 = < 20 m (below the likely rotor swept area);
- 2 = 20 m to 150 m (potentially within the likely rotor swept area, at least in part);
- 3 = 150 m to 200 m (within the likely rotor swept area); and
- 4 = > 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 and around the Project Site, in accordance with current NS guidance.

Table 2-1
Summary of VP Surveys Undertaken, Breeding Season 2021 and Non-Breeding Season 2021-22

VP Number	Co-ordinates (ITM)	Hours of Survey Completed													
		Breeding season 2021							Non-Breeding Season 2021/22						
		Apr	May	June	July	Aug	Sept[9]	**Total**	Oct	Nov	Dec	Jan	Feb	Mar	**Total**
1	664276 E 644585 N	6	6	6	6	6	6	36	6	6	6	6	6	6	36
2	661361 N 646428 N	6	6	6	6	6	6	36	6	6	6	6	6	6	36

[9] While it is unlikely birds were breeding in September, it has been included here as part of the survey effort for the breeding season.

2.4 Breeding Wader Surveys

Breeding wader surveys followed the methodology described in O'Brien and Smith (1992)[10]. The survey involved a walked transect which covered all habitat potentially suitable for breeding waders within the Project Site.

There are large plantations of mature conifer forestry in the central, western, and southern areas of the Project Site. These habitats are not suitable for breeding waders[11] and so were excluded from the survey. There are some areas of recolonising cutover bog which were as considered suitable habitats for breeding waders. As such, transects were undertaken where habitats which are more suited to breeding waders. These transects are located in the western, eastern and northern sections of the Project Site where semi-natural and wet grassland fields are present and also, passing near to areas of recolonising cutover bog.

The transect route was repeated three times across the 2021 breeding season on 13th May, 1st June and 17th June.

The location, movement and behaviour of all wader species were recorded onto field maps using standard BTO species codes. The following criteria was 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).

For birds to be considered as "confirmed breeding", one or more of the following criteria needed to be met:

- 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.

Please see Appendix 01 **Figure 3** for an outline of the walked transect and Appendices 02 and 03 for metadata relating to these surveys.

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[10] 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

[11] Apart from potentially for woodcock, which were not the target of surveys here.

2.5 Breeding Raptor Surveys

The survey methodology for breeding raptors used was a driven transect with regular stops, to carry out watches of suitable habitat from appropriate viewpoints to identify potential nesting territories in suitable breeding habitat[12]. The locations of these viewpoints are presented in Appendix 01 **Figure 4** together with the outline of the driven survey route and the results of the surveys.

A driven survey was used due to limitations to access to third party land within the 2 km buffer zone and the availability of a good road network in the vicinity of the Project Site. Visibility from the survey route was sufficient to cover the vast majority of potentially suitable breeding habitat within the survey area.

Survey timings followed NS guidelines. This survey was repeated along the same routes on 13th April, 1st June, 16th June, 19th and 20th July. Details of survey dates, times and observers are provided in Appendix 02 and a record of weather conditions during surveys is provided in Appendix 03.

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

2.6 Feeding Distribution Surveys

NS guidance recommends that for whooper swan, Greenland white-fronted goose 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. As there are SPAs for swans and geese located close to the Project Site, feeding distribution surveys were undertaken.

A buffer of 500 m around the Project Site was used for these surveys, which were undertaken by driven transects twice per month, stopping on a regular basis to check all fields for goose and swan feeding activity. The transect route is shown in Appendix 01 **Figure 5**, survey dates in Appendix 02, weather conditions in Appendix 03 and survey results are shown in Appendix 04.

2.7 Hen Harrier Winter Roost Surveys

NS guidance states surveys should be carried out at potential communal hen harrier roost sites within 2 km of the Project Site. A handful of hen harrier sightings (foraging birds only) were made in the previous winter season (2020/21) and one more was made in October 2021. Consequently, monthly surveys were carried out from January 2021 to March 2022 to determine whether harriers were roosting in the survey area.

The only suitable habitat that could be used for roosting was in the northeast of the Project Site where cutover bog had recolonised into scrubbier vegetation. An additional VP location was chosen to provide coverage of this area (refer to Appendix 01 **Figure 6**) and surveys were undertaken 40 minutes prior to subset following the Irish hen harrier winter survey methodology[13].

2.8 Survey Limitations

With regard to viewshed coverage of the 500 m Project Site infrastructure buffer, some gaps are apparent due to the terrain; however, these are relatively small and most lie within the buffer rather than within the Project

[12] Hardey, J., Crick, H.Q.P., Wernham, C., Riley, H., Etheridge, B., Thompson, D. (2013). Raptors: A field guide for surveys and monitoring (3rd Edition). The Stationery Office Edinburgh.
[13] http://ihhws.ie/ . Accessed 25/07/2022.

Site itself (refer to Appendix 01 **Figure 1**). Overall, it is considered that the vantage point data are representative of the Project Site as a whole and sufficient to inform a robust assessment of the Project.

There were intermittent periods of poor visibility during some surveys i.e. less than 1 km. This corresponded to 1 hour out of 72 (1.4%) in the breeding season and 5 hours out of 72 (6.9%) in the non-breeding season. However, these conditions were not persistent through the affected surveys and target species were still recorded. Therefore, these conditions are not considered to be significant limitations to the survey data obtained.

3.0 Results

3.1 Desk Based Results

The Project Site is not within or immediately adjacent to any SPA. However, there are a total of seven SPAs within a 20 km[14] radius with details shown in **Table 3-1**.

The closest SPAs to the Project Site are Dovegrove Callows SPA (Site Code: 004137), River Little Brosna Callows SPA (Site Code: 004086) and All Saints Bog SPA (Site Code: 004103) at distances of 1.5 km, 3.1 km and 3.1 km, respectively. Dovegrove Callows SPA and All Saints Bog SPA are designated for the protection of Greenland white-fronted geese, whereas the River Little Brosna Callows SPA is designated for a number of gull, wader and wildfowl species.

Table 3-1
SPAs within 20km of the Project Site and their Qualifying Interests (Species Present During the Breeding and Non-Breeding Season)

Site Name	Site Code	Distance/Direction from Site Boundary	Species of Special Conservation Interest
Dovegrove Callows SPA	004137	1.5 km southwest	• Greenland white-fronted goose
All Saints Bog SPA	004103	3.1 km west	• Greenland white-fronted goose
River Little Brosna Callows SPA	004086	3.1 km west	• Whooper swan • Eurasian wigeon *Mareca penelope* • Eurasian teal *Anas crecca* • Northern pintail *Anas acuta* • Northern shoveler *Anas clypeata* • Northern lapwing • European golden plover *Pluvialis apricaria* • Black-tailed godwit *Limosa limosa* • Black-headed gull *Chroicocephalus ridibundus* • Greenland white-fronted goose
Middle Shannon Callows SPA	004096	6.6 km northwest	• Whooper swan • Eurasian wigeon • Corncrake *Crex crex* • European golden plover • Northern lapwing • Black-tailed godwit • Black-headed gull
Slieve Bloom Mountains SPA	004160	11.7 km east	• Hen harrier

[14] A 20km search radius was used as this represents the maximum core foraging distance used by Qualifying Interest species of SPAs in the UK and Ireland

Site Name	Site Code	Distance/Direction from Site Boundary	Species of Special Conservation Interest
River Suck Callows SPA	004097	17.3 km northwest	• Whooper swan • Eurasian wigeon • European golden plover • Northern lapwing • Greenland white-fronted goose
Lough Derg (Shannon) SPA	004058	17.5 km southwest	• Great cormorant *Phalacrocorax carbo* • Tufted duck *Aythya fuligula* • Common goldeneye *Bucephala clangula* • Common tern *Sterna hirundo*

3.2 Breeding Season Flight Activity Surveys

Flight activity recorded from VP1 and VP2 combined by primary target species is summarised in **Table 3-2**. Primary target species flights from both VPs are shown in Appendix 01 Figures **2.1** to **2.4**. Flight activity data are provided in more detail in Appendix 04 with full data retained in GIS and excel format for subsequent collision risk modelling.

3.2.1 Primary Target Species

A total of 75 flights by five primary target species were recorded between April and September 2021.

Table 3-2
Number of Primary Target Species Flights from VP1 and VP2 Combined, April 2021 – September 2021

Species	Number of flight lines by month							Time at risk height* (s)	Cumulative number of birds recorded in flight
	April	May	June	July	August	September	**Total**		
Black-headed gull	15	0	21	6	0	0	**42**	4,185	81
European golden plover	1	0	0	0	0	0	**1**	120	5
Common kestrel *Falco tinnunculus*	2	0	0	2	1	2	**7**	420	7
Northern lapwing	11	0	7	4	1	1	**24**	1,080	37
Common snipe	0	0	1	0	0	0	**1**	0	1
Total	**29**	**0**	**29**	**12**	**2**	**3**	**75**	**5,805**	**131**

A summary description of flight activity by each species is presented below.

Black-Headed Gull

Black-headed gull flights were recorded in April, June and July 2022. The majority of flights consisted of single birds commuting low over improved agricultural grasslands and cutover bog, although there were a few of larger groups of birds (up to 14 flights per flight line).

European Golden Plover

A single European golden plover flight line was recorded in April 2022 only. This consisted of five birds and it is likely the species was transiting through the area.

Common Kestrel

Common kestrel was recorded in the months of April, July, August and September 2022. This consisted of a few flight lines of single birds hunting over the Project Site, mainly in the southwest.

Northern Lapwing

Northern lapwings were recorded in every month except May 2022. Most flight lines were recorded at VP1, which overlooks an area of recolonising cutover bog where lapwing have nested historically.

Common Snipe

A single snipe flight line was recorded in June 2022 only, with the solitary bird staying low (height band 1) and flying for 15 seconds over an agricultural field.

3.2.2 Secondary Target Species

Six secondary species were recorded, as follows (in order of frequency). A monthly breakdown is provided in

Table 3-3.

- Common buzzard: Recorded in every month, mostly of two birds observed at any one time. Most frequently seen circling.
- Northern raven: Recorded in every month except June 2021, frequently undertaking passage flights, occasionally in small groups.
- Common gull *Larus canus*: Recorded in every month except May and June 2021. Most frequently observed as single birds in the fields surrounding the Project Site.
- Grey heron: Recorded in every month except June 2021. Typically seen as a single bird commuting within the Project Site.
- Lesser black-backed gull *Larus fuscus*: Recorded in June-August 2021 in very low numbers. No observations were within the Project Site.
- Herring gull *Larus argentatus*: Recorded in May and August 2021, all as single birds transiting through the Project Site.
- Mallard *Anas platyrhynchos*: Two observations were made in April 2021, of a pair and a trio flying across the Project Site.
- Eurasian sparrowhawk: Single birds were recorded in August and September 2021 hunting within and adjacent to the Project site.
- Great black-backed gull *Larus maritimus*: A single observation was recorded in June 2021 of four birds transiting within the Project Site.

Table 3-3
Number of Secondary Target Species from VP1 and VP2 Combined, April 2021 – September 2021

Species	Number of 5-minute periods recorded by month							Peak count of birds recorded in any 5-minute period by month						
	April	May	June	July	August	September	**Total**	April	May	June	July	August	September	**Max**
Common buzzard	8	9	7	8	5	1	**38**	2	2	3	2	2	1	**3**
Northern raven	2	6	0	2	7	3	**20**	1	2	0	1	14	2	**14**
Common gull	1	0	0	6	1	3	**11**	1	0	0	2	1	26	**26**
Grey heron	2	1	0	1	2	1	**7**	1	1	0	2	2	1	**2**
Lesser black-backed gull	0	0	1	1	1	0	**3**	0	0	1	1	4	0	**4**
Herring gull	0	2	0	0	1	0	**3**	0	1	0	0	1	0	**1**
Mallard	2	0	0	0	0	0	**2**	3	0	0	0	0	0	**3**
Eurasian sparrowhawk	0	0	0	0	1	1	**2**	0	0	0	0	1	1	**1**
Great black-backed gull	0	0	1	0	0	0	**1**	0	0	4	0	0	0	**4**

3.3 Non-Breeding Season Flight Activity Surveys

Flight activity recorded from VP1 and VP2 combined by primary target species is summarised in **Table 3-4**. Primary target species flights from both VPs are shown in Appendix 01 Figures **2.1** to **2.4**. Flight activity data are provided in more detail in Appendix 04 with full data retained in GIS and excel format for subsequent collision risk modelling.

3.3.1 Primary Target Species

A total of 48 flights by 8 primary target species were recorded between October 2021 and March 2022.

Table 3-4
Number of Primary Target Species Flights from VP1 and VP2 Combined, October 2021 – March 2022

Species	Total number of flight lines by month							Time at risk height* (s)	Cumulative number of birds recorded in flight
	October	November	December	January	February	March	**Total**		
Black-headed gull	0	0	6	0	0	1	**7**	510	78
European golden plover	0	0	0	2	0	0	**2**	690	>2,042
Hen harrier	1	0	0	0	0	1	**2**	810	2
Common kestrel	3	2	0	11	3	3	**22**	2,640	22
Northern lapwing	1	0	0	0	0	0	**1**	480	27
Peregrine falcon *Falco peregrinus*	0	1	1	1	1	5	**9**	2,700	9
Common snipe	3	0	0	0	0	0	**3**	90	17
Whooper swan	0	0	0	1	0	1	**2**	270	16
Total	**8**	**3**	**7**	**15**	**4**	**11**	**48**	**8,190**	**>2,213**
*Precautionary risk height assumed to be between 28 m – 200 m									

A summary description of flight activity by each species is presented below.

Black-Headed Gull

Black-headed gull flight lines were recorded in December 2021 and March 2022. The majority of flight lines consisted of small flocks of birds transiting over agricultural fields in the southwest of the Project Site.

European Golden Plover

Two European golden plover flight lines were recorded in January 2022 in the southwest of the Project Site. One comprised 42 flights and the other of >2,000 flights at an average height of 35 m. It is likely the species was transiting through the area, as they were never observed in the winter season again.

Hen Harrier

Two hen harrier flight lines were recorded – one in October 2021 and one in March 2022. Both were of single, ringtail birds. The March flight line was at heights of approximately 150 m and it is likely the bird was transiting through the area as opposed to using the habitats for hunting.

Common Kestrel

Common kestrels were recorded in all months except December 2021. All observations were of single birds and in most months, only a handful of flight lines were observed, with the exception of January 2022 where 11 flight lines were recorded. Kestrels were typically recorded flying at heights of 20 m, hunting over the Project Site.

Northern Lapwing

Northern lapwings were recorded in October 2021 only, consisting of a single flight line of 27 birds. This small flock flew into the northern part of the Project Site, circled and headed due north again.

Peregrine Falcon

Peregrines were recorded in all months except October 2021. All flight lines were of single birds and distributed across the entire Project Site at a variety of flight heights.

Common Snipe

Three flight lines of common snipe were recorded in October 2021 only. All flights were above agricultural fields in the east of the Project Site at heights of approximately 15 m.

Whooper Swan

Two flight lines of whooper swan were recorded, with one in January and the other in March 2022. Both were in the west of the Project Site and comprised of four and 12 flights, respectively, at average flight heights of 35 m.

3.3.2 Secondary Target Species

Six secondary species were recorded, as follows (in order of frequency). A monthly breakdown is provided in **Table 3-5**.

- Common buzzard: Recorded in every month, most frequently as two birds together. Most frequently seen circling.
- Northern raven: Recorded in every month, usually as a pair.
- Mallard: Recorded in October-December 2021 and March 2022 as pairs or in a small group.
- Great cormorant: Recorded in December 2021, and January and March 2021. Likely commuting to watercourses surrounding the Project Site.
- Eurasian sparrowhawk: Single birds were recorded in November and December 2021, hunting and commuting.
- Grey heron: Recorded in October 2021, and January-February 2022 as single birds commuting within and adjacent to the Project Site.
- Little egret *Egretta garzetta*: Recorded in December 2021 only, as single birds on the cutover bog within the Project Site.
- Common gull: Recorded in December 2021 only as a flock of eight birds transiting through the 500 m buffer and outside the Project Site.

Table 3-5
Number of Secondary Target Species from VP1 and VP2 Combined, October 2021 – March 2022

Species	Number of 5-minute periods recorded by month							Peak count of birds recorded in any 5-minute period by month						
	October	November	December	January	February	March	**Total**	October	November	December	January	February	March	**Max**
Common buzzard	12	2	3	6	10	17	**50**	2	2	2	1	3	5	**5**
Northern raven	2	2	9	6	4	2	**25**	2	1	2	2	2	2	**2**
Mallard	1	2	1	0	0	7	**11**	2	2	2	0	0	5	**5**
Great cormorant	0	0	3	3	0	5	**11**	0	0	2	1	0	1	**2**
Eurasian sparrowhawk	0	4	1	0	0	0	**5**	0	1	1	0	0	0	**1**
Grey heron	2	0	0	1	1	0	**4**	1	0	0	1	1	0	**1**
Little egret	0	0	4	0	0	0	**4**	0	0	1	0	0	0	**1**
Common gull	0	0	1	0	0	0	**1**	0	0	8	0	0	0	**8**

3.4 Breeding Wader Surveys

A total of two wader species were recorded during the breeding wader surveys.

Common Snipe

There were three snipe observations made near the northwest of the Project Site in May and June 2021; however, these were of individual birds flushed by surveyors and they were not observed 'drumming' or exhibiting any other kind of breeding behaviour.

Northern Lapwing

Three observations of lapwing were made during surveys in May 2021. One adult and two chicks were recorded in the east of the Project Site, with the other two observations consisting of a calling lapwing (heard not seen) and a flight line of an adult bird that had been foraging on an agricultural field outside the Project Site.

Incidental Records of Other Species

During the survey, the following incidental records were made of other (non-wader) species of conservation concern:

- Gulls: black-headed gulls and other gull species; and
- Raptors: common buzzard and common kestrel.

3.5 Breeding Raptor Surveys

A total of three species of raptor were recorded during the targeted breeding raptor surveys.

Common Buzzard

There were nine buzzard observations made between May-July 2021, but no confirmed evidence of breeding was recorded during these months.

It is likely that at least one pair held a territory to the west of the Project Site within the 2 km survey buffer, as an observation of two birds circling and calling together was made in June and another in July 2021 of two birds calling nearby.

All other observations were of birds either perched on trees/telegraph poles or circling.

Common Kestrel

Kestrel was observed hunting or perched on trees/telegraph poles during May-July 2021 on six occasions, but there was no evidence of breeding by this species within 2 km of the Project Site.

Peregrine Falcon

This species was recorded once in July 2021 hunting to the south of the Project Site, although the observation was sufficiently fleeting that the bird's sex was unconfirmed.

Incidental Records of Other Species

During the survey visits the following incidental records were made of other (non-raptor) species of conservation concern:

- Waders: grey heron and northern lapwing;
- Gulls: lesser black-backed gull; and
- Wildfowl: mallard.

3.6 Feeding Distribution Surveys

The feeding distribution surveys did not record any aggregations of swans or geese.

Incidental Records of Other Species

No other incidental records of other (non-swan/goose) species of conservation concern were made during surveys.

3.7 Hen Harrier Winter Roost Surveys

No evidence of hen harrier roosts (communal or solitary) was recorded during surveys.

Incidental Records of Other Species

During the survey visits the following incidental records were made of other (non-raptor) species of conservation concern:

- Waders: northern lapwing;
- Raptors: merlin *Falco columbarius*; and
- Wildfowl: mallard and great cormorant.

4.0 Summary and Conclusions

Flight activity surveys (VPs), breeding wader, breeding raptor, hen harrier winter roost and feeding distribution surveys for geese and swans, specifically Greenland white fronted geese and whooper swan, were carried out at the Project Site during the breeding 2021 and non-breeding 2021/22 seasons.

The following primary target species were recorded during the breeding season flight activity surveys:

- Black-headed gull;
- European golden plover;
- Common kestrel;
- Northern lapwing; and;
- Common snipe.

The following primary target species were recorded during the non-breeding fight activity surveys:

- Black-headed gull;
- European golden plover;
- Hen harrier;
- Common kestrel;
- Northern lapwing;
- Peregrine falcon;
- Common snipe; and
- Whooper swan.

The most frequent flight activity in both seasons was from black-headed gulls. However, the flight line with the largest number of individual flights was for European golden plover in January 2021 (>2,000 birds). This was likely a one-off observation of birds on passage, as no other large golden plover observations were recorded during surveys.

Eleven secondary target species were recorded across both seasons: common buzzard, northern raven, common gull, grey heron, lesser black-backed gull, herring gull, mallard, Eurasian sparrowhawk, great black-backed gull, great cormorant and little egret.

Breeding lapwing (one nest) were recorded in the east of the Project Site and common buzzards were suspected to breed (as evidenced by territories) in the west of the Project Site (at least one pair).

No aggregations of feeding swans or geese were recorded during dedicated feeding distribution surveys and no hen harrier roosts were detected during dedicated winter roost surveys.

Incidental records made of species of conservation concern during taxon-specific surveys included:

- Gulls: black-backed gull and lesser black-backed gull;
- Raptors: common buzzard, common kestrel and merlin;
- Waders: grey heron and northern lapwing; and
- Wildfowl: great cormorant and mallard.

4.1 Legal and Conservation Status of Target Species Recorded

Table 4-1 summarises the legal and conservation status of the primary and secondary target species recorded during the range of ornithological surveys mentioned above. Note that all bird species in Ireland are afforded general protection by the Wildlife Acts 2000 (as amended).

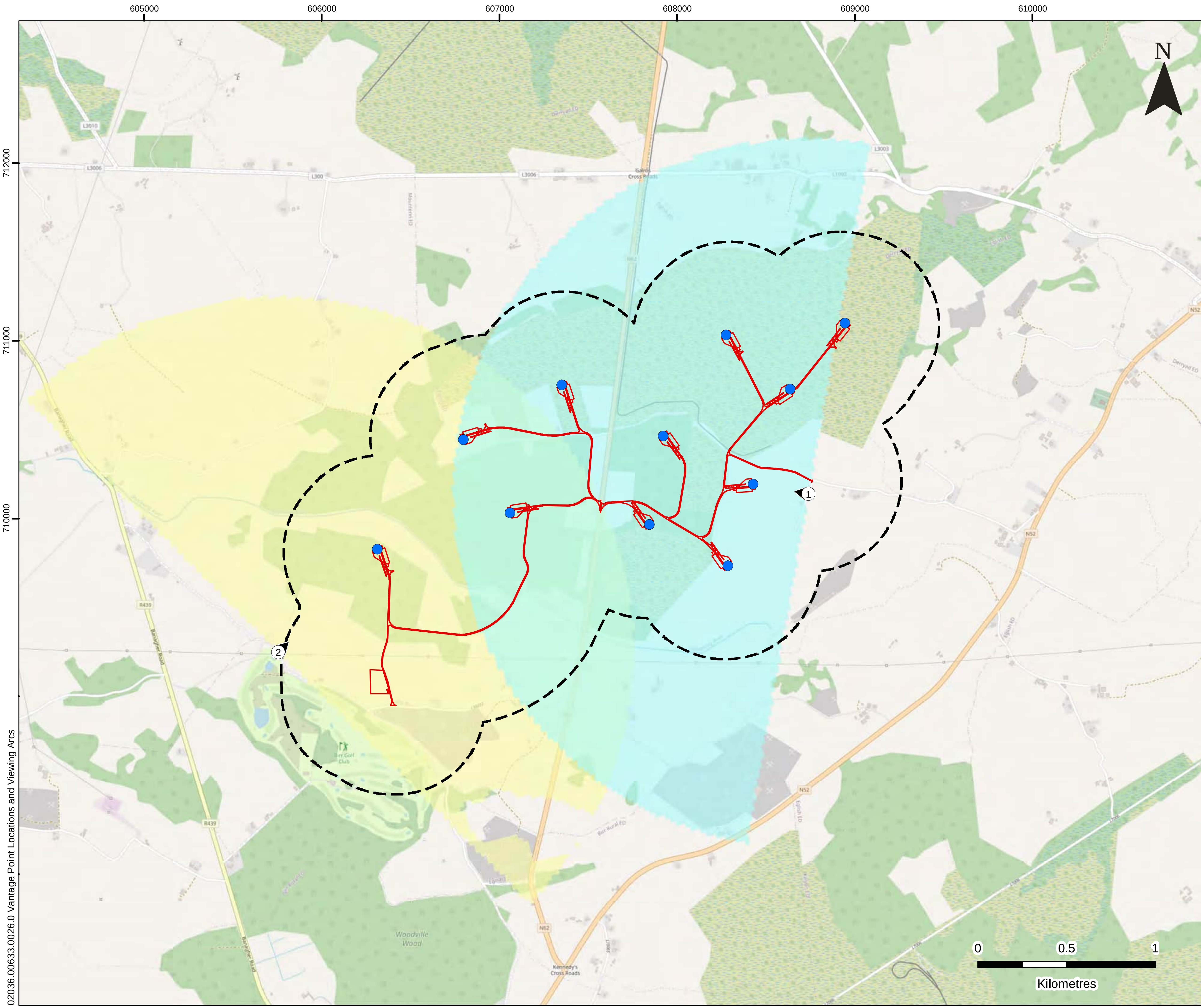
Table 4-1
Legal and Conservation Status of Target Species

Primary or Secondary Target	Species (BTO code)	Legal and Conservation status in Ireland
Primary	European golden plover (GP)	Annex 1, BoCCI4 Red
	Northern lapwing (L.)	BoCCI4 Red
	Common snipe (SN)	BoCCI4 Red
	Common kestrel (K.)	BoCCI4 Red
	Hen harrier (HH)	Annex 1, BoCCI4 Amber
	Whooper swan (WS)	Annex 1, BoCCI4 Amber
	Peregrine falcon (PE)	Annex 1, BoCCI4 Green
	Black-headed gull (BH)	BoCCI4 Amber
	Merlin (ML)	Annex 1, BoCCI4 Amber
Secondary	Common buzzard (BZ)	BoCCI4 Green
	Northern raven (RN)	BoCCI4 Green
	Common gull (CM)	BoCCI4 Amber
	Grey heron (H.)	BoCCI4 Green
	Lesser black-backed gull (LB)	BoCCI4 Amber
	Herring gull (HG)	BoCCI4 Amber
	Mallard (MA	BoCCI4 Amber
	Eurasian sparrowhawk (SH)	BoCCI4 Green
	Great black-backed gull (GB)	BoCCI4 Green

Primary or Secondary Target	Species (BTO code)	Legal and Conservation status in Ireland
	Great cormorant (CA)	BoCCI4 Amber
	Little egret (ET)	Annex 1, BoCCI4 Green
Key		WA - the species is afforded general protection by the Wildlife Acts 2000 (as amended); 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[5] status category.

Appendix 01

Figures



NOTES

1. The ZTV is calculated with a surface offset 20m & 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

- Site Infrastructure
- Site Infrastructure 500m Buffer
- Turbine Location
- Vantage Point
- Area Visible from Vantage Point 1
- Area Visible from Vantage Point 2

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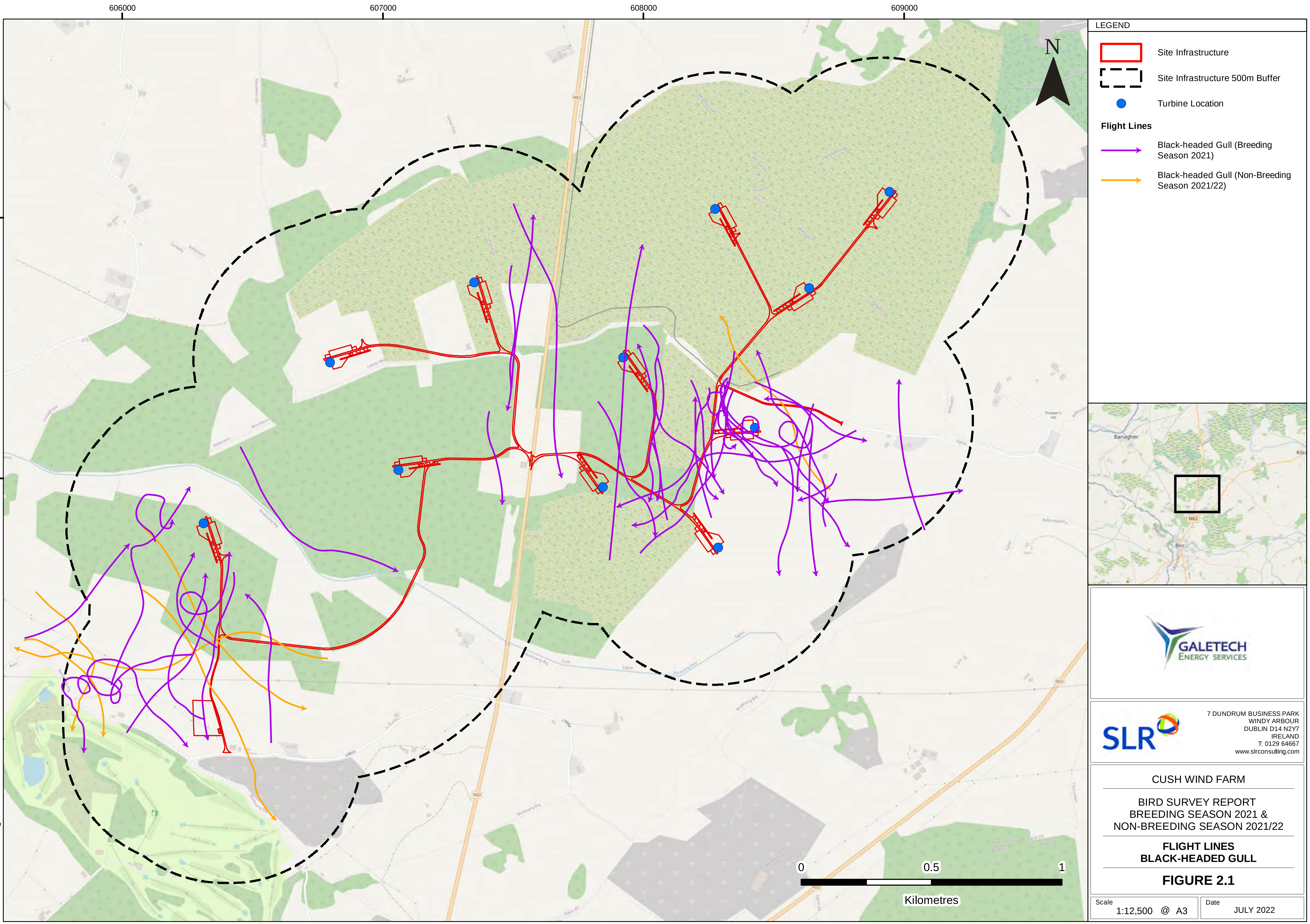
VANTAGE POINT LOCATIONS & VIEWING ARCS

FIGURE 1

Scale	Date
1:20,000 @ A3	JULY 2022

02036.00633.0026.0 Vantage Point Locations and Viewing Arcs


606000
607000
608000
609000
711000
710000
N
0
0.5
1
Kilometres
LEGEND
Site Infrastructure
Site Infrastructure 500m Buffer
Turbine Location
Flight Lines
Black-headed Gull (Breeding Season 2021)
Black-headed Gull (Non-Breeding Season 2021/22)
Banagher
Birr
N62
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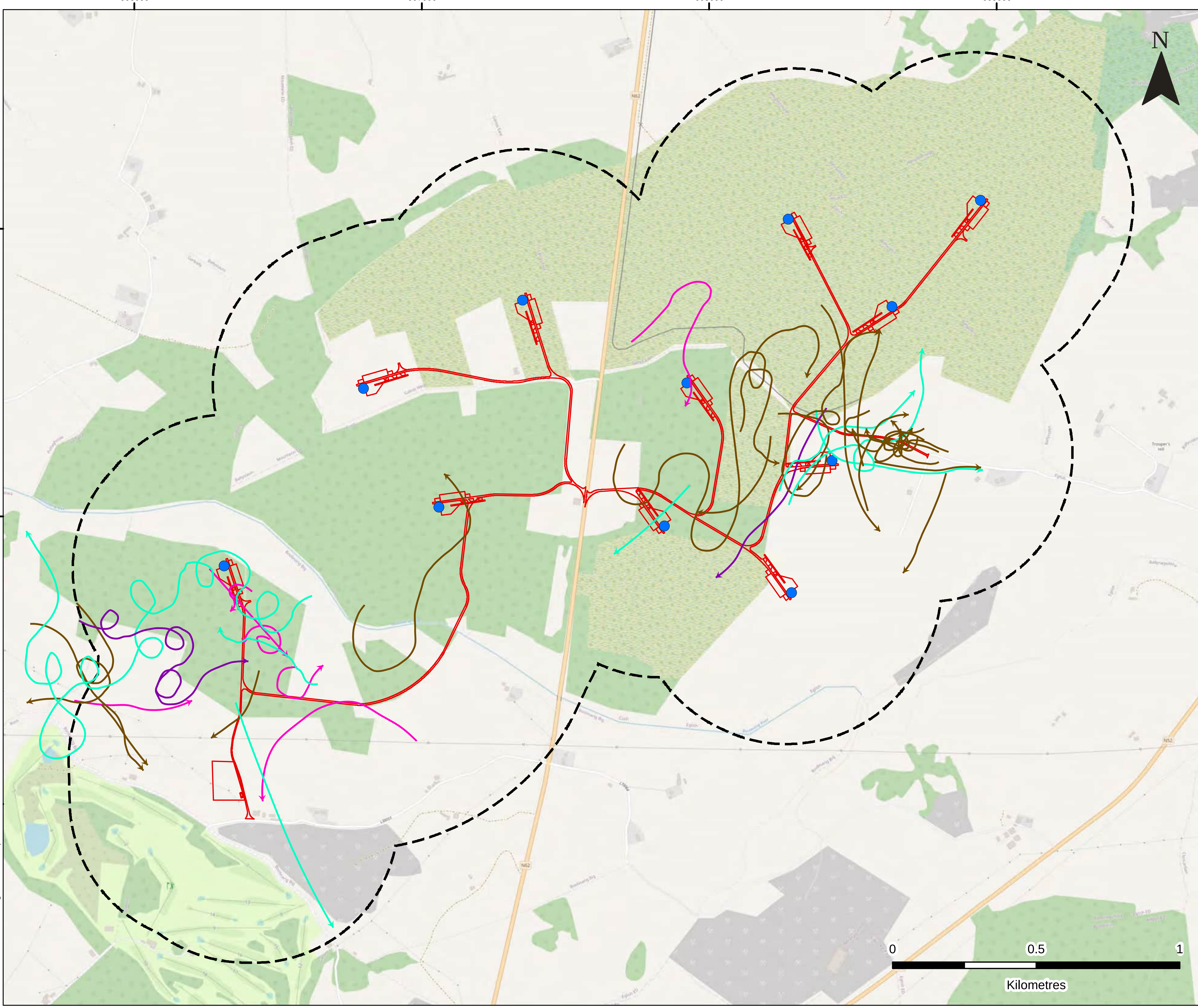
FLIGHT LINES
BLACK-HEADED GULL
FIGURE 2.1
Scale
1:12,500 @ A3
Date
JULY 2022
02036.00633.0019.0 Flight Lines Blackheaded Gull



LEGEND

Site Infrastructure

Site Infrastructure 500m Buffer

Turbine Location

Flight Lines

Kestrel (Breeding Season 2021)

Hen Harrier (Non-Breeding Season 2021/22)

Kestrel (Non-Breeding Season 2021/22)

Peregrine (Non-Breeding Season 2021/22)

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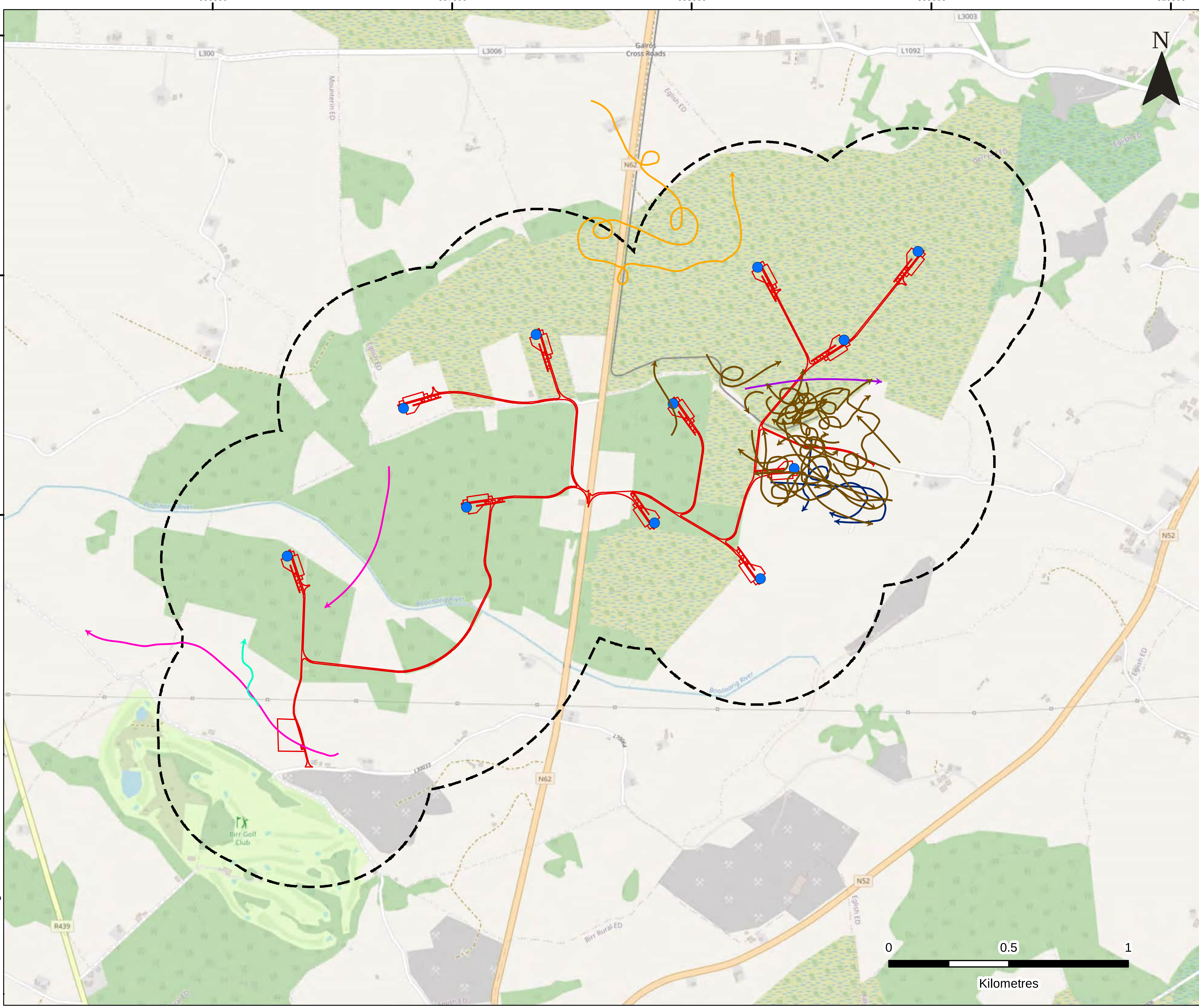
FLIGHT LINES RAPTORS

FIGURE 2.2

Scale	Date
1:12,500 @ A3	JULY 2022

02036.00633.0031.0 Flight Lines Raptors



LEGEND

Site Infrastructure

Site Infrastructure 500m Buffer

Turbine Location

Flight Lines

Golden Plover (Breeding Season 2021)

Lapwing (Breeding Season 2021)

Snipe (Breeding Season 2021)

Golden Plover (Non-Breeding Season 2021/22)

Lapwing (Non-Breeding Season 2021/22)

Snipe (Non-Breeding Season 2021/22)

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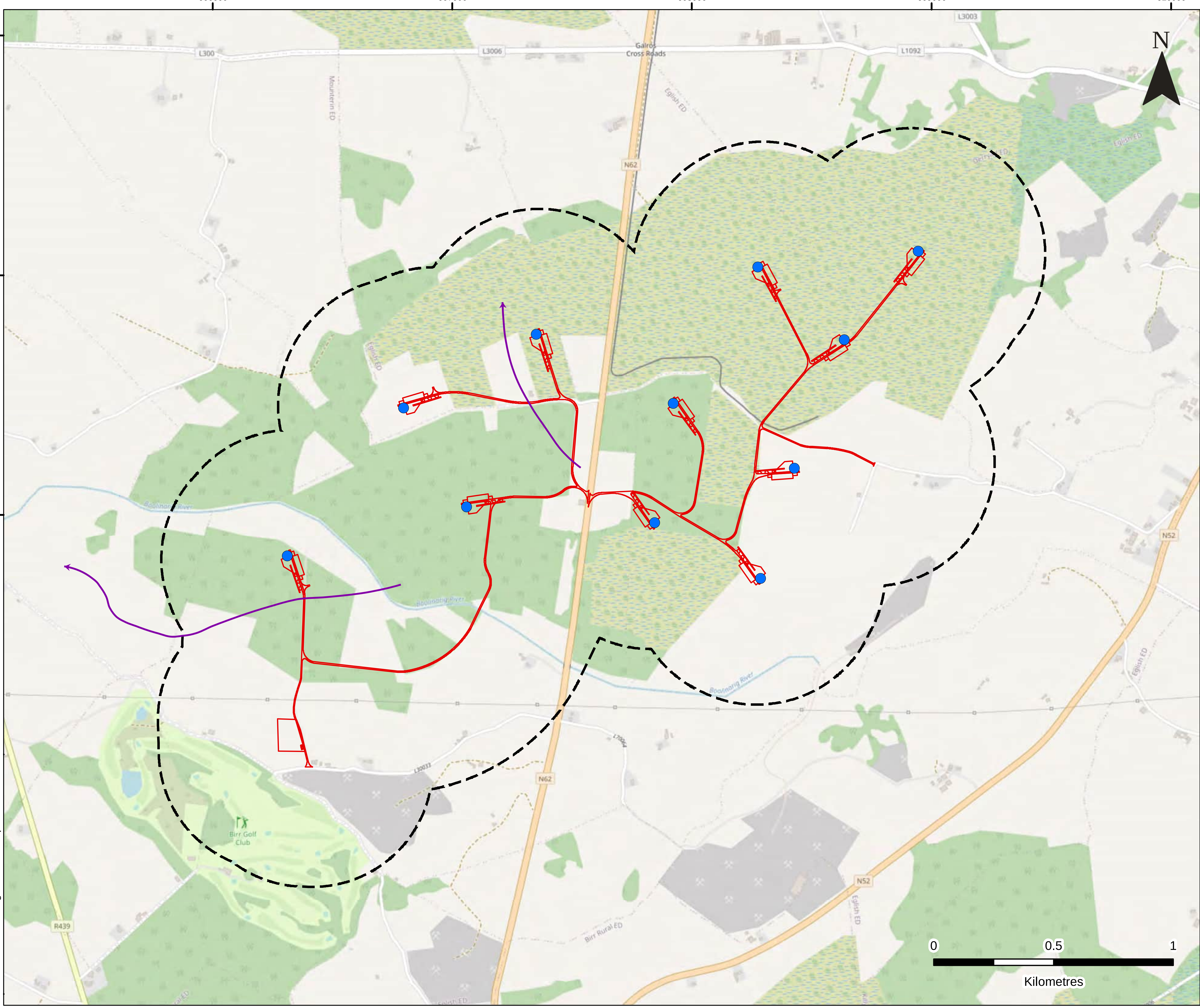
FLIGHT LINES WADERS

FIGURE 2.3

Scale 1:15,000 @ A3

Date JULY 2022

02036.00633.0020.0 Flight Lines Waders



LEGEND

Site Infrastructure

Site Infrastructure 500m Buffer

Turbine Location

Flight Lines

Whooper Swan (Non-Breeding Season 2021/22)

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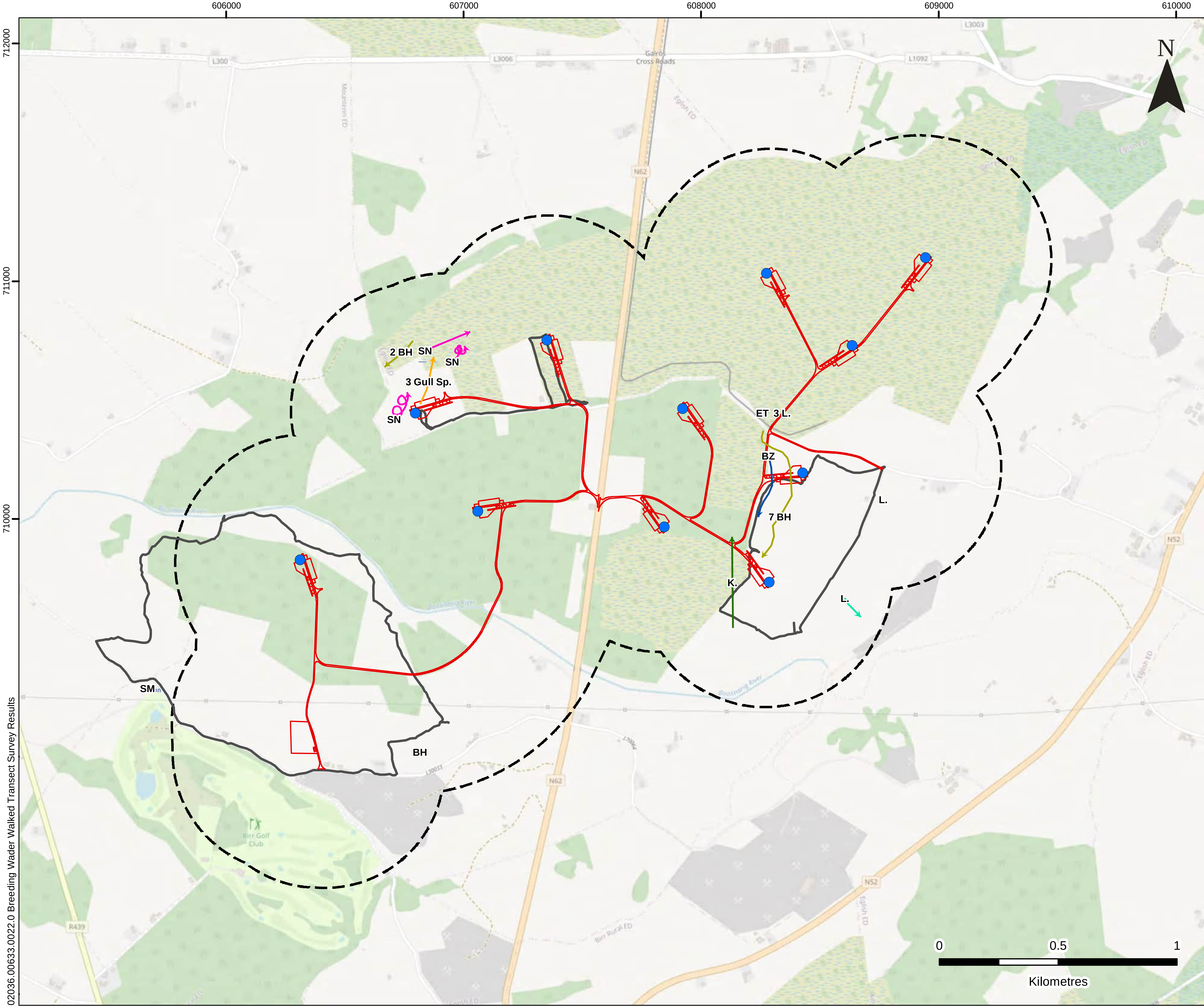
FLIGHT LINES WHOOPER SWAN

FIGURE 2.4

Scale	Date
1:15,000 @ A3	JULY 2022

02036.00633.0029.0 Flight Lines Whooper Swan



LEGEND

- Site Infrastructure
- Site Infrastructure 500m Buffer
- Turbine Location
- Transect Route

BTO Species Activity

- Calling
- on Occupied Nest with Adult

Wader Records

- Lapwing (L.)
- Snipe (SN)

Incidental Records

- Black-headed Gull (BH)
- Buzzard (BZ)
- Gull Sp.
- Kestrel (K.)

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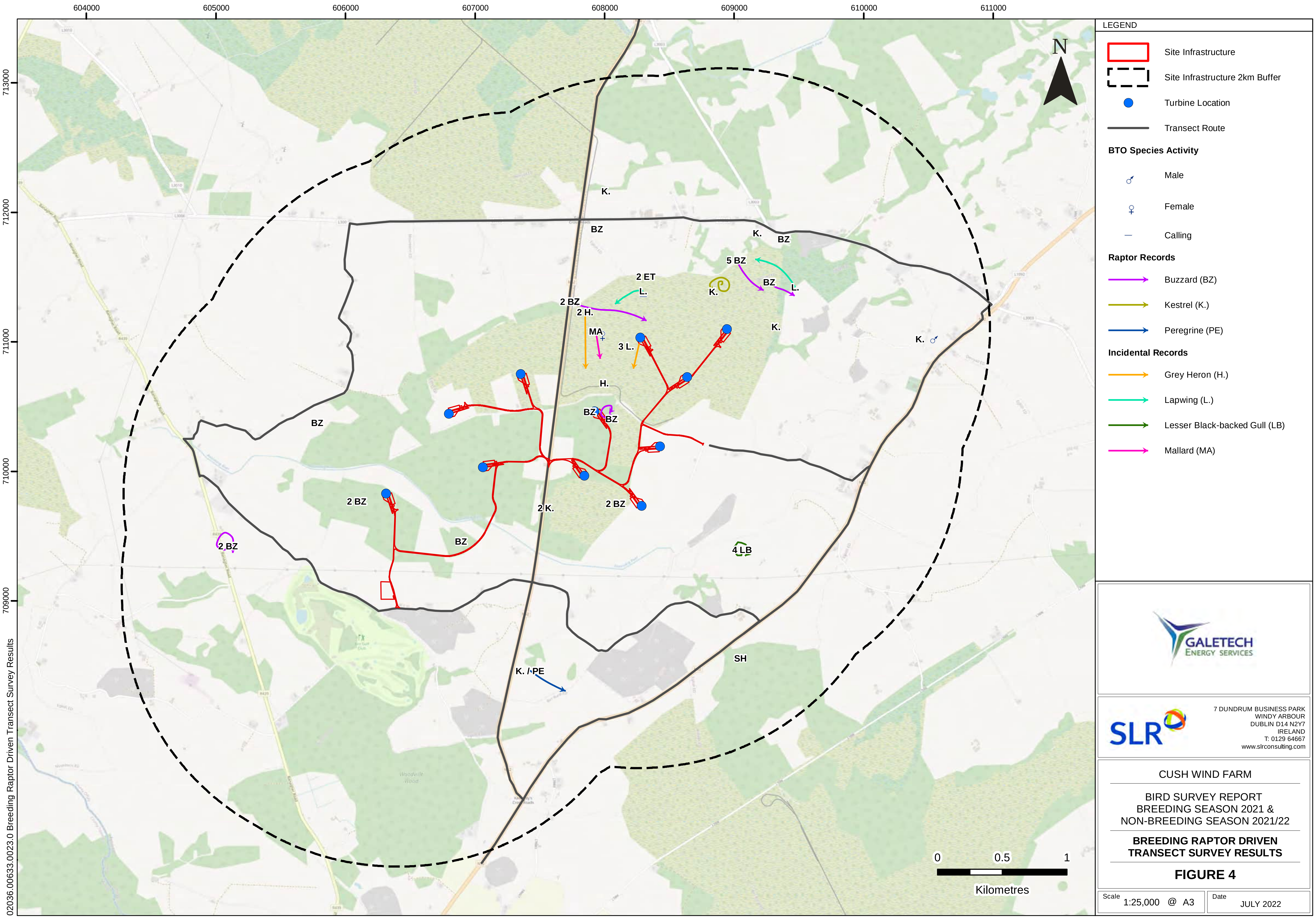
BREEDING WADER WALKED TRANSECT SURVEY RESULTS

FIGURE 3

Scale	Date
1:15,000 @ A3	JULY 2022

02036.00633.0022.0 Breeding Wader Walked Transect Survey Results



604000
605000
606000
607000
608000
609000
610000
611000
713000
712000
711000
710000
709000
LEGEND
Site Infrastructure
Site Infrastructure 2km Buffer
Turbine Location
Transect Route
BTO Species Activity
Male
Female
Calling
Raptor Records
Buzzard (BZ)
Kestrel (K.)
Peregrine (PE)
Incidental Records
Grey Heron (H.)
Lapwing (L.)
Lesser Black-backed Gull (LB)
Mallard (MA)
K.
BZ
5 BZ
2 ET
L.
2 BZ
2 H.
MA
3 L.
H.
2 BZ
2 K.
4 LB
SH
K. / PE
0
0.5
1
Kilometres
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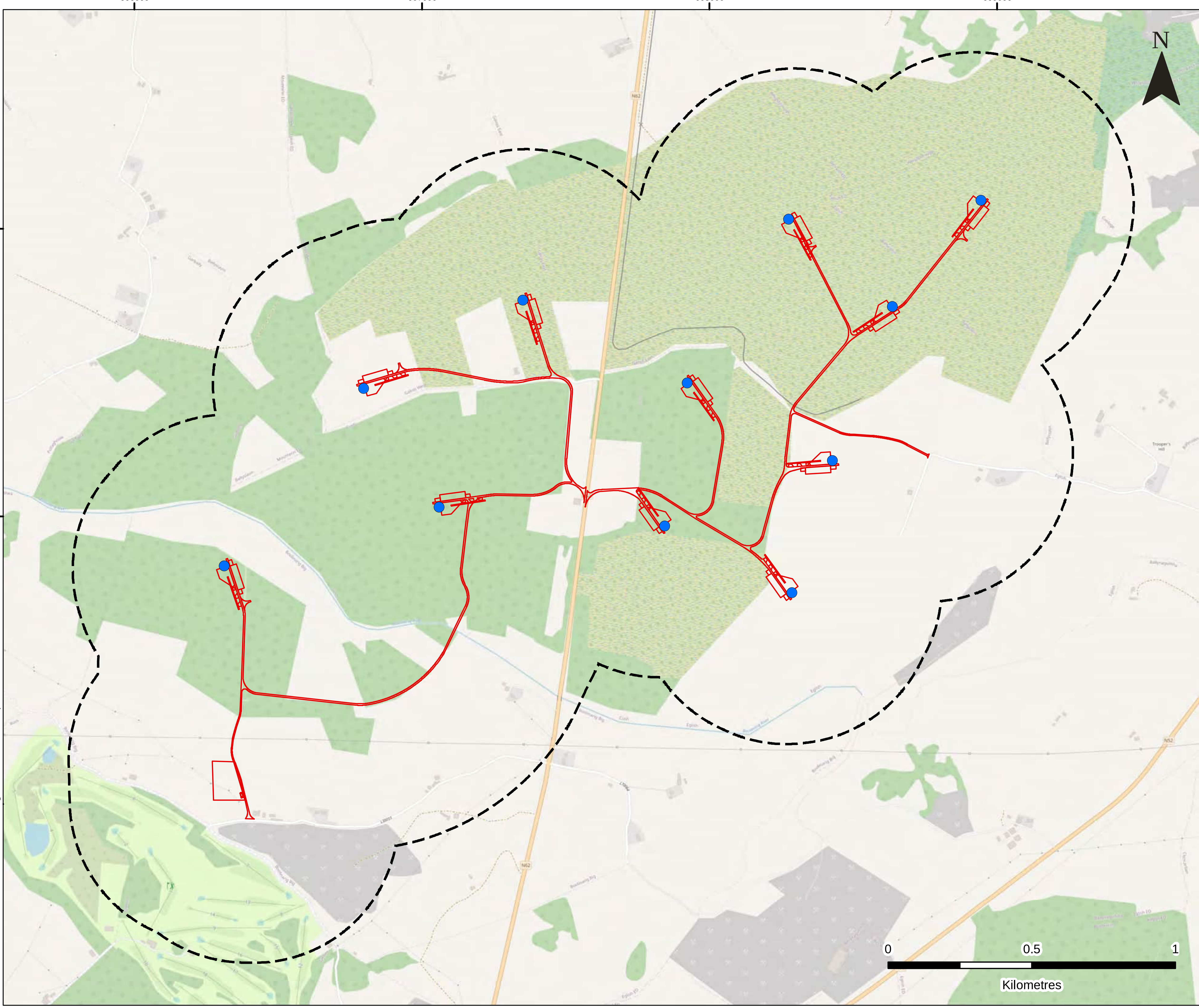
BREEDING RAPTOR DRIVEN
TRANSECT SURVEY RESULTS
FIGURE 4
Scale 1:25,000 @ A3
Date JULY 2022
02036.00633.0023.0 Breeding Raptor Driven Transect Survey Results



LEGEND

- Site Infrastructure
- Site Infrastructure 500m Buffer
- Turbine Location

*No Swans or Geese were Recorded.

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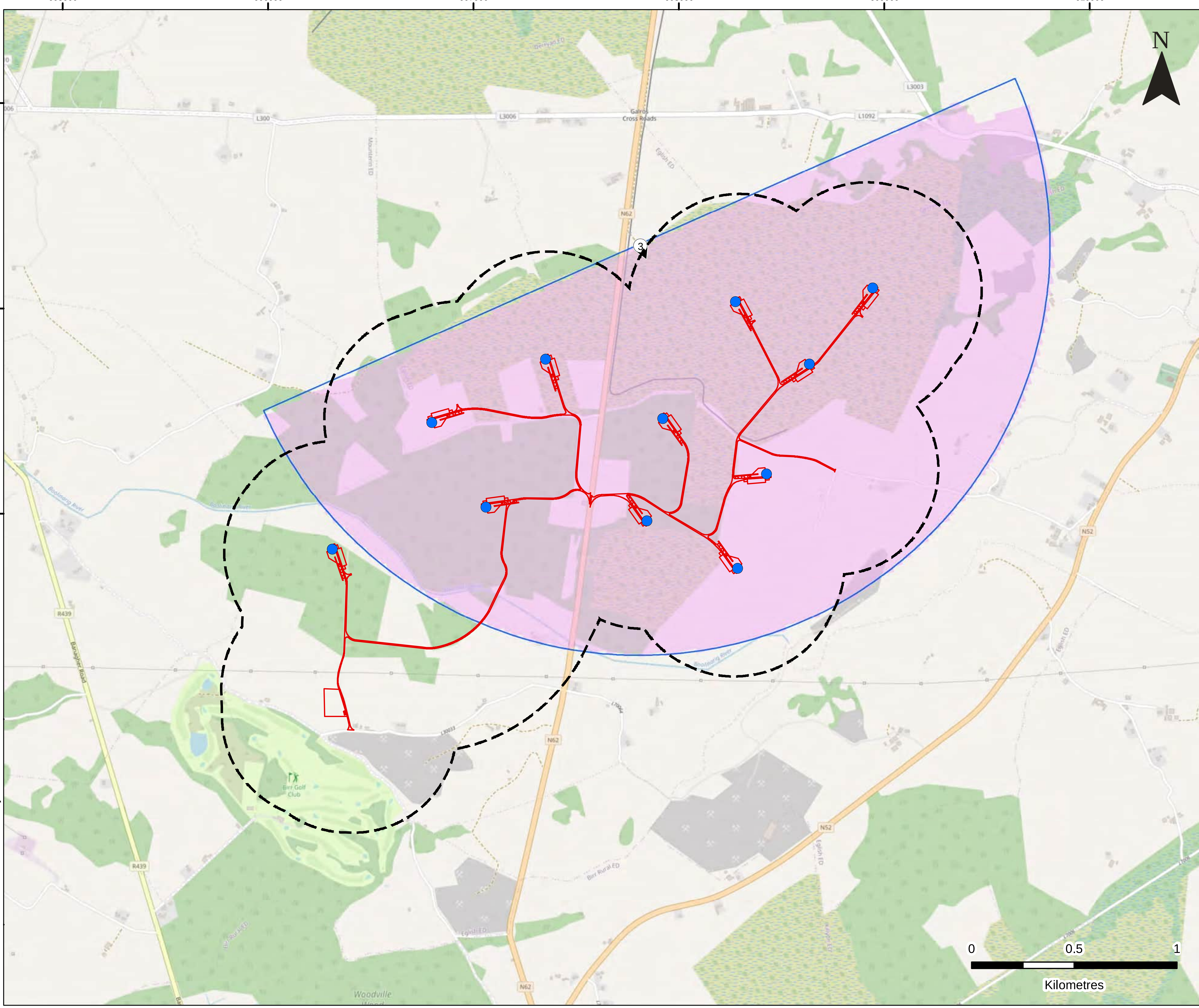
NON-BREEDING SEASON 2021/22

SWAN & GOOSE FEEDING DISTRIBUTION SURVEY RESULTS

FIGURE 5

Scale	Date
1:12,500 @ A3	JULY 2022

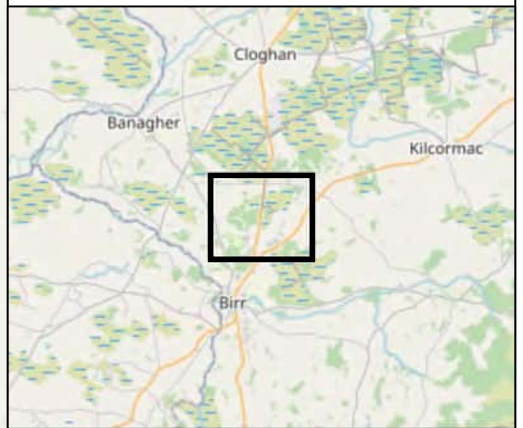
02036.00633.0034.0 Swan and Goose Feeding Distribution - Whooper Swan



LEGEND

- Site Infrastructure
- Site Infrastructure 500m Buffer
- Turbine Location
- Vantage Point
- Vantage Point Viewing Area
- Area Visible from Vantage Point 3

***No Hen Harriers were Recorded.**



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HEN HARRIER ROOST SURVEY RESULTS

FIGURE 6

Scale	Date
1:17,500 @ A3	JULY 2022

02036.00633.0037.0 Hen Harrier Roost Survey Results

Appendix 02

Survey dates times and observers

Table A2-1
Details of VP Surveys Undertaken from Vantage Point 1

Season	Date	Surveyor	Start time	End time	No. Hours
Breeding 2021	29/04/2021	AK	16:30	19:30	03:00
	30/04/2021	AK	06:50	09:50	03:00
	11/05/2021	JC	11:00	14:00	03:00
	12/05/2021	JC	16:10	19:10	03:00
	15/06/2021	AK	12:05	15:05	03:00
	16/06/2021	AK	07:00	10:00	03:00
	19/07/2021	AK	19:00	21:30	02:30
	20/07/2021	AK	10:30	14:00	03:30
	18/08/2021	AK	06:35	09:35	03:00
	16/08/2021	AK	17:35	20:35	03:00
	14/09/2021	AK	16:45	19:45	03:00
	15/09/2021	AK	10:35	13:35	03:00
	Total hours				**36**
Non-breeding 2021/22	13/10/2021	AK	15:40	18:40	03:00
	14/10/2021	AK	08:00	11:00	03:00
	12/11/2021	AK	08:00	11:00	03:00
	26/11/2021	AK	07:50	10:50	03:00
	10/12/2021	AK	08:15	11:15	03:00
	16/12/2021	AK	09:30	12:30	03:00
	18/01/2022	AK	10:00	13:00	03:00
	19/01/2022	AK	12:30	15:30	03:00
	03/02/2022	AK	14:30	17:30	03:00
	04/02/2022	AK	07:45	10:45	03:00
	03/03/2022	AK	07:00	10:00	03:00
	16/03/2022	AK	13:30	16:30	03:00
	Total hours				**36**

Table A2-2
Details of VP Surveys Undertaken from Vantage Point 2

Season	Date	Surveyor	Start time	End time	No. Hours
Breeding 2021	29/04/2021	AK	11:35	14:35	03:00
	30/04/2021	AK	10:45	13:45	03:00
	11/05/2021	JC	16:10	19:10	03:00
	12/05/2021	JC	08:05	11:05	03:00
	15/06/2021	AK	19:00	22:00	03:00
	17/06/2021	AK	13:50	16:50	03:00
	19/07/2021	AK	09:20	12:20	03:00
	20/07/2021	AK	06:40	09:40	03:00
	18/08/2021	AK	10:05	13:05	03:00
	17/08/2021	AK	11:10	14:10	03:00
	14/09/2021	AK	11:10	14:10	03:00
	15/09/2021	AK	07:05	10:05	03:00
	Total hours				**36**
Non-breeding 2021/22	14/10/2021	AK	11:30	14:30	03:00
	29/10/2021	AK	08:35	11:35	03:00
	11/11/2021	AK	13:45	16:45	03:00
	12/11/2021	AK	11:30	14:30	03:00
	16/12/2021	AK	13:00	16:00	03:00
	17/12/2021	AK	08:30	11:30	03:00
	06/01/2022	AK	13:30	16:30	03:00
	19/01/2022	AK	09:00	12:00	03:00
	03/02/2022	AK	10:30	13:30	03:00
	16/02/2022	AK	11:15	14:15	03:00
	02/03/2022	AK	12:30	15:30	03:00
	03/03/2022	AK	10:30	13:30	03:00
	Total hours				**36**

Table A2-3
Details of Breeding Wader Surveys

Date	Start time	Surveyor
13/05/2021	07:40	JC
01/06/2021	08:25	JC
17/06/2021	06:40	AK

Table A2-4
Details of Breeding Raptor Surveys

Date	Start time	Surveyor
13/05/2021	13:35	AK
01/06/2021	12:35	AK
16/06/2021	10:50	AK
19/07/2021	14:10	AK
20/07/2021	14:15	AK

Table A2-5
Details of Feeding Distribution Surveys

Date	Start time	Surveyor
13/10/2021	11:30	JC
11/11/2021	11:15	AK
26/11/2021	11:00	AK
10/12/2021	11:20	AK
17/12/2021	11:35	AK
06/01/2022	10:00	AK
18/01/2022	13:30	AK
04/02/2022	10:55	AK
16/02/2022	14:40	AK
02/03/2022	15:35	AK
16/03/2022	11:50	AK

Table A2-6
Details of Hen Harrier Winter Root Surveys

Date	Start time	Surveyor
18/01/2022	16:07	AK/FL
16/02/2022	16:45	AK/FL
02/03/2022	17:15	AK/FL

Appendix 03
Weather data

Table A3-1
Weather Data Collected During Flight Activity Surveys Undertaken from VP 1

Season	Date	Survey Start	Survey End	Hr	Wind Speed	Wind Direction	Rain[15]	Cloud Cover[16]	Cloud Height[17]	Visibility[18]	Snow[19]	Frost[20]	Temp (°c)	Notes
Breeding	29/04/2021	16:30	19:30	1	2	NE	1	7	2	2	0	0	10	
	29/04/2021	16:30	19:30	2	2	N	2	8	2	1	0	0	9	
	29/04/2021	16:30	19:30	3	3	N	1	7	2	2	0	0	8	Light shower majority of hour
	30/04/2021	06:50	09:50	1	0	n/a	0	3	2	2	0	1	3	
	30/04/2021	06:50	09:50	2	1	N	0	2	2	2	0	0	6	
	30/04/2021	06:50	09:50	3	1	N	0	1	2	2	0	0	8	
	11/05/2021	11:00	14:00	1	4	SE	0	3	2	2	0	0	12	
	11/05/2021	11:00	14:00	2	4	SE	0	4	2	2	0	0	13	
	11/05/2021	11:00	14:00	3	3	SE	0	4	2	2	0	0	14	
	12/05/2021	16:10	19:10	1	2	E	0	6	2	2	0	0	12	
	12/05/2021	16:10	19:10	2	2	E	0	5	2	2	0	0	12	
	12/05/2021	16:10	19:10	3	3	SE	0	4	2	2	0	0	11	
	15/06/2021	12:05	15:05	1	4	NE	0	7	2	2	0	0	16	

[15] Key: None = 0; Drizzle = 1; Light showers/snow = 2; Heavy showers/snow = 3; Heavy rain/snow = 4.
[16] Expressed in oktas (n/8)
[17] Key: Height of cloud above average height of viewshed. <150m = 0; 150-500m = 1; >500m = 2.
[18] Key: Poor (<1km) = 0; Moderate (1-3km) = 1; Good (>3km) = 2.
[19] Key: Lying snow. None = 0; On site = 1; On higher ground = 2.
[20] Key: None = 0; Ground = 1; All day = 2.

Season	Date	Survey Start	Survey End	Hr	Wind Speed	Wind Direction	Rain [15]	Cloud Cover [16]	Cloud Height [17]	Visibility [18]	Snow [19]	Frost [20]	Temp (°c)	Notes
	15/06/2021	12:05	15:05	2	3	NE	0	7	2	2	0	0	16	
	15/06/2021	12:05	15:05	3	4	NE	0	7	2	2	0	0	20	
	16/06/2021	07:00	10:00	1	2	E	0	6	2	2	0	0	11	
	16/06/2021	07:00	10:00	2	2	E	0	6	2	2	0	0	12	
	16/06/2021	07:00	10:00	3	3	E	0	7	2	2	0	0	13	
	19/07/2021	19:00	21:30	1	1	NE	0	1	2	2	0	0	27	
	19/07/2021	19:00	21:30	2	0	n/a	0	2	2	2	0	0	27	
	19/07/2021	19:00	21:30	3	0	n/a	0	2	2	2	0	0	26	
	20/07/2021	10:30	14:00	1	1	S	0	0	n/a	2	0	0	24	
	20/07/2021	10:30	14:00	2	0	n/a	0	0	n/a	2	0	0	26	
	20/07/2021	10:30	14:00	3	1	SW	0	1	2	2	0	0	27	
	20/07/2021	10:30	14:00	4	1	SW	0	2	2	2	0	0	27	
	18/08/2021	06:35	09:35	1	33	NE	1	8	2	2	0	0	12	
	18/08/2021	06:35	09:35	2	2	NE	0	8	2	2	0	0	12	
	18/08/2021	06:35	09:35	3	2	NE	0	8	2	2	0	0	12	
	16/08/2021	17:35	20:35	1	3	NE	0	8	2	2	0	0	16	
	16/08/2021	17:35	20:35	2	3	NE	0	8	2	2	0	0	16	
	16/08/2021	17:35	20:35	3	3	NE	0	8	2	2	0	0	15	
	14/09/2021	16:45	19:45	1	1	S	3	8	1	1	0	0	18	
	14/09/2021	16:45	19:45	2	0	n/a	0	7	2	2	0	0	18	
	14/09/2021	16:45	19:45	3	0	n/a	0	6	2	2	0	0	18	
	15/09/2021	10:35	13:35	1	0	n/a	0	8	2	2	0	0	16	
	15/09/2021	10:35	13:35	2	1	SW	0	8	2	2	0	0	16	

Season	Date	Survey Start	Survey End	Hr	Wind Speed	Wind Direction	Rain[15]	Cloud Cover[16]	Cloud Height[17]	Visibility[18]	Snow[19]	Frost[20]	Temp (°c)	Notes
	15/09/2021	10:35	13:35	3	1	SW	0	7	2	2	0	0	16	
Non-breeding	13/10/2021	15:40	18:40	1	1	SW	0	8	2	2	0	0	13	
	13/10/2021	15:40	18:40	2	1	SW	0	8	2	2	0	0	13	
	13/10/2021	15:40	18:40	3	1	SW	0	8	1	2	0	0	13	
	14/10/2021	08:00	11:00	1	0	n/a	0	8	1	2	0	0	11	
	14/10/2021	08:00	11:00	2	0	n/a	0	8	1	2	0	0	11	
	14/10/2021	08:00	11:00	3	1	S	0	8	1	2	0	0	12	
	12/11/2021	08:00	11:00	1	4	SW	2	8	1	1	0	0	11	
	12/11/2021	08:00	11:00	2	4	SW	2	8	1	2	0	0	12	
	12/11/2021	08:00	11:00	3	4	SW	3	8	1	0	0	0	12	
	26/11/2021	07:50	10:50	1	4	NW	2	8	2	2	0	0	7	
	26/11/2021	07:50	10:50	2	4	NW	2	6	2	2	0	0	8	Gusting up to BF7
	26/11/2021	07:50	10:50	3	4	NW	0	3	2	2	0	0	7	Gusting up to BF8
	10/12/2021	08:15	11:15	1	2	W	0	2	2	2	0	0	2	
	10/12/2021	08:15	11:15	2	3	W	0	4	2	2	0	0	3	
	10/12/2021	08:15	11:15	3	2	W	0	3	2	2	0	0	3	
	16/12/2021	09:30	12:30	1	2	S	0	8	2	2	0	0	9	
	16/12/2021	09:30	12:30	2	2	S	0	8	2	2	0	0	9	
	16/12/2021	09:30	12:30	3	2	S	0	8	2	2	0	0	9	
	18/01/2022	10:00	13:00	1	3	S	1	6	2	2	0	0	8	
	18/01/2022	10:00	13:00	2	3	S	2	8	2	2	0	0	8	
	18/01/2022	10:00	13:00	3	3	S	1	8	2	2	0	0	8	
	19/01/2022	12:30	15:30	1	2	NW	0	2	2	2	0	0	7	

Season	Date	Survey Start	Survey End	Hr	Wind Speed	Wind Direction	Rain[15]	Cloud Cover[16]	Cloud Height[17]	Visibility[18]	Snow[19]	Frost[20]	Temp (°c)	Notes
	19/01/2022	12:30	15:30	2	3	NW	1	6	2	2	0	0	7	
	19/01/2022	12:30	15:30	3	3	NW	1	6	2	2	0	0	7	
	03/02/2022	14:30	17:30	1	4	SW	0	7	2	2	0	0	1	
	03/02/2022	14:30	17:30	2	4	SW	2	8	2	2	0	0	1	Gusts up to BF6
	03/02/2022	14:30	17:30	3	4	SW	2	8	2	2	0	0	9	Gusts up to BF7
	04/02/2022	07:45	10:45	1	3	W	0	5	2	2	0	1	3	
	04/02/2022	07:45	10:45	2	3	W	0	4	2	2	0	0	3	
	04/02/2022	07:45	10:45	3	4	W	0	2	2	2	0	0	4	Gusts up to BF6
	03/03/2022	07:00	10:00	1	1	W	0	3	2	2	0	0	4	
	03/03/2022	07:00	10:00	2	1	W	0	2	2	2	0	0	4	
	03/03/2022	07:00	10:00	3	1	W	0	1	2	2	0	0	4	
	16/03/2022	13:30	16:30	1	1	NW	0	2	2	2	0	0	10	Warm & sunny
	16/03/2022	13:30	16:30	2	2	W	0	2	2	2	0	0	10	
	16/03/2022	13:30	16:30	3	2	W	0	2	2	2	0	0	10	

Table A3-2
Weather data collected during flight activity surveys undertaken from VP 2

Season	Date	Survey Start	Survey End	Hr	Wind Speed	Wind Direction	Rain[15]	Cloud Cover[16]	Cloud Height[17]	Visibility[18]	Snow[19]	Frost[20]	Temp (°c)	Notes
Breeding	29/04/2021	11:35	14:35	1	1	NNE	0	6	2	2	0	0	11	
	29/04/2021	11:35	14:35	2	1	NNE	0	6	2	2	0	0	11	
	29/04/2021	11:35	14:35	3	1	NNE	2	6	2	2	0	0	11	Light shower at 14:20
	30/04/2021	10:45	13:45	1	2	NE	0	4	2	2	0	0	11	

Season	Date	Survey Start	Survey End	Hr	Wind Speed	Wind Direction	Rain[15]	Cloud Cover[16]	Cloud Height[17]	Visibility[18]	Snow[19]	Frost[20]	Temp (°c)	Notes
	30/04/2021	10:45	13:45	2	2	NE	0	4	2	2	0	0	10	
	30/04/2021	10:45	13:45	3	4	S	2	7	2	2	0	0	11	
	11/05/2021	16:10	19:10	1	3	SE	0	3	2	2	0	0	15	
	11/05/2021	16:10	19:10	2	3	SE	0	4	2	2	0	0	13	
	11/05/2021	16:10	19:10	3	3	SE	0	4	2	2	0	0	13	
	12/05/2021	08:05	11:05	1	3	E	3	8	1	1	0	0	4	
	12/05/2021	08:05	11:05	2	4	E	3	8	1	1	0	0	6	
	12/05/2021	08:05	11:05	3	3	E	2	6	2	2	0	0	7	
	15/06/2021	19:00	22:00	1	2	N	0	7	2	2	0	0	18	
	15/06/2021	19:00	22:00	2	2	N	0	7	2	2	0	0	18	
	15/06/2021	19:00	22:00	3	2	N	0	8	2	2	0	0	17	
	17/06/2021	13:50	16:50	1	1	E	0	6	2	2	0	0	15	
	17/06/2021	13:50	16:50	2	2	E	0	6	2	2	0	0	16	
	17/06/2021	13:50	16:50	3	2	E	1	7	2	2	0	0	16	
	19/07/2021	09:20	12:20	1	0	n/a	0	0	n/a	2	0	0	21	
	19/07/2021	09:20	12:20	2	0	n/a	0	0	n/a	2	0	0	23	
	19/07/2021	09:20	12:20	3	1	NE	0	3	2	2	0	0	25	
	20/07/2021	06:40	09:40	1	0	n/a	0	0	n/a	1	0	0	17	sun/ heat haze
	20/07/2021	06:40	09:40	2	0	n/a	0	0	n/a	1	0	0	18	sun/ heat haze
	20/07/2021	06:40	09:40	3	0	n/a	0	0	n/a	2	0	0	21	
	18/08/2021	10:05	13:05	1	1	NE	0	8	2	2	0	0	14	
	18/08/2021	10:05	13:05	2	1	NE	0	7	2	2	0	0	15	
	18/08/2021	10:05	13:05	3	0	n/a	0	8	2	2	0	0	16	

Season	Date	Survey Start	Survey End	Hr	Wind Speed	Wind Direction	Rain[15]	Cloud Cover[16]	Cloud Height[17]	Visibility[18]	Snow[19]	Frost[20]	Temp (°c)	Notes
	17/08/2021	11:10	14:10	1	2	S	0	8	2	2	0	0	16	
	17/08/2021	11:10	14:10	2	2	S	1	8	2	1	0	0	16	
	17/08/2021	11:10	14:10	3	2	S	0	8	2	2	0	0	16	
	14/09/2021	11:10	14:10	1	1	S	0	7	2	2	0	0	17	
	14/09/2021	11:10	14:10	2	1	S	0	6	2	2	0	0	18	
	14/09/2021	11:10	14:10	3	0	n/a	0	7	2	2	0	0	18	
	15/09/2021	07:05	10:05	1	0	n/a	1	8	0	0	0	0	15	
	15/09/2021	07:05	10:05	2	0	n/a	1	8	1	1	0	0	15	
	15/09/2021	07:05	10:05	3	0	n/a	1	8	1	2	0	0	15	
Non-breeding	14/10/2021	11:30	14:30	1	1	S	0	8	1	2	0	0	13	
	14/10/2021	11:30	14:30	2	1	S	0	8	1	2	0	0	14	
	14/10/2021	11:30	14:30	3	1	S	0	8	1	2	0	0	14	
	11/11/2021	13:45	16:45	1	4	S	0	7	2	2	0	0	13	
	11/11/2021	13:45	16:45	2	4	S	0	8	2	2	0	0	13	
	11/11/2021	13:45	16:45	3	4	S	2	8	1	1	0	0	13	
	12/11/2021	11:30	14:30	1	4	W	1	8	1	2	0	0	13	
	12/11/2021	11:30	14:30	2	4	W	0	8	2	2	0	0	13	
	12/11/2021	11:30	14:30	3	4	W	1	6	2	2	0	0	13	
	16/12/2021	13:00	16:00	1	1	SE	0	8	2	2	0	0	10	
	16/12/2021	13:00	16:00	2	1	SE	0	8	2	2	0	0	10	
	16/12/2021	13:00	16:00	3	1	SE	0	8	2	2	0	0	10	
	17/12/2021	08:30	11:30	1	2	SE	0	6	2	2	0	0	7	
	17/12/2021	08:30	11:30	2	2	SE	0	6	2	2	0	0	7	

Season	Date	Survey Start	Survey End	Hr	Wind Speed	Wind Direction	Rain[15]	Cloud Cover[16]	Cloud Height[17]	Visibility[18]	Snow[19]	Frost[20]	Temp (°c)	Notes
	17/12/2021	08:30	11:30	3	2	SE	0	6	2	2	0	0	7	
	06/01/2022	13:30	16:30	1	4	SW	3	8	1	2	0	0	6	
	06/01/2022	13:30	16:30	2	4	SW	3	4	2	2	0	0	6	snow shower 15:10
	06/01/2022	13:30	16:30	3	3	SW	3	3	2	2	0	0	4	
	19/01/2022	09:00	12:00	1	2	NW	0	6	2	2	0	0	6	
	19/01/2022	09:00	12:00	2	2	NW	0	6	2	2	0	0	6	
	19/01/2022	09:00	12:00	3	2	NW	0	2	2	2	0	0	6	
	03/02/2022	10:30	13:20	1	3	SW	3	8	0	0	0	0	10	
	03/02/2022	10:30	13:20	2	4	SW	0	6	1	2	0	0	10	
	03/02/2022	10:30	13:20	3	4	SW	0	6	2	2	0	0	10	
	16/02/2022	11:15	14:15	1	4	SW	3	8	0	0	0	0	13	Gusts up to BF7 (Storm Dudley but visibility at least 500m and wind below gale force threshold)
	16/02/2022	11:15	14:15	2	4	SW	3	8	0	0	0	0	13	Gusts up to BF7 (Storm Dudley but visibility at least 500m and wind below gale force threshold)
	16/02/2022	11:15	14:15	3	4	SW	2	8	1	1	0	0	13	Gusts up to BF7 (Storm Dudley but visibility at least 500m and wind below gale force threshold)
	02/03/2022	12:30	15:30	1	2	SE	2	8	1	2	0	0	10	
	02/03/2022	12:30	15:30	2	2	SE	0	8	1	2	0	0	10	
	02/03/2022	12:30	15:30	3	2	SE	0	8	1	2	0	0	10	

Season	Date	Survey Start	Survey End	Hr	Wind Speed	Wind Direction	Rain[15]	Cloud Cover[16]	Cloud Height[17]	Visibility[18]	Snow[19]	Frost[20]	Temp (°c)	Notes
	03/03/2022	10:30	13:30	1	1	NW	0	1	2	2	0	0	7	clear & calm
	03/03/2022	10:30	13:30	2	1	NW	0	3	2	2	0	0	8	
	03/03/2022	10:30	13:30	3	1	NW	0	3	2	2	0	0	11	

Table A3-3
Weather During Breeding Wader Surveys

Date	Start	End	Hr	Wind Speed	Wind Direction	Rain[15]	Cloud Cover[16]	Cloud Height[17]	Visibility[18]	Snow[19]	Frost[20]	Temp (°c)
13/05/2021	07:40	11:45	All	2	SE	0	6	2	2	0	0	5
01/06/2021	08:25	11:50	All	1	NE	0	2	2	2	0	0	14
17/06/2021	06:40	12:00	1	2		0	1	2	2	0	0	10
17/06/2021	06:40	12:00	2	2	E	0	1	2	2	0	0	11
17/06/2021	06:40	12:00	3	2	E	0	5	1	2	0	0	14
17/06/2021	06:40	12:00	4	1	E	0	5	2	2	0	0	14
17/06/2021	06:40	12:00	5	1	E	0	5	2	2	0	0	14

Table A3-4
Weather During Breeding Raptor Surveys

Date	Start	End	Hr	Wind Speed	Wind Direction	Rain[15]	Cloud Cover[16]	Cloud Height[17]	Visibility[18]	Snow[19]	Frost[20]	Temp (°c)
13/05/2021	13:35	16:00	All	2	SW	0	4	2	2	0	0	12
01/06/2021	12:35	15:15	All	1	NE	0	2	2	2	0	0	20
16/06/2021	10:50	16:15	1	3	E	0	7	2	2	0	0	14

Date	Start	End	Hr	Wind Speed	Wind Direction	Rain[15]	Cloud Cover[16]	Cloud Height[17]	Visibility[18]	Snow[19]	Frost[20]	Temp (°c)
16/06/2021	10:50	16:15	2	3	E	0	7	2	2	0	0	14
16/06/2021	10:50	16:15	3	2	E	0	6	2	2	0	0	15
19/07/2021	14:10	17:35	1	1	NE	0	2	2	2	0	0	27
19/07/2021	14:10	17:35	2	1	NE	0	2	2	2	0	0	28
19/07/2021	14:10	17:35	3	1	NE	0	1	2	2	0	0	28
19/07/2021	14:10	17:35	4	1	NE	0	1	2	2	0	0	28
20/07/2021	14:15	15:30	1	1	SW	0	2	2	2	0	0	28

Table A3-5
Weather During Feeding and Distribution Surveys

Date	Start	End	Hr	Wind Speed	Wind Direction	Rain[15]	Cloud Cover[16]	Cloud Height[17]	Visibility[18]	Snow[19]	Frost[20]	Temp (°c)
13/10/2021	11:30	13:30	1	0	n/a	0	8	2	2	0	0	13
13/10/2021	11:30	13:30	2	0	n/a	0	8	2	2	0	0	13
11/11/2021	11:15	13:45	1	4	S	3	8	1	1	0	0	13
11/11/2021	11:15	13:45	2	4	S	0	5	2	2	0	0	13
11/11/2021	11:15	13:45	3	4	S	0	7	2	2	0	0	13
26/11/2021	11:00	13:30	1	4	NW	2	2	2	2	0	0	7
26/11/2021	11:00	13:30	2	4	NW	2	8	2	2	0	0	7
26/11/2021	11:00	13:30	3	4	NW	0	6	2	2	0	0	7
10/12/2021	11:20	13:20	1	3	W	0	3	2	2	0	0	5
10/12/2021	11:20	13:20	2	3	W	0	3	2	2	0	0	7
17/12/2021	11:35	13:05	1	2	E	0	6	2	2	0	0	7
17/12/2021	11:35	13:05	2	2	E	0	6	2	2	0	0	7
06/01/2022	10:00	13:15	1	4	SW	2	8	1	2	0	0	8
06/01/2022	10:00	13:15	2	4	SW	3	5	2	2	0	0	7
06/01/2022	10:00	13:15	3	4	SW	3	6	2	2	0	0	6
06/01/2022	10:00	13:15	4	4	SW	0	4	2	2	0	0	6
18/01/2022	13:30	15:30	1	4	S	1	8	2	2	0	0	10
18/01/2022	13:30	15:30	2	4	S	2	7	2	2	0	0	9
04/02/2022	10:55	12:40	1	4	W	0	4	2	2	0	0	4
04/02/2022	10:55	12:40	2	4	W	0	3	2	2	0	0	6

Date	Start	End	Hr	Wind Speed	Wind Direction	Rain[15]	Cloud Cover[16]	Cloud Height[17]	Visibility[18]	Snow[19]	Frost[20]	Temp (°c)
16/02/2022	14:40	16:40	1	4	W	2	7	1	2	0	0	12
16/02/2022	14:40	16:40	2	4	W	2	6	1	2	0	0	9
02/03/2022	15:35	17:10	1	2	SE	0	8	1	2	0	0	10
02/03/2022	15:35	17:10	2	2	SE	0	8	1	2	0	0	10
16/03/2022	11:50	13:25	1	1	NW	0	2	2	2	0	0	7
16/03/2022	11:50	13:25	2	1	NW	0	2	2	2	0	0	7

Table A3-6
Weather During Hen Harrier Winter Roost Surveys

Date	Start	End	Hr	Wind Speed	Wind Direction	Rain[15]	Cloud Cover[16]	Cloud Height[17]	Visibility[18]	Snow[19]	Frost[20]	Temp (°c)
18/01/2022	16:07	17:30	1	3	S	0	8	1	2	0	0	10
18/01/2022	16:07	17:30	2	3	S	0	7	1	1	0	0	9
16/02/2022	16:45	18:30	1	4	w	3	7	1	1	0	0	9
16/02/2022	16:45	18:30	2	4	w	2	6	1	1	0	0	8
02/03/2022	17:15	18:45	1	2	SE	0	8	1	2	0	0	9
02/03/2022	17:15	18:45	2	2	SE	0	8	1	1	0	0	7

Appendix 04

Flight activity survey data

Table A4-1
Flight activity survey data primary target species

Date	VP	Surveyor	Flight ID	BTO Code	No. Birds	Age (Ad = adult; Imm = immature)	Sex (M = male; F = female; U = unknown)	StartTime (hr:min)	Flight duration (s)
29/04/2021	1	AK	1.CU035.1.1	BH	1	Ad	U	16:53	45
29/04/2021	1	AK	1.CU035.2.1	BH	1	Ad	U	17:03	45
29/04/2021	1	AK	1.CU035.3.1	BH	1	Ad	U	17:08	60
29/04/2021	1	AK	1.CU035.4.1	BH	1	Ad	U	17:17	30
29/04/2021	1	AK	1.CU035.5.1	BH	2	Ad	U	17:59	45
29/04/2021	1	AK	1.CU035.6.1	BH	1	Ad	U	18:19	15
29/04/2021	1	AK	1.CU035.7.1	BH	1	Ad	U	18:20	30
29/04/2021	1	AK	1.CU035.8.1	BH	1	Ad	U	18:22	45
29/04/2021	1	AK	1.CU035.9.1	L.	2	Ad	U	19:07	75
29/04/2021	2	AK	2.CU036.1.1	K.	1	Ad	U	11:39	45
29/04/2021	2	AK	2.CU036.2.1	K.	1	Ad	U	12:41	60
29/04/2021	2	AK	2.CU036.3.1	BH	1	Ad	U	13:53	105
30/04/2021	1	AK	1.CU037.1.1	L.	2	Ad	U	06:58	45
30/04/2021	1	AK	1.CU037.2.1	L.	2	Ad	U	07:07	60
30/04/2021	1	AK	1.CU037.3.1	L.	2	Ad	U	07:09	45
30/04/2021	1	AK	1.CU037.4.1	L.	1	Ad	U	07:22	15
30/04/2021	1	AK	1.CU037.5.1	BH	1	Ad	U	07:32	30
30/04/2021	1	AK	1.CU037.6.1	L.	2	Ad	U	07:38	45
30/04/2021	1	AK	1.CU037.7.1	GP	5	Ad	U	07:53	60

Date	VP	Surveyor	Flight ID	BTO Code	No. Birds	Age (Ad = adult; Imm = immature)	Sex (M = male; F = female; U = unknown)	StartTime (hr:min)	Flight duration (s)
30/04/2021	1	AK	1.CU037.8.1	L.	2	Ad	U	07:54	15
30/04/2021	1	AK	1.CU037.9.1	L.	1	Ad	U	07:59	15
30/04/2021	1	AK	1.CU037.10.1	L.	2	Ad	U	08:15	45
30/04/2021	1	AK	1.CU037.11.1	BH	1	Ad	U	08:20	75
30/04/2021	1	AK	1.CU037.12.1	L.	2	Ad	U	08:28	30
30/04/2021	1	AK	1.CU037.13.1	L.	2	Ad	U	09:13	60
30/04/2021	1	AK	1.CU037.14.1	BH	1	Ad	U	09:14	75
30/04/2021	1	AK	1.CU038.1.1	BH	1	Ad	U	12:37	60
30/04/2021	1	AK	1.CU038.2.1	BH	1	Ad	U	12:55	105
30/04/2021	1	AK	1.CU038.3.1	BH	1	Ad	U	13:04	75
15/06/2021	2	AK	2.CU047.1.1	BH	1	Ad	U	12:36	90
15/06/2021	2	AK	2.CU047.2.1	BH	5	Ad	U	12:55	60
15/06/2021	2	AK	2.CU047.3.1	BH	1	Ad	U	13:06	75
15/06/2021	2	AK	2.CU047.4.1	BH	2	Ad	U	14:18	60
15/06/2021	2	AK	2.CU047.5.1	L.	1	U	U	14:36	15
15/06/2021	2	AK	2.CU047.6.1	BH	1	Ad	U	14:50	15
15/06/2021	2	AK	2.CU047.7.1	BH	1	Ad	U	14:54	15
15/06/2021	2	AK	2.CU048.1.1	BH	3	Ad	U	20:29	30

Date	VP	Surveyor	Flight ID	BTO Code	No. Birds	Age (Ad = adult; Imm = immature)	Sex (M = male; F = female; U = unknown)	StartTime (hr:min)	Flight duration (s)
15/06/2021	2	AK	2.CU048.2.1	BH	1	Ad	U	20:46	45
15/06/2021	2	AK	2.CU048.3.1	SN	1	Ad	U	21:32	15
16/06/2021	2	AK	2.CU049.1.1	L.	1	Ad	U	06:51	15
16/06/2021	2	AK	2.CU049.2.1	L.	1	Imm	U	07:03	15
16/06/2021	2	AK	2.CU049.3.1	L.	1	Imm	U	07:07	45
16/06/2021	2	AK	2.CU049.4.1	BH	1	Ad	U	07:38	45
16/06/2021	2	AK	2.CU049.5.1	L.	1	Imm	U	08:04	15
16/06/2021	2	AK	2.CU049.6.1	L.	1	Imm	U	08:27	60
16/06/2021	2	AK	2.CU049.7.1	BH	1	Ad	U	08:36	90
16/06/2021	2	AK	2.CU049.8.1	BH	1	Ad	U	08:45	75
16/06/2021	2	AK	2.CU049.9.1	BH	1	Ad	U	08:55	75
16/06/2021	2	AK	2.CU049.10.1	BH	1	Ad	U	09:10	60
16/06/2021	2	AK	2.CU049.11.1	BH	2	Ad	U	09:16	30
16/06/2021	2	AK	2.CU049.12.1	BH	1	Ad	U	09:29	75
16/06/2021	2	AK	2.CU049.13.1	L.	1	Imm	U	09:31	60
16/06/2021	2	AK	2.CU049.14.1	BH	1	Ad	U	09:47	120
17/06/2021	2	AK	2.CU050.1.1	BH	1	Ad	U	14:49	75
17/06/2021	2	AK	2.CU050.2.1	BH	2	Ad	U	15:04	60

Date	VP	Surveyor	Flight ID	BTO Code	No. Birds	Age (Ad = adult; Imm = immature)	Sex (M = male; F = female; U = unknown)	StartTime (hr:min)	Flight duration (s)
17/06/2021	2	AK	2.CU050.3.1	BH	1	Ad	U	15:53	75
17/06/2021	2	AK	2.CU050.4.1	BH	1	Ad	U	16:12	60
17/06/2021	2	AK	2.CU050.5.1	BH	1	Ad	U	16:19	45
19/07/2021	1	AK	1.CU053.1.1	BH	14	Imm	U	18:58	45
19/07/2021	1	AK	1.CU053.2.1	BH	1	Imm	U	19:06	30
19/07/2021	1	AK	1.CU053.3.1	L.	1	Ad	U	19:29	120
19/07/2021	1	AK	1.CU053.4.1	BH	3	Ad	U	19:31	60
19/07/2021	1	AK	1.CU053.5.1	L.	2	Ad	U	19:49	45
19/07/2021	1	AK	1.CU053.6.1	L.	1	Ad	U	20:11	30
19/07/2021	1	AK	1.CU053.7.1	L.	4	Ad	U	20:25	75
19/07/2021	1	AK	1.CU053.8.1	BH	1	Ad	U	20:42	45
19/07/2021	1	AK	1.CU053.9.1	BH	5	Imm	U	21:13	30
19/07/2021	2	AK	2.CU054.1.1	K.	1	U	U	09:36	15
19/07/2021	2	AK	2.CU054.2.1	K.	1	Ad	F	10:12	30
20/07/2021	1	AK	1.CU055.1.1	BH	11	2 Ad., 9 Imm.	U	11:13	90
18/08/2021	1	AK	1.CU059.1.1	L.	1	Ad	U	07:27	15
17/08/2021	2	AK	2.CU062.1.1	K.	1	Ad	U	11:36	15
14/09/2021	2	AK	2.CU063.1.1	K.	1	Ad	M	12:20	30
15/09/2021	1	AK	1.CU066.1.1	K.	1	Ad	U	11:09	120
15/09/2021	1	AK	1.CU066.2.1	L.	1	Ad	U	11:27	30
13/10/2021	1	AK	1.CU068.1.1	HH	1	Ringtail	Ringtail	15:53	11

Date	VP	Surveyor	Flight ID	BTO Code	No. Birds	Age (Ad = adult; Imm = immature)	Sex (M = male; F = female; U = unknown)	StartTime (hr:min)	Flight duration (s)
13/10/2021	1	AK	1.CU068.2.1	K.	1	U	U	16:11	4
13/10/2021	1	AK	1.CU068.3.1	SN	7	U	U	16:33	39
13/10/2021	1	AK	1.CU068.4.1	SN	7	U	U	16:35	8
13/10/2021	1	AK	1.CU068.5.1	L.	27	U	U	17:07	200
13/10/2021	1	AK	1.CU068.6.1	SN	3	U	U	17:56	14
14/10/2021	1	AK	1.CU069.1.1	K.	1	Ad	F	10:07	79
14/10/2021	2	AK	2.CU070.1.1	K.	1	U	U	11:37	18
11/11/2021	2	AK	2.CU072.1.1	K.	1	Ad	M	13:57	10
11/11/2021	2	AK	2.CU072.2.1	K.	1	Ad	M	15:05	20
26/11/2021	a	AK	a.CU075.1.1	PE	1	Ad	U	11:32	40
10/12/2021	1	AK	1.CU077.1.1	PE	1	U	U	10:12	48
16/12/2021	1	AK	1.CU079.1.1	BH	2	Ad	U	12:02	35
16/12/2021	2	AK	2.CU080.1.1	BH	46	U	U	15:34	50
17/12/2021	2	AK	2.CU082.2.1	BH	1	Ad	U	09:29	20
17/12/2021	2	AK	2.CU082.3.1	BH	5	U	U	09:38	35
17/12/2021	2	AK	2.CU082.4.1	BH	8	U	U	09:42	10
17/12/2021	2	AK	2.CU082.5.1	BH	3	U	U	09:51	48
06/01/2022	2	AK	2.CU084.1.1	PE	1	U	U	16:19	20
18/01/2022	1	AK	1.CU085.1.1	GP	2000+	U	U	11:58	
18/01/2022	1	AK	1.CU085.2.1	K.	1	Ad	M	12:18	60
18/01/2022	1	AK	1.CU085.3.1	K.	1	Ad	M	12:39	90

Date	VP	Surveyor	Flight ID	BTO Code	No. Birds	Age (Ad = adult; Imm = immature)	Sex (M = male; F = female; U = unknown)	StartTime (hr:min)	Flight duration (s)
19/01/2022	1	AK	1.CU088.1.1	K.	1	U	U	12:42	60
19/01/2022	1	AK	1.CU088.2.1	K.	1	U	U	12:43	60
19/01/2022	1	AK	1.CU088.3.1	K.	1	Ad	M	12:56	195
19/01/2022	1	AK	1.CU088.4.1	K.	1	Ad	M	13:11	100
19/01/2022	1	AK	1.CU088.5.1	K.	1	Ad	M	13:27	45
19/01/2022	1	AK	1.CU088.6.1	K.	1	Ad	M	13:43	30
19/01/2022	1	AK	1.CU088.7.1	K.	1	Ad	M	14:15	75
19/01/2022	1	AK	1.CU088.8.1	K.	1	Ad	M	14:30	60
19/01/2022	1	AK	1.CU088.9.1	K.	1	Ad	M	14:51	120
19/01/2022	2	AK	2.CU089.1.1	WS	4	Ad	U	09:41	75
19/01/2022	2	AK	2.CU089.2.1	GP	42	U	U	10:32	45
03/02/2022	1	AK	1.CU090.1.1	PE	1	Ad	U	15:12	35
03/02/2022	1	AK	1.CU090.2.1	K.	1	Ad	M	16:48	30
03/02/2022	2	AK	2.CU091.1.1	K.	1	U	U	12:39	110
16/02/2022	2	AK	2.CU094.1.1	K.	1	Ad	M	11:50	75
02/03/2022	2	AK	2.CU099.2.1	WS	12	U	U	13:!2	60
03/03/2022	1	AK	1.CU100.7.1	PE	1	U	U	09:49	420
03/03/2022	1	AK	1.CU100.7.2	PE	1	U	U	09:49	420
03/03/2022	2	AK	2.CU101.1.1	BH	13	U	U	11:17	60
03/03/2022	2	AK	2.CU101.2.1	PE	1	U	U	12:03	570
03/03/2022	2	AK	2.CU101.2.2	PE	1	U	U	12:03	570

Date	VP	Surveyor	Flight ID	BTO Code	No. Birds	Age (Ad = adult; Imm = immature)	Sex (M = male; F = female; U = unknown)	StartTime (hr:min)	Flight duration (s)
03/03/2022	2	AK	2.CU101.3.2	HH	1	Ringtail	Ringtail	12:09	270
03/03/2022	2	AK	2.CU101.4.1	PE	1	U	U	12:52	22
16/03/2022	1	AK	1.CU103.1.1	K.	1	Ad	M	14:21	35
16/03/2022	1	AK	1.CU103.2.1	K.	1	Ad	U	14:33	310
16/03/2022	1	AK	1.CU103.3.1	K.	1	Ad	U	15:!7	115

Table A4- 3
Flight Activity secondary target species

Date	VP	Survey start	Survey end	5 min period start time	5 min period end time	Species	Count Max	Location (on site, in buffer, or beyond)
08/10/2021	2	09:30	12:30	10:05	10:10	BZ	1	Buffer
08/10/2021	2	09:30	12:30	10:25	10:30	BZ	1	Buffer
08/10/2021	2	09:30	12:30	11:35	11:40	BZ	2	Buffer
08/10/2021	2	09:30	12:30	11:40	11:45	RN	2	Buffer
08/10/2021	1	13:00	16:00	13:05	13:10	BZ	2	Buffer
08/10/2021	1	13:00	16:00	13:20	13:25	BZ	2	Buffer
08/10/2021	1	13:00	16:00	15:05	15:10	RN	2	Buffer
08/10/2021	1	13:00	16:00	15:15	15:20	BZ	1	Buffer
08/10/2021	1	13:00	16:00	15:20	15:25	BZ	2	Buffer
08/10/2021	1	13:00	16:00	15:55	16:00	BZ	2	Buffer
29/04/2021	1	16:30	19:30	17:15	17:20	H.	1	Buffer, beyond
29/04/2021	1	16:30	19:30	18:30	18:35	MA	3	On site
29/04/2021	2	11:35	14:35	11:55	12:00	RN	1	Buffer, beyond
29/04/2021	2	11:35	14:35	12:05	12:10	RN	1	Beyond
29/04/2021	2	11:35	14:35	12:20	12:25	BZ	1	Beyond
29/04/2021	2	11:35	14:35	12:25	12:30	BZ	2	On site
29/04/2021	2	11:35	14:35	12:50	12:55	BZ	1	Buffer
29/04/2021	2	11:35	14:35	12:55	13:00	BZ	2	On site, buffer
29/04/2021	2	11:35	14:35	13:15	13:20	BZ	1	On site
30/04/2021	1	06:50	09:50	09:00	09:05	CM	1	Buffer, beyond

Date	VP	Survey start	Survey end	5 min period start time	5 min period end time	Species	Count Max	Location (on site, in buffer, or beyond)
30/04/2021	1	10:45	13:45	11:45	11:50	H.	1	On site
30/04/2021	1	10:45	13:45	11:50	11:55	BZ	1	On site
30/04/2021	1	10:45	13:45	12:35	12:40	BZ	2	On site, buffer
30/04/2021	1	10:45	13:45	12:40	12:45	BZ	2	Buffer
30/04/2021	1	10:45	13:45	13:40	13:45	MA	2	Buffer, beyond
11/05/2021	1	11:00	14:00	11:25	11:30	HG	1	On site
11/05/2021	1	11:00	14:00	11:55	12:00	BZ	2	Buffer
11/05/2021	1	11:00	14:00	12:10	12:15	BZ	2	Buffer
11/05/2021	1	11:00	14:00	13:05	13:10	HG	1	Buffer
11/05/2021	1	11:00	14:00	13:20	13:25	BZ	1	Beyond
11/05/2021	1	11:00	14:00	13:40	13:45	K.	1	Buffer
11/05/2021	2	16:10	19:10	16:20	16:25	RN	2	Beyond
11/05/2021	2	16:10	19:10	16:40	16:45	RN	1	Buffer
11/05/2021	2	16:10	19:10	17:10	17:15	BZ	1	Buffer
11/05/2021	2	16:10	19:10	18:25	18:30	RN	1	Buffer
12/05/2021	2	08:05	11:05	09:10	09:15	BZ	1	Beyond
12/05/2021	2	08:05	11:05	09:30	09:35	H.	1	Beyond
12/05/2021	2	08:05	11:05	10:20	10:25	BZ	1	Buffer
12/05/2021	2	08:05	11:05	10:20	10:25	RN	1	Beyond
12/05/2021	2	08:05	11:05	10:40	10:45	RN	1	Buffer
12/05/2021	2	08:05	11:05	10:55	11:00	RN	1	Buffer
12/05/2021	1	16:10	19:10	16:40	16:45	BZ	2	Beyond

Date	VP	Survey start	Survey end	5 min period start time	5 min period end time	Species	Count Max	Location (on site, in buffer, or beyond)
12/05/2021	1	16:10	19:10	16:45	16:50	BZ	2	Buffer
12/05/2021	1	16:10	19:10	18:30	18:35	BZ	2	Beyond
15/06/2021	1	12:05	15:05	12:20	12:25	GB	4	On site
15/06/2021	1	12:05	15:05	12:35	12:40	BZ	1	On site
15/06/2021	1	12:05	15:05	12:40	12:45	BZ	1	Buffer, beyond
15/06/2021	1	12:05	15:05	12:45	12:50	BZ	1	Buffer
15/06/2021	1	12:05	15:05	13:30	13:35	BZ	1	On site
15/06/2021	1	12:05	15:05	14:05	14:10	BZ	1	Buffer
15/06/2021	1	12:05	15:05	14:35	14:40	LB	1	Buffer
16/06/2021	1	07:00	10:00	08:05	08:10	BZ	1	Beyond
17/06/2021	2	13:50	16:50	13:50	13:55	BZ	3	Buffer, beyond
19/07/2021	1	19:00	21:30	18:55	19:00	CM	1	Buffer
19/07/2021	1	19:00	21:30	19:10	19:15	CM	1	Buffer
19/07/2021	1	19:00	21:30	19:45	19:50	LB	1	Buffer, beyond
19/07/2021	1	19:00	21:30	19:55	20:00	CM	1	Buffer, beyond
19/07/2021	1	19:00	21:30	20:05	20:10	CM	2	Buffer, beyond
19/07/2021	1	19:00	21:30	20:10	20:15	H.	2	On site, buffer
19/07/2021	1	19:00	21:30	20:20	20:25	CM	1	On site
19/07/2021	1	19:00	21:30	20:45	20:50	CM	1	Buffer, beyond
19/07/2021	2	09:20	12:20	10:30	10:35	RN	1	Buffer
19/07/2021	2	09:20	12:20	10:40	10:45	BZ	1	On site
19/07/2021	2	09:20	12:20	11:55	12:00	BZ	1	Buffer, beyond

Date	VP	Survey start	Survey end	5 min period start time	5 min period end time	Species	Count Max	Location (on site, in buffer, or beyond)
19/07/2021	2	09:20	12:20	12:05	12:10	BZ	2	On site, buffer
19/07/2021	2	09:20	12:20	12:15	12:20	BZ	1	On site, buffer
20/07/2021	1	10:30	14:00	12:10	12:15	BZ	1	On site
20/07/2021	1	10:30	14:00	13:15	13:20	BZ	1	On site
20/07/2021	1	10:30	14:00	13:35	13:40	BZ	1	On site
20/07/2021	1	10:30	14:00	13:45	13:50	BZ	2	On site
20/07/2021	2	06:40	09:40	07:10	07:15	RN	1	Buffer
18/08/2021	1	06:35	09:35	08:45	08:50	RN	2	Beyond
18/08/2021	1	06:35	09:35	09:15	09:20	RN	1	On site, buffer
16/08/2021	1	17:35	20:35	17:40	17:45	CM	1	On site
16/08/2021	1	17:35	20:35	18:10	18:15	LB	4	Buffer, beyond
18/08/2021	2	10:05	13:05	10:10	10:15	RN	14	On site, buffer, beyond
18/08/2021	2	10:05	13:05	10:20	10:25	RN	2	On site, buffer
18/08/2021	2	10:05	13:05	10:35	10:40	RN	1	On site, buffer
18/08/2021	2	10:05	13:05	10:50	10:55	BZ	2	On site
18/08/2021	2	10:05	13:05	11:00	11:05	BZ	1	On site
18/08/2021	2	10:05	13:05	11:45	11:50	BZ	1	On site
18/08/2021	2	10:05	13:05	11:50	11:55	BZ	1	On site
18/08/2021	2	10:05	13:05	12:35	12:40	H.	2	On site, buffer, beyond
17/08/2021	2	11:10	14:10	11:35	11:40	BZ	1	Buffer
17/08/2021	2	11:10	14:10	11:35	11:40	SH	1	Buffer
17/08/2021	2	11:10	14:10	11:50	11:55	H.	1	On site

Date	VP	Survey start	Survey end	5 min period start time	5 min period end time	Species	Count Max	Location (on site, in buffer, or beyond)
17/08/2021	2	11:10	14:10	12:25	12:30	RN	3	Buffer
17/08/2021	2	11:10	14:10	12:35	12:40	RN	4	On site, buffer
17/08/2021	2	11:10	14:10	12:45	12:50	HG	1	Buffer, beyond
14/09/2021	1	16:45	19:45	17:10	17:15	SH	1	On site
14/09/2021	1	16:45	19:45	17:10	17:15	RN	1	Buffer, beyond
14/09/2021	1	16:45	19:45	17:55	18:00	RN	2	Buffer
14/09/2021	1	16:45	19:45	19:35	19:40	CM	26	On site, buffer, beyond
15/09/2021	2	07:05	10:05	07:50	07:55	CM	1	Buffer
15/09/2021	2	07:05	10:05	08:05	08:10	H.	1	On site, buffer
15/09/2021	2	07:05	10:05	08:20	08:25	RN	1	On site, buffer
15/09/2021	1	10:35	13:35	11:15	11:20	CM	1	Buffer
15/09/2021	1	10:35	13:35	12:05	12:10	BZ	1	On site, buffer
13/10/2021	1	15:40	18:40	16:05	16:10	BZ	1	On site
13/10/2021	1	15:40	18:40	16:15	16:20	BZ	1	On site
13/10/2021	1	15:40	18:40	16:20	16:25	BZ	1	On site
13/10/2021	1	15:40	18:40	17:30	17:35	H.	1	On site, buffer, beyond
14/10/2021	1	08:00	11:00	10:25	10:30	MA	1	On site
14/10/2021	2	11:30	14:30	12:30	12:35	H.	1	On site, buffer, beyond
14/10/2021	2	11:30	14:30	13:40	13:45	BZ	1	Beyond
11/11/2021	2	13:45	16:45	14:35	14:40	BZ	2	On site
11/11/2021	2	13:45	16:45	14:40	14:45	BZ	2	On site
12/11/2021	1	08:00	11:00	08:15	08:20	SH	1	On site

Date	VP	Survey start	Survey end	5 min period start time	5 min period end time	Species	Count Max	Location (on site, in buffer, or beyond)
12/11/2021	1	08:00	11:00	08:35	08:40	SH	1	On site
12/11/2021	1	08:00	11:00	09:40	09:45	SH	1	On site, buffer
12/11/2021	1	08:00	11:00	09:35	09:40	MA	2	On site
12/11/2021	1	08:00	11:00	10:10	10:15	MA	2	On site
12/11/2021	2	11:30	14:30	11:30	11:35	RN	1	On site
26/11/2021	1	07:50	10:50	10:05	10:10	RN	1	On site, buffer, beyond
26/11/2021	1	07:50	10:50	10:05	10:10	SH	1	Buffer, beyond
10/12/2021	1	08:15	11:15	09:20	09:25	RN	1	On site, buffer
10/12/2021	1	08:15	11:15	09:25	09:30	BZ	1	On site
10/12/2021	1	08:15	11:15	10:35	10:40	RN	2	On site, buffer
10/12/2021	1	08:15	11:15	10:55	11:00	RN	2	On site, buffer, beyond
10/12/2021	1	08:15	11:15	11:00	11:05	RN	1	On site, buffer, beyond
16/12/2021	1	09:30	12:30	09:30	09:35	ET	1	On site
16/12/2021	1	09:30	12:30	09:50	09:55	ET	1	On site
16/12/2021	1	09:30	12:30	10:00	10:05	RN	1	On site
16/12/2021	1	09:30	12:30	10:40	10:45	BZ	2	On site
16/12/2021	1	09:30	12:30	11:20	11:25	RN	1	On site
16/12/2021	1	09:30	12:30	11:35	11:40	SH	1	On site
16/12/2021	1	09:30	12:30	11:40	11:45	ET	1	On site
16/12/2021	1	09:30	12:30	11:40	11:45	BZ	1	On site
16/12/2021	1	09:30	12:30	11:55	12:00	ET	1	On site
16/12/2021	2	13:00	16:00	15:10	15:15	CA	1	On site, buffer, beyond

Date	VP	Survey start	Survey end	5 min period start time	5 min period end time	Species	Count Max	Location (on site, in buffer, or beyond)
16/12/2021	2	13:00	16:00	15:30	15:35	RN	2	On site, buffer, beyond
17/12/2021	2	08:30	11:30	09:00	09:05	MA	2	On site
17/12/2021	2	08:30	11:30	09:05	09:10	RN	1	On site, buffer, beyond
17/12/2021	2	08:30	11:30	09:25	09:30	CA	2	On site, buffer, beyond
17/12/2021	2	08:30	11:30	09:40	09:45	CM	8	Buffer, beyond
17/12/2021	2	08:30	11:30	09:45	09:50	CA	1	On site
17/12/2021	2	08:30	11:30	09:55	10:00	RN	1	On site
06/01/2022	2	13:30	16:30	14:55	15:00	BZ	1	On site
06/01/2022	2	13:30	16:30	16:00	16:05	BZ	1	On site, buffer
06/01/2022	2	13:30	16:30	16:10	16:15	H.	1	On site, buffer
18/01/2022	1	10:00	13:00	12:10	12:15	BZ	1	On site
18/01/2022	1	10:00	13:00	12:10	12:15	RN	2	On site
18/01/2022	1	10:00	13:00	12:40	12:45	RN	2	On site, buffer
19/01/2022	1	12:30	15:30	12:40	12:45	CA	1	On site, buffer, beyond
19/01/2022	1	12:30	15:30	13:00	13:05	CA	1	On site, buffer, beyond
19/01/2022	1	12:30	15:30	13:10	13:15	RN	2	Buffer,. Beyond
19/01/2022	1	12:30	15:30	14:15	14:20	BZ	1	On site, buffer
19/01/2022	1	12:30	15:30	14:20	14:25	RN	1	On site, buffer, beyond
19/01/2022	1	12:30	15:30	15:30	15:35	CA	1	Buffer, beyond
19/01/2022	2	09:00	12:00	09:35	09:40	BZ	1	Buffer
19/01/2022	2	09:00	12:00	10:00	10:05	RN	2	Buffer, beyond
19/01/2022	2	09:00	12:00	10:05	10:10	RN	1	Buffer, beyond

Date	VP	Survey start	Survey end	5 min period start time	5 min period end time	Species	Count Max	Location (on site, in buffer, or beyond)
19/01/2022	2	09:00	12:00	10:40	10:45	BZ	1	Buffer
03/02/2022	1	14:30	17:30	15:00	15:05	RN	1	On site
03/02/2022	1	14:30	17:30	15:05	15:10	BZ	2	Buffer
03/02/2022	1	14:30	17:30	15:15	15:20	BZ	2	Buffer
03/02/2022	1	14:30	17:30	15:30	15:35	BZ	1	Buffer
03/02/2022	1	14:30	17:30	16:10	16:15	BZ	1	Buffer
03/02/2022	1	14:30	17:30	17:10	17:15	RN	2	Buffer
03/02/2022	2	10:30	13:30	11:15	11:20	BZ	2	On site
03/02/2022	2	10:30	13:30	11:25	11:30	RN	2	On site
03/02/2022	2	10:30	13:30	11:30	11:35	BZ	1	On site
03/02/2022	2	10:30	13:30	11:30	11:35	BZ	3	On site, buffer, beyond
03/02/2022	2	10:30	13:30	11:35	11:40	BZ	2	On site, buffer, beyond
03/02/2022	2	10:30	13:30	11:55	12:00	RN	2	On site, buffer, beyond
03/02/2022	2	10:30	13:30	12:30	12:35	BZ	1	On site
04/02/2022	1	07:45	10:45	10:00	10:05	H.	1	On site, buffer
16/02/2022	2	11:15	14:15	11:45	11:50	BZ	2	Buffer
02/03/2022	2	12:30	15:30	13:25	13:30	BZ	1	Buffer, beyond
02/03/2022	2	12:30	15:30	14:35	14:40	CA	1	Buffer
02/03/2022	2	12:30	15:30	14:40	14:45	BZ	1	On site
02/03/2022	2	12:30	15:30	14:50	14:55	CA	1	On site, buffer, beyond
02/03/2022	2	12:30	15:30	15:10	15:15	BZ	1	On site, buffer, beyond
03/03/2022	1	07:00	10:00	07:35	07:40	MA	2	On site, buffer, beyond

Date	VP	Survey start	Survey end	5 min period start time	5 min period end time	Species	Count Max	Location (on site, in buffer, or beyond)
03/03/2022	1	07:00	10:00	07:40	07:45	MA	2	On site, buffer, beyond
03/03/2022	1	07:00	10:00	07:40	07:45	MA	1	On site, buffer, beyond
03/03/2022	1	07:00	10:00	07:45	07:50	MA	4	On site, buffer, beyond
03/03/2022	1	07:00	10:00	08:00	08:05	MA	1	On site, buffer, beyond
03/03/2022	1	07:00	10:00	08:05	08:10	NMA	2	On site, buffer, beyond
03/03/2022	1	07:00	10:00	08:45	08:50	CA	1	On site, buffer, beyond
03/03/2022	1	07:00	10:00	09:00	09:05	CA	1	On site, buffer, beyond
03/03/2022	2	10:30	13:30	10:35	10:40	BZ	1	On site
03/03/2022	2	10:30	13:30	11:10	11:15	BZ	1	Buffer, beyond
03/03/2022	2	10:30	13:30	11:20	11:25	BZ	1	On site
03/03/2022	2	10:30	13:30	11:25	11:30	BZ	2	On site, buffer, beyond
03/03/2022	2	10:30	13:30	11:30	11:35	CA	1	On site, buffer, beyond
03/03/2022	2	10:30	13:30	11:35	11:40	BZ	1	Buffer
03/03/2022	2	10:30	13:30	11:40	11:45	BZ	1	On site, buffer
03/03/2022	2	10:30	13:30	11:45	11:50	BZ	3	On site, buffer
03/03/2022	2	10:30	13:30	11:50	11:55	BZ	5	On site, buffer, beyond
03/03/2022	2	10:30	13:30	12:00	12:05	BZ	5	On site, buffer
03/03/2022	2	10:30	13:30	12:05	12:10	BZ	3	On site, buffer
03/03/2022	2	10:30	13:30	12:05	12:10	RN	2	On site, buffer
03/03/2022	2	10:30	13:30	12:15	12:20	BZ	3	On site, buffer, beyond
03/03/2022	2	10:30	13:30	12:15	12:20	RN	2	On site, buffer
03/03/2022	2	10:30	13:30	12:30	12:35	BZ	1	On site, buffer

Date	VP	Survey start	Survey end	5 min period start time	5 min period end time	Species	Count Max	Location (on site, in buffer, or beyond)
03/03/2022	2	10:30	13:30	12:50	12:55	BZ	2	Buffer
03/03/2022	2	10:30	13:30	12:55	13:00	BZ	1	On site
16/03/2022	1	13:30	16:30	15:45	15:50	MA	5	On site
16/03/2022	1	13:30	16:30	16:20	16:25	MA	1	On site

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BIRD SURVEY REPORT
BREEDING 2022

Cush Wind Farm

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1.0 Introduction

Bird surveys have been previously undertaken at the proposed wind farm development site at Cush, Co. Offaly (hereafter 'the Project Site') by SLR Consulting Ireland (SLR) for the breeding 2020, non-breeding 2020/21, breeding 2021, and non-breeding 2021/22 seasons. The Project Site also includes a linear area that was previously surveyed for a proposed overhead line[1]. Flight activity surveys were carried out at two vantage point locations along the proposed overhead line route corridor during the breeding season in 2018.

SLR was commissioned by Galetech Energy Developments to carry out a bird survey programme for the proposed wind farm at Cush, Co. Offaly (hereafter 'the Project') during the breeding season in 2022.

1.1 Background to the Commission

No previous planning permission has been sought on the application site for the development of wind farms by Galetech Energy Developments or any other party.

1.2 Site Description

The Project site located in the townland of Cush approximately 4 km north of Birr, Co. Offaly. The habitats within the proposed development site are dominated by conifer plantations of varying age classes (c.327 ha), cutaway bog (c.102 ha) and agricultural grasslands (ca. 327 ha; refer to Appendix 01 **Figure 1**).

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[2], with details provided in **Table 1-1**. Further details are provided in Sections 2.2 to 2.5.

Table 1-1
Scope of Ornithological Survey Work May to August 2022

Survey Type	Summary Methodology (see Section 2 for further details)
Vantage Point (VP) surveys	12 hours of survey per month were carried out from each of the three VPs between May and June 2022. Six hours of survey per month were carried out from each VP between July and August 2022.
Breeding wader surveys	Three breeding wader surveys were carried out from May to June 2022 to search for lowland waders breeding within the Project Site.
Breeding raptor surveys	Five breeding raptor surveys were carried out from May to July to search for any raptors breeding within 2 km of the Project Site. An additional survey was undertaken at [redacted] Quarry in August to search for breeding peregrine falcon *Falco peregrinus*.

[1] SLR (2018) *Cloghan Wind Farm and Long Oak Wind Farm Breeding Bird Survey Report 2018*. Prepared for Galetech Energy Services Ltd

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

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[3]. 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[4]; and
- Other raptors, waders or wildfowl red-listed on the latest Birds of Conservation Concern in Ireland (BoCCI)[5] 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;*
- Eurasian sparrowhawk *Accipiter nisus*;
- Northern raven *Corvus corax*;
- Grey heron *Ardea cinerea;*
- Great cormorant *Phalacrocorax carbo;* and
- Gulls *Larus* sp.

NS guidance states that “it is generally considered the passerine species are not significantly impacted by wind farms”. It goes on to state that “survey of woodland passerines, especially in commercial conifer forest is generally not required”. The only exception is if the desk study identifies that the Project Site is in a key area for a Schedule 1 woodland passerine species. As Schedule 1 refers to UK legislation, it is prudent to assume

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

that passerines red-listed under the latest Birds of Conservation Concern in Ireland (BoCCI) scheme[6] should be considered as equivalent. No such species were returned during the desk-based review or data request. NS guidance also states that "surveys of farmland passerines especially on more intensive arable habitat are generally not required". Based on the above, while not the targets, any red-listed passerines were recorded as incidental species during other surveys.

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 to 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 this Report

This report outlines the surveys undertaken and methods used. It then summarises the survey data obtained and provides descriptions of the legal and conservation status of the species recorded.

The assessment of impacts resulting from the proposed development and the development of mitigation measures, if required, are beyond the scope of this report and will be covered in a separate Environmental Impact Assessment (EIA) Report in due course.

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

2.0 Methods

2.1 Desk-Based Review

The desk review collated any available information to date on the breeding and non-breeding bird populations and movements around the Project site.

The following reports resulting from previous breeding and non-breeding bird surveys were reviewed for any relevant information that could be used to inform the current bird surveys:

- SLR (2020) Cush Wind Farm Breeding Bird Survey Report 2020.
- SLR (2022) Cush Wind Farm Winter Bird Survey Report 2020-2021.
- SLR (2022) Cush Wind Farm Breeding and Winter Bird Survey Report 2021-2022.
- SLR (2018) Cloghan Wind Farm and Long Oak Wind Farm Breeding Bird Survey Report 2018

The websites of the National Parks and Wildlife Service (NPWS)[7], the UK and Ireland Bird Atlas 2007-2011[8] and the National Biodiversity Data Centre (NBDC)[9] were accessed for information on sites designated for nature conservation and notable bird species in the vicinity of the Project Site.

2.2 Field Survey Dates and Personnel

Surveys were undertaken by Jonathon Dunn (JD) PhD, Aisling Kinsella (AK) BSc (Hons) MSc, Darragh Nagle (DN) BSc (Hons), and Maeve Maher-McWilliams BSc (Hons) MSc.

Details of survey dates and times are provided in Appendix 02 and a record of weather conditions during surveys is provided in Appendix 03.

2.3 Flight Activity Surveys

VP locations, 2 km viewing arcs and viewsheds are shown in Appendix 01 **Figure 1**.

A total of 108 hours of flight activity surveys were conducted from all VP locations combined during the 2022 breeding season, as summarised in **Table 2-1**.

In order to avoid possible complications during any subsequent collision risk modelling, VP watches were timed such that surveys were not undertaken simultaneously from both VPs. This avoids double-counting birds and ensures that no disturbance is made to birds within viewsheds from presence of the observer.

VP watches 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 Project Site;
- The relative use by birds of different parts of the Project Site;

[7] www.npws.ie Accessed 16/10/2022
[8] https://app.bto.org/mapstore/StoreServlet Accessed 16/10/2022
[9] http://maps.biodiversityireland.ie/#/Map Accessed 16/10/2022

- 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);
- Number of birds observed;
- 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. For the 2022 breeding season, height bands were determined allowing for the maximum rotor tip height of 200 m and a lowest rotor swept height of 28 m. The relation of the height bands to the latest turbine specification is shown below.

Flight heights were attributed to four distinct height bands for the breeding season as follows:

- 1 = <25 m (below the likely rotor swept area);
- 2 = 25 m to 160 m (potentially within the likely rotor swept area, at least in part);
- 3 = 160 m to 200 m (within the likely rotor swept area); and
- 4 = >200 m (potentially within the likely rotor swept area, at least in part).

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 and around the Project Site, in accordance with current NS guidance.

Table 2-1
Summary of VP Surveys Undertaken during the Breeding Season 2022

Month	VP1 (hours)	VP2 (hours)	VP3 (hours)
May	12:00	12:00	12:00
June	12:00	12:00	12:00
July	6:00	6:00	6:00
August	6:00	6:00	6:00
Total hrs	**36:00**	**36:00**	**36:00**
VP locations ITM (**Figure 1**)	608735 E 710130 N	605883 N 709097 N	607798 E 711305 N

2.4 Breeding Wader Surveys

Breeding wader surveys followed the methodology described in O'Brien and Smith (1992)[10]. The survey involved a walked transect which covered all habitat potentially suitable for breeding waders within the Project Site.

There are large plantations of mature conifer forestry in the central, western, and southern areas of the Project Site. These habitats are not suitable for breeding waders[11] and so were excluded from the survey. There are some areas of recolonising cutover bog which were as considered suitable habitats for breeding waders. As such, transects were undertaken where habitats which are more suited to breeding waders. These transects are located in the western, eastern and northern sections of the Project Site where semi-natural and wet grassland fields are present and also, passing near to areas of recolonising cutover bog.

The transect route was repeated three times across the 2022 breeding season on 9th May, 17th May and 8th June.

The location, movement and behaviour of all wader species were recorded onto field maps using standard BTO species codes. The following criteria was 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).

For birds to be considered as "confirmed breeding", one or more of the following criteria needed to be met:

- 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.

Please see Appendix 01 **Figure 3** for an outline of the walked transect and Appendices 02 and 03 for metadata relating to these surveys.

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[10] 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

[11] Apart from potentially for woodcock, which were not the target of surveys here.

2.5 Breeding Raptor Surveys

The survey methodology for breeding raptors used was a driven transect with regular stops, to carry out watches of suitable habitat from appropriate viewpoints to identify potential nesting territories in suitable breeding habitat[12]. The locations of these viewpoints are presented in Appendix 01 **Figure 4** together with the outline of the driven survey route and the results of the surveys.

A driven survey was used due to limitations to access to third party land within the 2 km buffer zone and the availability of a good road network in the vicinity of the Project Site. Visibility from the survey route was sufficient to cover the vast majority of potentially suitable breeding habitat within the survey area.

Survey timings followed NS guidelines. This survey was repeated along the same routes on once on 9th May, 17th May and 7th June, and twice on 14th July (dawn and dusk). An additional survey was undertaken on 2nd August at [redacted] Quarry (located 1 km south of the Project Site) to search for evidence of breeding peregrine falcon. Details of survey dates, times and observers are provided in Appendix 02 and a record of weather conditions during surveys is provided in Appendix 03.

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

2.6 Survey Limitations

Regarding viewshed coverage of the 500 m Project Site infrastructure buffer, some gaps are apparent in the southwest of the Project Site; however, there is visibility of the 500 m buffer around all turbine locations (refer to Appendix 01 **Figure 1**). Overall, it is considered that the vantage point data are representative of the Project Site as a whole and sufficient to inform a robust assessment of the Project.

No surveys were completed in April 2022. However, the survey effort was doubled up in May and June, which ensured that the required number of surveys was completed before the end of the breeding season.

Most vantage point 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 three hours out of the total of 108 during which the visibility was recorded as “moderate”, i.e. 1-3 km. This comprises 2.8% of the total survey effort but in almost all cases all the relevant 2 km viewing arc was visible, and this is not considered to significantly affect the validity of the data collected. There were no recorded hours of “poor” visibility during the surveys i.e., less than 1 km. Further details regarding weather conditions during surveys are provided in Appendix 02.

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[12] Hardey, J., Crick, H.Q.P., Wernham, C., Riley, H., Etheridge, B., Thompson, D. (2013). Raptors: A field guide for surveys and monitoring (3rd Edition). The Stationery Office Edinburgh.

3.0 Results

3.1 Desk Based Results

The Project Site is not within or immediately adjacent to any SPA. However, there are a total of seven SPAs within a 20 km[13] radius with details shown in **Table 3-1**.

The closest SPAs to the Project Site are Dovegrove Callows SPA (Site Code: 004137), River Little Brosna Callows SPA (Site Code: 004086) and All Saints Bog SPA (Site Code: 004103) at distances of 1.5 km, 3.1 km and 3.1 km, respectively. Dovegrove Callows SPA and All Saints Bog SPA are designated for the protection of wintering Greenland white-fronted geese *Anser albifrons flavirostris,* whereas the River Little Brosna Callows SPA is designated for several wintering gull, wader and wildfowl species.

Table 3-1
SPAs within 20 km of the Project Site and their Qualifying Interests (Species Present During the Breeding Season)

Site Name	Site Code	Distance/Direction from Site Boundary	Species of Special Conservation Interest Relevant to the Breeding Season
Dovegrove Callows SPA	004137	1.5 km southwest	• N/A
All Saints Bog SPA	004103	3.1 km west	• N/A
River Little Brosna Callows SPA	004086	3.1 km west	• N/A
Middle Shannon Callows SPA	004096	6.6 km northwest	• Corncrake *Crex crex* • Northern lapwing
Slieve Bloom Mountains SPA	004160	11.7 km east	• Hen harrier *Circus cyaneus*
River Suck Callows SPA	004097	17.3 km northwest	• N/A
Lough Derg (Shannon) SPA	004058	17.5 km southwest	• Great cormorant *Phalacrocorax carbo* • Tufted duck *Aythya fuligula* • Common tern *Sterna hirundo*

3.2 Breeding Season Flight Activity Surveys

Flight activity recorded from all VPs combined by primary target species is summarised in **Table 3-2**. Primary target species flights from both VPs are shown in Appendix 01 Figures **2.1** to **2.4**. Flight activity data are provided in more detail in Appendix 04 with full data retained in GIS and excel format for subsequent collision risk modelling.

[13] A 20 km search radius was used as this represents the maximum core foraging distance used by Qualifying Interest species of SPAs in the UK and Ireland

3.2.1 Primary Target Species

A total of 459 flight lines by six primary target species were recorded between May and August 2022.

Table 3-2
Number of Primary Target Species Flights from All VPs Combined, May to August 2022

Species	Number of flight lines by month				Total number of flight lines	Time at risk height* (s)	Cumulative number of flights
	May	June	July	August			
Black-headed gull	129	60	3	0	192	5,310	470
Common kestrel *Falco tinnunculus*	16	35	9	6	66	6,480	66
Northern lapwing	62	44	24	1	131	1,575	224
Peregrine falcon	1	3	1	0	5	240	5
Common ringed plover *Charadrius hiaticula*	0	10	2	0	12	15	19
Common snipe	8	37	7	0	52	4,485	63
Total	**216**	**189**	**46**	**7**	**458**	**18,105**	**847**
* precautionary risk height assumed to be between 28 – 200 m							

A summary description of flight activity by each species is presented below.

Black-Headed Gull

A total of 192 black-headed gull flight lines were recorded from May to July 2022, with a cumulative total of 470 flights. A total of 108 flight lines (56%) were recorded within potential collision risk heights. The highest number of flight lines was recorded in May, with numbers declining in later months. Most flight lines consisted of a small number of birds, but there were a few larger flocks recorded (up to 34 flights per flight line). Flight durations varied with a maximum duration of 480 seconds.

Common Kestrel

A total of 66 common kestrel flight lines were recorded during the flight activity surveys, with all observations consisting of a single bird. A total of 51 flight lines (77%) were recorded within potential collision risk heights. Flight durations varied with a maximum duration of 446 seconds.

Northern Lapwing

A total of 131 northern lapwing flight lines were recorded during the flight activity surveys, with a cumulative total of 224 flights. Most flight lines were recorded at VP3, which overlooks an area of cutover bog. The highest number of flight lines was recorded in May, with numbers declining in later months. Most flight lines consisted of a single bird, but there were a few larger flocks recorded (up to 13 flights per flight line). A total of 25 flight lines (19%) were recorded within potential collision risk heights.

Peregrine Falcon

Five peregrine falcon flight lines were recorded from May to July 2022, with all observations consisting of a single bird. Four flight lines were recorded within potential collision risk heights, and all of these were observed from VP3.

Common Ringed Plover

A total of 12 common ringed plover flight lines were recorded during June and July 2022, with a cumulative total of 19 flights. All flight lines were recorded at VP3, and most flights were recorded in June. Only one flight line was recorded at potential collision risk height, and it consisted of two flights within the 500 m survey buffer. Most flight lines lasted less than 15 seconds, and the longest flight duration recorded was 25 seconds.

Common Snipe

A total of 52 common snipe flight lines were recorded from May to July 2022, with a cumulative total of 63 flights. The highest number of flight lines was recorded in June, and all flights were recorded from either VP1 or VP3. A total of 33 flight lines (63%) were recorded within potential collision risk heights. Flight durations varied with a maximum duration of 814 seconds.

3.2.2 Secondary Target Species

Secondary species activity at the Project Site is summarised in **Table 3-3**. There were 10 secondary species recorded throughout the season. Common buzzard was the most frequently recorded secondary species (in 204 five-minute periods out of a possible 1,296). The highest number of birds recorded in one observation was 19 mallards *Anas platyrhynchos.*

Table 3-3
Secondary Species Activity Summary for VP1 and VP2 Combined – May to August 2022

Species	Number of 5 min periods recorded	Peak count of birds recorded in any 5 min period	Comments
Common buzzard	204	4	Activity in all months, within the Project Site, survey buffer and beyond.
Common gull *Larus canus*	1	1	Activity in May only, within the Project Site.
Little egret *Egretta garzetta*	1	1	Activity in June only, within the Project Site.
Grey heron	15	3	Activity in all months, within the Project Site and survey buffer.
Great black-backed gull *Larus marinus*	3	2	Activity in August only, within the Project Site and survey buffer.
Common gull	1	5	Activity in August only, within the Project Site and survey buffer.

Species	Number of 5 min periods recorded	Peak count of birds recorded in any 5 min period	Comments
Herring gull *Larus argentatus*	15	8	Activity in all months, within the Project Site and survey buffer.
Lesser black-backed gull *Larus fuscus*	25	4	Activity in all months, within the Project Site and survey buffer.
Mallard	12	19	Activity in all months except July, within the Project Site, survey buffer and beyond.
Northern raven	43	4	Activity in all months, within the Project Site, survey buffer and beyond.
Eurasian sparrowhawk	9	1	Activity in all months, within the Project Site and survey buffer.

3.3 Breeding Wader Surveys

A total of three wader species were recorded during the breeding wader surveys. All wader observations were recorded during the two surveys in May.

Eurasian Curlew

Two observations of Eurasian curlew were made during the survey on 9th May. Two birds were recorded from the north transect within the Project Site, and one bird was recorded from the east transect in an agricultural field approximately 100 m from the site infrastructure. No evidence of breeding was recorded for this species.

Common Snipe

A single common snipe was recorded flying briefly over the survey area north-west of the Project Site on 17th May. No evidence of breeding was recorded for this species. No drumming behaviour was recorded during flight activity surveys.

Northern Lapwing

A probable northern lapwing territory was identified within 500 m survey buffer to the north of the Project Site, as evidenced by frequent flight activity and aggressive behaviour. A single bird was also observed flying further south.

Incidental Records of Other Species

No incidental records of non-target surveys were recorded during the breeding wader surveys.

3.4 Breeding Raptor Surveys

A total of four species of raptor were recorded during the targeted breeding raptor surveys.

Common Buzzard

There were 17 common buzzard observations made between May-July 2022, but no confirmed evidence of breeding was recorded during these months. Two possible territories were identified within 500 m of the Project Site in May. Three birds were observed circling over suitable nest habitat in July, but no nests or young birds were recorded.

Common Kestrel

Common kestrel was observed hunting during May-July 2022 on six occasions, but there was no evidence of breeding by this species within 2 km of the Project Site.

Peregrine Falcon

A single peregrine falcon was observed flying towards [redacted] Quarry in July 2022. During the survey at the quarry in August, one bird was recorded perched on a ledge. A possible nest site and several used roosts were also recorded.

Eurasian Sparrowhawk

A single Eurasian sparrowhawk was observed circling over woodland within 2 km of the Project Site, but there was no evidence of breeding by this species within 2 km of the Project Site.

Incidental Records of Other Species

Incidental records were made of sandwich tern *Sterna sandvicensis*, northern lapwing and little egret during the surveys in May. A barn owl *Tyto alba* was recorded hunting on 18th May during a bat activity transect undertaken after a breeding raptor survey.

4.0 Summary and Conclusions

Flight activity surveys (VPs), breeding wader and breeding raptor surveys were carried out at the Project Site during the breeding season in 2022.

The following primary target species were recorded during the breeding season flight activity surveys:

- Black-headed gull;
- Common kestrel;
- Northern lapwing;
- Peregrine falcon;
- Common ringed plover; and
- Common snipe.

Black-headed gull was the most frequently recorded species and the most numerous species, with a peak count of 34 flights being recorded in a single flight line.

Ten secondary target species were recorded during the breeding season: common buzzard, common gull, little egret, great black-backed gull, grey heron, herring gull, lesser black-backed gull, mallard, northern raven and Eurasian sparrowhawk.

Northern lapwing was probably breeding (as evidenced by a territory and aggressive behaviour) within 500 m of the Project Site in the same location where a nest and chicks were recorded previously. Common buzzards were suspected to breed (i.e. territories were present) within 500 m of the Project Site, and peregrine falcon were suspected to breed (one possible nest) in [redacted] Quarry located 1 km south of the Project Site.

Incidental records made of species of conservation concern during taxon-specific surveys included sandwich tern, little egret, northern lapwing and barn owl.

4.1 Legal and Conservation Status of Target Species Recorded

Table 4-1 summarises the legal and conservation status of the primary and secondary target species recorded during the range of ornithological surveys mentioned above. Note that all bird species in Ireland are afforded general protection by the Wildlife Acts 2000 (as amended).

Table 4-1
Legal and Conservation Status of Target Species

Primary or Secondary Target	Species (BTO code)	Legal and Conservation status in Ireland
Primary	Black-headed gull (BH)	BoCCI4 Amber
	Common kestrel (K.)	BoCCI4 Red
	Northern lapwing (L.)	BoCCI4 Red
	Peregrine falcon (PE)	Annex 1, BoCCI4 Green
	Common ringed plover (RP)	BoCCI4 Amber
	Common snipe (SN)	BoCCI4 Red
Secondary	Common buzzard (BZ)	BoCCI4 Green
	Common gull (CM)	BoCCI4 Amber
	Little egret (ET)	Annex 1, BoCCI4 Green
	Great black-backed gull (GB)	BoCCI4 Green
	Grey heron (H.)	BoCCI4 Green
	Herring gull (HG)	BoCCI4 Amber
	Lesser black-backed gull (LB)	BoCCI4 Amber
	Mallard (MA)	BoCCI4 Amber
	Northern raven (RN)	BoCCI4 Green
	Eurasian sparrowhawk (SH)	BoCCI4 Green
Incidentals	Sandwich tern (TE)	Annex 1, BoCCI4 Amber
	Barn owl (BO)	BoCCI4 Red

Primary or Secondary Target	Species (BTO code)	Legal and Conservation status in Ireland
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[5] status category.

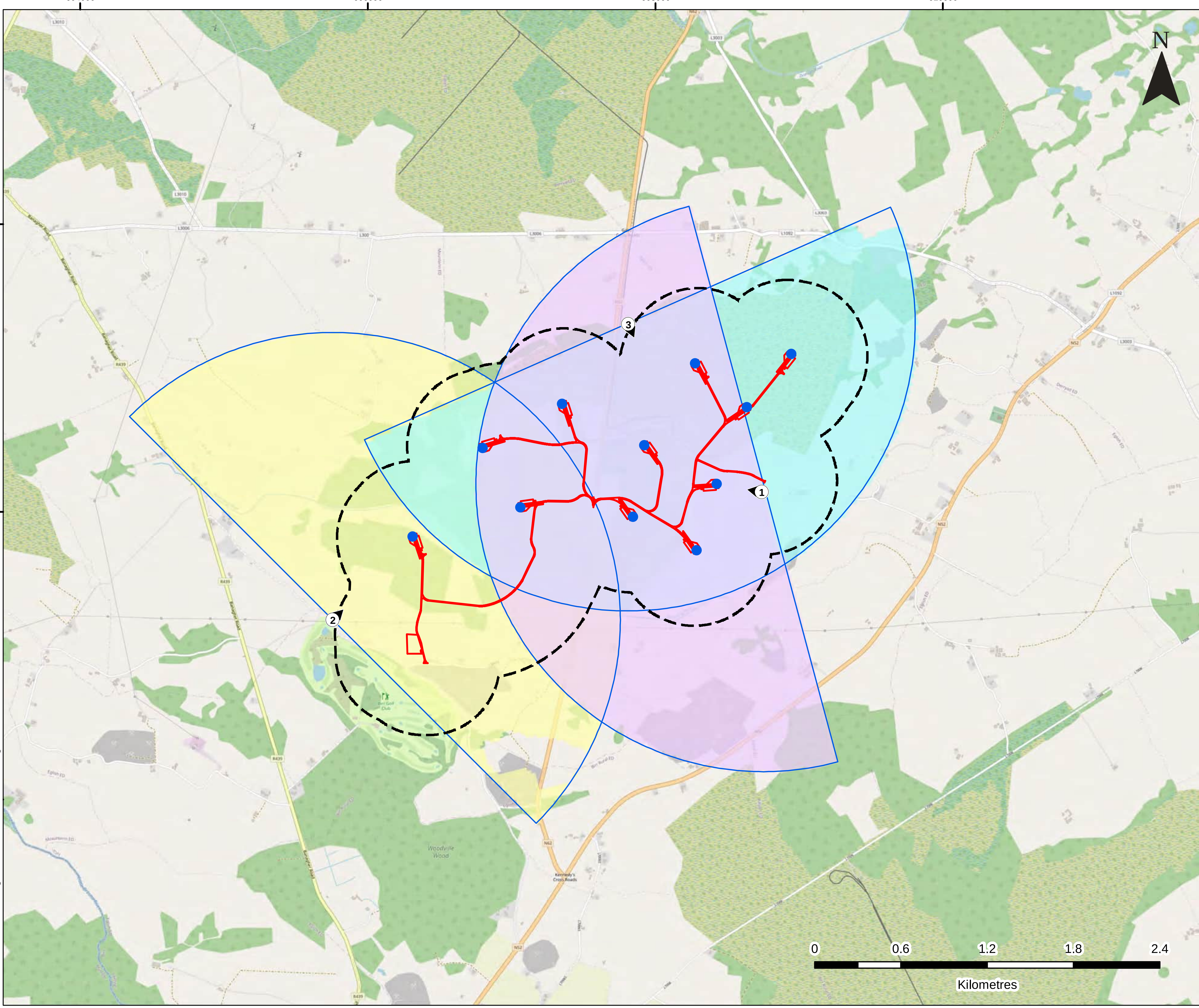
APPENDIX 01

Figures

604000 606000 608000 610000

712000

710000



NOTES

The ZTV is calculated with a surface offset 28m & from a viewing height of 1.8m above ground level. The terrain model is derived from EU Copernicus 28 m data with a vertical accuracy of ± 7m. The ZTV was calculated using ArcMAP 10.5.1 software

The analysis does not take into account the screening effects of vegetation, buildings or other screening features.

LEGEND

- Site Infrastructure
- Site Infrastructure 500 m Buffer
- Turbine Location
- Vantage Point (VP)
- VP 2 km Viewing Arc
- Theoretical Visibility from VP 1
- Theoretical Visibility from VP 3
- Theoretical Visibility from VP 2

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CUSH WIND FARM ORNITHOLOGY

BREEDING BIRD SURVEYS

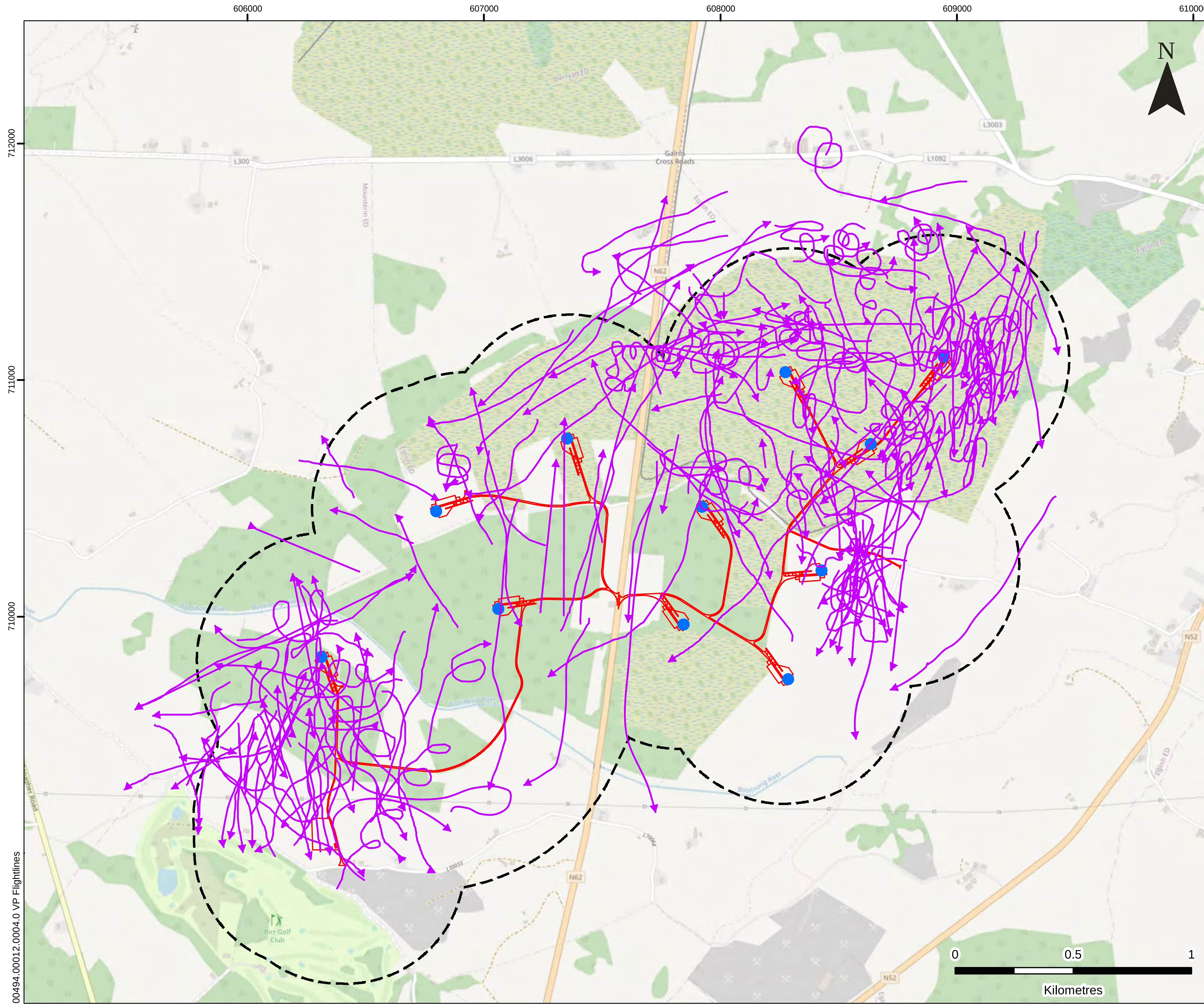
VANTAGE POINT LOCATIONS AND VIEWING ARCS

FIGURE 1

Scale 1:25,000 @ A3

Date JANUARY 2023

00494.00012.0001.0 Vantage Point Locations and Viewing Arcs



LEGEND

- Site Infrastructure
- Site Infrastructure 500 m Buffer
- Turbine Locations

Species Flightline

- Black-headed Gull

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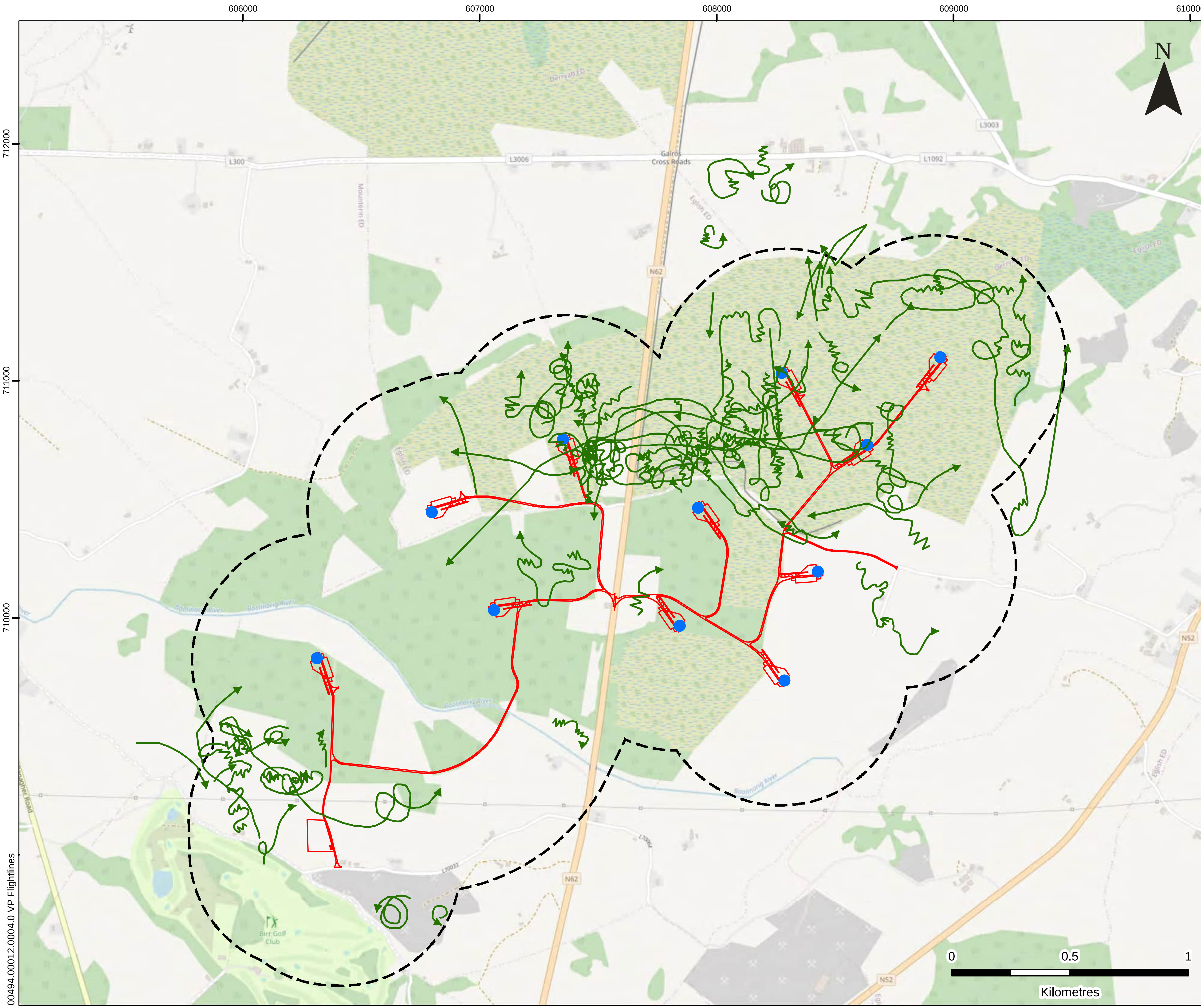
BREEDING BIRD SURVEYS 2022

BLACK-HEADED GULL FLIGHTLINES

FIGURE 2.2

Scale	Date
1:15,000 @ A3	JANUARY 2023

00494.00012.0004.0 VP Flightlines



LEGEND

- Site Infrastructure
- Site Infrastructure 500 m Buffer
- Turbine Locations

Species Flightline

- Kestrel

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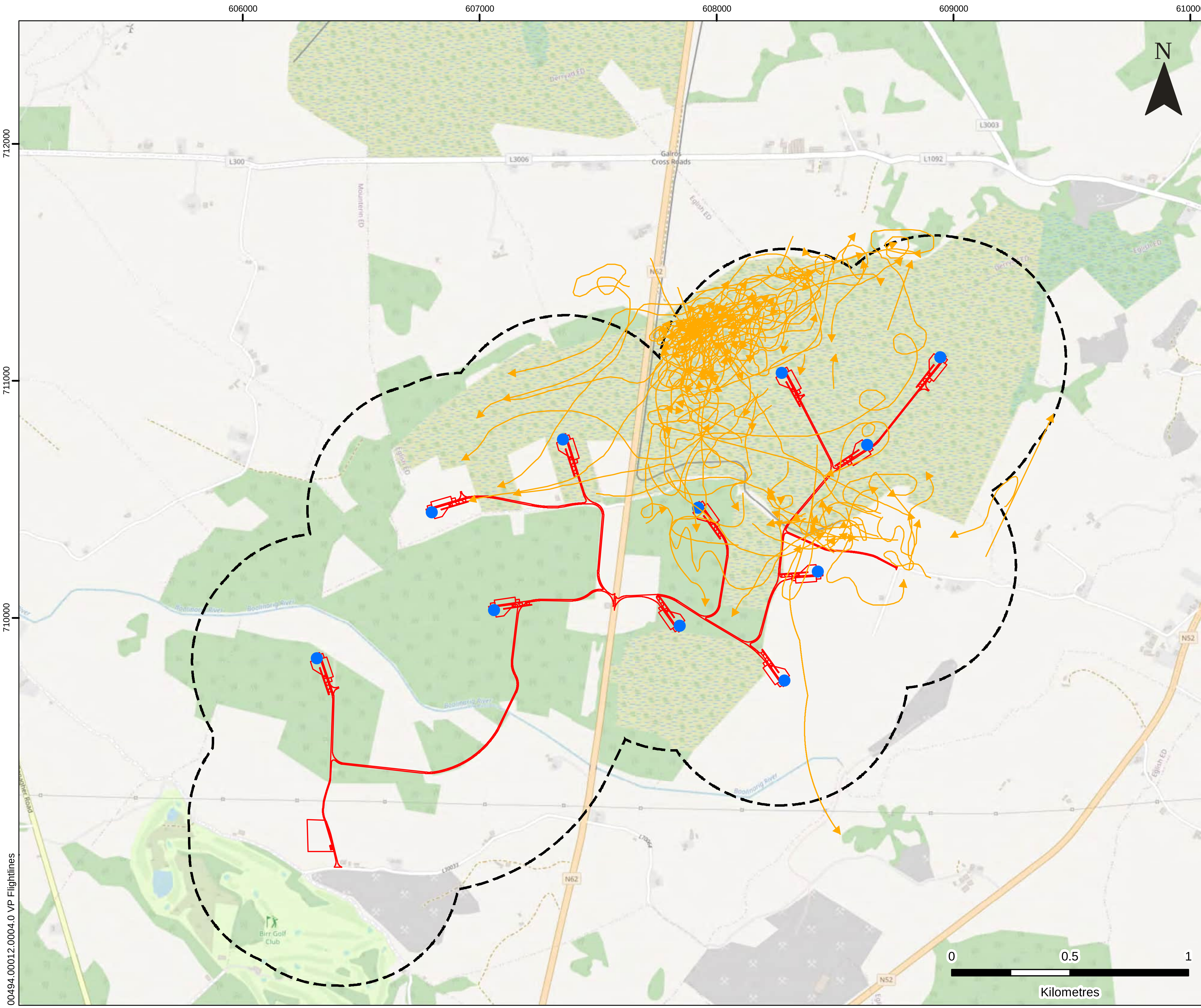
BREEDING BIRD SURVEYS 2022

KESTREL FLIGHTLINES

FIGURE 2.3

Scale	Date
1:15,000 @ A3	JANUARY 2023

00494.00012.0004.0 VP Flightlines



LEGEND

Site Infrastructure

Site Infrastructure 500 m Buffer

Turbine Locations

Species Flightline

Lapwing

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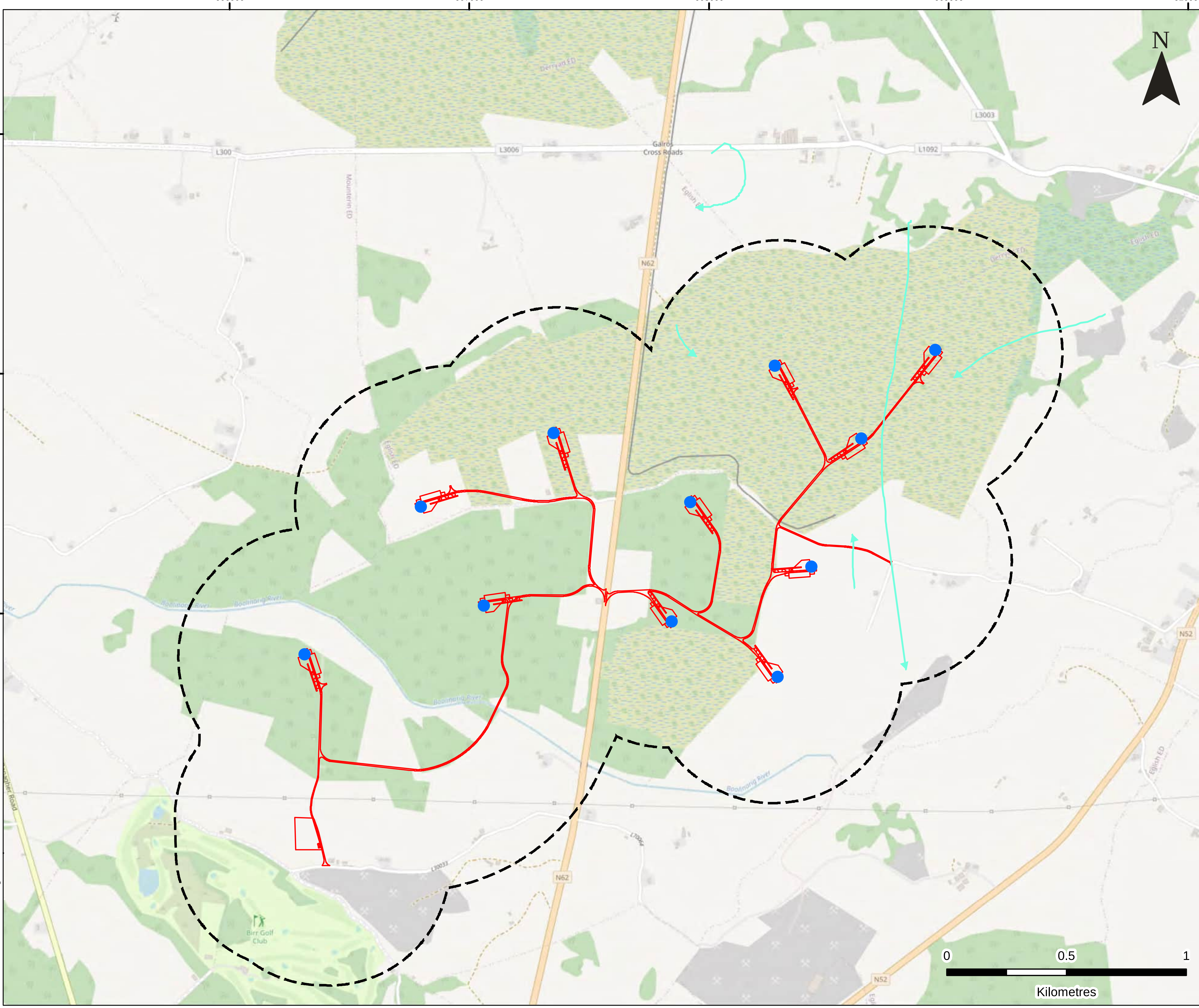
BREEDING BIRD SURVEYS 2022

LAPWING FLIGHTLINES

FIGURE 2.4

Scale	Date
1:15,000 @ A3	JANUARY 2023

00494.00012.0004.0 VP Flightlines



LEGEND

Site Infrastructure

Site Infrastructure 500 m Buffer

Turbine Locations

Species Flightline

Peregrine

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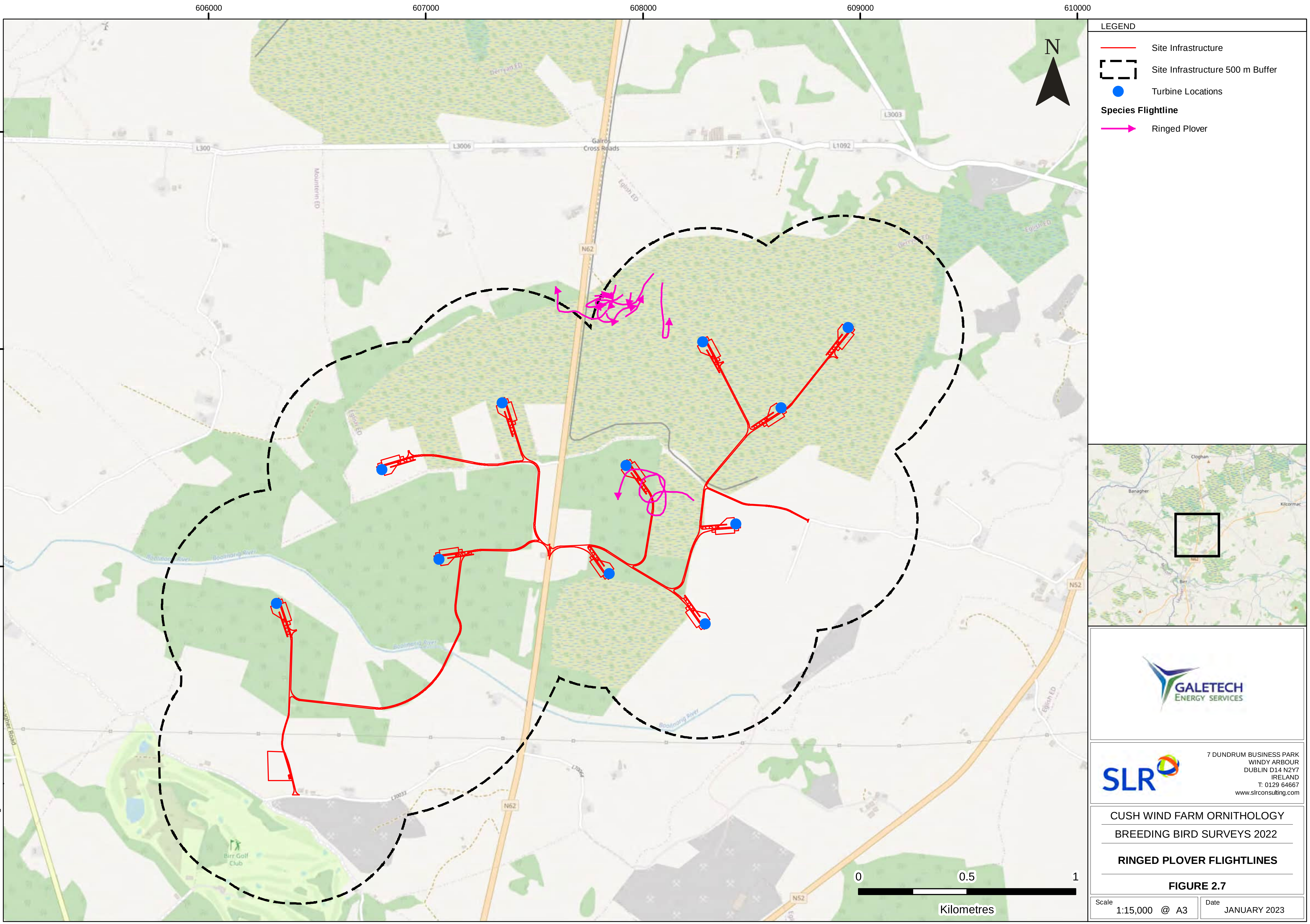
BREEDING BIRD SURVEYS 2022

PEREGRINE FLIGHTLINES

FIGURE 2.6

Scale	Date
1:15,000 @ A3	JANUARY 2023

00494.00012.0004.0 VP Flightlines



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BREEDING BIRD SURVEYS 2022

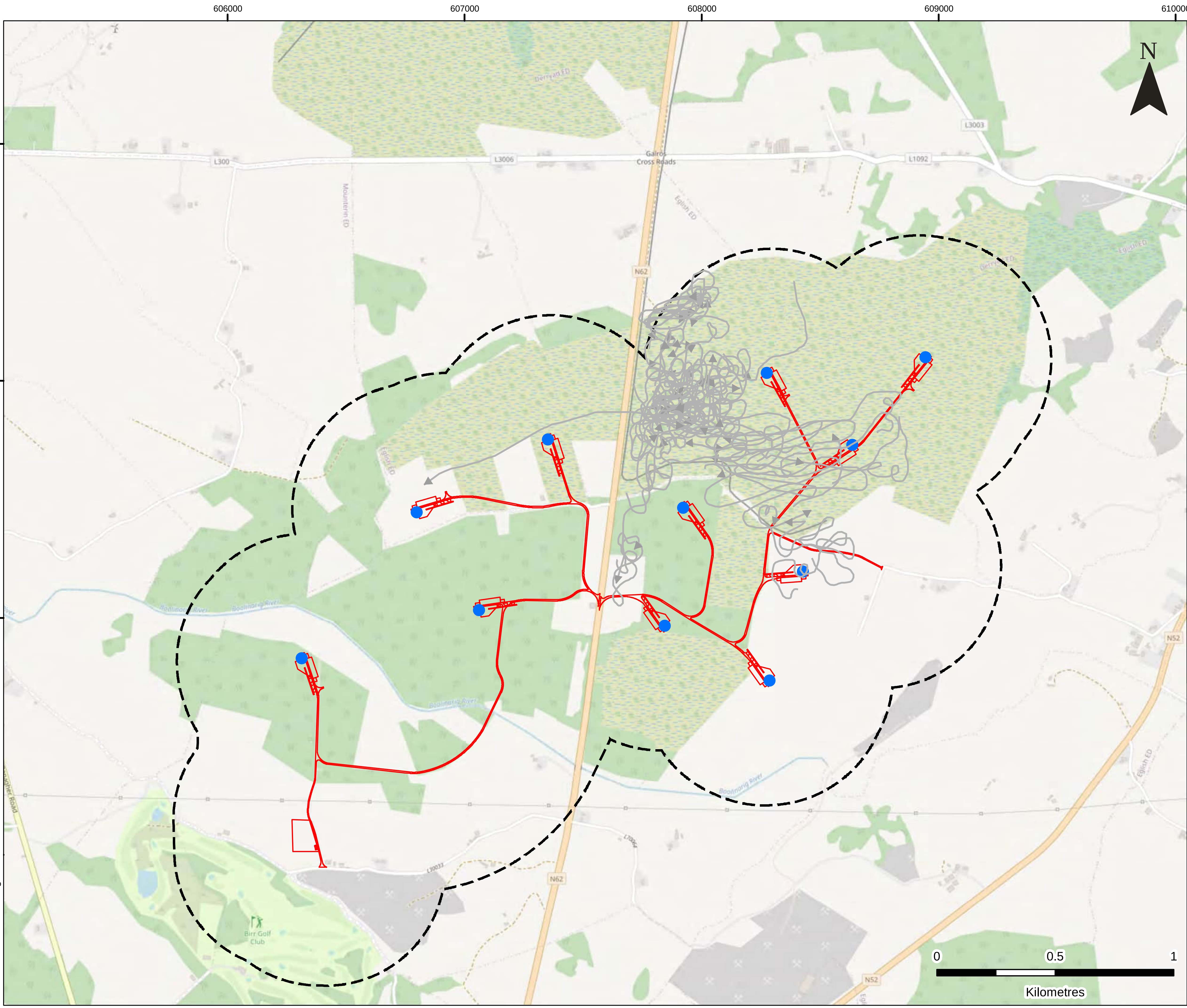
RINGED PLOVER FLIGHTLINES

FIGURE 2.7

Scale 1:15,000 @ A3

Date JANUARY 2023

00494.00012.0004.0 VP Flightlines



LEGEND

- Site Infrastructure
- Site Infrastructure 500 m Buffer
- Turbine Locations

Species Flightline

- Snipe

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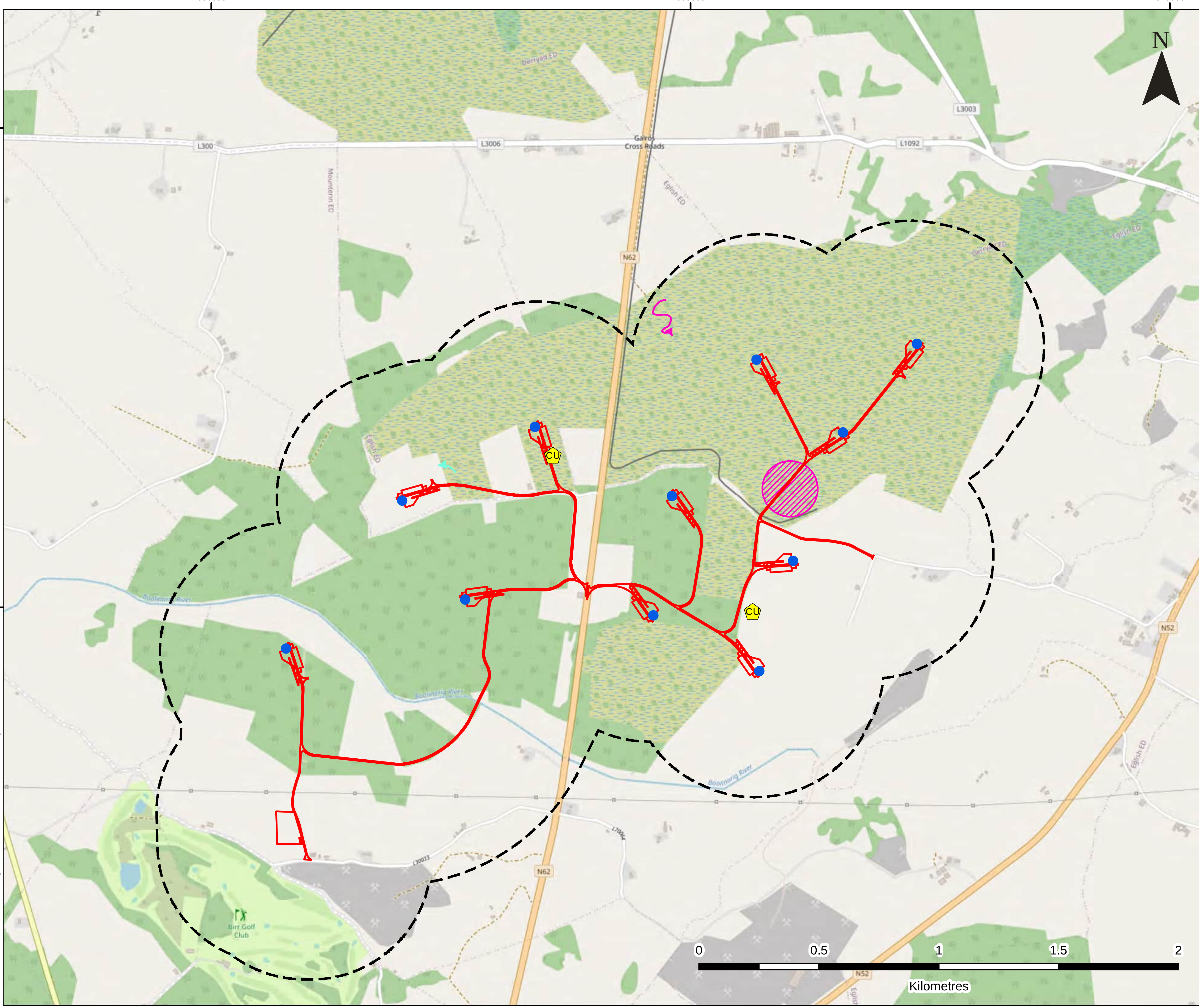
BREEDING BIRD SURVEYS 2022

SNIPE FLIGHTLINES

FIGURE 2.8

Scale	Date
1:15,000 @ A3	JANUARY 2023

00494.00012.0004.0 VP Flightlines



LEGEND

- Site Infrastructure
- Site Infrastructure 500 m Buffer
- Turbine Location

Wader Point

- CU Curlew

Wader Flight Line

- Lapwing
- Snipe

Lapwing Territory

- Lapwing

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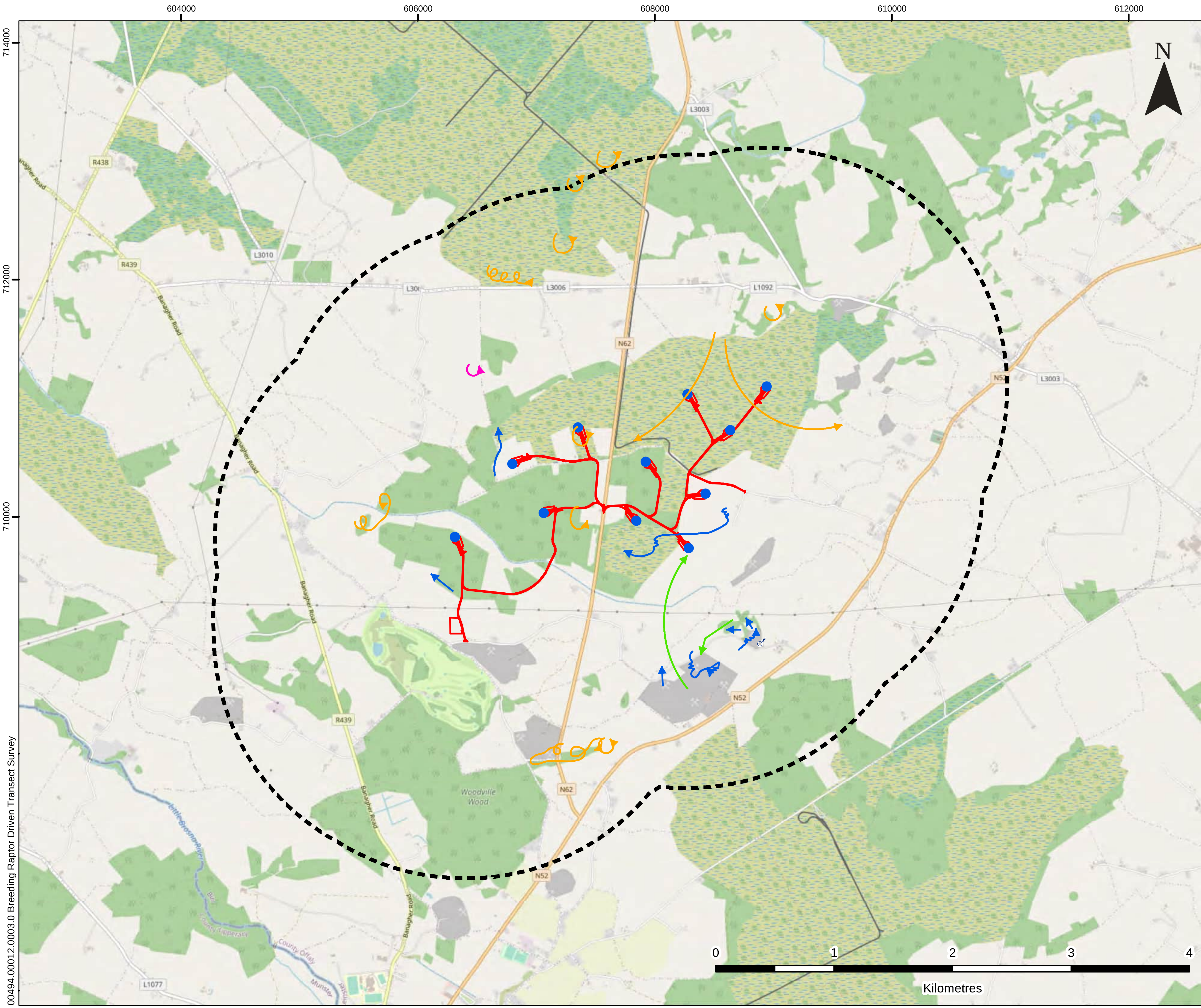
BREEDING BIRD SURVEYS

BREEDING WADER WALKED TRANSECT SURVEY

FIGURE 3

Scale 1:15,000 @ A3 | Date JANUARY 2023

00494.00012.0002.0 Breeding Wader Walked Transect Survey



LEGEND

- Site Infrastructure
- Site Infrastructure 2 km Buffer
- Turbine Location
- <all other values>

Species Code

- Buzzard
- Kestrel
- Peregrine
- Sparrowhawk

BTO Activity Code

- ♂ Male

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BREEDING BIRD SURVEYS

BREEDING RAPTOR DRIVEN TRANSECT SURVEY

FIGURE 4

Scale	Date
1:30,000 @ A3	JANUARY 2023

00494.00012.0003.0 Breeding Raptor Driven Transect Survey

APPENDIX 02

Survey dates times and observers[14]

[14] Surveyor initials are given in Section 2.2

Table A2-1
Details of VP Surveys Undertaken from Vantage Point 1

Date	Surveyor	Start time	End time	No. Hours
17/05/2022	JD	11:30	14:30	03:00
19/05/2022	AK	14:00	17:00	03:00
25/05/2022	MMW	14:15	17:15	03:00
26/05/2022	MMW	08:50	11:50	03:00
13/06/2022	MMW	19:00	22:00	03:00
15/06/2022	MMW	10:10	13:10	03:00
27/06/2022	MMW	15:15	18:15	03:00
29/06/2022	MMW	06:15	09:15	03:00
12/07/2022	MMW	12:50	15:50	03:00
13/07/2022	MMW	06:30	09:30	03:00
02/08/2022	MMW	18:30	21:30	03:00
03/08/2022	MMW	10:10	13:10	03:00
Total hours				**36**

Table A2-2
Details of VP Surveys Undertaken from Vantage Point 2

Date	Surveyor	Start time	End time	No. Hours
20/05/2022	JD	12:30	15:30	03:00
19/05/2022	AK	10:30	13:30	03:00
24/05/2022	MMW	14:20	17:20	03:00
25/05/2022	MMW	10:15	13:15	03:00
14/06/2022	MMW	15:10	18:10	03:00
15/06/2022	MMW	06:05	09:05	03:00
27/06/2022	MMW	19:00	22:00	03:00
28/06/2022	MMW	09:45	12:45	03:00
11/07/2022	MMW	12:30	15:30	03:00
13/07/2022	MMW	10:00	13:00	03:00
01/08/2022	MMW	17:30	20:30	03:00
02/08/2022	MMW	15:00	18:00	03:00
Total hours				**36**

Table A2-3
Details of VP Surveys Undertaken from Vantage Point 3

Date	Surveyor	Start time	End time	No. Hours
18/05/2022	JD	09:00	12:00	03:00
20/05/2022	JD	16:00	19:00	03:00
24/05/2022	MMW	10:15	13:15	03:00
26/05/2022	MMW	12:50	15:50	03:00
13/06/2022	MMW	15:30	18:30	03:00
14/06/2022	MMW	19:00	22:00	03:00
28/06/2022	MMW	06:10	09:10	03:00
29/06/2022	MMW	09:45	12:45	03:00
11/07/2022	MMW	16:00	19:00	03:00
12/07/2022	MMW	09:20	12:20	03:00
01/08/2022	MMW	11:30	14:30	03:00
03/08/2022	MMW	06:40	09:40	03:00
Total hours				**36**

Table A2-4
Details of Breeding Wader Surveys

Date	Surveyor	Start time	End time	No. Hours
09/05/2022	DN	18:00	21:00	03:00
17/05/2022	JD	18:30	21:30	03:00
08/06/2022	MMW	05:30	07:35	02:05
08/06/2022	MMW	20:00	20:55	00:55
08/06/2022	MMW	21:15	22:05	00:50
Total hours				**09:50**

Table A2-4
Details of Breeding Raptor Surveys

Date	Surveyor	Start time	End time	No. Hours
09/05/2022	DN	12:20	16:00	03:40
17/05/2022	JD	14:30	18:30	04:00
07/06/2022	MMW	10:15	14:30	04:15
14/07/2022	MMW	07:00	10:00	03:00
14/07/2022	MMW	17:00	22:00	05:00
02/08/2022	MMW	10:00	12:30	02:30
Total hours				**22:25**

APPENDIX 03

Weather data

Table A3-1
Weather Data Collected During Flight Activity Surveys Undertaken from VP1

Date	Survey Start	Survey End	Hr	Wind Speed	Wind Direction	Rain[15]	Cloud Cover[16]	Cloud Height[17]	Visibility[18]	Snow[19]	Frost[20]	Temp (°c)
17/05/2022	11:30	14:30	1	3	S	0	8	2	2	0	0	14
17/05/2022	11:30	14:30	2	2	S	0	8	2	2	0	0	13
17/05/2022	11:30	14:30	3	2	S	1	8	1	2	0	0	12
19/05/2022	14:00	17:00	1	3	SW	0	6	2	2	0	0	16
19/05/2022	14:00	17:00	2	3	SW	0	6	2	2	0	0	16
19/05/2022	14:00	17:00	3	4	SW	0	6	2	2	0	0	16
25/05/2022	14:15	17:15	1	5	SW	0	5	1	2	0	0	14
25/05/2022	14:15	17:15	2	5	SW	0	7	1	2	0	0	13
25/05/2022	14:15	17:15	3	4	SW	0	7	1	2	0	0	13
26/05/2022	08:50	11:50	1	4	SW	1	8	1	1	0	0	13
26/05/2022	08:50	11:50	2	4	SW	3	8	1	1	0	0	13
26/05/2022	08:50	11:50	3	5	SW	0	8	1	2	0	0	14
13/06/2022	19:00	22:00	1	2	SW	0	8	1	2	0	0	14
13/06/2022	19:00	22:00	2	2	SW	0	8	1	2	0	0	14

15 Key: None = 0; Drizzle = 1; Light showers/snow = 2; Heavy showers/snow = 3; Heavy rain/snow = 4.
16 Expressed in oktas (n/8)
17 Key: Height of cloud above average height of viewshed. <150m = 0; 150-500m = 1; >500m = 2.
18 Key: Poor (<1km) = 0; Moderate (1-3km) = 1; Good (>3km) = 2.
19 Key: Lying snow. None = 0; On site = 1; On higher ground = 2.
20 Key: None = 0; Ground = 1; All day = 2.

Date	Survey Start	Survey End	Hr	Wind Speed	Wind Direction	Rain[15]	Cloud Cover[16]	Cloud Height[17]	Visibility[18]	Snow[19]	Frost[20]	Temp (°c)
13/06/2022	19:00	22:00	3	2	SW	0	7	1	2	0	0	13
15/06/2022	10:10	13:10	1	2	SE	0	5	2	2	0	0	17
15/06/2022	10:10	13:10	2	3	S	0	6	2	2	0	0	18
15/06/2022	10:10	13:10	3	2	S	0	4	2	2	0	0	19
27/06/2022	15:15	18:15	1	4	W	1	8	1	2	0	0	16
27/06/2022	15:15	18:15	2	4	W	0	8	1	2	0	0	16
27/06/2022	15:15	18:15	3	4	W	3	8	1	2	0	0	15
29/06/2022	06:15	09:15	1	2	S	0	3	2	2	0	0	12
29/06/2022	06:15	09:15	2	2	S	0	5	2	2	0	0	12
29/06/2022	06:15	09:15	3	2	S	0	7	1	2	0	0	13
12/07/2022	12:50	15:50	1	3	S	0	7	2	2	0	0	20
12/07/2022	12:50	15:50	2	2	S	0	7	2	2	0	0	20
12/07/2022	12:50	15:50	3	4	S	0	8	2	2	0	0	19
13/07/2022	06:30	09:30	1	3	SW	0	7	2	2	0	0	13
13/07/2022	06:30	09:30	2	2	SW	0	8	2	2	0	0	12
13/07/2022	06:30	09:30	3	2	SW	0	2	2	2	0	0	16
02/08/2022	18:30	21:30	1	5	SW	0	7	2	2	0	0	19
02/08/2022	18:30	21:30	2	4	SW	0	6	2	2	0	0	19
02/08/2022	18:30	21:30	3	4	SW	0	7	2	2	0	0	19
03/08/2022	10:10	13:10	1	3	SW	2	7	1	2	0	0	17
03/08/2022	10:10	13:10	2	4	SW	0	7	1	2	0	0	17
03/08/2022	10:10	13:10	3	3	SW	0	7	2	2	0	0	18

Table A3-2
Weather Data Collected During Flight Activity Surveys Undertaken from VP2

Date	Survey Start	Survey End	Hr	Wind Speed	Wind Direction	Rain[21]	Cloud Cover[22]	Cloud Height[23]	Visibility[24]	Snow[25]	Frost[26]	Temp (°c)
20/05/2022	12:30	15:30	1	3	SW	0	4	2	2	0	0	13
20/05/2022	12:30	15:30	2	3	SW	1	7	1	2	0	0	13
20/05/2022	12:30	15:30	3	3	SW	0	6	1	2	0	0	13
19/05/2022	10:30	13:30	1	3	SW	0	5	2	2	0	0	14
19/05/2022	10:30	13:30	2	3	SW	0	5	2	2	0	0	16
19/05/2022	10:30	13:30	3	3	SW	0	6	2	2	0	0	16
24/05/2022	14:20	17:20	1	3	SW	0	5	1	2	0	0	16
24/05/2022	14:20	17:20	2	3	SW	0	5	1	2	0	0	15
24/05/2022	14:20	17:20	3	3	SW	0	6	1	2	0	0	15
25/05/2022	10:15	13:15	1	5	SW	2	7	1	2	0	0	13
25/05/2022	10:15	13:15	2	5	SW	2	8	1	2	0	0	13
25/05/2022	10:15	13:15	3	5	SW	0	8	1	2	0	0	13
14/06/2022	15:10	18:10	1	2	SW	0	8	1	2	0	0	17
14/06/2022	15:10	18:10	2	2	SW	0	8	1	2	0	0	17

[21] Key: None = 0; Drizzle = 1; Light showers/snow = 2; Heavy showers/snow = 3; Heavy rain/snow = 4.
[22] Expressed in oktas (n/8)
[23] Key: Height of cloud above average height of viewshed. <150m = 0; 150-500m = 1; >500m = 2.
[24] Key: Poor (<1km) = 0; Moderate (1-3km) = 1; Good (>3km) = 2.
[25] Key: Lying snow. None = 0; On site = 1; On higher ground = 2.
[26] Key: None = 0; Ground = 1; All day = 2.

Date	Survey Start	Survey End	Hr	Wind Speed	Wind Direction	Rain[21]	Cloud Cover[22]	Cloud Height[23]	Visibility[24]	Snow[25]	Frost[26]	Temp (°c)
14/06/2022	15:10	18:10	3	1	SW	0	7	1	2	0	0	18
15/06/2022	06:05	09:05	1	0	n/a	0	7	2	2	0	0	10
15/06/2022	06:05	09:05	2	0	n/a	0	7	2	2	0	0	10
15/06/2022	06:05	09:05	3	1	S	0	8	2	2	0	0	10
27/06/2022	19:00	22:00	1	4	SW	0	8	1	2	0	0	13
27/06/2022	19:00	22:00	2	3	SW	3	8	1	2	0	0	13
27/06/2022	19:00	22:00	3	3	SW	2	8	1	2	0	0	12
28/06/2022	09:45	12:45	1	4	SW	0	7	1	2	0	0	16
28/06/2022	09:45	12:45	2	3	SW	0	7	1	2	0	0	16
28/06/2022	09:45	12:45	3	3	SW	3	8	1	2	0	0	16
11/07/2022	12:30	15:30	1	3	SW	0	7	2	2	0	0	22
11/07/2022	12:30	15:30	2	4	S	0	7	2	2	0	0	24
11/07/2022	12:30	15:30	3	3	S	0	5	2	2	0	0	24
13/07/2022	10:00	13:00	1	2	SW	0	4	2	2	0	0	17
13/07/2022	10:00	13:00	2	2	SW	0	2	2	2	0	0	18
13/07/2022	10:00	13:00	3	2	SW	0	3	2	2	0	0	19
01/08/2022	17:30	20:30	1	3	SW	0	8	2	2	0	0	19
01/08/2022	17:30	20:30	2	4	SW	2	8	2	2	0	0	19
01/08/2022	17:30	20:30	3	3	SW	3	8	1	1	0	0	19
02/08/2022	15:00	18:00	1	4	S	0	6	2	2	0	0	20
02/08/2022	15:00	18:00	2	5	S	0	5	2	2	0	0	18
02/08/2022	15:00	18:00	3	4	S	0	6	2	2	0	0	19

Table A3-3
Weather Data Collected During Flight Activity Surveys Undertaken from VP3

Date	Survey Start	Survey End	Hr	Wind Speed	Wind Direction	Rain[27]	Cloud Cover[28]	Cloud Height[29]	Visibility[30]	Snow[31]	Frost[32]	Temp (°c)
18/05/2022	09:00	12:00	1	4	S	0	4	2	2	0	0	12
18/05/2022	09:00	12:00	2	4	S	0	5	1	2	0	0	14
18/05/2022	09:00	12:00	3	4	S	0	7	1	2	0	0	15
20/05/2022	16:00	19:00	1	3	E	0	7	1	2	0	0	15
20/05/2022	16:00	19:00	2	3	NE	0	8	1	2	0	0	14
20/05/2022	16:00	19:00	3	3	NE	0	8	1	2	0	0	13
24/05/2022	10:15	13:15	1	2	NW	0	7	1	2	0	0	13
24/05/2022	10:15	13:15	2	3	NW	0	5	2	2	0	0	15
24/05/2022	10:15	13:15	3	3	NW	0	6	2	2	0	0	15
26/05/2022	12:50	15:50	1	4	SW	0	8	1	2	0	0	15
26/05/2022	12:50	15:50	2	4	SW	0	6	1	2	0	0	16
26/05/2022	12:50	15:50	3	4	SW	0	3	2	2	0	0	16
13/06/2022	15:30	18:30	1	2	SW	0	8	1	2	0	0	15
13/06/2022	15:30	18:30	2	2	SW	0	8	1	2	0	0	15

[27] Key: None = 0; Drizzle = 1; Light showers/snow = 2; Heavy showers/snow = 3; Heavy rain/snow = 4.
[28] Expressed in oktas (n/8)
[29] Key: Height of cloud above average height of viewshed. <150m = 0; 150-500m = 1; >500m = 2.
[30] Key: Poor (<1km) = 0; Moderate (1-3km) = 1; Good (>3km) = 2.
[31] Key: Lying snow. None = 0; On site = 1; On higher ground = 2.
[32] Key: None = 0; Ground = 1; All day = 2.

Date	Survey Start	Survey End	Hr	Wind Speed	Wind Direction	Rain[27]	Cloud Cover[28]	Cloud Height[29]	Visibility[30]	Snow[31]	Frost[32]	Temp (°c)
13/06/2022	15:30	18:30	3	3	SW	0	8	1	2	0	0	14
14/06/2022	19:00	22:00	1	1	SW	0	7	1	2	0	0	18
14/06/2022	19:00	22:00	2	1	SW	0	8	1	2	0	0	17
14/06/2022	19:00	22:00	3	1	SW	0	7	1	2	0	0	16
28/06/2022	06:10	09:10	1	4	S	2	8	1	2	0	0	13
28/06/2022	06:10	09:10	2	4	S	2	8	1	2	0	0	14
28/06/2022	06:10	09:10	3	4	S	3	7	1	2	0	0	14
29/06/2022	09:45	12:45	1	2	SW	0	8	1	2	0	0	14
29/06/2022	09:45	12:45	2	2	SW	3	8	1	2	0	0	17
29/06/2022	09:45	12:45	3	2	SW	0	8	1	2	0	0	18
11/07/2022	16:00	19:00	1	3	S	0	6	2	2	0	0	24
11/07/2022	16:00	19:00	2	4	S	0	7	2	2	0	0	23
11/07/2022	16:00	19:00	3	3	S	0	8	2	2	0	0	22
12/07/2022	09:20	12:20	1	2	S	0	6	2	2	0	0	18
12/07/2022	09:20	12:20	2	2	S	0	7	2	2	0	0	19
12/07/2022	09:20	12:20	3	3	SW	0	8	2	2	0	0	20
01/08/2022	11:30	14:30	1	3	SW	0	8	1	2	0	0	19
01/08/2022	11:30	14:30	2	4	SW	0	5	2	2	0	0	20
01/08/2022	11:30	14:30	3	4	SW	0	6	2	2	0	0	20
03/08/2022	06:40	09:40	1	4	SW	0	7	2	2	0	0	15
03/08/2022	06:40	09:40	2	4	SW	0	8	1	2	0	0	15
03/08/2022	06:40	09:40	3	3	SW	1	8	1	2	0	0	17

Table A3-4
Weather During Breeding Wader Surveys

Date	Start	End	Hr	Wind Speed	Wind Direction	Rain[15]	Cloud Cover[16]	Cloud Height[17]	Visibility[18]	Snow[19]	Frost[20]	Temp (°c)
09/05/2022	18:00	21:00	All	4	S	1	8	1	2	0	0	13
17/05/2022	18:30	21:30	1	2	S	0	7	1	2	0	0	14
17/05/2022	18:30	21:30	2	2	S	0	6	1	2	0	0	13
17/05/2022	18:30	21:30	3	2	S	0	6	1	2	0	0	12

Table A3-4
Weather During Breeding Raptor Surveys

Date	Start	End	Hr	Wind Speed	Wind Direction	Rain[15]	Cloud Cover[16]	Cloud Height[17]	Visibility[18]	Snow[19]	Frost[20]	Temp (°c)
09/05/2022	12:20	16:00	1	5	S	0	8	1	1	0	0	13
09/05/2022	12:20	16:00	2	4	S	0	8	2	2	0	0	13
09/05/2022	12:20	16:00	3	4	S	1	8	1	2	0	0	13
17/05/2022	1	3	S	1	8	1	2	0	0	12	1	3
17/05/2022	2	3	S	1	8	1	2	0	0	12	2	3
17/05/2022	3	3	S	2	8	1	2	0	0	12	3	3
17/05/2022	4	3	S	0	8	1	2	0	0	12	4	3
14/07/2022	07:00	10:00	All	3	SW	2	8	1	2	0	0	16
14/07/2022	17:00	22:00	All	3	S	0	8	2	2	0	0	23
02/08/2022	10:00	12:30	1	2	SW	1	8	1	2	0	0	17

APPENDIX 04

Flight activity survey data[33]

[33] Surveyor initials are given in Section 2.2 and BTO code information is given in Section 4.1

Table A4-1
Primary target species recorded during flight activity surveys undertaken at VP1

Date	Surveyor	Flight ID	BTO Code	No. Birds	Age (Ad = adult; Imm = immature)	Sex (M = male; F = female; U = unknown)	StartTime (hr:min)	Flight duration (s)
17/05/2022	JD	1	BH	1	AD	U	11:51	45
17/05/2022	JD	2	BH	1	AD	U	11:55	10
17/05/2022	JD	3	BH	1	AD	U	12:00	15
17/05/2022	JD	4	L.	1	AD	U	12:04	80
17/05/2022	JD	5	BH	3	AD	U	12:13	90
17/05/2022	JD	6	L.	1	AD	U	12:36	80
17/05/2022	JD	7	BH	3	AD	U	12:36	45
17/05/2022	JD	8	BH	3	AD	U	12:49	25
17/05/2022	JD	9	BH	1	AD	U	13:08	100
19/05/2022	AK	1	BH	1	AD	U	14:21	20
19/05/2022	AK	2	BH	1	AD	U	14:30	5
19/05/2022	AK	3	BH	1	AD	U	14:43	20
19/05/2022	AK	4	BH	1	AD	U	14:48	43
19/05/2022	AK	5	L.	1	AD	U	14:54	5
19/05/2022	AK	6	BH	1	AD	U	14:56	45
19/05/2022	AK	7	BH	1	AD	U	15:03	9
19/05/2022	AK	8	BH	1	AD	U	15:07	25
19/05/2022	AK	9	L.	1	AD	U	15:13	12
19/05/2022	AK	10	BH	1	AD	U	15:18	28

Date	Surveyor	Flight ID	BTO Code	No. Birds	Age (Ad = adult; Imm = immature)	Sex (M = male; F = female; U = unknown)	StartTime (hr:min)	Flight duration (s)
19/05/2022	AK	11	MA	1	AD	U	15:32	15
19/05/2022	AK	12	BH	8	U	U	15:34	100
19/05/2022	AK	13	BH	3	AD	U	15:39	35
19/05/2022	AK	14	BH	1	AD	U	15:41	32
25/05/2022	MMW	1	BH	2	AD	U	14:27	87
25/05/2022	MMW	2	K.	1	AD	M	14:38	10
25/05/2022	MMW	3	K.	1	AD	M	14:41	171
25/05/2022	MMW	4	BH	2	AD	U	14:46	12
25/05/2022	MMW	5	BH	1	AD	U	14:57	66
25/05/2022	MMW	6	L.	1	AD	U	14:59	101
25/05/2022	MMW	7	BH	9	AD	U	15:28	18
25/05/2022	MMW	8	L.	1	AD	U	15:43	39
25/05/2022	MMW	9	L.	1	AD	U	15:47	5
25/05/2022	MMW	10	L.	1	AD	U	16:00	20
25/05/2022	MMW	11	BH	1	AD	U	16:00	30
25/05/2022	MMW	12	BH	3	AD	U	16:08	54
25/05/2022	MMW	13	BH	5	AD	U	16:36	15
25/05/2022	MMW	14	BH	10	AD	U	16:42	60
25/05/2022	MMW	15	BH	1	AD	U	16:52	19
25/05/2022	MMW	16	L.	1	AD	U	16:56	3
25/05/2022	MMW	17	BH	2	AD	U	17:03	30

Date	Surveyor	Flight ID	BTO Code	No. Birds	Age (Ad = adult; Imm = immature)	Sex (M = male; F = female; U = unknown)	StartTime (hr:min)	Flight duration (s)
25/05/2022	MMW	18	L.	1	AD	U	17:07	14
26/05/2022	MMW	1	K.	1	AD	M	08:52	72
26/05/2022	MMW	2	BH	1	AD	U	08:55	10
26/05/2022	MMW	3	L.	1	AD	U	09:08	22
26/05/2022	MMW	4	BH	3	AD	U	09:09	11
26/05/2022	MMW	5	L.	1	AD	U	09:09	29
26/05/2022	MMW	6	BH	1	AD	U	09:16	15
26/05/2022	MMW	7	BH	1	AD	U	09:17	23
26/05/2022	MMW	8	BH	1	AD	U	09:20	8
26/05/2022	MMW	9	BH	1	AD	U	09:23	46
26/05/2022	MMW	10	BH	1	AD	U	09:24	34
26/05/2022	MMW	11	BH	2	AD	U	09:29	52
26/05/2022	MMW	12	K.	1	AD	F	09:34	165
26/05/2022	MMW	13	SN	1	AD	U	09:46	39
26/05/2022	MMW	14	SN	1	AD	U	09:51	37
26/05/2022	MMW	15	SN	2	AD	U	09:54	14
26/05/2022	MMW	16	SN	2	AD	U	09:59	160
26/05/2022	MMW	17	BH	1	AD	U	10:00	33
26/05/2022	MMW	18	L.	1	AD	U	10:05	19
26/05/2022	MMW	19	SN	3	AD	U	10:40	56
26/05/2022	MMW	20	SN	1	AD	U	10:43	144

Date	Surveyor	Flight ID	BTO Code	No. Birds	Age (Ad = adult; Imm = immature)	Sex (M = male; F = female; U = unknown)	StartTime (hr:min)	Flight duration (s)
26/05/2022	MMW	21	L.	1	AD	U	10:45	17
26/05/2022	MMW	22	L.	3	AD	U	10:48	25
26/05/2022	MMW	23	SN	1	AD	U	10:56	110
26/05/2022	MMW	24	L.	1	AD	U	11:09	64
26/05/2022	MMW	25	L.	1	AD	U	11:27	68
26/05/2022	MMW	26	L.	1	AD	U	11:31	13
26/05/2022	MMW	27	BH	1	AD	U	11:35	5
26/05/2022	MMW	28	L.	1	AD	U	11:43	48
13/06/2022	MMW	1	L.	1	AD	U	19:22	35
13/06/2022	MMW	2	L.	3	AD	U	19:24	48
13/06/2022	MMW	3	L.	2	AD	U	19:25	74
13/06/2022	MMW	4	BH	1	AD	U	19:28	69
13/06/2022	MMW	5	SN	2	AD	U	19:31	421
13/06/2022	MMW	5	SN	2	AD	U	19:31	421
13/06/2022	MMW	6	L.	1	AD	U	19:44	5
13/06/2022	MMW	7	SN	1	AD	U	19:49	10
13/06/2022	MMW	8	SN	1	AD	U	19:55	151
13/06/2022	MMW	9	BH	1	AD	U	20:00	12
13/06/2022	MMW	10	SN	1	AD	U	20:02	337
13/06/2022	MMW	10	SN	1	AD	U	20:02	337
13/06/2022	MMW	11	K.	1	AD	F	20:11	169

Date	Surveyor	Flight ID	BTO Code	No. Birds	Age (Ad = adult; Imm = immature)	Sex (M = male; F = female; U = unknown)	StartTime (hr:min)	Flight duration (s)
13/06/2022	MMW	12	SN	1	AD	U	20:17	490
13/06/2022	MMW	12	SN	1	AD	U	20:17	490
13/06/2022	MMW	13	L.	1	AD	U	20:31	52
13/06/2022	MMW	14	BH	1	AD	U	20:39	17
13/06/2022	MMW	15	SN	1	AD	U	20:39	59
13/06/2022	MMW	16	BH	2	AD	U	20:47	64
13/06/2022	MMW	17	K.	1	AD	U	20:57	78
13/06/2022	MMW	18	L.	1	AD	U	21:09	6
13/06/2022	MMW	19	L.	1	AD	U	21:25	11
15/06/2022	MMW	1	L.	1	AD	U	10:48	12
15/06/2022	MMW	2	L.	2	AD	U	10:53	33
15/06/2022	MMW	3	K.	1	AD	U	11:09	255
15/06/2022	MMW	4	BH	2	AD	U	11:09	20
15/06/2022	MMW	5	BH	5	U	U	11:56	76
15/06/2022	MMW	6	BH	2	1st summer	U	12:00	48
15/06/2022	MMW	7	BH	1	AD	U	12:01	29
15/06/2022	MMW	8	BH	1	AD	U	12:16	17
15/06/2022	MMW	9	BH	2	AD	U	12:33	63
15/06/2022	MMW	10	K.	1	AD	U	12:40	91
15/06/2022	MMW	11	K.	1	AD	U	12:44	427
15/06/2022	MMW	11	K.	1	AD	U	12:44	427

Date	Surveyor	Flight ID	BTO Code	No. Birds	Age (Ad = adult; Imm = immature)	Sex (M = male; F = female; U = unknown)	StartTime (hr:min)	Flight duration (s)
15/06/2022	MMW	12	BH	2	AD	U	12:46	240
15/06/2022	MMW	13	BH	1	AD	U	13:01	56
27/06/2022	MMW	1	BH	1	AD	U	15:27	20
27/06/2022	MMW	2	L.	1	AD	U	15:39	99
27/06/2022	MMW	3	K.	1	AD	U	15:45	71
27/06/2022	MMW	4	K.	1	AD	U	15:49	24
27/06/2022	MMW	5	L.	2	AD	U	15:53	43
27/06/2022	MMW	6	BH	2	AD	U	16:02	36
27/06/2022	MMW	7	BH	3	AD	U	16:35	121
27/06/2022	MMW	8	BH	1	AD	U	16:45	19
27/06/2022	MMW	9	BH	1	AD	U	16:57	37
27/06/2022	MMW	10	BH	6	AD	U	18:00	16
27/06/2022	MMW	11	BH	1	AD	U	18:06	34
27/06/2022	MMW	12	BH	3	AD	U	18:11	75
29/06/2022	MMW	1	BH	2	AD	U	06:27	47
29/06/2022	MMW	2	SN	2	AD	U	06:31	29
29/06/2022	MMW	3	PE	1	AD	U	06:46	12
29/06/2022	MMW	4	SN	1	AD	U	06:50	16
29/06/2022	MMW	5	SN	1	AD	U	06:52	32
29/06/2022	MMW	6	BH	1	AD	U	06:56	186
29/06/2022	MMW	7	SN	2	AD	U	07:02	99

Date	Surveyor	Flight ID	BTO Code	No. Birds	Age (Ad = adult; Imm = immature)	Sex (M = male; F = female; U = unknown)	StartTime (hr:min)	Flight duration (s)
29/06/2022	MMW	8	SN	1	AD	U	07:14	15
29/06/2022	MMW	9	BH	1	AD	U	07:19	27
29/06/2022	MMW	10	SN	1	AD	U	07:23	114
29/06/2022	MMW	11	BH	1	AD	U	07:31	84
29/06/2022	MMW	12	BH	1	AD	U	08:04	29
29/06/2022	MMW	13	SN	1	AD	U	08:16	16
29/06/2022	MMW	14	SN	1	AD	U	08:20	143
29/06/2022	MMW	15	SN	1	AD	U	08:28	66
29/06/2022	MMW	16	L.	1	AD	U	08:30	79
29/06/2022	MMW	17	SN	2	AD	U	08:36	175
29/06/2022	MMW	18	SN	1	AD	U	08:43	121
29/06/2022	MMW	19	BH	1	AD	U	08:45	43
29/06/2022	MMW	20	SN	1	AD	U	08:57	26
29/06/2022	MMW	21	SN	2	AD	U	08:53	657
29/06/2022	MMW	21	SN	2	AD	U	08:53	657
29/06/2022	MMW	21	SN	2	AD	U	08:53	657
12/07/2022	MMW	1	K.	1	AD	U	13:14	71
12/07/2022	MMW	2	K.	1	AD	U	14:03	54
12/07/2022	MMW	3	L.	7	U	U	14:04	41
12/07/2022	MMW	4	K.	1	AD	M	14:12	168
12/07/2022	MMW	5	K.	1	AD	U	14:25	23

Date	Surveyor	Flight ID	BTO Code	No. Birds	Age (Ad = adult; Imm = immature)	Sex (M = male; F = female; U = unknown)	StartTime (hr:min)	Flight duration (s)
12/07/2022	MMW	6	L.	2	U	U	15:24	29
13/07/2022	MMW	1	L.	13	U	U	07:14	132
13/07/2022	MMW	2	L.	2	U	U	08:05	109
13/07/2022	MMW	3	L.	8	U	U	08:30	171
13/07/2022	MMW	4	BH	2	AD	U	09:25	51
03/08/2022	MMW	1	K.	1	U	U	11:46	35
03/08/2022	MMW	2	K.	1	U	U	11:46	30
03/08/2022	MMW	3	K.	1	AD	U	12:15	88
03/08/2022	MMW	4	K.	1	AD	M	12:40	142
03/08/2022	MMW	5	K.	1	AD	U	13:05	255
03/08/2022	MMW	5	K.	1	AD	U	14:05	255

Table A4-2
Primary target species recorded during flight activity surveys undertaken at VP2

Date	Surveyor	Flight ID	BTO Code	No. Birds	Age (Ad = adult; Imm = immature)	Sex (M = male; F = female; U = unknown)	StartTime (hr:min)	Flight duration (s)
20/05/2022	JD	1	BH	3	AD	U	14:00	75
20/05/2022	JD	2	BH	5	AD	U	14:22	140
19/05/2022	AK	1	BH	2	AD	U	10:42	55
19/05/2022	AK	2	BH	1	AD	U	10:46	80
19/05/2022	AK	3	BH	1	AD	U	11:13	35
19/05/2022	AK	4	BH	4	AD	U	11:23	83
19/05/2022	AK	5	BH	5	AD	U	11:43	20
19/05/2022	AK	6	BH	4	AD	U	11:50	114
19/05/2022	AK	7	BH	1	AD	U	11:53	27
19/05/2022	AK	8	BH	1	AD	U	12:12	55
19/05/2022	AK	9	BH	3	AD	U	12:15	20
19/05/2022	AK	10	K.	1	U	U	12:43	15
19/05/2022	AK	11	BH	2	AD	U	13:16	30
24/05/2022	MMW	1	BH	1	AD	U	15:05	28
24/05/2022	MMW	2	BH	1	AD	U	15:11	32
24/05/2022	MMW	3	BH	1	AD	U	15:18	125
24/05/2022	MMW	4	BH	1	AD	U	15:21	13
24/05/2022	MMW	5	BH	2	AD	U	15:35	34
24/05/2022	MMW	6	K.	1	AD	M	15:37	237

Date	Surveyor	Flight ID	BTO Code	No. Birds	Age (Ad = adult; Imm = immature)	Sex (M = male; F = female; U = unknown)	StartTime (hr:min)	Flight duration (s)
24/05/2022	MMW	7	K.	1	AD	U	15:52	6
24/05/2022	MMW	8	BH	1	AD	U	16:29	3
24/05/2022	MMW	9	BH	1	AD	U	16:34	31
24/05/2022	MMW	10	BH	1	AD	U	16:43	18
24/05/2022	MMW	11	BH	1	AD	U	16:52	5
25/05/2022	MMW	1	BH	1	AD	U	10:17	14
25/05/2022	MMW	2	BH	1	AD	U	10:29	6
25/05/2022	MMW	3	BH	1	AD	U	10:35	23
25/05/2022	MMW	4	BH	1	AD	U	10:46	33
25/05/2022	MMW	5	BH	9	AD	U	11:09	22
25/05/2022	MMW	6	BH	1	AD	U	11:49	5
25/05/2022	MMW	7	BH	1	AD	U	11:55	49
25/05/2022	MMW	8	BH	1	AD	U	12:08	11
25/05/2022	MMW	9	BH	2	AD	U	12:12	30
25/05/2022	MMW	10	BH	2	AD	U	12:17	31
25/05/2022	MMW	11	BH	1	AD	U	12:25	155
25/05/2022	MMW	12	BH	1	AD	U	12:29	51
25/05/2022	MMW	13	BH	2	AD	U	12:55	163
25/05/2022	MMW	14	BH	1	AD	U	13:06	14
25/05/2022	MMW	15	BH	1	AD	U	13:10	22
25/05/2022	MMW	16	BH	1	AD	U	13:12	9

Date	Surveyor	Flight ID	BTO Code	No. Birds	Age (Ad = adult; Imm = immature)	Sex (M = male; F = female; U = unknown)	StartTime (hr:min)	Flight duration (s)
14/06/2022	MMW	1	BH	1	AD	U	15:15	28
14/06/2022	MMW	2	BH	1	AD	U	15:55	21
14/06/2022	MMW	3	BH	3	AD	U	16:17	44
14/06/2022	MMW	4	BH	1	AD	U	16:46	47
14/06/2022	MMW	5	BH	1	AD	U	16:54	26
14/06/2022	MMW	6	BH	1	AD	U	17:00	60
14/06/2022	MMW	7	BH	1	AD	U	17:10	13
14/06/2022	MMW	8	K.	1	AD	U	17:13	144
14/06/2022	MMW	9	BH	1	AD	U	17:28	35
14/06/2022	MMW	10	BH	1	AD	U	17:54	45
14/06/2022	MMW	11	BH	1	AD	U	18:03	37
15/06/2022	MMW	1	BH	6	AD	U	06:09	121
15/06/2022	MMW	2	BH	3	AD	U	06:48	159
15/06/2022	MMW	3	BH	1	AD	U	07:04	58
15/06/2022	MMW	4	BH	2	AD	U	07:37	15
15/06/2022	MMW	5	K.	1	AD	M	07:49	46
15/06/2022	MMW	6	K.	1	AD	M	07:52	31
15/06/2022	MMW	7	K.	1	AD	U	08:03	10
15/06/2022	MMW	8	K.	1	AD	U	08:08	6
15/06/2022	MMW	9	BH	1	AD	U	08:39	14
27/06/2022	MMW	1	K.	1	AD	U	19:36	58

Date	Surveyor	Flight ID	BTO Code	No. Birds	Age (Ad = adult; Imm = immature)	Sex (M = male; F = female; U = unknown)	StartTime (hr:min)	Flight duration (s)
27/06/2022	MMW	2	BH	1	AD	U	20:10	63
27/06/2022	MMW	3	K.	1	AD	U	20:29	11
27/06/2022	MMW	4	BH	2	AD	U	21:13	32
28/06/2022	MMW	1	BH	1	AD	U	10:03	31
28/06/2022	MMW	2	K.	1	AD	U	10:22	19
28/06/2022	MMW	3	BH	1	AD	U	11:29	34
28/06/2022	MMW	4	BH	3	AD	U	12:05	97
11/07/2022	MMW	1	K.	1	AD	U	13:01	26
11/07/2022	MMW	2	BH	7	AD	U	15:02	23
13/07/2022	MMW	1	BH	1	AD	U	10:38	61
13/07/2022	MMW	2	K.	1	AD	M	12:34	437
13/07/2022	MMW	2	K.	1	AD	M	12:34	437
13/07/2022	MMW	3	K.	1	AD	U	12:44	29
02/08/2022	MMW	1	K.	1	AD	U	15:52	14

Table A4-3

Primary target species recorded during flight activity surveys undertaken at VP3

Date	Surveyor	Flight ID	BTO Code	No. Birds	Age (Ad = adult; Imm = immature)	Sex (M = male; F = female; U = unknown)	StartTime (hr:min)	Flight duration (s)
18/05/2022	JD	1	K.	1	U	U	09:00	90
18/05/2022	JD	2	K.	1	U	U	09:04	60
18/05/2022	JD	3	BH	2	AD	U	09:14	120
18/05/2022	JD	4	K.	1	AD	M	09:27	45
18/05/2022	JD	5	PE	1	AD	M	09:27	30
18/05/2022	JD	6	BH	2	AD	U	09:33	87
18/05/2022	JD	7	BH	1	AD	U	09:47	10
18/05/2022	JD	8	BH	1	AD	U	10:11	48
18/05/2022	JD	9	BH	3	AD	U	10:55	25
18/05/2022	JD	10	BH	2	AD	U	11:47	5
20/05/2022	JD	1	L.	2	AD	U	16:00	10
20/05/2022	JD	2	L.	1	AD	U	16:05	10
20/05/2022	JD	3	BH	1	AD	U	16:05	20
20/05/2022	JD	4	L.	3	AD	U	16:38	30
20/05/2022	JD	5	L.	2	AD	U	16:40	20
20/05/2022	JD	6	BH	7	AD	U	16:40	120
20/05/2022	JD	7	BH	2	AD	U	16:40	20
20/05/2022	JD	8	L.	2	AD	U	17:00	20

Date	Surveyor	Flight ID	BTO Code	No. Birds	Age (Ad = adult; Imm = immature)	Sex (M = male; F = female; U = unknown)	StartTime (hr:min)	Flight duration (s)
20/05/2022	JD	9	L.	2	AD	U	17:00	60
20/05/2022	JD	10	L.	2	AD	U	17:05	240
20/05/2022	JD	11	BH	2	AD	U	18:00	35
24/05/2022	MMW	1	L.	1	AD	U	10:18	12
24/05/2022	MMW	2	L.	1	AD	U	10:19	29
24/05/2022	MMW	3	L.	1	AD	U	10:20	3
24/05/2022	MMW	4	L.	1	AD	U	10:22	55
24/05/2022	MMW	5	L.	1	AD	U	10:24	34
24/05/2022	MMW	6	L.	1	AD	U	10:28	22
24/05/2022	MMW	7	L.	1	AD	U	10:31	17
24/05/2022	MMW	8	L.	1	AD	U	10:33	9
24/05/2022	MMW	9	L.	1	AD	U	10:36	6
24/05/2022	MMW	10	L.	1	AD	U	10:39	11
24/05/2022	MMW	11	L.	1	AD	U	10:43	27
24/05/2022	MMW	12	L.	1	AD	U	10:45	51
24/05/2022	MMW	13	L.	1	AD	U	10:48	3
24/05/2022	MMW	14	L.	1	AD	U	10:57	39
24/05/2022	MMW	15	BH	2	AD	U	10:57	480
24/05/2022	MMW	15	BH	2	AD	U	10:57	480
24/05/2022	MMW	16	L.	1	AD	U	10:56	42
24/05/2022	MMW	17	BH	2	AD	U	11:00	36

Date	Surveyor	Flight ID	BTO Code	No. Birds	Age (Ad = adult; Imm = immature)	Sex (M = male; F = female; U = unknown)	StartTime (hr:min)	Flight duration (s)
24/05/2022	MMW	18	L.	1	AD	U	11:00	49
24/05/2022	MMW	19	BH	1	AD	U	11:02	66
24/05/2022	MMW	20	L.	1	AD	U	11:03	5
24/05/2022	MMW	21	BH	3	AD	U	11:07	92
24/05/2022	MMW	22	BH	4	AD	U	11:10	59
24/05/2022	MMW	23	L.	1	AD	U	11:11	13
24/05/2022	MMW	24	BH	2	AD	U	11:12	4
24/05/2022	MMW	25	L.	1	AD	U	11:13	2
24/05/2022	MMW	26	BH	5	AD	U	11:16	57
24/05/2022	MMW	27	L.	1	AD	U	11:17	27
24/05/2022	MMW	28	BH	1	AD	U	11:18	78
24/05/2022	MMW	29	BH	4	AD	U	11:18	65
24/05/2022	MMW	30	BH	3	AD	U	11:22	44
24/05/2022	MMW	31	L.	2	AD	U	11:22	38
24/05/2022	MMW	32	L.	1	AD	U	11:23	24
24/05/2022	MMW	33	L.	1	AD	U	11:29	55
24/05/2022	MMW	34	L.	1	AD	U	11:32	27
24/05/2022	MMW	35	BH	1	AD	U	11:33	12
24/05/2022	MMW	36	BH	1	AD	U	11:34	33
24/05/2022	MMW	37	BH	2	AD	U	11:38	64
24/05/2022	MMW	38	BH	3	AD	U	11:43	22

Date	Surveyor	Flight ID	BTO Code	No. Birds	Age (Ad = adult; Imm = immature)	Sex (M = male; F = female; U = unknown)	StartTime (hr:min)	Flight duration (s)
24/05/2022	MMW	39	BH	4	AD	U	11:47	73
24/05/2022	MMW	40	L.	1	AD	U	11:56	26
24/05/2022	MMW	41	BH	4	AD	U	12:02	31
24/05/2022	MMW	42	BH	2	AD	U	12:03	7
24/05/2022	MMW	43	L.	1	AD	U	12:04	18
24/05/2022	MMW	44	L.	1	AD	U	12:08	13
24/05/2022	MMW	45	BH	1	AD	U	12:09	129
24/05/2022	MMW	46	BH	2	AD	U	12:17	55
24/05/2022	MMW	47	BH	3	AD	U	12:28	156
24/05/2022	MMW	48	BH	7	AD	U	12:33	242
24/05/2022	MMW	49	L.	1	AD	U	12:34	11
24/05/2022	MMW	50	BH	2	AD	U	12:37	63
24/05/2022	MMW	51	BH	2	AD	U	12:43	30
24/05/2022	MMW	52	BH	1	AD	U	12:52	44
24/05/2022	MMW	53	BH	1	AD	U	12:58	28
24/05/2022	MMW	54	BH	1	AD	U	13:02	71
24/05/2022	MMW	55	L.	1	AD	U	13:05	23
24/05/2022	MMW	56	BH	1	AD	U	13:06	49
26/05/2022	MMW	1	BH	3	AD	U	12:57	48
26/05/2022	MMW	2	SN	1	AD	U	12:57	3
26/05/2022	MMW	3	BH	22	U	U	13:06	91

Date	Surveyor	Flight ID	BTO Code	No. Birds	Age (Ad = adult; Imm = immature)	Sex (M = male; F = female; U = unknown)	StartTime (hr:min)	Flight duration (s)
26/05/2022	MMW	4	K.	1	AD	U	13:12	47
26/05/2022	MMW	5	BH	2	AD	U	13:16	19
26/05/2022	MMW	6	L.	2	AD	U	13:21	142
26/05/2022	MMW	7	L.	1	AD	U	13:30	54
26/05/2022	MMW	8	L.	1	AD	U	13:31	16
26/05/2022	MMW	9	BH	3	AD	U	13:34	33
26/05/2022	MMW	10	K.	1	AD	U	13:36	11
26/05/2022	MMW	11	BH	1	AD	U	13:41	18
26/05/2022	MMW	12	L.	1	AD	U	13:45	27
26/05/2022	MMW	13	K.	1	AD	U	13:46	45
26/05/2022	MMW	14	BH	34	AD	U	13:50	44
26/05/2022	MMW	15	BH	1	AD	U	13:53	10
26/05/2022	MMW	16	BH	1	AD	U	13:58	13
26/05/2022	MMW	17	BH	1	AD	U	14:00	35
26/05/2022	MMW	18	BH	1	AD	U	14:07	22
26/05/2022	MMW	19	K.	1	AD	F	14:15	81
26/05/2022	MMW	20	K.	1	AD	F	14:21	367
26/05/2022	MMW	20	K.	1	AD	F	14:21	367
26/05/2022	MMW	21	L.	1	AD	U	14:27	3
26/05/2022	MMW	22	K.	1	AD	F	14:28	42
26/05/2022	MMW	23	L.	1	AD	U	14:28	17

Date	Surveyor	Flight ID	BTO Code	No. Birds	Age (Ad = adult; Imm = immature)	Sex (M = male; F = female; U = unknown)	StartTime (hr:min)	Flight duration (s)
26/05/2022	MMW	24	BH	2	AD	U	14:36	48
26/05/2022	MMW	25	BH	9	AD	U	14:39	63
26/05/2022	MMW	26	BH	8	AD	U	14:53	65
26/05/2022	MMW	27	BH	31	AD	U	15:07	61
26/05/2022	MMW	28	L.	1	AD	U	15:16	19
26/05/2022	MMW	29	BH	1	AD	U	15:27	50
26/05/2022	MMW	30	BH	1	AD	U	15:38	34
26/05/2022	MMW	31	BH	2	AD	U	15:49	48
13/06/2022	MMW	1	K.	1	AD	F	15:55	143
13/06/2022	MMW	2	K.	1	AD	F	16:08	237
13/06/2022	MMW	2	K.	1	AD	F	16:08	237
13/06/2022	MMW	3	K.	1	AD	F	16:13	8
13/06/2022	MMW	4	SN	1	AD	U	16:26	3
13/06/2022	MMW	5	BH	1	AD	U	16:28	29
13/06/2022	MMW	6	RP	1	AD	U	16:33	8
13/06/2022	MMW	7	PE	1	AD	U	16:43	55
13/06/2022	MMW	8	PE	1	AD	U	17:00	61
13/06/2022	MMW	9	BH	1	AD	U	17:10	42
13/06/2022	MMW	10	BH	1	AD	U	17:28	44
13/06/2022	MMW	11	BH	1	AD	U	17:32	10
13/06/2022	MMW	12	K.	1	AD	F	17:34	5

Date	Surveyor	Flight ID	BTO Code	No. Birds	Age (Ad = adult; Imm = immature)	Sex (M = male; F = female; U = unknown)	StartTime (hr:min)	Flight duration (s)
13/06/2022	MMW	13	K.	1	AD	M	17:35	9
13/06/2022	MMW	14	K.	1	AD	F	17:35	3
13/06/2022	MMW	15	BH	1	AD	U	17:37	16
13/06/2022	MMW	16	SN	1	AD	U	17:46	130
13/06/2022	MMW	17	SN	1	AD	U	17:55	73
13/06/2022	MMW	18	SN	2	AD	U	17:58	249
13/06/2022	MMW	19	L.	1	AD	U	18:15	16
13/06/2022	MMW	20	SN	1	AD	U	18:17	28
13/06/2022	MMW	21	K.	1	AD	F	18:25	293
14/06/2022	MMW	1	K.	1	AD	F	19:04	6
14/06/2022	MMW	2	SN	1	AD	U	19:10	10
14/06/2022	MMW	3	RP	1	AD	U	19:12	3
14/06/2022	MMW	4	SN	1	AD	U	19:19	34
14/06/2022	MMW	5	SN	1	AD	U	19:21	4
14/06/2022	MMW	6	BH	2	AD	U	19:22	52
14/06/2022	MMW	7	SN	1	AD	U	19:29	4
14/06/2022	MMW	8	K.	1	AD	U	19:32	267
14/06/2022	MMW	9	K.	1	AD	F	19:38	159
14/06/2022	MMW	10	K.	1	AD	F	19:41	446
14/06/2022	MMW	10	K.	1	AD	F	19:41	446
14/06/2022	MMW	11	K.	1	AD	U	19:48	5

Date	Surveyor	Flight ID	BTO Code	No. Birds	Age (Ad = adult; Imm = immature)	Sex (M = male; F = female; U = unknown)	StartTime (hr:min)	Flight duration (s)
14/06/2022	MMW	12	BH	1	AD	U	19:52	18
14/06/2022	MMW	13	L.	1	AD	U	19:58	31
14/06/2022	MMW	14	K.	1	AD	M	19:59	289
14/06/2022	MMW	15	SN	1	AD	U	20:01	10
14/06/2022	MMW	16	L.	1	AD	U	20:10	36
14/06/2022	MMW	17	K.	1	AD	F	20:13	257
14/06/2022	MMW	18	BH	1	AD	U	20:17	5
14/06/2022	MMW	19	L.	1	AD	U	20:17	46
14/06/2022	MMW	20	K.	1	AD	U	20:31	207
14/06/2022	MMW	21	K.	1	AD	U (M?)	20:37	33
14/06/2022	MMW	22	BH	1	AD	U	20:45	74
14/06/2022	MMW	23	BH	2	AD	U	20:58	25
14/06/2022	MMW	24	BH	2	AD	U	21:02	22
28/06/2022	MMW	1	L.	2	AD	U	06:19	43
28/06/2022	MMW	2	RP	2	AD	U	06:20	5
28/06/2022	MMW	3	L.	1	AD	U	06:22	11
28/06/2022	MMW	4	L.	1	AD	U	06:27	46
28/06/2022	MMW	5	L.	1	AD	U	06:30	15
28/06/2022	MMW	6	L.	2	AD	U	06:31	50
28/06/2022	MMW	7	RP	1	AD	U	06:31	5
28/06/2022	MMW	8	L.	1	AD	U	06:33	17

Date	Surveyor	Flight ID	BTO Code	No. Birds	Age (Ad = adult; Imm = immature)	Sex (M = male; F = female; U = unknown)	StartTime (hr:min)	Flight duration (s)
28/06/2022	MMW	9	RP	2	AD	U	06:33	10
28/06/2022	MMW	10	L.	3	AD	U	06:37	63
28/06/2022	MMW	11	L.	11	U	U	06:43	88
28/06/2022	MMW	12	L.	1	AD	U	06:48	12
28/06/2022	MMW	13	RP	3	AD	U	06:57	16
28/06/2022	MMW	14	SN	1	AD	U	06:58	54
28/06/2022	MMW	15	L.	1	AD	U	07:16	28
28/06/2022	MMW	16	SN	1	AD	U	07:24	7
28/06/2022	MMW	17	L.	1	AD	U	07:35	5
28/06/2022	MMW	18	RP	2	AD	U	07:35	15
28/06/2022	MMW	19	L.	1	AD	U	07:41	12
28/06/2022	MMW	20	BH	2	AD	U	07:42	31
28/06/2022	MMW	21	SN	1	AD	U	07:46	78
28/06/2022	MMW	22	SN	1	AD	U	07:50	33
28/06/2022	MMW	23	K.	1	AD	U	07:57	232
28/06/2022	MMW	24	SN	1	AD	U	07:57	27
28/06/2022	MMW	25	L.	1	U	U	08:10	6
28/06/2022	MMW	26	SN	1	AD	U	08:16	237
28/06/2022	MMW	27	SN	1	AD	U	08:26	74
28/06/2022	MMW	28	L.	1	U	U	08:27	43
28/06/2022	MMW	29	L.	1	AD	U	08:33	11

Date	Surveyor	Flight ID	BTO Code	No. Birds	Age (Ad = adult; Imm = immature)	Sex (M = male; F = female; U = unknown)	StartTime (hr:min)	Flight duration (s)
28/06/2022	MMW	30	L.	1	AD	U	08:37	34
28/06/2022	MMW	31	BH	1	AD	U	08:48	44
28/06/2022	MMW	32	RP	1	AD	U	08:57	10
28/06/2022	MMW	33	SN	1	AD	U	09:05	17
29/06/2022	MMW	1	L.	1	AD	U	09:47	40
29/06/2022	MMW	2	L.	1	AD	U	09:59	11
29/06/2022	MMW	3	L.	1	AD	U	10:18	6
29/06/2022	MMW	4	L.	1	AD	U	10:37	5
29/06/2022	MMW	5	L.	1	AD	U	10:42	34
29/06/2022	MMW	6	L.	2	AD	U	10:48	26
29/06/2022	MMW	7	RP	1	AD	U	10:50	3
29/06/2022	MMW	8	L.	1	AD	U	10:50	5
29/06/2022	MMW	9	L.	2	AD	U	10:58	21
29/06/2022	MMW	10	RP	1	AD	U	11:03	6
29/06/2022	MMW	11	L.	1	AD	U	11:04	17
29/06/2022	MMW	12	L.	3	AD	U	11:06	4
29/06/2022	MMW	13	L.	1	AD	U	11:08	78
29/06/2022	MMW	14	K.	1	AD	U	11:21	163
29/06/2022	MMW	15	SN	2	AD	U	11:59	102
29/06/2022	MMW	16	BH	2	AD	U	12:19	63
29/06/2022	MMW	17	K.	1	AD	F	12:25	21

Date	Surveyor	Flight ID	BTO Code	No. Birds	Age (Ad = adult; Imm = immature)	Sex (M = male; F = female; U = unknown)	StartTime (hr:min)	Flight duration (s)
29/06/2022	MMW	18	K.	1	AD	F	12:26	244
29/06/2022	MMW	19	L.	1	AD	U	12:26	7
11/07/2022	MMW	1	L.	1	U	U	16:06	9
11/07/2022	MMW	2	L.	1	AD	U	16:18	12
11/07/2022	MMW	3	L.	1	AD	U	17:01	26
11/07/2022	MMW	4	L.	1	U	U	17:06	10
11/07/2022	MMW	5	L.	3	U	U	17:27	93
11/07/2022	MMW	6	L.	2	U	U	17:49	78
11/07/2022	MMW	7	SN	1	U	U	18:06	88
11/07/2022	MMW	8	PE	1	AD	U	18:21	130
11/07/2022	MMW	9	K.	1	U	U	18:43	101
11/07/2022	MMW	10	K.	1	U	U	18:57	35
12/07/2022	MMW	1	L.	1	AD	U	07:22	5
12/07/2022	MMW	2	L.	4	AD	U	09:34	52
12/07/2022	MMW	3	SN	1	AD	U	09:45	44
12/07/2022	MMW	4	SN	1	AD	U	09:48	6
12/07/2022	MMW	5	L.	5	AD	U	09:51	161
12/07/2022	MMW	6	L.	5	AD	U	09:51	148
12/07/2022	MMW	7	L.	1	AD	U	09:57	45
12/07/2022	MMW	8	L.	1	AD	U	10:02	50
12/07/2022	MMW	9	L.	2	AD	U	10:05	140

Date	Surveyor	Flight ID	BTO Code	No. Birds	Age (Ad = adult; Imm = immature)	Sex (M = male; F = female; U = unknown)	StartTime (hr:min)	Flight duration (s)
12/07/2022	MMW	10	L.	5	AD	U	10:23	11
12/07/2022	MMW	11	L.	3	AD	U	10:25	65
12/07/2022	MMW	12	SN	1	AD	M	10:30	814
12/07/2022	MMW	12	SN	1	AD	M	10:30	814
12/07/2022	MMW	12	SN	1	AD	M	10:30	814
12/07/2022	MMW	13	SN	1	AD	U	10:57	13
12/07/2022	MMW	14	SN	1	AD	M	10:59	554
12/07/2022	MMW	14	SN	1	AD	M	10:59	554
12/07/2022	MMW	15	RP	2	AD	U	11:18	22
12/07/2022	MMW	16	L.	1	AD	U	11:22	14
12/07/2022	MMW	17	SN	1	AD	U	11:58	10
12/07/2022	MMW	18	L.	10	U	U	12:05	8
12/07/2022	MMW	19	L.	1	U	U	12:10	16
12/07/2022	MMW	20	L.	3	U	U	12:10	123
12/07/2022	MMW	21	RP	2	AD	U	12:11	25
03/08/2022	MMW	1	L.	1	U	U	08:21	34

Table A4-4
Secondary target species recorded during flight activity surveys undertaken at VP1

Date	Survey start	Survey end	5 min period start time	5 min period end time	Species	Count Max	Height band	Location (on site, in buffer or beyond)
17/05/2022	11:30	14:30	11:45	11:50	BZ	1	2	On site
17/05/2022	11:30	14:30	12:00	12:05	BZ	1	1	On site
17/05/2022	11:30	14:30	12:15	12:20	RN	1	1	On site
17/05/2022	11:30	14:30	12:20	12:25	BZ	1	1,2	On site, buffer
17/05/2022	11:30	14:30	12:25	12:30	BZ	1	1	On site
17/05/2022	11:30	14:30	12:35	12:40	BZ	2	1,2	On site
17/05/2022	11:30	14:30	12:55	13:00	BZ	1	1	On site
19/05/2022	14:00	17:00	15:05	15:10	BZ	1	2	Beyond
19/05/2022	14:00	17:00	16:25	16:30	BZ	1	2	On site
19/05/2022	14:00	17:00	16:35	16:40	BZ	1	2	On site
25/05/2022	14:15	17:15	14:20	14:25	BZ	1	2	On site, buffer
25/05/2022	14:15	17:15	14:40	14:45	BZ	1	3	On site, buffer
25/05/2022	14:15	17:15	14:45	14:50	MA	1	1	On site
25/05/2022	14:15	17:15	14:50	14:55	BZ	1	2	On site
25/05/2022	14:15	17:15	14:50	14:55	LB	2	2	On site, buffer
25/05/2022	14:15	17:15	15:00	15:05	BZ	1	2	On site
25/05/2022	14:15	17:15	15:10	15:15	BZ	1	3	On site, buffer
25/05/2022	14:15	17:15	15:10	15:15	BZ	1	2	On site, buffer
25/05/2022	14:15	17:15	15:20	15:25	BZ	1	2	On site
25/05/2022	14:15	17:15	15:45	15:50	BZ	1	2	On site

Date	Survey start	Survey end	5 min period start time	5 min period end time	Species	Count Max	Height band	Location (on site, in buffer or beyond)
25/05/2022	14:15	17:15	15:55	16:00	BZ	2	2	On site
25/05/2022	14:15	17:15	16:15	16:20	BZ	1	2	On site, buffer
25/05/2022	14:15	17:15	16:20	16:25	BZ	2	2	On site
25/05/2022	14:15	17:15	16:20	16:25	BZ	1	3	On site, buffer
25/05/2022	14:15	17:15	16:45	16:50	BZ	1	2	On site
25/05/2022	14:15	17:15	16:50	16:55	BZ	1	2	On site
25/05/2022	14:15	17:15	17:00	17:05	HG	2	2	On site, buffer
26/05/2022	08:50	11:50	10:05	10:10	RN	1	2	On site, buffer
26/05/2022	08:50	11:50	10:05	10:10	H.	1	2	Buffer
26/05/2022	08:50	11:50	10:45	10:50	LB	4	1	On site
26/05/2022	08:50	11:50	10:45	10:50	HG	5	1	On site
26/05/2022	08:50	11:50	11:30	11:35	BZ	1	2	On site, buffer
26/05/2022	08:50	11:50	11:35	11:40	MA	1	1	On site, buffer
26/05/2022	08:50	11:50	11:40	11:45	BZ	1	3	Buffer, beyond
13/06/2022	19:00	22:00	19:05	19:10	BZ	1	2	Buffer
13/06/2022	19:00	22:00	19:10	19:15	H.	1	2	On site, buffer
13/06/2022	19:00	22:00	20:35	20:40	MA	1	1	On site
13/06/2022	19:00	22:00	20:45	20:50	LB	1	2	On site
15/06/2022	10:10	13:10	10:20	10:25	BZ	1	2	On site, buffer
15/06/2022	10:10	13:10	10:25	10:30	BZ	2	2	Buffer
15/06/2022	10:10	13:10	10:50	10:55	BZ	2	2	Buffer, beyond
15/06/2022	10:10	13:10	10:50	10:55	BZ	1	2	On site, buffer

Date	Survey start	Survey end	5 min period start time	5 min period end time	Species	Count Max	Height band	Location (on site, in buffer or beyond)
15/06/2022	10:10	13:10	10:55	11:00	BZ	1	3	On site, buffer
15/06/2022	10:10	13:10	10:55	11:00	RN	1	1	Buffer
15/06/2022	10:10	13:10	11:00	11:05	BZ	2	2	On site
15/06/2022	10:10	13:10	11:10	11:15	BZ	2	2	On site
15/06/2022	10:10	13:10	11:10	11:15	BZ	2	1	On site, buffer
15/06/2022	10:10	13:10	11:20	11:25	BZ	2	2	On site
15/06/2022	10:10	13:10	11:20	11:25	BZ	3	3	Buffer
15/06/2022	10:10	13:10	11:25	11:30	BZ	3	2	On site
15/06/2022	10:10	13:10	11:25	11:30	BZ	1	2	On site
15/06/2022	10:10	13:10	11:35	11:40	BZ	1	2	On site
15/06/2022	10:10	13:10	11:45	11:50	BZ	1	2	On site
15/06/2022	10:10	13:10	11:55	12:00	BZ	1	3	On site
15/06/2022	10:10	13:10	12:05	12:10	BZ	2	2	On site
15/06/2022	10:10	13:10	12:10	12:15	BZ	2	2	On site
15/06/2022	10:10	13:10	12:10	12:15	BZ	2	1	On site
15/06/2022	10:10	13:10	12:20	12:25	BZ	2	2	Buffer
15/06/2022	10:10	13:10	12:25	12:30	BZ	2	2	Buffer
15/06/2022	10:10	13:10	12:25	12:30	BZ	1	2	Buffer, beyond
15/06/2022	10:10	13:10	12:35	12:40	BZ	2	2	Buffer, beyond
15/06/2022	10:10	13:10	12:35	12:40	RN	1	2	Buffer, beyond
15/06/2022	10:10	13:10	12:40	12:45	BZ	1	2	Buffer
15/06/2022	10:10	13:10	12:55	13:00	BZ	2	2	Buffer

Date	Survey start	Survey end	5 min period start time	5 min period end time	Species	Count Max	Height band	Location (on site, in buffer or beyond)
15/06/2022	10:10	13:10	12:55	13:00	BZ	2	2	On site
15/06/2022	10:10	13:10	13:00	13:05	BZ	1	2	On site
15/06/2022	10:10	13:10	13:05	13:10	BZ	4	2	On site
15/06/2022	10:10	13:10	13:05	13:10	BZ	4	2	Buffer
27/06/2022	15:15	18:15	15:15	15:20	BZ	1	2	On site, buffer
27/06/2022	15:15	18:15	15:20	15:25	BZ	2	2	On site
27/06/2022	15:15	18:15	15:20	15:25	BZ	2	3	Buffer, beyond
27/06/2022	15:15	18:15	15:25	15:30	BZ	2	2	On site
27/06/2022	15:15	18:15	15:25	15:30	BZ	2	2	Buffer, beyond
27/06/2022	15:15	18:15	15:35	15:40	BZ	1	2	Buffer, beyond
27/06/2022	15:15	18:15	15:40	15:45	BZ	2	2	Buffer, beyond
27/06/2022	15:15	18:15	15:40	15:45	BZ	2	2	On site, buffer
27/06/2022	15:15	18:15	15:50	15:55	BZ	1	2	On site
27/06/2022	15:15	18:15	15:50	15:55	BZ	1	2	Buffer, beyond
27/06/2022	15:15	18:15	16:00	16:05	BZ	1	2	On site
27/06/2022	15:15	18:15	16:05	16:10	BZ	2	2	On site
27/06/2022	15:15	18:15	16:30	16:35	BZ	2	2	Buffer
27/06/2022	15:15	18:15	16:40	16:45	BZ	2	2	Buffer, beyond
27/06/2022	15:15	18:15	16:40	16:45	BZ	2	2	On site, buffer
27/06/2022	15:15	18:15	16:50	16:55	BZ	1	2	On site
27/06/2022	15:15	18:15	16:50	16:55	BZ	1	2	Buffer
27/06/2022	15:15	18:15	16:55	17:00	BZ	1	2	On site

Date	Survey start	Survey end	5 min period start time	5 min period end time	Species	Count Max	Height band	Location (on site, in buffer or beyond)
27/06/2022	15:15	18:15	17:00	17:05	BZ	1	2	Buffer
27/06/2022	15:15	18:15	17:10	17:15	RN	1	1	On site
27/06/2022	15:15	18:15	17:20	17:25	BZ	1	2	On site
27/06/2022	15:15	18:15	17:35	17:40	BZ	1	2	On site, buffer
27/06/2022	15:15	18:15	17:40	17:45	BZ	1	2	On site
27/06/2022	15:15	18:15	18:00	18:05	BZ	1	1	On site
27/06/2022	15:15	18:15	18:05	18:10	BZ	1	1	On site
27/06/2022	15:15	18:15	18:10	18:15	BZ	1	2	Buffer, beyond
29/06/2022	06:15	09:15	07:15	07:20	MA	1	2	On site
29/06/2022	06:15	09:15	07:20	07:25	HG	2	2	On site
29/06/2022	06:15	09:15	07:50	07:55	BZ	1	2	Buffer
29/06/2022	06:15	09:15	08:15	08:20	HG	1	2	On site
29/06/2022	06:15	09:15	08:25	08:30	BZ	1	2	Buffer
29/06/2022	06:15	09:15	08:30	08:35	BZ	1	2	Buffer
29/06/2022	06:15	09:15	09:10	09:15	BZ	1	2	On site, buffer
12/07/2022	12:50	15:50	12:50	12:55	BZ	1	1	On site, buffer
12/07/2022	12:50	15:50	13:10	13:15	BZ	1	1	On site
12/07/2022	12:50	15:50	13:20	13:25	BZ	1	1	Buffer, beyond
12/07/2022	12:50	15:50	13:25	13:30	BZ	1	2	Buffer
12/07/2022	12:50	15:50	13:35	13:40	SH	1	2	On site, buffer
12/07/2022	12:50	15:50	13:55	14:00	LB	1	2	On site
12/07/2022	12:50	15:50	14:05	14:10	BZ	1	2	On site, buffer

Date	Survey start	Survey end	5 min period start time	5 min period end time	Species	Count Max	Height band	Location (on site, in buffer or beyond)
12/07/2022	12:50	15:50	14:25	14:30	BZ	1	2	Buffer, beyond
12/07/2022	12:50	15:50	14:55	15:00	BZ	1	2	Buffer, beyond
12/07/2022	12:50	15:50	15:20	15:25	HG	1	2	On site, buffer
12/07/2022	12:50	15:50	15:45	15:50	BZ	1	2	Buffer
13/07/2022	06:30	09:30	06:50	06:55	H	1	1	On site
13/07/2022	06:30	09:30	08:05	08:10	H	1	1	On site
13/07/2022	06:30	09:30	09:20	09:25	LB	1	2	On site
02/08/2022	18:30	21:30	19:05	19:10	SH	1	1	Buffer
02/08/2022	18:30	21:30	19:10	19:15	RN	1	2	On Site
02/08/2022	18:30	21:30	19:20	19:25	RN	1	2	Buffer
02/08/2022	18:30	21:30	20:00	20:05	BZ	1	2	On site, buffer
03/08/2022	10:10	13:10	10:20	10:25	RN	1	1	On site
03/08/2022	10:10	13:10	10:50	10:55	RN	1	2	On site, buffer
03/08/2022	10:10	13:10	11:05	11:10	BZ	2	2	On site, buffer
03/08/2022	10:10	13:10	11:05	11:10	BZ	2	2	Buffer, beyond
03/08/2022	10:10	13:10	11:10	11:15	RN	1	2	On site
03/08/2022	10:10	13:10	11:25	11:30	MA	3	1	Buffer
03/08/2022	10:10	13:10	11:35	11:40	H.	1	2	On site, buffer
03/08/2022	10:10	13:10	11:45	11:50	BZ	1	2	Buffer, beyond
03/08/2022	10:10	13:10	11:55	12:00	RN	2	2	Buffer, beyond
03/08/2022	10:10	13:10	12:30	12:35	MA	3	1	On site, buffer
03/08/2022	10:10	13:10	12:35	12:40	RN	1	2	On site, buffer

Date	Survey start	Survey end	5 min period start time	5 min period end time	Species	Count Max	Height band	Location (on site, in buffer or beyond)
03/08/2022	10:10	13:10	12:50	12:55	LB	2	2	On site, buffer
03/08/2022	10:10	13:10	12:50	12:55	LB	2	2	On site, buffer

Table A4-5
Secondary target species recorded during flight activity surveys undertaken at VP2

Date	Survey start	Survey end	5 min period start time	5 min period end time	Species	Count Max	Height band	Location (on site, in buffer or beyond)
20/05/2022	12:30	15:30	12:40	12:45	BZ	1	2	On site, buffer
20/05/2022	12:30	15:30	13:20	13:25	BZ	1	2	On site, buffer
20/05/2022	12:30	15:30	15:00	15:05	RN	2	2	On site
19/05/2022	10:30	13:30	10:50	10:55	BZ	1	2,3	On site, buffer
19/05/2022	10:30	13:30	11:15	11:20	BZ	3	2	On site, buffer
19/05/2022	10:30	13:30	11:45	11:50	BZ	1	1	Buffer
19/05/2022	10:30	13:30	11:50	11:55	BZ	2	1,2	Buffer, beyond
19/05/2022	10:30	13:30	11:55	12:00	BZ	1	2	On site
19/05/2022	10:30	13:30	12:00	12:05	BZ	1	2	On site
19/05/2022	10:30	13:30	12:35	12:40	SH	1	1	On site, buffer
24/05/2022	14:20	17:20	14:20	14:25	BZ	1	2	On site
24/05/2022	14:20	17:20	14:40	14:45	BZ	1	4	On site
24/05/2022	14:20	17:20	14:45	14:50	BZ	2	2	On site
24/05/2022	14:20	17:20	14:50	14:55	BZ	2	2	On site

Date	Survey start	Survey end	5 min period start time	5 min period end time	Species	Count Max	Height band	Location (on site, in buffer or beyond)
24/05/2022	14:20	17:20	15:05	15:10	RN	1	2	On site
24/05/2022	14:20	17:20	15:15	15:20	H.	1	2	On site
24/05/2022	14:20	17:20	15:15	15:20	RN	1	2	On site
24/05/2022	14:20	17:20	15:30	15:35	BZ	1	3	On site
24/05/2022	14:20	17:20	15:40	15:45	BZ	1	3	On site
24/05/2022	14:20	17:20	15:45	15:50	BZ	1	2	On site
24/05/2022	14:20	17:20	15:50	15:55	BZ	2	2	On site
24/05/2022	14:20	17:20	15:55	16:00	BZ	1	4	On site
24/05/2022	14:20	17:20	16:00	16:05	BZ	1	4	On site
24/05/2022	14:20	17:20	16:05	16:10	BZ	1	3	On site
24/05/2022	14:20	17:20	16:15	16:20	BZ	1	3	On site
24/05/2022	14:20	17:20	16:45	16:50	BZ	1	4	Buffer
24/05/2022	14:20	17:20	16:55	17:00	BZ	1	3	Buffer
24/05/2022	14:20	17:20	17:10	17:15	RN	1	1	On site
24/05/2022	14:20	17:20	17:15	17:20	RN	2	2	Buffer
25/05/2022	10:15	13:15	10:25	10:30	RN	1	1	On site
25/05/2022	10:15	13:15	10:35	10:40	RN	3	2	On site
25/05/2022	10:15	13:15	10:50	10:55	RN	2	1	On site
25/05/2022	10:15	13:15	10:55	11:00	RN	3	1	On site
25/05/2022	10:15	13:15	11:00	11:05	LB	1	2	On site, buffer
25/05/2022	10:15	13:15	11:05	11:10	LB	3	2	Buffer
25/05/2022	10:15	13:15	11:20	11:25	BZ	1	2	On site

Date	Survey start	Survey end	5 min period start time	5 min period end time	Species	Count Max	Height band	Location (on site, in buffer or beyond)
25/05/2022	10:15	13:15	11:30	11:35	BZ	1	2	On site, buffer
25/05/2022	10:15	13:15	11:45	11:50	BZ	1	2	Buffer
25/05/2022	10:15	13:15	11:55	12:00	BZ	1	3	Buffer
25/05/2022	10:15	13:15	12:15	12:20	BZ	1	2	On site
25/05/2022	10:15	13:15	12:50	12:55	RN	1	1	On site, buffer
14/06/2022	15:10	18:10	15:25	15:30	BZ	1	2	Buffer
14/06/2022	15:10	18:10	15:35	15:40	RN	1	2	On site
14/06/2022	15:10	18:10	15:40	15:45	LB	1	2	On site, buffer
14/06/2022	15:10	18:10	15:45	15:50	BZ	1	2	Buffer
14/06/2022	15:10	18:10	15:50	15:55	HG	2	2	On site, buffer
14/06/2022	15:10	18:10	16:00	16:05	BZ	1	3	Buffer
14/06/2022	15:10	18:10	16:10	16:15	BZ	1	2	Buffer
14/06/2022	15:10	18:10	16:15	16:20	BZ	1	3	On site, buffer
14/06/2022	15:10	18:10	16:20	16:25	RN	2	2	Buffer
14/06/2022	15:10	18:10	16:20	16:25	BZ	1	2	On site
14/06/2022	15:10	18:10	16:40	16:45	BZ	1	2	On site
14/06/2022	15:10	18:10	16:45	16:50	BZ	1	3	Buffer
15/06/2022	06:05	09:05	06:25	06:30	H.	3	2	On site
15/06/2022	06:05	09:05	06:30	06:35	ET	1	1	On site
15/06/2022	06:05	09:05	06:35	06:40	LB	1	2	On site, buffer
15/06/2022	06:05	09:05	06:35	06:40	H.	1	1	On site
15/06/2022	06:05	09:05	07:40	07:45	BZ	1	1	On site

Date	Survey start	Survey end	5 min period start time	5 min period end time	Species	Count Max	Height band	Location (on site, in buffer or beyond)
15/06/2022	06:05	09:05	07:45	07:50	BZ	1	1	On site
15/06/2022	06:05	09:05	07:50	07:55	BZ	1	1	On site
15/06/2022	06:05	09:05	08:45	08:50	HG	2	2	On site
27/06/2022	19:00	22:00	19:05	19:10	BZ	1	2	Buffer
27/06/2022	19:00	22:00	19:10	19:15	BZ	1	2	Buffer
27/06/2022	19:00	22:00	19:25	19:30	HG	2	2	On site, buffer
27/06/2022	19:00	22:00	20:35	20:40	H.	1	2	On site
28/06/2022	09:45	12:45	10:30	10:35	RN	1	2	On site
28/06/2022	09:45	12:45	10:35	10:40	BZ	1	2	On site
28/06/2022	09:45	12:45	11:35	11:40	BZ	1	2	On site, buffer
28/06/2022	09:45	12:45	11:55	12:00	M	1	1	On site
28/06/2022	09:45	12:45	12:30	12:35	BZ	1	2	On site, buffer
28/06/2022	09:45	12:45	12:35	12:40	BZ	1	2	On site
11/07/2022	12:30	15:30	14:05	14:10	BZ	1	2	On site
11/07/2022	12:30	15:30	15:00	15:05	HG	1	2	On site
13/07/2022	10:00	13:00	10:40	10:45	HG	3	2	On site
13/07/2022	10:00	13:00	11:05	11:10	RN	1	2	On site
13/07/2022	10:00	13:00	11:30	11:35	BZ	1	2	On site
13/07/2022	10:00	13:00	11:35	11:40	BZ	1	2	On site
13/07/2022	10:00	13:00	12:55	13:00	BZ	1	2	On site, buffer
01/08/2022	17:30	20:30	19:25	19:30	HG	1	2	On site
01/08/2022	17:30	20:30	20:20	20:25	H.	1	2	On site

Date	Survey start	Survey end	5 min period start time	5 min period end time	Species	Count Max	Height band	Location (on site, in buffer or beyond)
02/08/2022	15:00	18:00	15:10	15:15	RN	2	2	Buffer
02/08/2022	15:00	18:00	15:15	15:20	RN	2	1	On site
02/08/2022	15:00	18:00	15:20	15:25	RN	2	2	On site
02/08/2022	15:00	18:00	15:25	15:30	BZ	1	2	On site, buffer
02/08/2022	15:00	18:00	15:40	15:45	BZ	1	2	On Site
02/08/2022	15:00	18:00	15:45	15:50	BZ	1	2	On Site
02/08/2022	15:00	18:00	15:50	15:55	BZ	1	2	Buffer
02/08/2022	15:00	18:00	16:15	16:20	BZ	1	3	On site
02/08/2022	15:00	18:00	16:40	16:45	LB	2	2	On site, buffer
02/08/2022	15:00	18:00	16:45	16:50	LB	2	2	Buffer
02/08/2022	15:00	18:00	17:35	17:40	LB	1	3	On site
02/08/2022	15:00	18:00	17:40	17:45	LB	1	3	On site

Table A4-6
Secondary target species recorded during flight activity surveys undertaken at VP3

Date	Survey start	Survey end	5 min period start time	5 min period end time	Species	Count Max	Height band	Location (on site, in buffer or beyond)
18/05/2022	09:00	12:00	09:00	09:05	RN	2	1	Buffer, beyond
18/05/2022	09:00	12:00	09:50	09:55	RN	1	2	Beyond
18/05/2022	09:00	12:00	10:40	10:45	BZ	2	2	Buffer
18/05/2022	09:00	12:00	10:25	10:30	RN	2	1	On site
20/05/2022	16:00	19:00	16:40	16:45	BZ	4	2	On site, buffer
24/05/2022	10:15	13:15	10:45	10:50	H.	2	1	On site
24/05/2022	10:15	13:15	11:05	11:10	BZ	1	3	Beyond
24/05/2022	10:15	13:15	11:10	11:15	BZ	1	2	Beyond
24/05/2022	10:15	13:15	11:20	11:25	RN	1	2	On site
24/05/2022	10:15	13:15	11:40	11:45	MA	1	1	On site
24/05/2022	10:15	13:15	12:00	12:05	H.	1	1	On site
24/05/2022	10:15	13:15	12:00	12:05	RN	1	2	On site
24/05/2022	10:15	13:15	12:20	12:25	RN	1	2	Beyond
24/05/2022	10:15	13:15	12:25	12:30	BZ	1	2	On site
24/05/2022	10:15	13:15	12:30	12:35	BZ	1	2	Buffer
24/05/2022	10:15	13:15	12:45	12:50	RN	3	2	On site
24/05/2022	10:15	13:15	13:00	13:05	BZ	1	2	On site
24/05/2022	10:15	13:15	13:10	13:15	BZ	1	2	Buffer
26/05/2022	12:50	15:50	13:05	13:10	BZ	1	2	Buffer, beyond
26/05/2022	12:50	15:50	13:05	13:10	HG	1	1	Onsite, buffer

Date	Survey start	Survey end	5 min period start time	5 min period end time	Species	Count Max	Height band	Location (on site, in buffer or beyond)
26/05/2022	12:50	15:50	13:25	13:30	BZ	2	2	Buffer
26/05/2022	12:50	15:50	13:25	13:30	BZ	2	2	On site
26/05/2022	12:50	15:50	13:30	13:35	RN	1	1	On site
26/05/2022	12:50	15:50	13:40	13:45	BZ	3	2	Buffer
26/05/2022	12:50	15:50	13:40	13:45	BZ	3	2	On site, buffer
26/05/2022	12:50	15:50	13:40	13:45	BZ	3	2	Beyond
26/05/2022	12:50	15:50	13:45	13:50	LB	4	2	On site
26/05/2022	12:50	15:50	13:50	13:55	HG	8	1	On site
26/05/2022	12:50	15:50	13:50	13:55	CM	1	1	On site
26/05/2022	12:50	15:50	14:40	14:45	BZ	1	2	Buffer
26/05/2022	12:50	15:50	14:45	14:50	BZ	1	2	Buffer
26/05/2022	12:50	15:50	15:00	15:05	BZ	2	2	On site, buffer
26/05/2022	12:50	15:50	15:00	15:05	RN	1	1	On site
26/05/2022	12:50	15:50	15:10	15:15	BZ	1	2	On site
26/05/2022	12:50	15:50	15:25	15:30	SH	1	1	On site, buffer
26/05/2022	12:50	15:50	15:40	15:45	BZ	1	3	On site, buffer
26/05/2022	12:50	15:50	15:45	15:50	BZ	1	2	Buffer
13/06/2022	15:30	18:30	15:30	15:35	BZ	1	2	Buffer
13/06/2022	15:30	18:30	15:35	15:40	BZ	2	2	On site, buffer
13/06/2022	15:30	18:30	15:35	15:40	H.	1	2	On site
13/06/2022	15:30	18:30	15:40	15:45	BZ	2	2	On site, buffer
13/06/2022	15:30	18:30	15:45	15:50	BZ	3	2	On site, buffer

Date	Survey start	Survey end	5 min period start time	5 min period end time	Species	Count Max	Height band	Location (on site, in buffer or beyond)
13/06/2022	15:30	18:30	16:45	16:50	BZ	1	1	On site, buffer
13/06/2022	15:30	18:30	17:00	17:05	SH	1	1	Buffer
13/06/2022	15:30	18:30	17:15	17:20	BZ	1	2	Buffer
13/06/2022	15:30	18:30	17:40	17:45	H.	1	1	On site
13/06/2022	15:30	18:30	17:40	17:45	BZ	1	2	On site
13/06/2022	15:30	18:30	17:55	18:00	HG	2	2	On site, buffer
13/06/2022	15:30	18:30	18:00	18:05	BZ	2	2	On site, buffer
13/06/2022	15:30	18:30	18:10	18:15	BZ	1	2	Buffer
13/06/2022	15:30	18:30	18:15	18:20	BZ	1	2	On site
13/06/2022	15:30	18:30	18:20	18:25	BZ	1	2	Buffer
13/06/2022	15:30	18:30	18:25	18:30	BZ	1	2	Buffer
14/06/2022	19:00	22:00	20:10	20:15	LB	1	2	On site
14/06/2022	19:00	22:00	20:20	20:25	BZ	1	1	On site
14/06/2022	19:00	22:00	20:20	20:25	BZ	1	2	On site
14/06/2022	19:00	22:00	21:15	21:20	HG	2	1	On site
28/06/2022	06:10	09:10	07:35	07:40	BZ	1	2	On site, buffer
28/06/2022	06:10	09:10	07:40	07:45	BZ	1	2	On site, buffer
28/06/2022	06:10	09:10	07:40	07:45	MA	1	1	On site
28/06/2022	06:10	09:10	07:45	07:50	BZ	1	2	Buffer
29/06/2022	09:45	12:45	10:35	10:40	MA	2	1	On site
29/06/2022	09:45	12:45	11:10	11:15	BZ	2	2	On site, buffer
29/06/2022	09:45	12:45	11:10	11:15	BZ	2	2	On site, buffer

Date	Survey start	Survey end	5 min period start time	5 min period end time	Species	Count Max	Height band	Location (on site, in buffer or beyond)
29/06/2022	09:45	12:45	11:20	11:25	BZ	2	2	On site, buffer
29/06/2022	09:45	12:45	11:25	11:30	BZ	2	2	On site, buffer
29/06/2022	09:45	12:45	12:30	12:35	BZ	2	2	On site, buffer
11/07/2022	16:00	19:00	16:30	16:35	BZ	1	2	On site
11/07/2022	16:00	19:00	16:35	16:40	LB	4	2	On site
11/07/2022	16:00	19:00	16:35	16:40	BZ	1	2	On site
11/07/2022	16:00	19:00	16:40	16:45	BZ	1	1	On site
11/07/2022	16:00	19:00	17:00	17:05	BZ	1	2	On site
11/07/2022	16:00	19:00	17:05	17:10	BZ	1	2	On site
11/07/2022	16:00	19:00	17:50	17:55	BZ	1	2	On site
11/07/2022	16:00	19:00	17:55	18:00	SH	1	2	On site
11/07/2022	16:00	19:00	18:00	18:05	SH	1	2	On site
12/07/2022	09:20	12:20	09:20	09:25	LB	1	1	On site
12/07/2022	09:20	12:20	09:30	09:35	SH	1	1	On site
12/07/2022	09:20	12:20	11:00	11:05	H	1	1	On site
12/07/2022	09:20	12:20	11:15	11:20	LB	2	2	On site
12/07/2022	09:20	12:20	11:25	11:30	LB	1	2	On site
12/07/2022	09:20	12:20	11:40	11:45	BZ	1	2	On site, buffer
12/07/2022	09:20	12:20	11:45	11:50	BZ	1	2	On site, buffer
12/07/2022	09:20	12:20	12:15	12:20	BZ	1	2	On site
01/08/2022	11:30	14:30	12:05	12:10	RN	1	2	On site
01/08/2022	11:30	14:30	12:30	12:35	BZ	1	2	Buffer

Date	Survey start	Survey end	5 min period start time	5 min period end time	Species	Count Max	Height band	Location (on site, in buffer or beyond)
01/08/2022	11:30	14:30	12:45	12:50	BZ	1	2	On site
01/08/2022	11:30	14:30	13:05	13:10	SH	1	1	On site
01/08/2022	11:30	14:30	13:15	13:20	BZ	2	2	On site
01/08/2022	11:30	14:30	13:15	13:20	RN	1	2	On site
01/08/2022	11:30	14:30	13:15	13:20	BZ	2	2	Buffer
01/08/2022	11:30	14:30	13:20	13:25	LB	1	2	On site, buffer
01/08/2022	11:30	14:30	13:40	13:45	BZ	1	2	On site, buffer
01/08/2022	11:30	14:30	14:25	14:30	GB	2	2	Buffer
01/08/2022	11:30	14:30	14:25	14:30	GB	2	2	On site
03/08/2022	06:40	09:40	07:05	07:10	LB	1	2	Buffer
03/08/2022	06:40	09:40	07:25	07:30	MA	19	2	On site, buffer
03/08/2022	06:40	09:40	07:40	07:45	LB	3	2	On site, buffer
03/08/2022	06:40	09:40	07:50	07:55	LB	2	2	On site, buffer
03/08/2022	06:40	09:40	08:00	08:05	MA	6	2	On site, buffer
03/08/2022	06:40	09:40	08:15	08:20	MA	2	2	Buffer, beyond
03/08/2022	06:40	09:40	08:50	08:55	RN	1	2	On site
03/08/2022	06:40	09:40	08:55	09:00	RN	1	2	On site
03/08/2022	06:40	09:40	09:10	09:15	GB	1	2	On site, buffer
03/08/2022	06:40	09:40	09:10	09:15	RN	4	2	On site

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Bird Survey Report Non-Breeding 2022/23

Cush Wind Farm

Galetech Energy Developments Ltd

Clondargan, Stradone, Co. Cavan

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5 September 2023

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Revision	Date	Prepared By	Checked By	Authorised By
0	29 August 2023	Alice Magee	Aisling Kinsella	Dr Jonathon Dunn

Basis of Report

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1.0 Introduction

SLR Environmental Consulting (Ireland) Ltd. (SLR) was commissioned by Galetech Energy Developments Ltd to carry out a bird survey programme for the proposed wind farm at Cush, Co. Offaly (hereafter 'the Project') during the non-breeding season in 2022/23. The purpose of this report is to describe these surveys and the resulting ornithological baseline.

1.1 Background to the Commission

No previous planning permission has been sought on the application site for the development of wind farms by Galetech Energy Developments Ltd or any other party.

Bird surveys have been previously undertaken at the proposed wind farm development site at Cush, Co. Offaly (hereafter 'the Project Site') by SLR for the breeding 2020, non-breeding 2020/21, breeding 2021, non-breeding 2021/22, and breeding 2022 seasons. The Project Site also includes a linear area that was previously surveyed for a proposed overhead line[1]. Flight activity surveys were carried out at two vantage point locations along the proposed overhead line route corridor during the breeding season in 2018.

1.2 Site Description

The Project Site is located in the townland of Cush approximately 4 km north of Birr, Co. Offaly at approximate ITM coordinates 608237, 709946. The habitats within the Project Site are dominated by conifer plantations of varying age classes (c.327 ha), cutaway bog (c.102 ha) and agricultural grasslands (ca. 327 ha; refer to Appendix A **Figure 1**). The Project Site is not designated for nature conservation.

1.3 Terminology

For this report, "flight line" refers to the line drawn to record avian movement during a vantage point (VP) survey. A single flight line may be used to 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.

1.4 Purpose of this Report

This report outlines the surveys undertaken and methods used. It then summarises the survey data obtained and provides descriptions of the legal and conservation status of the species recorded.

The assessment of impacts resulting from the Project and the development of mitigation measures, if required, are beyond the scope of this report and will be covered in a separate Environmental Impact Assessment (EIA) Report in due course.

---

[1] SLR (2018) *Cloghan Wind Farm and Long Oak Wind Farm Breeding Bird Survey Report 2018*. Prepared for Galetech Energy Services Ltd

2.0 Methods

2.1 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[2], with details provided in **Table 2-1**. Further details are provided in Section 2.0.

Surveys were undertaken by Senior Ecologist Aisling Kinsella (AK) BSc (Hons) MSc, Senior Field Ecologist Faolán Linnane BSc (Hons) MSc, Project Ecologist Darragh Nagle (DN) BSc (Hons), and Graduate Ecologist Hugo Brooks (HB) BSc (Hons).

Details of survey dates and times are provided in Appendix B and a record of weather conditions during surveys is provided in Appendix C.

Table 2-1: Scope of Ornithological Survey Work October 2022 to March 2023

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 three VPs between October 2022 and March 2023.
Feeding distribution surveys	Feeding distribution surveys were carried out on a twice-monthly basis during the period October 2022 to March 2023 to search for swans and/or geese using the fields for foraging within 500 m of the Project Site.
Nocturnal golden plover surveys	Two nocturnal golden plover surveys (one in January and one in March) were carried out during the 2022/23 non-breeding season.

2.2 Desk-Based Review

The desk review collated any available information to date on the breeding and non-breeding bird populations and movements around the Project Site.

The following reports resulting from previous breeding and non-breeding bird surveys were reviewed for any relevant information that could be used to inform the current bird surveys:

- SLR (2018) Cloghan Wind Farm and Long Oak Wind Farm Breeding Bird Survey Report 2018.
- SLR (2020) Cush Wind Farm Breeding Bird Survey Report 2020.
- SLR (2022) Cush Wind Farm Winter Bird Survey Report 2020-2021.
- SLR (2022) Cush Wind Farm Breeding and Winter Bird Survey Report 2021-2022.
- SLR (2022) Cush Wind Farm Breeding Bird Survey Report 2022.

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

The websites of the National Parks and Wildlife Service (NPWS)[3], the UK and Ireland Bird Atlas 2007-2011[4] and the National Biodiversity Data Centre (NBDC)[5] were accessed for information on sites designated for nature conservation and notable bird species in the vicinity of the Project Site.

2.3 Flight Activity Surveys

VP locations, 2 km viewing arcs and viewsheds are shown in Appendix A **Figure 1**.

A total of 108 hours of flight activity surveys were conducted from all VP locations combined during the 2022/23 non-breeding season, as summarised in **Table 2-2**.

In order to avoid possible complications during any subsequent collision risk modelling, VP watches were timed such that surveys were not undertaken simultaneously from both VPs. This avoids double-counting birds and ensures that no disturbance is made to birds within viewsheds from presence of the observer.

VP watches aimed to quantify the flight activity of primary and secondary target species (as defined below) 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 Project Site;
- The relative use by birds of different parts of the Project 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.

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.

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[6]. 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[7]; and
- Other raptors, waders or wildfowl red-listed on the latest Birds of Conservation Concern in Ireland (BoCCI)[8] scheme.

[3] www.npws.ie (Last accessed August 2023)

[4] https://app.bto.org/mapstore/StoreServlet Accessed 29/08/2023

[5] http://maps.biodiversityireland.ie/#/Map Accessed 29/08/2023

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

[7] The relevant SPAs are listed in Section 3.1.

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

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

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

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. 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 and around the Project Site, in accordance with current NS guidance.

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; and*
- Gulls *Larus* sp.

NS guidance states that “it is generally considered the passerine species are not significantly impacted by wind farms”. It goes on to state that “survey of woodland passerines, especially in commercial conifer forest is generally not required”. The only exception is if the desk study identifies that the Project Site is in a key area for a Schedule 1 woodland passerine species. As Schedule 1 refers to UK legislation, it is prudent to assume that passerines red-listed under the latest Birds of Conservation Concern in Ireland (BoCCI) scheme[8] should be considered as equivalent. No such species were returned during the desk-based review or data request. NS guidance also states that “surveys of farmland passerines especially on more intensive arable habitat are generally not required”. Based on the above, while not the targets, any red-listed passerines were recorded as incidental species during other surveys.

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. For the 2022/23 non-breeding season, height bands were determined allowing for the maximum rotor tip height of 200 m and a lowest rotor swept height of 28 m. The relation of the height bands to the latest turbine specification is shown below.

Flight heights were attributed to four distinct height bands for the non-breeding season as follows:

- 1 = <25 m (below the likely rotor swept area);
- 2 = 25 m to 160 m (potentially within the likely rotor swept area, at least in part);
- 3 = 160 m to 200 m (within the likely rotor swept area); and
- 4 = >200 m (above the likely rotor swept area).

Table 2-2: Summary of VP Surveys Undertaken during the Non-Breeding Season 2022/23

Month	VP1 (hours)	VP2 (hours)	VP3 (hours)
October	06:00	06:00	06:00
November	09:00	06:00	06:00
December	03:00	06:00	06:00
January	06:00	03:00	09:00
February	06:00	06:00	03:00
March	06:00	09:00	06:00
Total hrs	**36:00**	**36:00**	**36:00**
VP locations ITM (**Figure 1**)	608735 E 710130 N	605883 N 709097 N	607798 E 711305 N

2.4 Feeding Distribution Surveys

NS guidance recommends that for whooper swan *Cygnus cygnus*, Greenland white-fronted goose *Anser albifrons 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. As there are SPAs for swans and geese located close to the Project Site, feeding distribution surveys were undertaken.

A buffer of 500 m around the Project Site was used for these surveys, which were undertaken by driven transects twice per month, stopping on a regular basis to check all fields for goose and swan feeding activity. The transect route is shown in Appendix A **Figure 18**, survey dates in Appendix B, weather conditions in Appendix C.

2.5 Nocturnal Golden Plover Surveys

Survey transects were identified that were representative of potentially suitable winter habitats (see Gillings et al., 2007)[9] for European golden plover *Pluvialis apricaria* and northern lapwing *Vanellus vanellus* (see **Figure 19**). Transects were focused on pastures and bog habitats.

Surveys were undertaken using a Helion 2 XP50 Pro Thermal Monocular. This enables birds to be readily detected by their body heat at up to c. 350 m range. Where birds were detected, images were recorded as videos.

Each transect was walked twice, once in January 2023 and once in March 2023, after dark using the thermal monocular to detect and identify the presence of target species. Birds were also detected and identified by sound, as appropriate. Nocturnal surveys were conducted by a pair of surveyors on the basis of health and safety.

Two golden plover surveys were completed. Full details of survey dates, times and observers are provided in Appendix B and details of the weather conditions during surveys are provided in Appendix C.

2.6 Survey Limitations

Most 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 16 hours out of the total of 108 during which the visibility was recorded as “moderate”, i.e. 1-3 km. This comprises 14% of the total survey effort but in almost all cases all the relevant 2 km viewing arc was visible. There were intermittent periods of poor visibility during some surveys i.e. less than 1 km, which corresponded to three hours out of 108 (2.7%). However, these conditions were not persistent through the affected surveys and target species were still recorded. Therefore, these conditions are not considered to be significant limitations to the survey data obtained. Details regarding weather conditions during surveys are provided in Appendix C.

[9] Gillings, S., Fuller, R.J. and Sutherland, W.J. (2007). Winter field use and habitat selection by Eurasian Golden Plovers *Pluvialis apricaria* and Northern Lapwings *Vanellus vanellus* on arable farmland. Ibis. 149: 509 – 520.

3.0 Results

3.1 Desk Based Results

3.1.1 Natura 2000 Sites

The Project Site is not within or immediately adjacent to any SPA. However, there are a total of seven SPAs within a 20 km[10] radius with details shown in **Table 3-1**.

The closest SPAs to the Project Site are Dovegrove Callows SPA (Site Code: 004137), River Little Brosna Callows SPA (Site Code: 004086) and All Saints Bog SPA (Site Code: 004103) at distances of 1.5 km, 3.1 km and 3.1 km, respectively. Dovegrove Callows SPA and All Saints Bog SPA are designated for the protection of wintering Greenland white-fronted geese, whereas the River Little Brosna Callows SPA is designated for several wintering gull, wader and wildfowl species.

Table 3-1: SPAs within 20 km of the Project Site and their Qualifying Interests (Species Present During the Non-Breeding Season)

Site Name	Site Code	Distance/Direction from Site Boundary	Species of Special Conservation Interest Relevant to the Non-Breeding Season
Dovegrove Callows SPA	004137	1.5 km southwest	• Greenland white-fronted goose
All Saints Bog SPA	004103	3.1 km west	• Greenland white-fronted goose
River Little Brosna Callows SPA	004086	3.1 km west	• Whooper swan • Eurasian wigeon *Mareca penelope* • Eurasian teal *Anas crecca* • Northern pintail *Anas acuta* • Northern shoveler *Anas clypeata* • European golden plover • Northern lapwing • Black-tailed godwit *Limosa limosa* • Black-headed gull *Chroicocephalus ridibundus* • Greenland white-fronted goose
Middle Shannon Callows SPA	004096	6.6 km northwest	• Whooper swan • Eurasian wigeon • European golden plover • Northern lapwing • Black-tailed godwit • Black-headed gull
Slieve Bloom Mountains SPA	004160	11.7 km east	• Hen harrier *Circus cyaneus*
River Suck Callows SPA	004097	17.3 km northwest	• Whooper swan • Eurasian wigeon • European golden plover • Northern lapwing • Greenland white-fronted goose
Lough Derg (Shannon) SPA	004058	17.5 km southwest	• Great cormorant *Phalacrocorax carbo* • Tufted duck *Aythya fuligula*

[10] A 20 km search radius was used as this represents the maximum core foraging distance used by Qualifying Interest species of SPAs in the UK and Ireland

Site Name	Site Code	Distance/Direction from Site Boundary	Species of Special Conservation Interest Relevant to the Non-Breeding Season
			• Common goldeneye *Bucephala clangula*

3.1.2 Other Nature Conservation Sites

The Project Site is not within or immediately adjacent to any Natural Heritage Area (NHA) or proposed NHA (pNHA). However, there are a total of eight NHAs and 52 pNHAs within a 20 km radius, with details shown in **Table 3-2**.

River Little Brosna Callows NHA is located 9.4 km west of the Project Site and is the only NHA within a 20 km radius which is designated for its bird populations. The site has internationally important populations of Greenland white-fronted goose and black-tailed godwit, and a further seven species have populations of national importance: whooper swan, Eurasian wigeon, Eurasian teal, northern pintail, northern shoveler, European golden plover and lapwing[11]. All remaining NHAs within a 20 km radius are designated for peatlands.

The Project Site is not within or immediately adjacent to any Ramsar site. The Slieve Bloom Mountains Ramsar site is located 11.7 km east of the Project Site and is contained within the boundaries of the Slieve Bloom Mountains SPA. There are no other Ramsar sites within a 20 km radius of the Project Site.

[11] NPWS (2014) Site Synopsis: River Little Brosna Callows SPA [000564] National Parks and Wildlife Service, Department of Housing, Local Government and Heritage.

Table 3-2: NHAs and pNHAs within 20 km of the Project Site and their Qualifying Interests (Sites Designated for Ornithological Qualifying Interests Only)[12]

Site Name	Site Code	Distance/Direction from Site Boundary	Qualifying Interests
Woodville Woods pNHA	000927	0.35 km south	Common snipe *Gallinago gallinago*
River Little Brosna Callows NHA	000564	9.4 km west	Peatlands [4] Birds [12]
Lough Nahinch (Tipperary) pNHA	000936	15.5 km southwest	Common redshank *Tringa totanus* Common snipe Water rail *Rallus arquaticus*
Pallas Lough pNHA		18.1 km northeast	Mallard *Anas platyrhynchos* Eurasian teal Eurasian wigeon Western marsh harrier *Circus aeruginosus*

3.1.3 Species Records

The NBDC database was searched for records of bird species within the 10 km grid squares which overlap the Project Site (N00 and N01). All bird species are protected under the Wildlife Acts 1976 – 2018 but for the purposes of this report, only records of species that are Red or Amber-listed in Birds of Conservation Concern in Ireland or listed on Annex 1 of the Birds Directive are included in the results. Only records within the last 10 years are considered within this report as older records are unlikely to be relevant. Details of the results are shown in **Table 3-3.**

Table 3-3: Species recorded within the 10 km grid squares N00 and N01 (Species Present During the Non-Breeding Season)

Species name	Season	Grid square	Last Record Year	Designation
Barn owl *Tyto alba*	Breeding	N01	2019	BoCCI4 Red
Black-headed gull	Breeding and wintering	N01	2022	BoCCI4 Amber
Black-tailed godwit	Wintering	N00	2019	BoCCI4 Red
Common gull *Larus canus*	Breeding and wintering	N00	2019	BoCCI4 Amber
Common kestrel *Falco tinnunculus*	Breeding	N00, N01	2023	BoCCI4 Red
Common kingfisher *Alcedo atthis*	Breeding	N00, N01	2022	Annex 1, BoCCI4 Amber

[12] Only pNHAs that do not overlap with SPAs are shown.

Species name	Season	Grid square	Last Record Year	Designation
Common linnet *Linaria cannabina*	Breeding	N00, N01	2019	BoCCI4 Amber
Common pochard *Aythya ferrina*	Breeding and wintering	N00, N01	2019	BoCCI4 Red
Common redshank	Breeding and wintering	N00	2019	BoCCI4 Red
Common snipe	Breeding and wintering	N01	2022	BoCCI4 Red
Common starling *Sturnus vulgaris*	Breeding	N00, N01	2019	BoCCI4 Amber
Dunlin *Calidris alpina*	Breeding and wintering	N00, N01	2019	BoCCI4 Red
Eurasian curlew *Numenius arquata*	Breeding and wintering	N01	2019	BoCCI4 Red
Eurasian skylark *Alauda arvensis*	Breeding	N01	2019	BoCCI4 Amber
Eurasian teal	Breeding and wintering	N00, N01	2019	BoCCI4 Amber
Eurasian wigeon	Breeding and wintering	N00, N01	2019	BoCCI4 Amber
European golden plover	Breeding and wintering	N01	2019	Annex 1, BoCCI4 Red
Gadwall *Mareca strepera*	Breeding and wintering	N00, N01	2019	BoCCI4 Amber
Greenland white-fronted goose	Wintering	N00, N01	2019	Annex 1, BoCCI4 Amber
Greylag goose *Anser anser*	Wintering	N00, N01	2019	BoCCI4 Amber
Hen harrier	Breeding	N01	2014	BoCCI4 Amber
House sparrow *Passer domesticus*	Breeding	N00, N01	2022	BoCCI4 Amber
Little egret *Egretta garzetta*	Breeding and wintering	N00	2020	Annex 1, BoCCI4 Green
Mallard	Breeding and wintering	N00, N01	2023	BoCCI4 Amber
Meadow pipit *Anthus pratensis*	Breeding	N00, N01	2019	BoCCI4 Red
Merlin *Falco columbarius*	Breeding	N01	2017	Annex 1, BoCCI4 Amber
Mute swan *Cygnus olor*	Breeding and wintering	N00, N01	2022	BoCCI4 Amber
Northern lapwing	Breeding and wintering	N00, N01	2022	BoCCI4 Red

Species name	Season	Grid square	Last Record Year	Designation
Northern pintail	Wintering	N00, N01	2019	BoCCI4 Amber
Northern shoveler	Breeding and wintering	N00, N01	2019	BoCCI4 Red
Peregrine falcon *Falco peregrinus*	Breeding	N00, N01	2023	Annex 1, BoCCI4 Green
Tufted duck	Breeding and wintering	N01	2018	BoCCI4 Amber
Whooper swan	Wintering	N00, N01	2021	Annex 1, BoCCI4 Amber
Willow warbler *Phylloscopus trochilus*	Breeding	N00, N01	2019	BoCCI4 Amber
Yellowhammer *Emberiza citrinella*	Breeding	N00, N01	2021	BoCCI4 Red
Key	Season – indicates which season was assessed for each species under the Birds of Conservation Concern in Ireland[13]; 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 status category.			

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

3.2 Flight Activity Surveys

Flight activity recorded from all VPs combined by primary target species is summarised in **Table 3-4**. Primary target species flights from both VPs are shown in Appendix A Figures **2** to **17**. Flight activity data are provided in more detail in Appendix D with full data retained in GIS and excel format for sub-sequent collision risk modelling.

3.2.1 Primary Target Species

A total of 159 flight lines by 16 primary target species were recorded between October 2022 and March 2023. Common kestrel and northern lapwing were the most frequently recorded primary target species, with a total of 38 flight lines recorded for each species. European golden plover was the most numerous species, with a peak count of 3,500 flights recorded in a single flight line.

Table 3-4: Number of Primary Target Species Flights from All VPs Combined, October 2022 to March 2023

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			
Black-headed gull	0	0	2	1	0	2	5	480	37
Common kestrel	10	11	5	6	2	4	38	2,250	39
Common snipe	3	0	5	2	0	1	11	360	12
Eurasian teal	0	0	0	1	0	0	1	420	42
Eurasian wigeon	1	0	0	0	0	0	1	15	13
European golden plover	14	5	2	0	1	1	23	3,375	4,661
Great cormorant	0	2	4	3	2	0	11	585	11
Great white egret *Ardea alba*	1	0	0	0	0	0	1	0	1
Greylag goose	0	0	0	1	0	0	1	135	3
Hen harrier	2	0	1	5	0	0	8	255	8
Little egret	0	2	1	0	0	0	3	345	5
Mallard	2	1	0	1	0	1	5	240	13
Merlin	1	1	2	0	0	0	4	45	4
Northern lapwing	0	5	18	0	0	15	38	2,205	696
Peregrine falcon	0	2	3	0	0	0	5	60	5
Whooper swan	1	1	1	1	0	0	4	390	20
Total	**35**	**30**	**44**	**21**	**5**	**24**	**159**	**23,625**	**5,570**
* precautionary risk height assumed to be between 28 – 200 m									

A summary description of flight activity by each species is presented below.

3.2.1.1 Black-Headed Gull

A total of five black-headed gull flight lines were recorded from December 2022 to March 2023, with a cumulative total of 37 flights. All flight lines were recorded at VP1, which overlooks agricultural fields and an area of cutover bog. A total of four flight lines (80%) were recorded within potential collision risk heights. Most flight lines consisted of a small number of birds, but one flight line in January consisted of 23 flights. Flight line durations varied with a maximum duration of 196 seconds.

3.2.1.2 Common Kestrel

A total of 38 common kestrel flight lines were recorded during the flight activity surveys, with a cumulative total of 39 flights. The highest number of flight lines occurred in November 2022. A total of 21 flight lines (55%) were recorded within potential collision risk heights. Flight durations varied with a maximum duration of 330 seconds.

3.2.1.3 Common Snipe

A total of 11 common snipe flight lines were recorded during the flight activity surveys, with a cumulative total of 12 flights. A total of nine flight lines (81%) were recorded within potential collision risk heights. Flight durations varied with a maximum duration of 72 seconds.

3.2.1.4 Eurasian Teal

One flight line consisting of 42 flights was recorded at VP1 in January 2023 flying over the agricultural fields within the Site. The flight line was within potential collision risk heights and lasted 420 seconds.

3.2.1.5 Eurasian Wigeon

One flight line consisting of 13 flights was recorded at VP1 in October 2022 flying over the cutover bog within the Site. The flight line was within potential collision risk heights for 15 seconds out of a total of 31 seconds.

3.2.1.6 European Golden Plover

A total of 23 European golden plover flight lines were recorded during the flight activity surveys, with a cumulative total of 4,658 flights. The highest number of flight lines occurred in October 2022, with numbers declining in later months. Most flock sizes ranged from four to 250 birds, but one flock in November consisted of 3,500 birds. A total of 21 flight lines (91%) were recorded within potential collision risk heights. Flight durations varied with a maximum duration of 510 seconds.

3.2.1.7 Hen Harrier

A total of eight hen harrier flight lines were recorded from October 2022 to January 2023, with all observations consisting of a single flight. The highest number of flight lines occurred in January 2023, and most flights were recorded at VP3, which overlooks an area of cutover bog. A total of six flights (75%) were recorded within potential collision risk heights. Flight durations varied with a maximum duration of 195 seconds.

3.2.1.8 Great Cormorant

A total of 11 great cormorant flight lines were recorded during the flight activity surveys, with all observations consisting of a single flight. A total of 10 flight lines (91%) were recorded within potential collision risk heights. Flight durations varied with a maximum duration of 137 seconds. Most flight lines were recorded at VP2, which overlooks Boolinarig River.

3.2.1.9 Great White Egret

A single great white egret was recorded at VP3 in October 2022 flying south over an area of cutover bog within the Project Site. The flight line was below potential collision risk heights and lasted for 15 seconds. No other observations of this species were recorded during the 2022/23 non-breeding season.

3.2.1.10 Greylag Goose

One flight line consisting of three flights was recorded in January 2023 from VP2. The birds were flying within potential collision risk heights towards an area of cutover bog in the east of the Project Site. No other observations of this species were recorded during the 2022/23 non-breeding season.

3.2.1.11 Little Egret

A total of three little egret flight lines were recorded in November and December 2022 from VP2. Two flight lines consisted of two flights and one flightline consisted of a single flight. All flight lines were recorded within potential collision risk heights.

3.2.1.12 Mallard

A total of five mallard flightlines were recorded during the flight activity surveys, with a cumulative total of 13 flights. Three flight lines (60%) were recorded within potential collision risk heights.

3.2.1.13 Merlin

A total of four merlin flight lines were recorded during the flight activity surveys from October to December 2022, with all flight lines consisting of a single flight. All flight lines were recorded at VP3. One flight line (25%) was recorded within potential collision risk heights.

3.2.1.14 Northern Lapwing

A total of 38 northern lapwing flight lines were recorded during the flight activity surveys in November 2022, December 2022 and March 2023, with a cumulative total of 696 flights. Most flight lines consisted of a small number of birds, but there were a few larger flocks recorded (up to 250 flights per flight line). A total of 26 flight lines (68%) were recorded within potential collision risk heights.

3.2.1.15 Peregrine Falcon

A total of five peregrine falcon flight lines were recorded in November and December 2022, with all observations consisting of a single flight. Four flight lines were recorded from VP1 and one was recorded from VP3. One flight line (20%) was recorded within potential collision risk heights at VP1.

3.2.1.16 Whooper Swan

A total of four whooper swan flight lines were recorded during the flight activity surveys from October 2022 to January 2023, with a cumulative total of 20 flights. Three flight lines (75%) were recorded within potential collision risk heights. Flight durations varied with a maximum duration of 205 seconds.

3.2.2 Secondary Target Species

Secondary species activity at the Project Site is summarised in **Table 3-5**. There were four secondary species recorded throughout the season. Common buzzard was the most frequently recorded secondary species (in 63 five-minute periods out of a possible 1,296). Northern raven was the most numerous species, with a peak count of seven birds recorded in one five-minute period.

Table 3-5: Secondary Species Activity Summary for VP1 and VP2 Combined – October 2022 to March 2023

Species	Number of 5 min periods recorded	Peak count of birds recorded in any 5 min period	Comments
Common buzzard	63	3	Activity in all months, within the Project Site, survey buffer and beyond.
Grey heron	21	2	Activity in all months except February, within the Project Site, survey buffer and beyond.
Northern raven	24	7	Activity in all months, within the Project Site, survey buffer and beyond.
Eurasian sparrowhawk	10	2	Activity in all months except February, within the Project Site, survey buffer and beyond.

3.3 Feeding Distribution Surveys

The feeding distribution surveys did not record any aggregations of swans or geese.

3.3.1 Incidental Records of Other Species

During the survey visits, the following incidental records were made of other species of conservation concern:

- Raptors: buzzard, kestrel, merlin, peregrine falcon and sparrowhawk;
- Waders: common snipe and northern lapwing; and
- Wildfowl: grey heron

3.4 Nocturnal Golden Plover Surveys

No European golden plover activity was recorded during surveys.

3.4.1 Incidental Records of Other Species

Incidental observations of common snipe, Eurasian curlew, northern lapwing and hen harrier were recorded during one survey in March 2023.

4.0 Summary and Conclusions

Flight activity surveys (VPs), feeding distribution surveys and nocturnal golden plover surveys were carried out at the Project Site during the non-breeding season in 2022/23.

The following primary target species were recorded during the non-breeding season flight activity surveys:

- Black-headed gull;
- Common snipe
- Common kestrel;
- Great cormorant;
- Eurasian teal;
- Eurasian wigeon;
- European golden plover;
- Great white egret;
- Greylag goose;
- Hen harrier;
- Little egret;
- Mallard;
- Merlin;
- Northern lapwing;
- Peregrine falcon; and
- Whooper swan

Common kestrel and northern lapwing were the most frequently recorded species, with a total of 38 flight lines recorded for each species. European golden plover was the most numerous species, with a peak count of 3,500 being recorded in a single flight line.

Four secondary target species were recorded during the non-breeding season: common buzzard, grey heron, northern raven and Eurasian sparrowhawk.

No aggregations of swans or geese were recorded during the feeding distribution surveys. No golden plover activity was recorded during the nocturnal golden plover surveys.

Incidental records made of species of conservation concern during taxon-specific surveys included the following:

- Raptors: buzzard, hen harrier, kestrel, merlin, peregrine falcon, and sparrowhawk;
- Waders: common snipe, Eurasian curlew and northern lapwing; and
- Wildfowl: grey heron

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 ornithological surveys mentioned above. Note that all bird species in Ireland 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 and Conservation status in Ireland
Primary	Black-headed gull (BH)	BoCCI4 Amber
	Common kestrel (K.)	BoCCI4 Red
	Common snipe (SN)	BoCCI4 Red
	Eurasian teal (T.)	BoCCI4 Amber
	Eurasian wigeon (WN)	BoCCI4 Amber
	European golden plover (GP)	Annex 1, BoCCI4 Red
	Great cormorant (CA)	BoCCI4 Amber
	Great white egret (HW)	Annex 1, not assessed under BoCCI4
	Greylag goose (GJ)	BoCCI4 Amber
	Hen harrier (HH)	Annex 1, BoCCI4 Amber
	Little egret (ET)	Annex 1, BoCCI4 Green
	Mallard (MA)	BoCCI4 Amber
	Merlin (ML)	Annex 1, BoCCI4 Amber
	Northern lapwing (L.)	BoCCI4 Red
	Peregrine falcon (PE)	Annex 1, BoCCI4 Green
	Whooper swan (WS)	Annex 1, BoCCI4 Amber
Secondary	Common buzzard (BZ)	BoCCI4 Green
	Grey heron (H.)	BoCCI4 Green

Primary or Secondary Target	Species (BTO code)	Legal and Conservation status in Ireland
	Northern raven (RN)	BoCCI4 Green
	Eurasian sparrowhawk (SH)	BoCCI4 Green
Incidentals	Eurasian curlew (CU)	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[8] status category.

Appendix A Figures

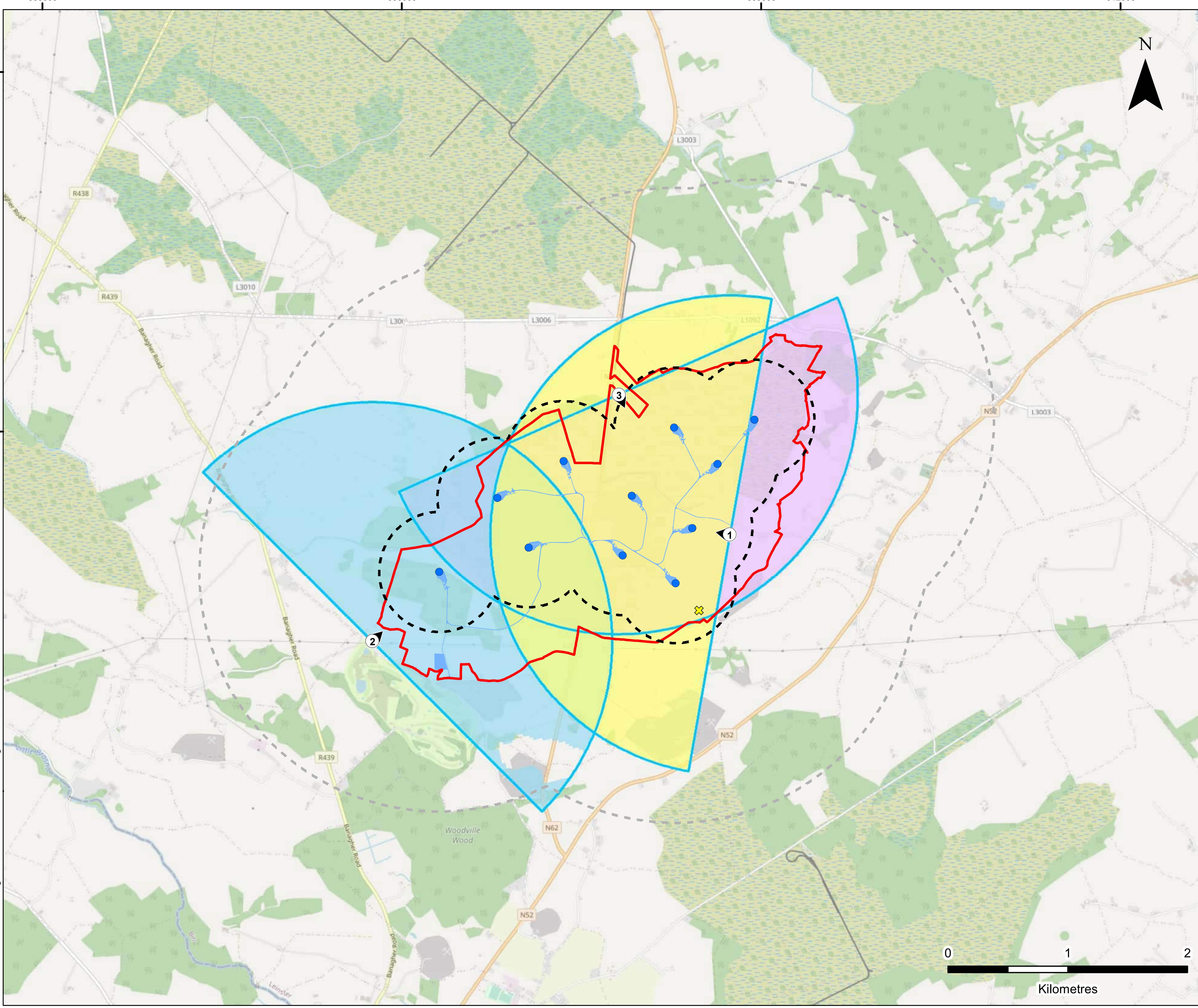
Bird Survey Report Non-Breeding 2022/23

Cush Wind Farm

Galetech Energy Developments Ltd

SLR Project No.: 501.V64760.00001

5 September 2023



NOTES

1.The ZTV is calculated with a surface offset of 28m & 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

- Site Boundary
- Proposed Turbine Location 500m Buffer
- Proposed Turbine Location 2 km Buffer
- Proposed Turbine Location
- Proposed Met Mast
- Vantage Point (VP) Location
- Proposed Site Infrastructure
- Vantage Point 2 km Viewing Arc
- Theoretical Visibility from VP1
- Theoretical Visibility from VP2
- Theoretical Visibility from VP3

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CUSH WIND FARM

WINTER BIRD SURVEYS

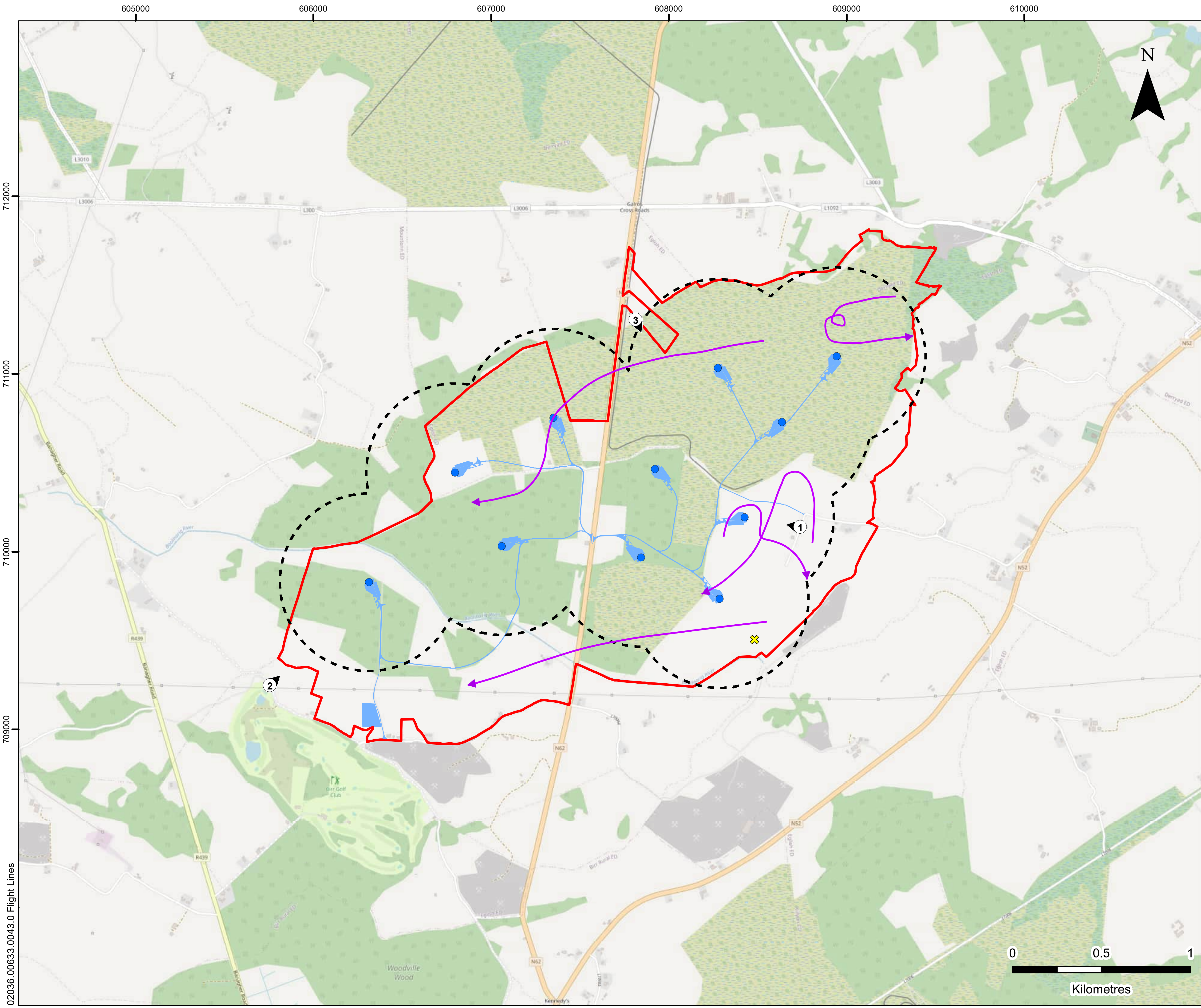
VANTAGEPOINTS

FIGURE 1

Scale 1:30,000 @ A3

Date SEPTEMBER 2023

02036.00633.0042.0 Vantage Point Locations and Viewing Arcs



LEGEND

- Site Boundary
- Proposed Turbine Location 500m Buffer
- Proposed Turbine Location
- Proposed Met Mast
- Vantage Point (VP) Location
- Proposed Site Infrastructure

Flight Lines

- Black-headed Gull

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WINTER BIRD SURVEYS

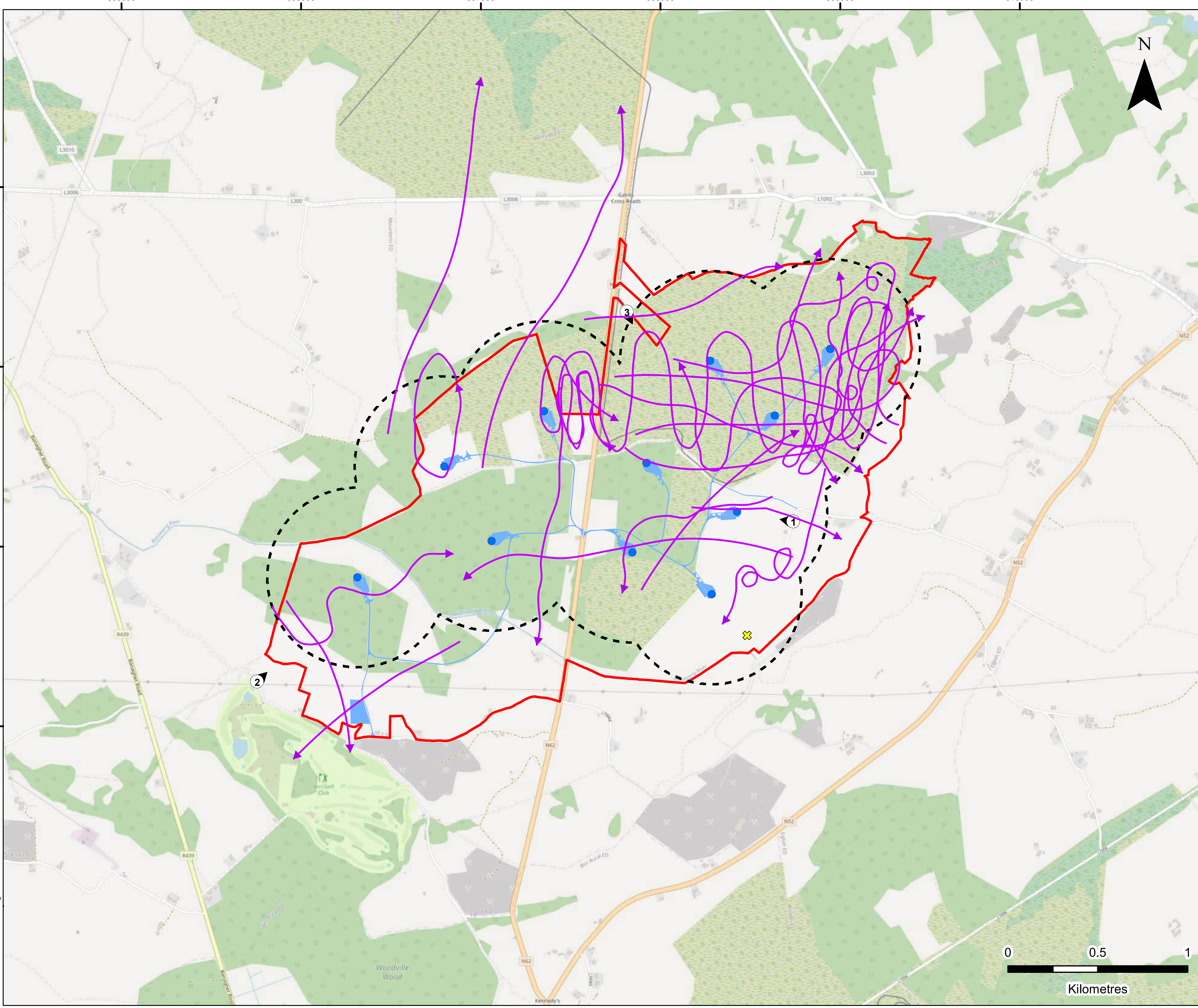
FLIGHT LINES: BLACK-HEADED GULL

FIGURE 2

Scale 1:20,000 @ A3

Date SEPTEMBER 2023

02036.00633.0043.0 Flight Lines



LEGEND

- Site Boundary
- Proposed Turbine Location 500m Buffer
- Proposed Turbine Location
- Proposed Met Mast
- Vantage Point (VP) Location
- Proposed Site Infrastructure

Flight Lines

- Golden Plover

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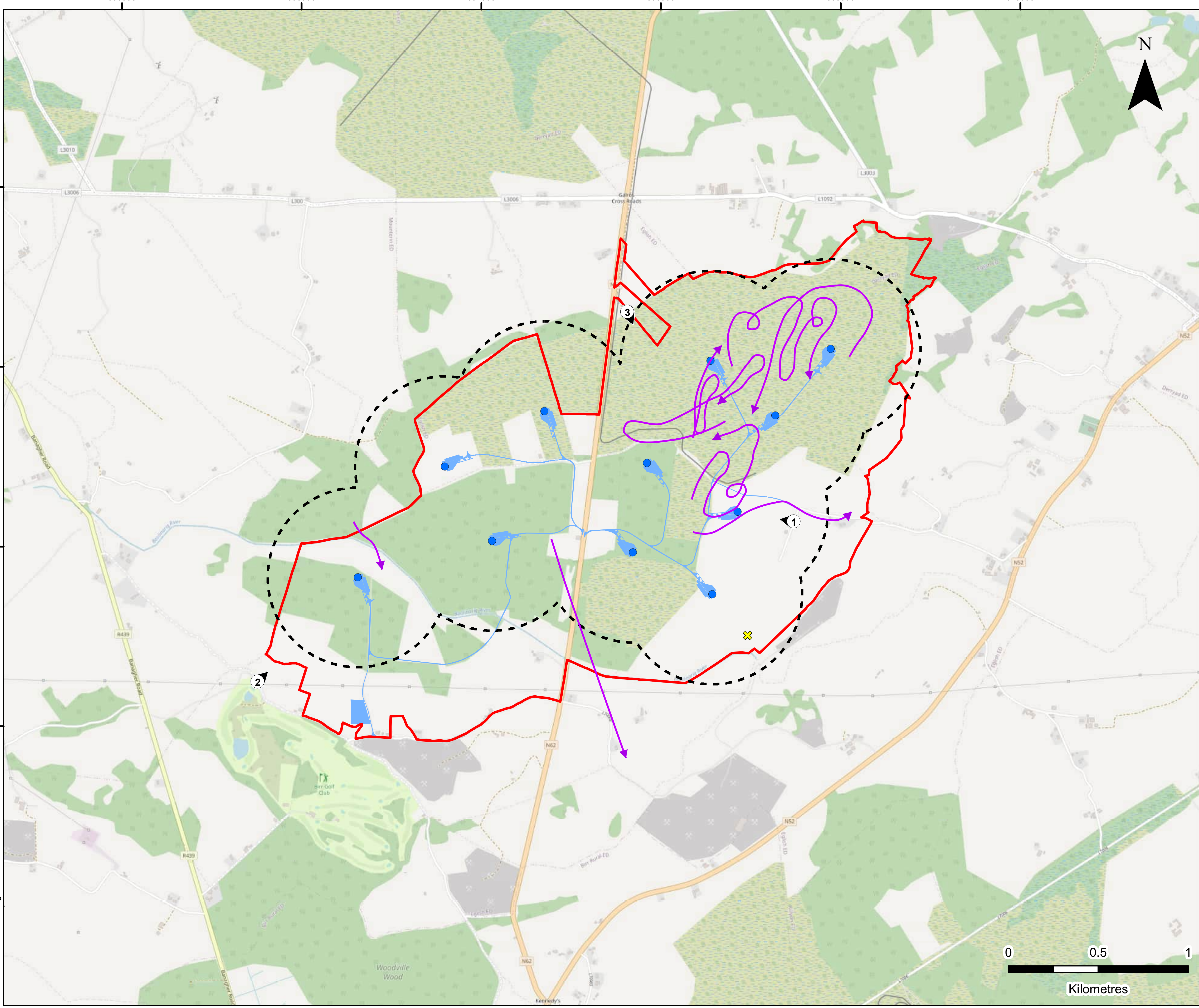
WINTER BIRD SURVEYS

FLIGHT LINES: GOLDEN PLOVER

FIGURE 3

Scale	Date
1:20,000 @ A3	SEPTEMBER 2023

02036.00633.0043.0 Flight Lines



02036.00633.0043.0 Flight Lines

LEGEND

- Site Boundary
- Proposed Turbine Location 500m Buffer
- Proposed Turbine Location
- Proposed Met Mast
- Vantage Point (VP) Location
- Proposed Site Infrastructure

Flight Lines

- Hen Harrier

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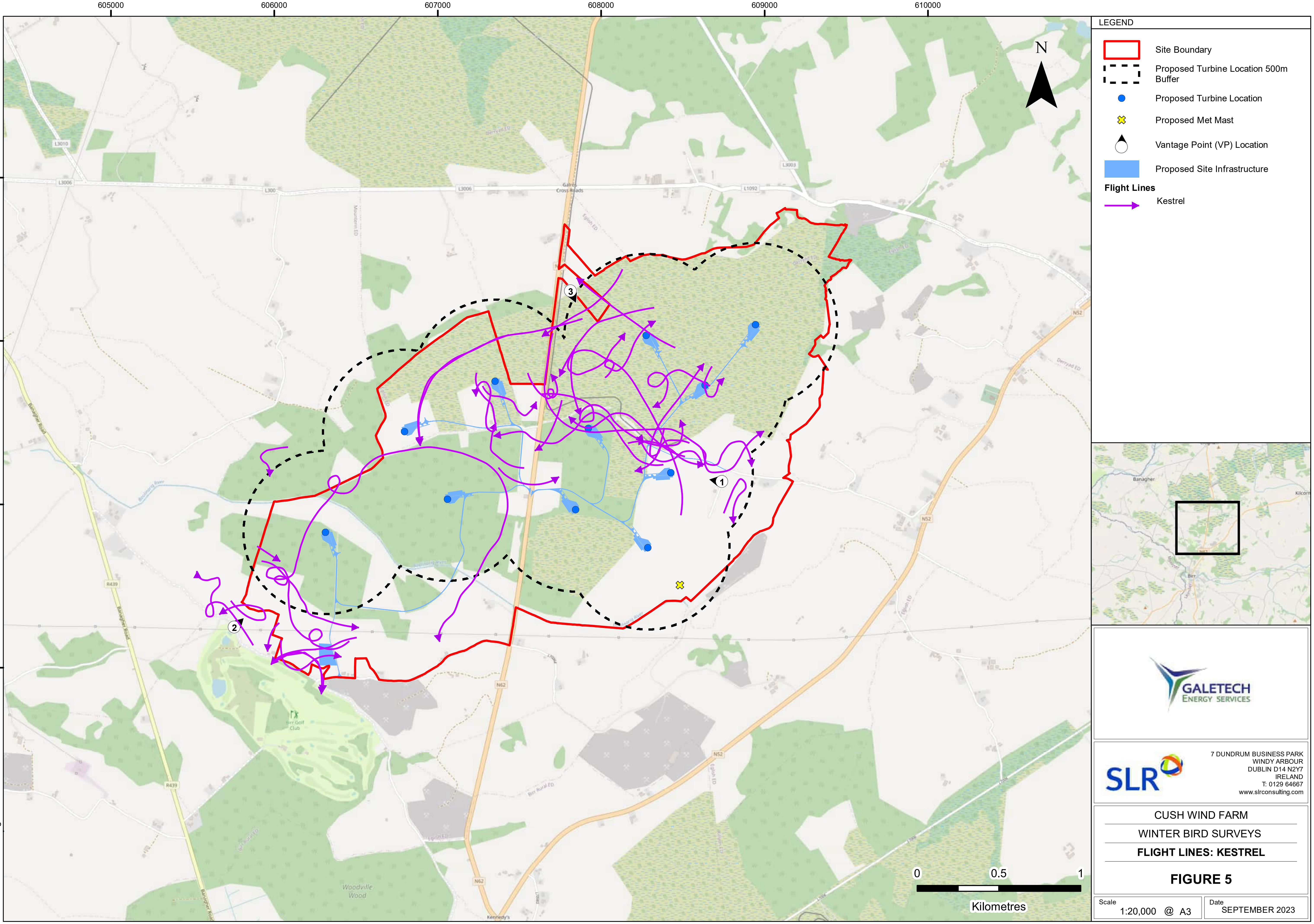
WINTER BIRD SURVEYS

FLIGHT LINES: HEN HARRIER

FIGURE 4

Scale	Date
1:20,000 @ A3	SEPTEMBER 2023



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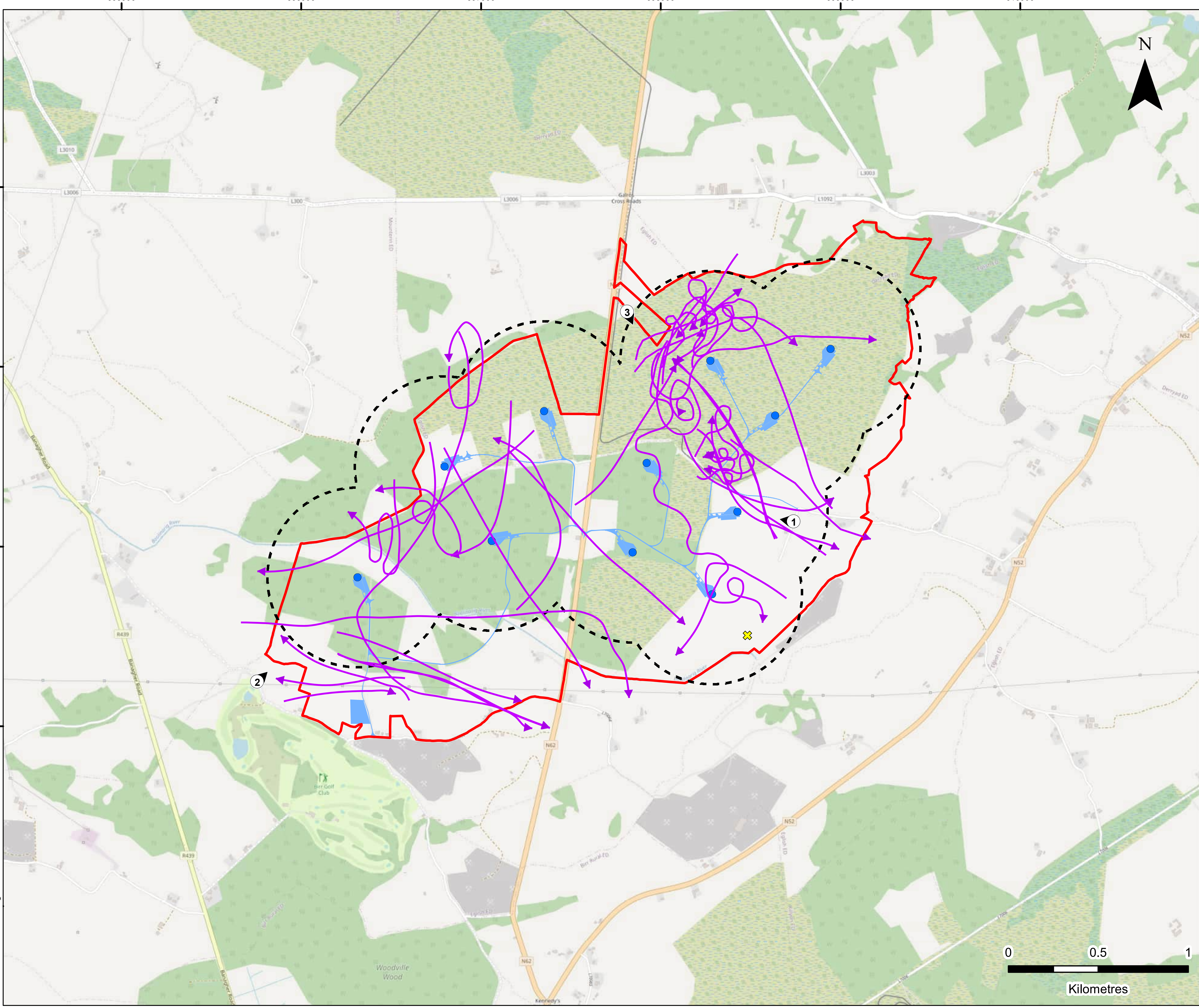
WINTER BIRD SURVEYS

FLIGHT LINES: KESTREL

FIGURE 5

Scale 1:20,000 @ A3

Date SEPTEMBER 2023



LEGEND

- Site Boundary
- Proposed Turbine Location 500m Buffer
- Proposed Turbine Location
- Proposed Met Mast
- Vantage Point (VP) Location
- Proposed Site Infrastructure

Flight Lines

- Lapwing

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WINTER BIRD SURVEYS

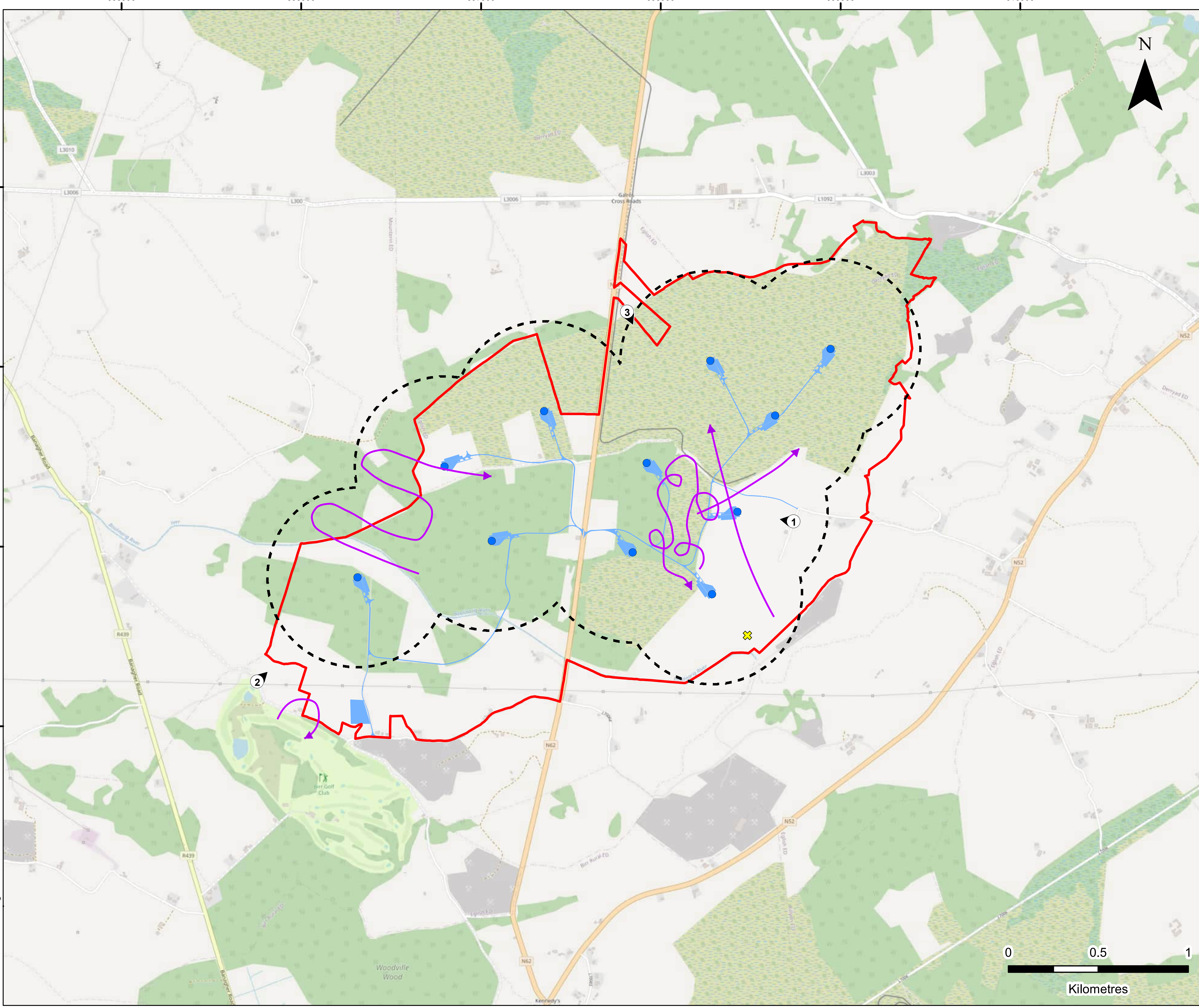
FLIGHT LINES: LAPWING

FIGURE 6

Scale 1:20,000 @ A3

Date SEPTEMBER 2023

02036.00633.0043.0 Flight Lines



LEGEND

- Site Boundary
- Proposed Turbine Location 500m Buffer
- Proposed Turbine Location
- Proposed Met Mast
- Vantage Point (VP) Location
- Proposed Site Infrastructure

Flight Line

- Mallard

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WINTER BIRD SURVEYS

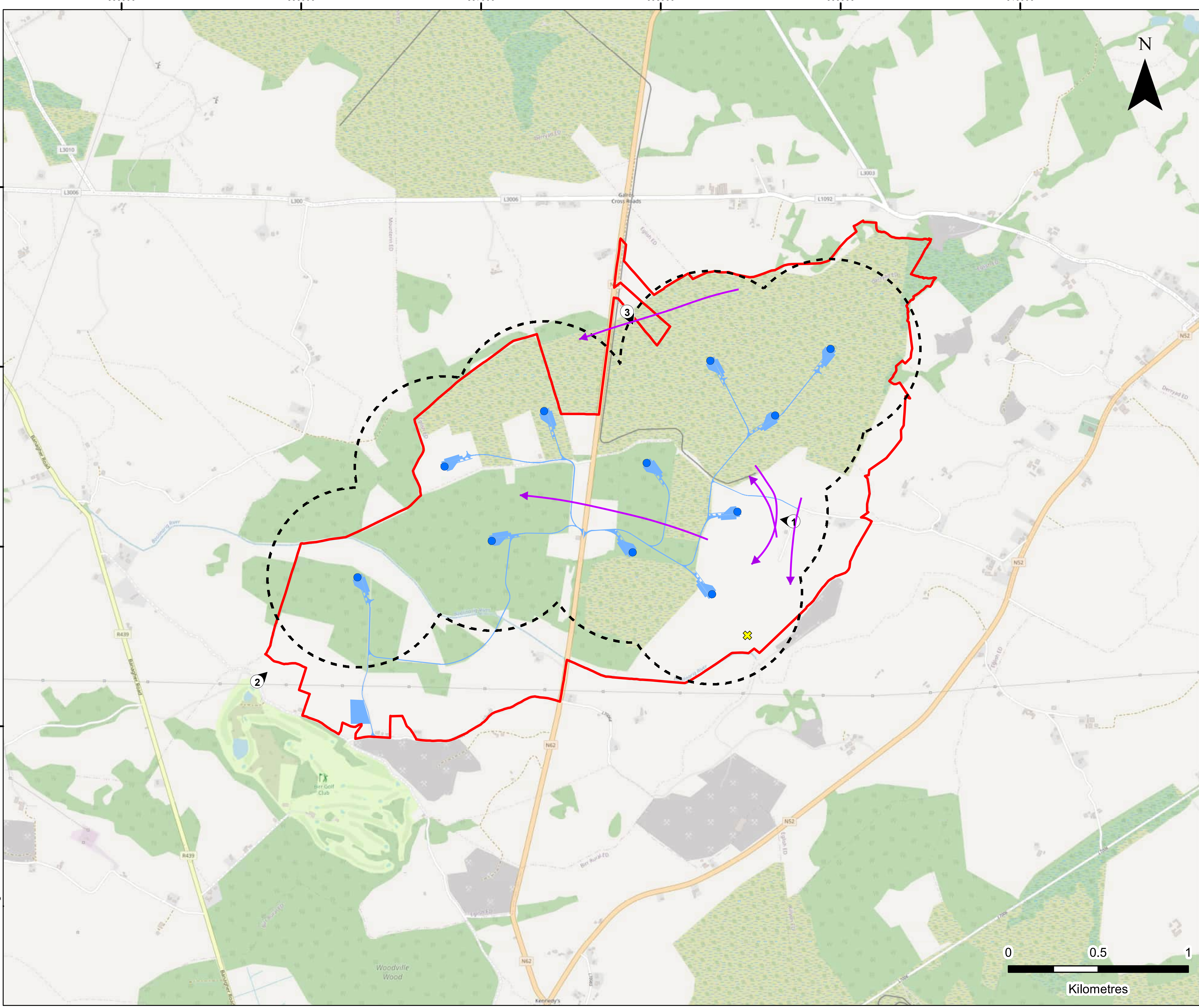
FLIGHT LINES: MALLARD

FIGURE 7

Scale 1:20,000 @ A3

Date SEPTEMBER 2023

02036.00633.0043.0 Flight Lines



02036.00633.0043.0 Flight Lines

LEGEND

- Site Boundary
- Proposed Turbine Location 500m Buffer
- Proposed Turbine Location
- Proposed Met Mast
- Vantage Point (VP) Location
- Proposed Site Infrastructure

Flight Lines

- Peregrine

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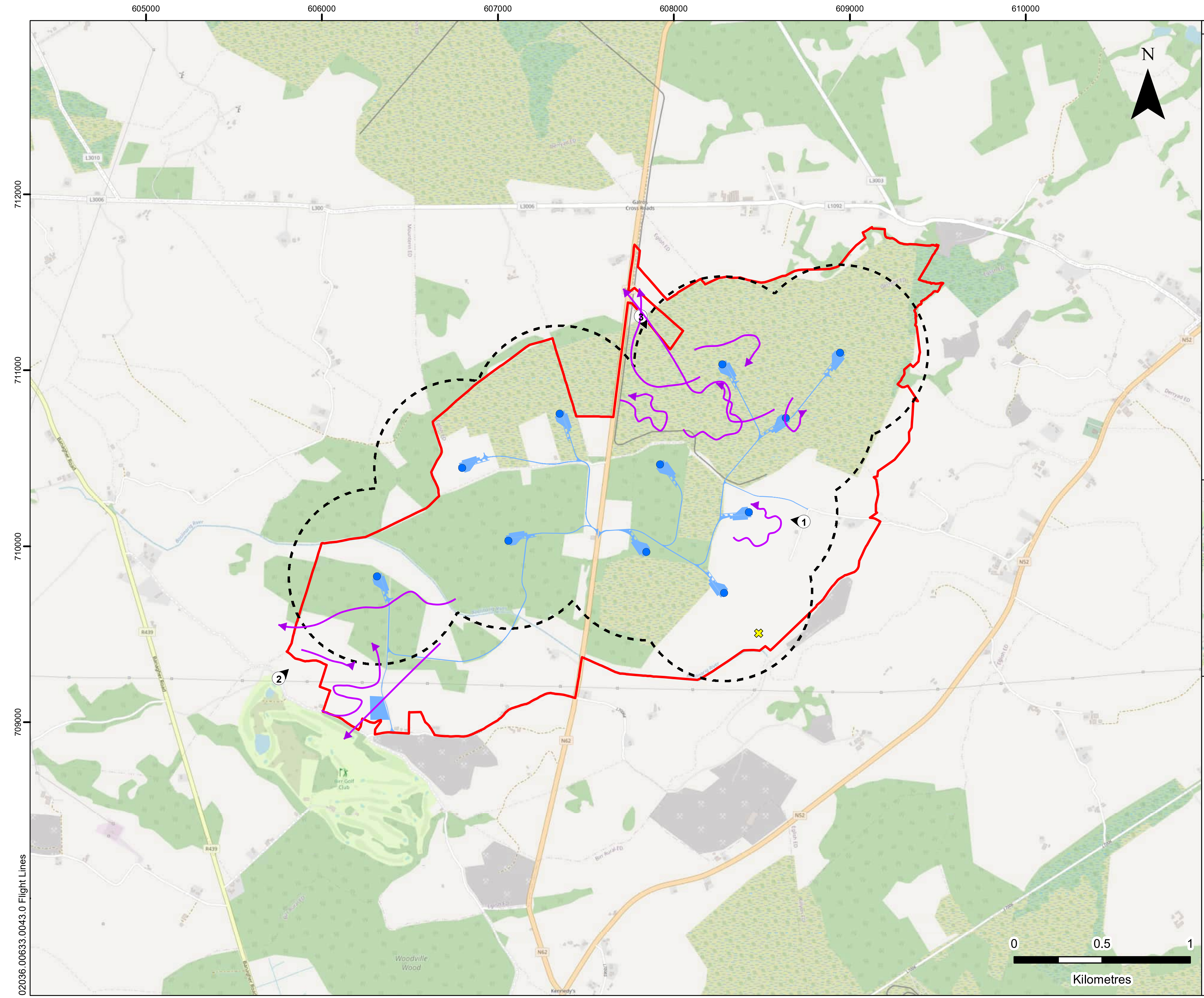
WINTER BIRD SURVEYS

FLIGHT LINES: PEREGRINE

FIGURE 8

Scale	Date
1:20,000 @ A3	SEPTEMBER 2023



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CUSH WIND FARM

WINTER BIRD SURVEYS

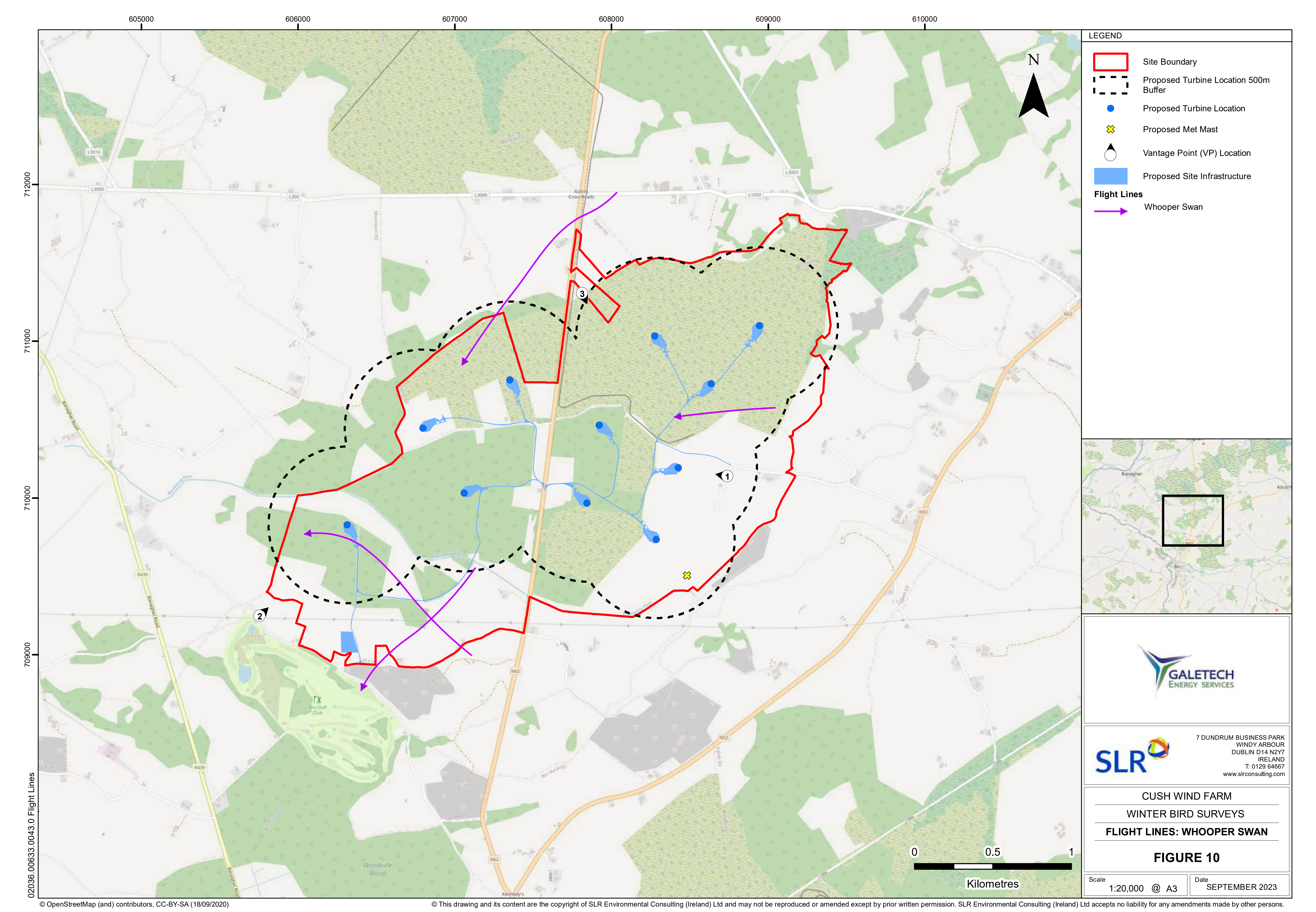
FLIGHT LINES: SNIPE

FIGURE 9

Scale 1:20,000 @ A3

Date SEPTEMBER 2023

02036.00633.0043.0 Flight Lines


LEGEND
Site Boundary
Proposed Turbine Location 500m Buffer
Proposed Turbine Location
Proposed Met Mast
Vantage Point (VP) Location
Proposed Site Infrastructure
Flight Lines
Whooper Swan
N
605000
606000
607000
608000
609000
610000
712000
711000
710000
709000
0
0.5
1
Kilometres
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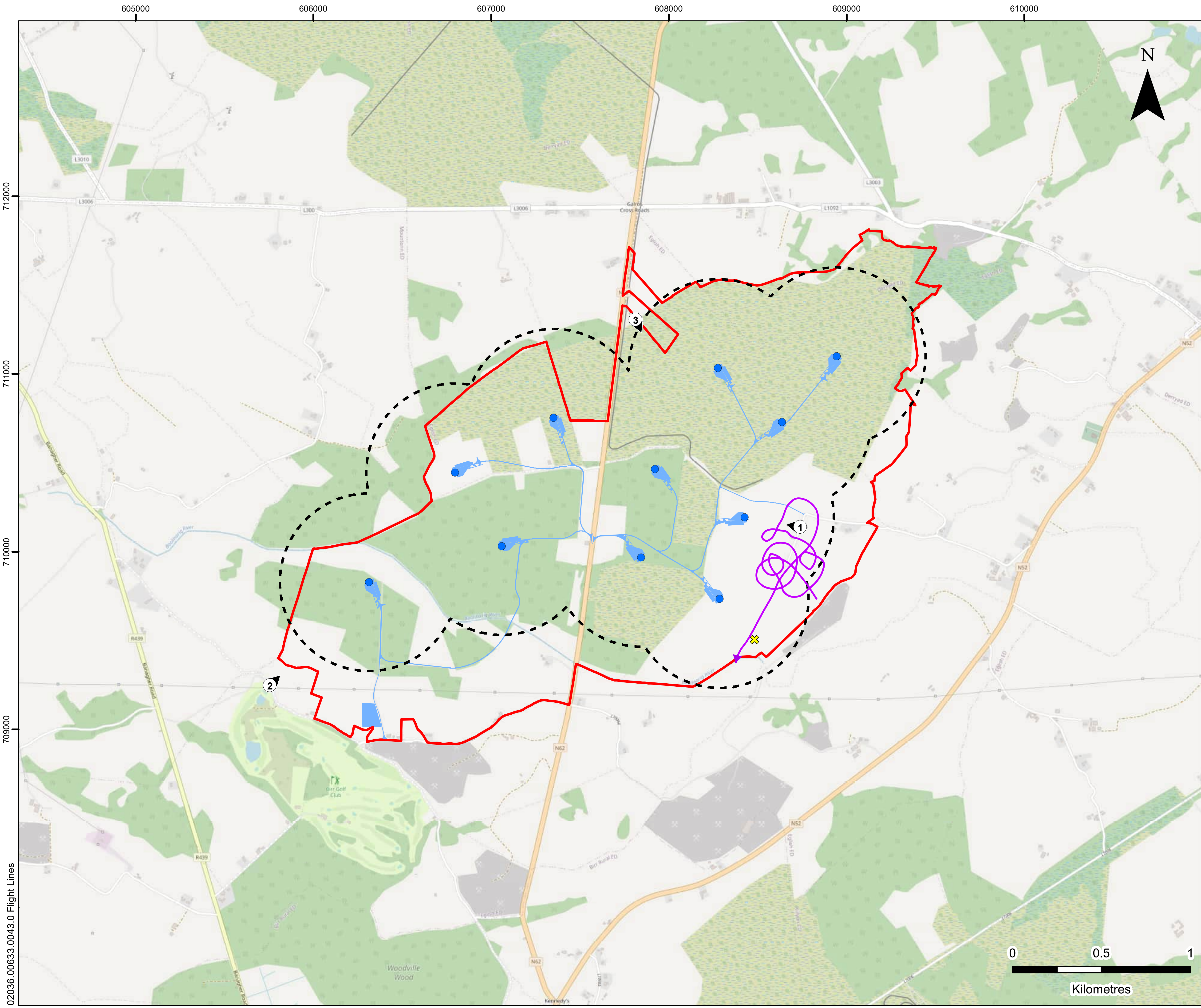
WINTER BIRD SURVEYS
FLIGHT LINES: WHOOPER SWAN
FIGURE 10
Scale 1:20,000 @ A3
Date SEPTEMBER 2023
02036.00633.0043.0 Flight Lines



LEGEND

- Site Boundary
- Proposed Turbine Location 500m Buffer
- Proposed Turbine Location
- Proposed Met Mast
- Vantage Point (VP) Location
- Proposed Site Infrastructure

Flight Lines

- Teal

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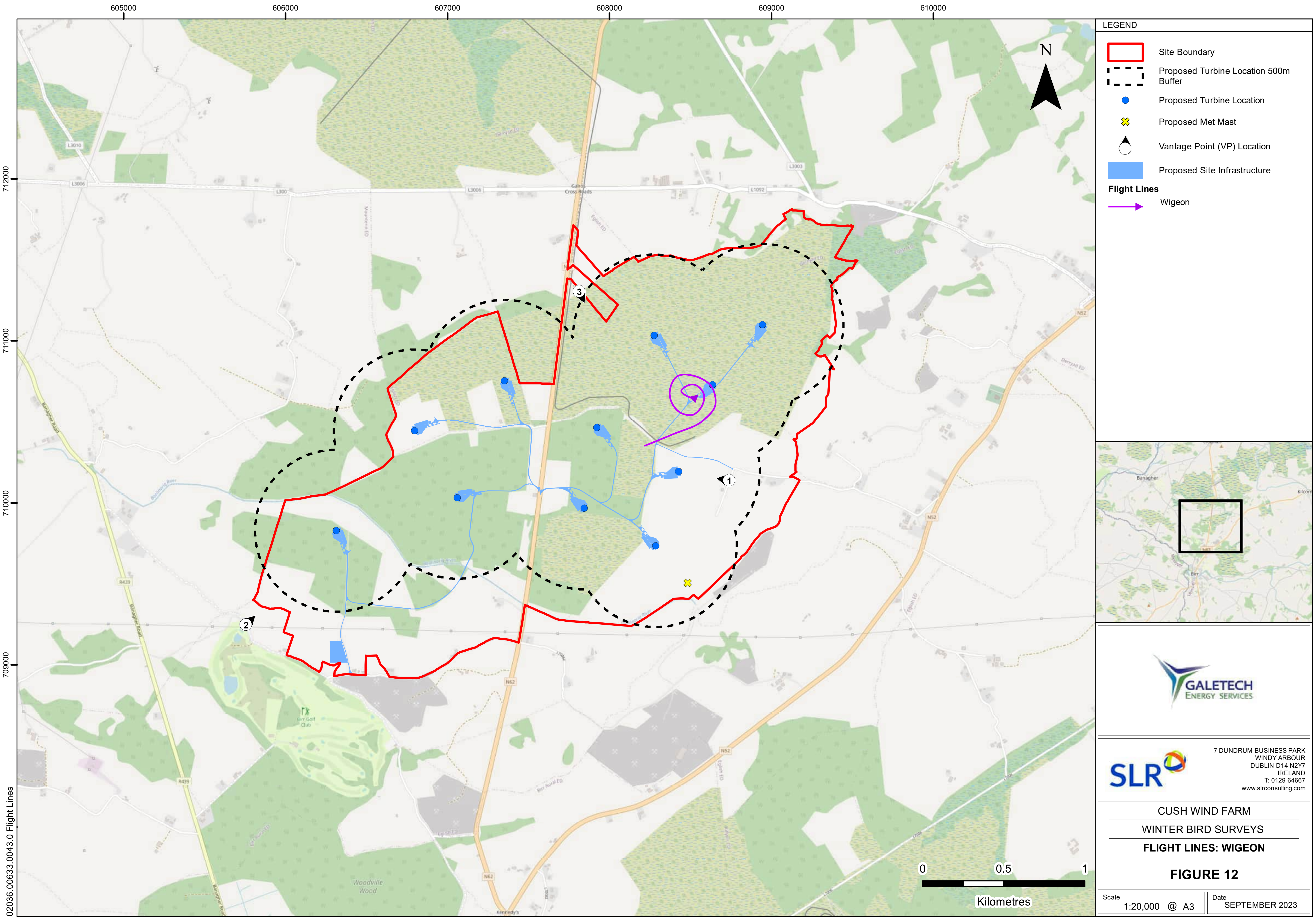
WINTER BIRD SURVEYS

FLIGHT LINES: TEAL

FIGURE 11

Scale	Date
1:20,000 @ A3	SEPTEMBER 2023

02036.00633.0043.0 Flight Lines



605000
606000
607000
608000
609000
610000
712000
711000
710000
709000
N
LEGEND
Site Boundary
Proposed Turbine Location 500m Buffer
Proposed Turbine Location
Proposed Met Mast
Vantage Point (VP) Location
Proposed Site Infrastructure
Flight Lines
Wigeon
1
2
3
0
0.5
1
Kilometres
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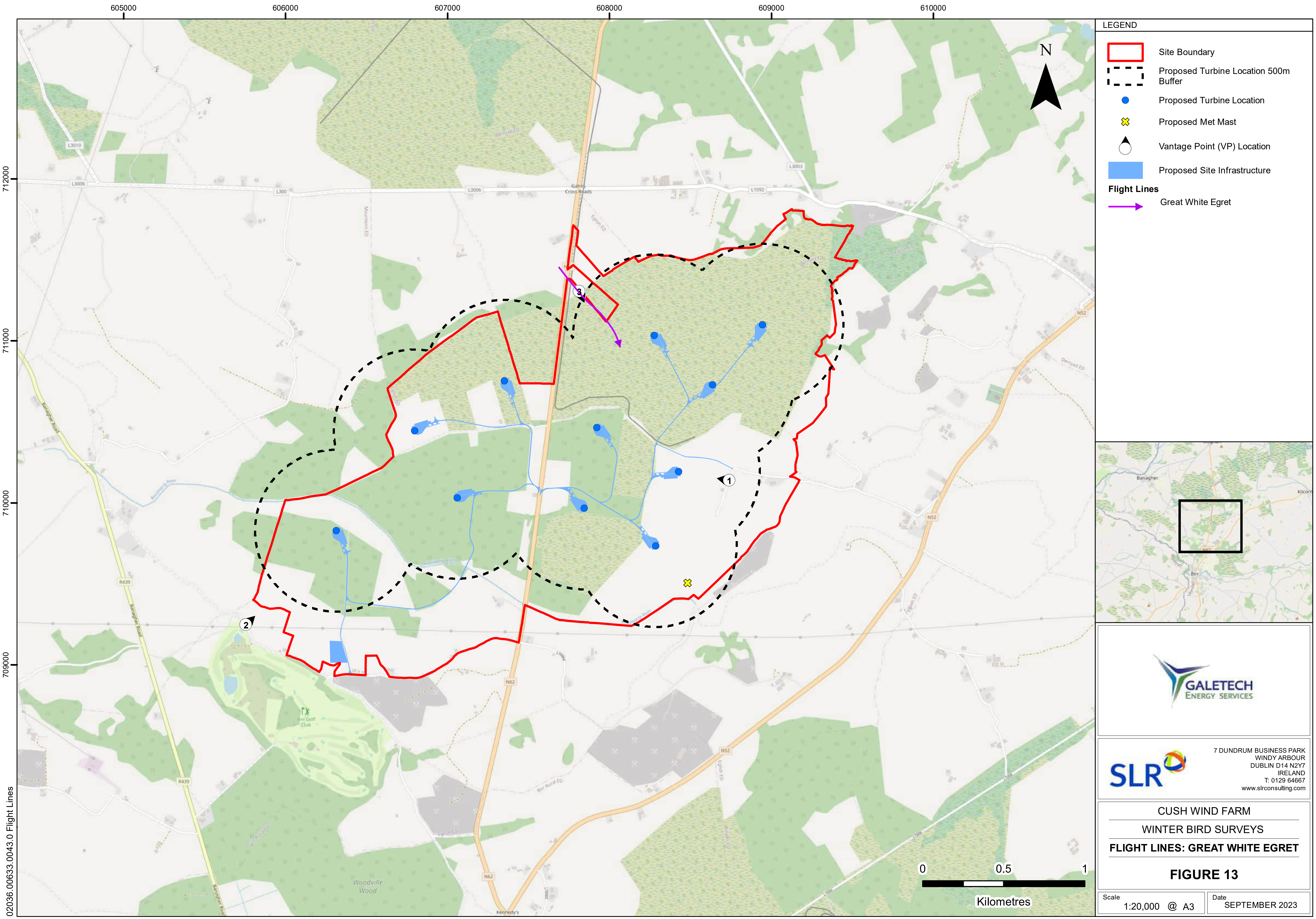
WINTER BIRD SURVEYS
FLIGHT LINES: WIGEON
FIGURE 12
Scale 1:20,000 @ A3
Date SEPTEMBER 2023
02036.00633.0043.0 Flight Lines


605000
606000
607000
608000
609000
610000
712000
711000
710000
709000
LEGEND
Site Boundary
Proposed Turbine Location 500m Buffer
Proposed Turbine Location
Proposed Met Mast
Vantage Point (VP) Location
Proposed Site Infrastructure
Flight Lines
Great White Egret
N
1
2
3
0
0.5
1
Kilometres
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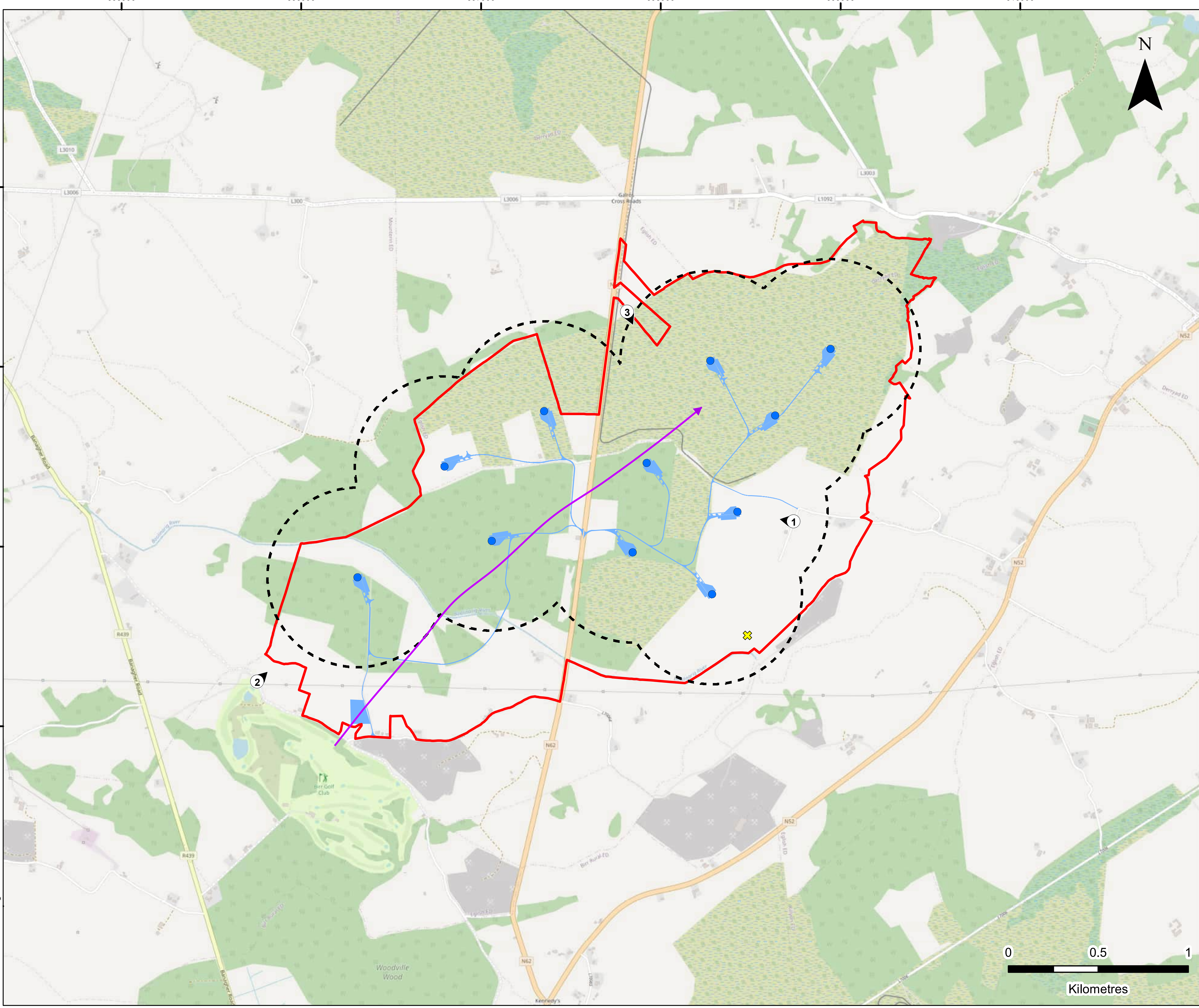
WINTER BIRD SURVEYS
FLIGHT LINES: GREAT WHITE EGRET
FIGURE 13
Scale
1:20,000 @ A3
Date
SEPTEMBER 2023
02036.00633.0043.0 Flight Lines



LEGEND

- Site Boundary
- Proposed Turbine Location 500m Buffer
- Proposed Turbine Location
- Proposed Met Mast
- Vantage Point (VP) Location
- Proposed Site Infrastructure

Flight Lines

- Greylag Goose

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WINTER BIRD SURVEYS

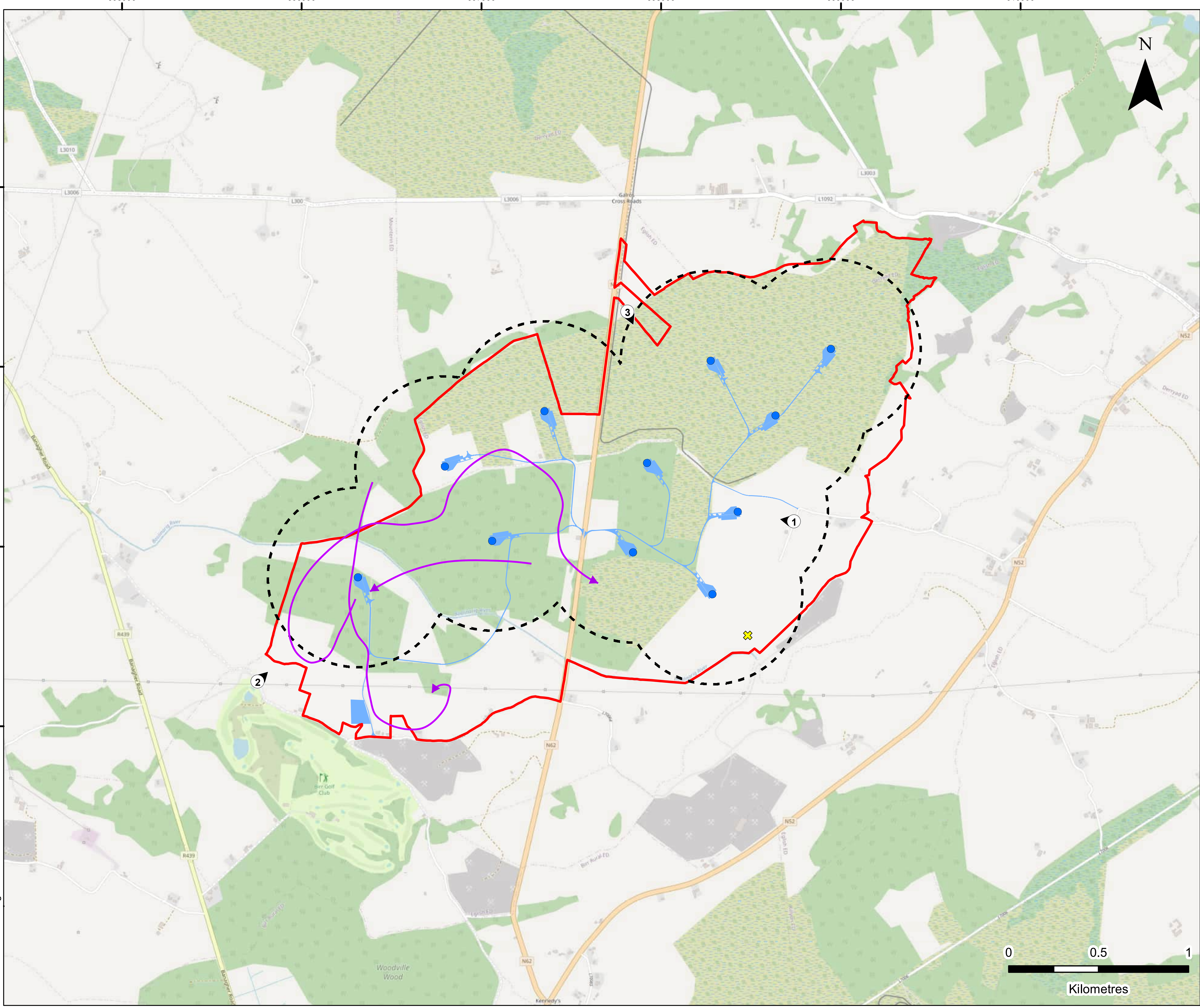
FLIGHT LINES: GREYLAG GOOSE

FIGURE 14

Scale 1:20,000 @ A3

Date SEPTEMBER 2023

02036.00633.0043.0 Flight Lines



LEGEND

- Site Boundary
- Proposed Turbine Location 500m Buffer
- Proposed Turbine Location
- Proposed Met Mast
- Vantage Point (VP) Location
- Proposed Site Infrastructure

Flight Lines

- Little Egret

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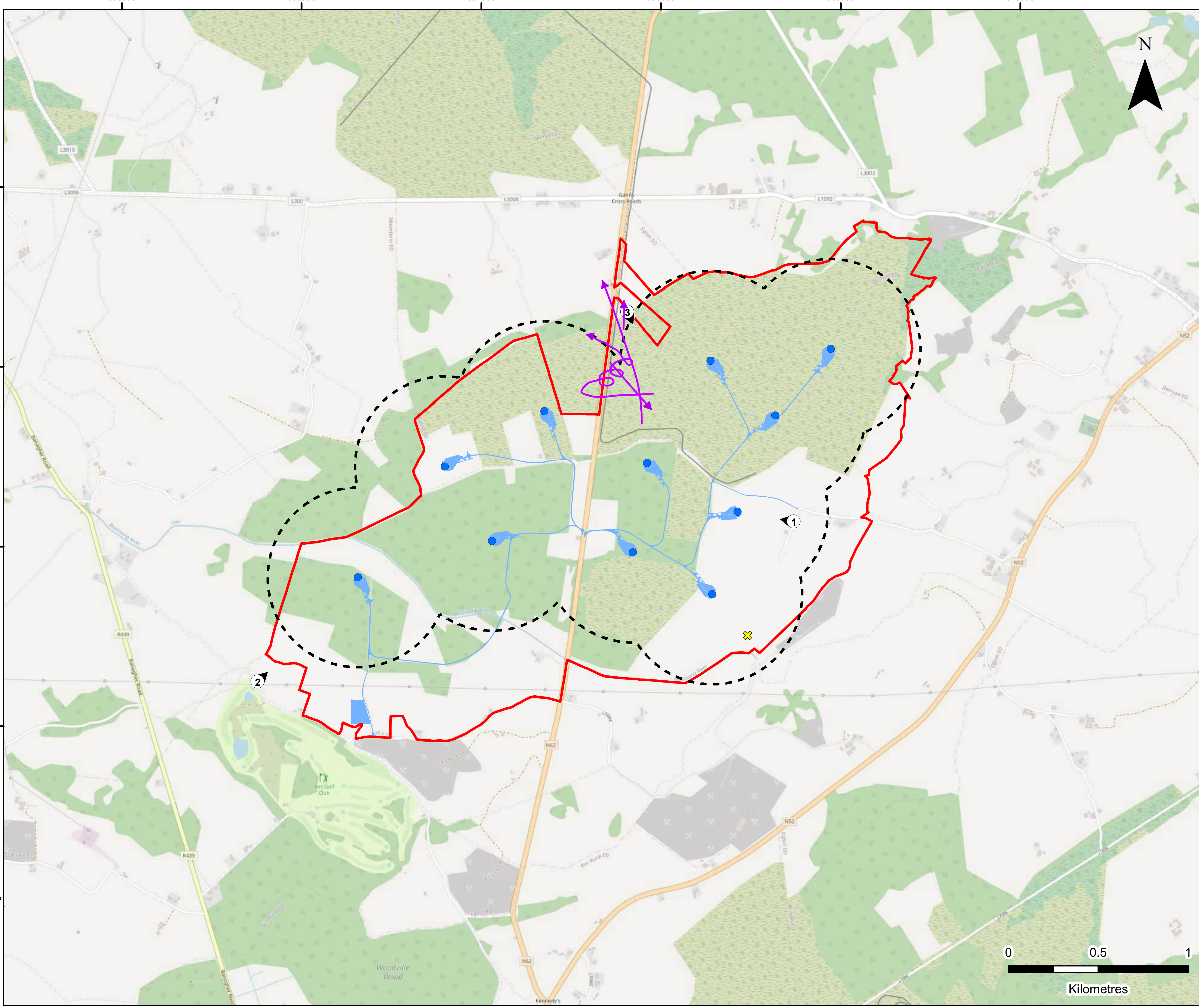
WINTER BIRD SURVEYS

FLIGHT LINES: LITTLE EGRET

FIGURE 15

Scale	Date
1:20,000 @ A3	SEPTEMBER 2023

02036.00633.0043.0 Flight Lines



LEGEND

- Site Boundary
- Proposed Turbine Location 500m Buffer
- Proposed Turbine Location
- Proposed Met Mast
- Vantage Point (VP) Location
- Proposed Site Infrastructure

Flight Line

- Merlin

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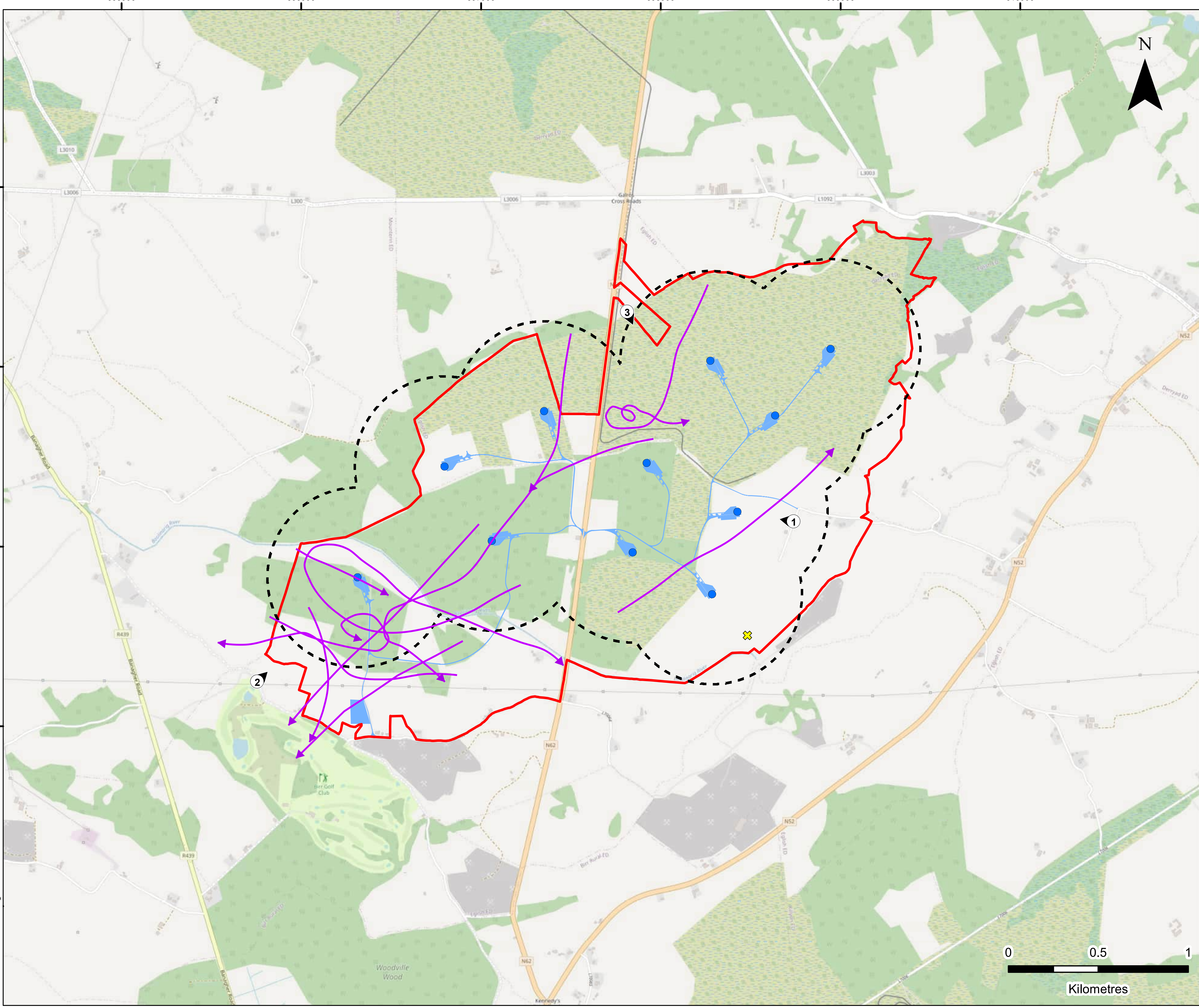
WINTER BIRD SURVEYS

FLIGHT LINES: MERLIN

FIGURE 16

Scale 1:20,000 @ A3

Date SEPTEMBER 2023



LEGEND

Site Boundary

Proposed Turbine Location 500m Buffer

Proposed Turbine Location

Proposed Met Mast

Vantage Point (VP) Location

Proposed Site Infrastructure

Flight Lines

Cormorant

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WINTER BIRD SURVEYS

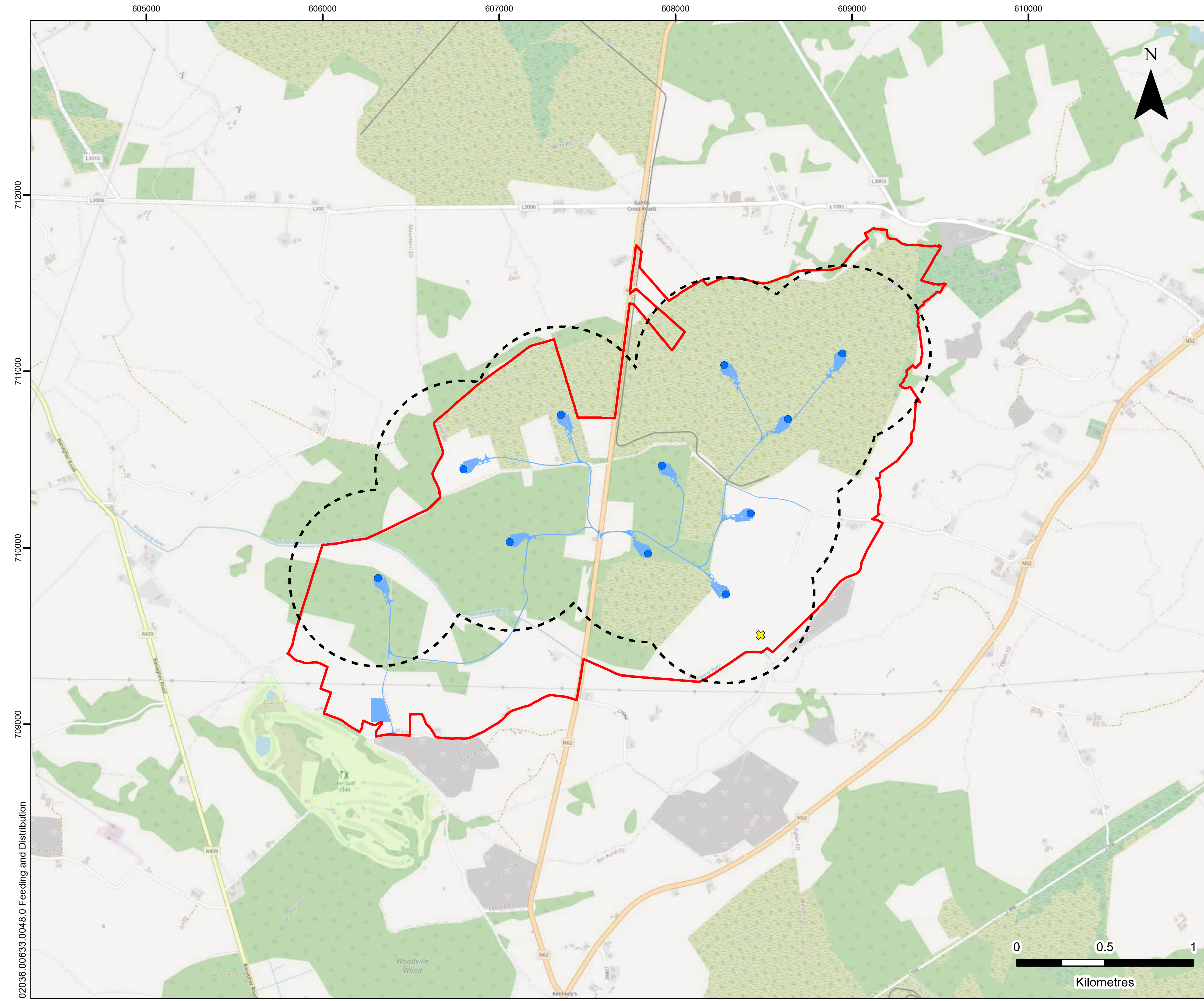
FLIGHT LINES: CORMORANT

FIGURE 17

Scale 1:20,000 @ A3

Date SEPTEMBER 2023

02036.00633.0043.0 Flight Lines



LEGEND

- Site Boundary
- Proposed Turbine Location 500m Buffer
- Proposed Turbine Location
- Proposed Met Mast
- Vantage Point (VP) Location
- Proposed Site Infrastructure

No Swans or Geese were recorded.

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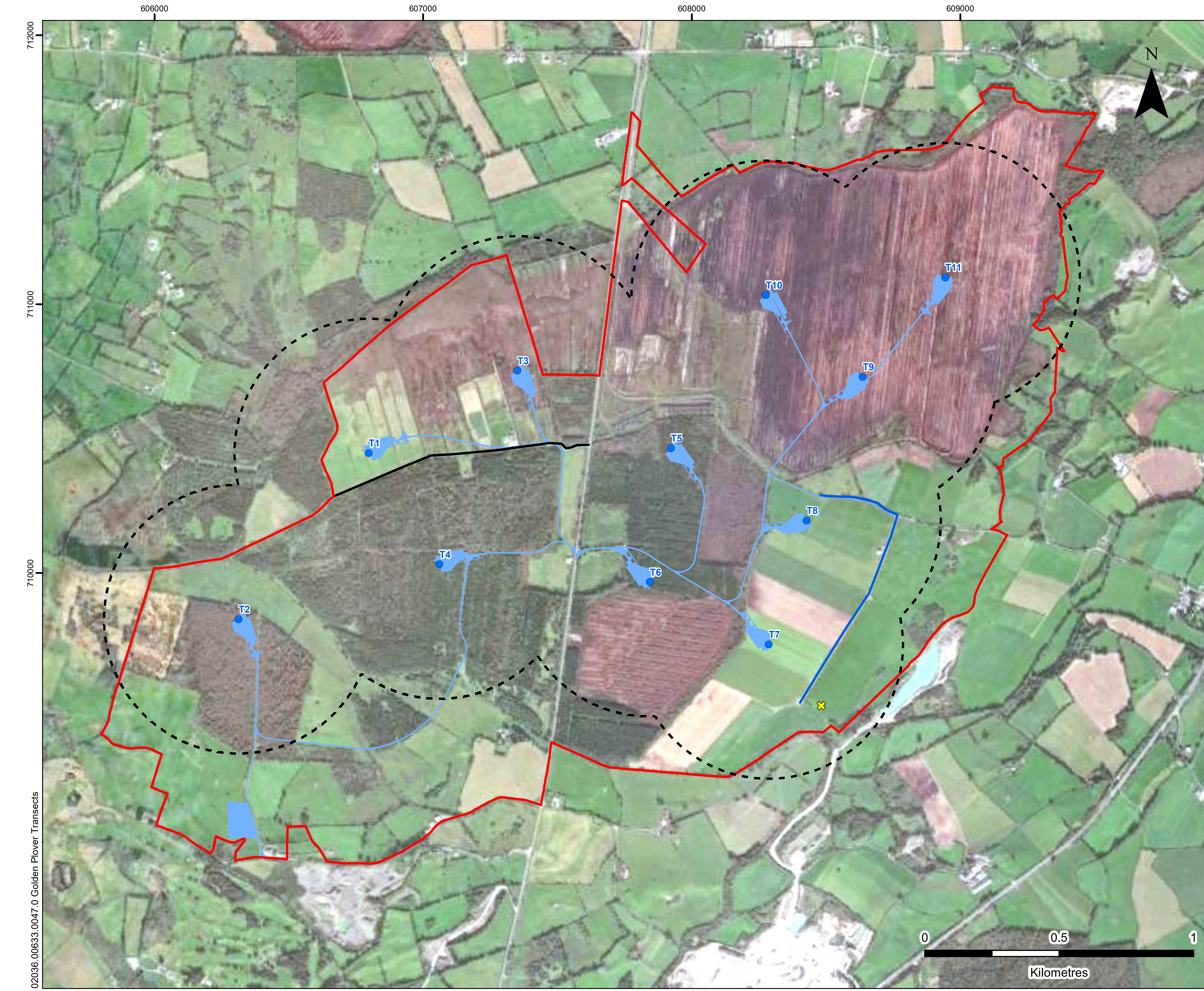
WINTER BIRD SURVEYS

SWAN & GEESE FEEDING AND DISTRIBUTION SURVEY RESULTS

FIGURE 18

Scale	Date
1:20,000 @ A3	APRIL 2023

02036.00633.0048.0 Feeding and Distribution



LEGEND

Site Boundary

Proposed Turbine Location 500 m Buffer

Proposed Turbine Location

Proposed Met Mast

Proposed Site Infrastructure

Golden Plover Transect West

Golden Plover Transect East

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WINTER BIRD SURVEYS

NOCTURNAL GOLDER PLOVER SURVEY

FIGURE 19

Scale 1:13,000 @ A3

Date SEPTEMBER 2023

02036.00633.0047.0 Golden Plover Transects

Appendix B Survey dates, times and observers[14]

Bird Survey Report Non-Breeding 2022/23

Cush Wind Farm

Galetech Energy Developments Ltd

SLR Project No.: 501.V64760.00001

5 September 2023

[14] Surveyor initials are given in Section 2.1

Table B-1: Details of VP Surveys Undertaken from Vantage Point 1

Date	Surveyor	Start time	End time	No. Hours
04/10/2022	AK	16:00	19:00	03:00
20/10/2022	AK	15:30	18:30	03:00
01/11/2022	AK	10:15	13:15	03:00
16/11/2022	AK	07:50	10:50	03:00
29/11/2022	AK	13:20	16:20	03:00
12/12/2022	AK	13:15	16:15	03:00
03/01/2023	AK	13:15	16:15	03:00
26/01/2023	AK	14:15	17:15	03:00
02/02/2023	AK	08:00	11:00	03:00
15/02/2023	AK	11:30	14:30	03:00
14/03/2023	AK	10:30	13:30	03:00
16/03/2023	AK	06:35	09:35	03:00
Total hours				36

Table B-2: Details of VP Surveys Undertaken from Vantage Point 2

Date	Surveyor	Start time	End time	No. Hours
04/10/2022	AK	12:30	15:30	03:00
21/10/2022	AK	10:15	13:15	03:00
15/11/2022	AK	10:15	13:15	03:00
16/11/2022	AK	11:20	14:20	03:00
02/12/2022	AK	09:00	12:00	03:00
16/12/2022	AK	10:45	13:45	03:00
04/01/2023	AK	08:40	11:40	03:00
02/02/2023	AK	11:15	14:15	03:00
16/02/2023	AK	09:30	12:30	03:00
03/03/2023	AK	07:00	10:00	03:00
14/03/2023	AK	15:30	18:30	03:00
15/03/2023	AK	10:30	13:30	03:00
Total hours				36

Table B-3: Details of VP Surveys Undertaken from Vantage Point 3

Date	Surveyor	Start time	End time	No. Hours
18/10/2022	AK	15:25	18:25	03:00
19/10/2022	AK	07:45	10:45	03:00
01/11/2022	AK	14:00	17:00	03:00
15/11/2022	AK	13:45	16:45	03:00
01/12/2022	AK	13:30	16:30	03:00
15/12/2022	AK	13:45	16:45	03:00
04/01/2023	AK	13:20	16:20	03:00
26/01/2023	AK	11:05	14:05	03:00
31/01/2023	AK	14:15	17:15	03:00
15/02/2023	AK	15:00	18:00	03:00
15/03/2023	AK	13:40	16:40	03:00
16/03/2023	AK	09:55	12:55	03:00
Total hours				36

Table B-4: Details of Feeding Distribution Surveys

Date	Surveyor	Start time	End time	No. Hours
05/10/2022	AK	10:40	13:00	02:20
21/10/2022	AK	13:25	15:30	02:05
03/11/2022	AK	08:50	11:20	02:30
16/11/2022	AK	14:30	16:00	01:30
02/12/2022	AK	12:10	13:45	01:35
16/12/2022	AK	13:55	15:30	01:35
04/01/2023	AK	11:50	13:15	01:25
20/01/2023	DN	10:00	11:50	01:50
02/02/2023	AK	14:20	15:30	01:10
16/02/2023	AK	12:45	13:50	01:05
03/03/2023	AK	11:30	12:45	01:15
14/03/2023	AK	13:40	15:15	01:35
Total hours				19:55

Table B-5: Details of Nocturnal Golden Plover Surveys

Date	Surveyor	Start time	End time	No. Hours
03/01/2023	AK/FL	16:45	18:30	01:45
13/03/2023	AK/HB	19:20	21:00	01:40
Total hours				03:25

Appendix C Weather data

Bird Survey Report Non-Breeding 2022/23

Cush Wind Farm

Galetech Energy Developments Ltd

SLR Project No.: 501.V64760.00001

5 September 2023

Table C-1: Weather Data Collected During Flight Activity Surveys Undertaken from VP1

Date	Survey Start	Survey End	Hr	Wind Speed	Wind Direction	Rain[15]	Cloud Cover[16]	Cloud Height[17]	Visibility[18]	Snow[19]	Frost[20]	Temp (°c)
04/10/2022	16:00	19:00	1	1	SW	2	8	1	1	0	0	15
04/10/2022	16:00	19:00	2	1	SW	2	8	1	1	0	0	15
04/10/2022	16:00	19:00	3	1	SW	3	8	1	1	0	0	12
20/10/2022	15:30	18:30	1	3	E	0	4	2	2	0	0	15
20/10/2022	15:30	18:30	2	2	E	0	6	2	2	0	0	15
20/10/2022	15:30	18:30	3	2	SE	0	3	2	2	0	0	14
01/11/2022	10:15	13:15	1	2	S	0	6	2	2	0	0	10
01/11/2022	10:15	13:15	2	2	S	0	8	2	2	0	0	10
01/11/2022	10:15	13:15	3	2	SW	1	8	2	2	0	0	12
16/11/2022	07:50	10:50	1	1	SE	0	2	2	2	0	1	4
16/11/2022	07:50	10:50	2	1	S	0	2	2	2	0	1	4

15 Key: None = 0; Drizzle = 1; Light showers/snow = 2; Heavy showers/snow = 3; Heavy rain/snow = 4.

16 Expressed in oktas (n/8)

17 Key: Height of cloud above average height of viewshed. <150m = 0; 150-500m = 1; >500m = 2.

18 Key: Poor (<1km) = 0; Moderate (1-3km) = 1; Good (>3km) = 2.

19 Key: Lying snow. None = 0; On site = 1; On higher ground = 2.

20 Key: None = 0; Ground = 1; All day = 2.

Date	Survey Start	Survey End	Hr	Wind Speed	Wind Direction	Rain[15]	Cloud Cover[16]	Cloud Height[17]	Visibility[18]	Snow[19]	Frost[20]	Temp (°c)
16/11/2022	07:50	10:50	3	1	S	0	2	2	2	0	0	4
29/11/2022	13:20	16:20	1	2	SE	0	8	2	2	0	0	6
29/11/2022	13:20	16:20	2	2	SE	0	8	1	2	0	0	6
29/11/2022	13:20	16:20	3	2	SE	0	8	1	2	0	0	6
12/12/2022	13:15	16:15	1	2	NE	0	6	0	1	1	2	1
12/12/2022	13:15	16:15	2	2	NE	0	6	0	1	1	2	1
12/12/2022	13:15	16:15	3	1	NE	0	6	0	1	1	2	0
03/01/2023	13:15	16:15	1	3	S	2	8	1	2	0	0	11
03/01/2023	13:15	16:15	2	3	S	2	8	1	1	0	0	11
03/01/2023	13:15	16:15	3	3	S	3	8	1	1	0	0	12
26/01/2023	14:15	17:15	1	2	N	0	8	1	2	0	0	7
26/01/2023	14:15	17:15	2	2	N	0	8	1	2	0	0	8
26/01/2023	14:15	17:15	3	2	N	0	8	1	2	0	0	8
02/02/2023	08:00	11:00	1	3	SW	0	8	2	2	0	0	9
02/02/2023	08:00	11:00	2	4	SW	2	8	1	1	0	0	9
02/02/2023	08:00	11:00	3	4	SW	1	8	1	2	0	0	9
15/02/2023	11:30	14:30	1	4	SW	0	3	2	2	0	0	9
15/02/2023	11:30	14:30	2	5	SW	0	6	2	2	0	0	9
15/02/2023	11:30	14:30	3	5	SW	0	6	2	2	0	0	9

Date	Survey Start	Survey End	Hr	Wind Speed	Wind Direction	Rain[15]	Cloud Cover[16]	Cloud Height[17]	Visibility[18]	Snow[19]	Frost[20]	Temp (°c)
14/03/2023	10:30	13:30	1	3	W	0	6	2	2	0	0	5
14/03/2023	10:30	13:30	2	4	W	4	8	0	0	0	0	5
14/03/2023	10:30	13:30	3	4	W	0	8	2	2	0	0	5
16/03/2023	06:35	09:35	1	3	S	0	8	1	2	0	0	11
16/03/2023	06:35	09:35	2	3	S	0	7	1	2	0	0	11
16/03/2023	06:35	09:35	3	3	S	2	8	1	2	0	0	11

Table C-2: Weather Data Collected During Flight Activity Surveys Undertaken from VP2

Date	Survey Start	Survey End	Hr	Wind Speed	Wind Direction	Rain[21]	Cloud Cover[22]	Cloud Height[23]	Visibility[24]	Snow[25]	Frost[26]	Temp (°c)
04/10/2022	12:30	15:30	1	2	SW	0	8	1	2	0	0	15
04/10/2022	12:30	15:30	2	1	SW	0	8	1	2	0	0	15
04/10/2022	12:30	15:30	3	1	SW	2	8	1	2	0	0	15
21/10/2022	10:15	13:15	1	3	E	3	8	1	1	0	0	14
21/10/2022	10:15	13:15	2	3	E	0	5	2	2	0	0	14
21/10/2022	10:15	13:15	3	3	SE	0	5	1	2	0	0	14
15/11/2022	10:15	13:15	1	0	n/a	0	2	2	2	0	0	8
15/11/2022	10:15	13:15	2	0	n/a	0	2	2	2	0	0	8
15/11/2022	10:15	13:15	3	1	S	0	1	2	2	0	0	9
16/11/2022	11:20	14:20	1	1	SE	0	1	2	2	0	0	7
16/11/2022	11:20	14:20	2	1	S	0	2	2	2	0	0	9
16/11/2022	11:20	14:20	3	1	S	0	2	2	2	0	0	9

[21] Key: None = 0; Drizzle = 1; Light showers/snow = 2; Heavy showers/snow = 3; Heavy rain/snow = 4.
[22] Expressed in oktas (n/8)
[23] Key: Height of cloud above average height of viewshed. <150m = 0; 150-500m = 1; >500m = 2.
[24] Key: Poor (<1km) = 0; Moderate (1-3km) = 1; Good (>3km) = 2.
[25] Key: Lying snow. None = 0; On site = 1; On higher ground = 2.
[26] Key: None = 0; Ground = 1; All day = 2.

Date	Survey Start	Survey End	Hr	Wind Speed	Wind Direction	Rain[21]	Cloud Cover[22]	Cloud Height[23]	Visibility[24]	Snow[25]	Frost[26]	Temp (°c)
02/12/2022	09:00	12:00	1	1	SE	0	6	2	2	0	0	7
02/12/2022	09:00	12:00	2	1	SE	0	5	2	2	0	0	7
02/12/2022	09:00	12:00	3	1	SE	0	4	2	2	0	0	8
16/12/2022	10:45	13:45	1	0	NA	0	1	2	2	1	2	0
16/12/2022	10:45	13:45	2	0	NA	0	2	2	2	1	2	0
16/12/2022	10:45	13:45	3	0	NA	0	2	2	2	1	2	1
04/01/2023	08:40	11:40	1	4	SW	0	8	1	2	0	0	10
04/01/2023	08:40	11:40	2	4	SW	0	6	1	2	0	0	10
04/01/2023	08:40	11:40	3	4	SW	0	6	1	2	0	0	10
02/02/2023	11:15	14:15	1	3	SW	0	8	2	2	0	0	9
02/02/2023	11:15	14:15	2	3	SW	2	8	2	2	0	0	10
02/02/2023	11:15	14:15	3	3	SW	2	8	0	0	0	0	10
16/02/2023	09:30	12:30	1	2	W	0	8	2	2	0	0	9
16/02/2023	09:30	12:30	2	2	W	0	6	2	2	0	0	9
16/02/2023	09:30	12:30	3	2	W	0	6	2	2	0	0	9
03/03/2023	07:00	10:00	1	1	NE	0	8	1	2	0	0	4
03/03/2023	07:00	10:00	2	1	NE	0	8	1	2	0	0	4
03/03/2023	07:00	10:00	3	1	NE	0	8	2	2	0	0	4
14/03/2023	15:30	18:30	1	4	NW	0	4	2	2	0	0	6

Date	Survey Start	Survey End	Hr	Wind Speed	Wind Direction	Rain[21]	Cloud Cover[22]	Cloud Height[23]	Visibility[24]	Snow[25]	Frost[26]	Temp (°c)
14/03/2023	15:30	18:30	2	4	NW	0	3	2	2	0	0	6
14/03/2023	15:30	18:30	3	2	NW	0	2	2	2	0	0	6
15/03/2023	10:30	13:30	1	4	SE	3	8	1	1	0	0	6
15/03/2023	10:30	13:30	2	4	SE	3	8	1	1	0	0	6
15/03/2023	10:30	13:30	3	3	SE	2	8	1	1	0	0	6

Table A3-3: Weather Data Collected During Flight Activity Surveys Undertaken from VP3

Date	Survey Start	Survey End	Hr	Wind Speed	Wind Direction	Rain[27]	Cloud Cover[28]	Cloud Height[29]	Visibility[30]	Snow[31]	Frost[32]	Temp (°c)
18/10/2022	15:25	18:25	1	3	E	0	6	2	2	0	0	15
18/10/2022	15:25	18:25	2	3	E	0	4	2	2	0	0	15
18/10/2022	15:25	18:25	3	3	E	0	3	2	2	0	0	15
19/10/2022	07:45	10:45	1	4	SE	3	8	1	1	0	0	13
19/10/2022	07:45	10:45	2	4	E	3	8	1	2	0	0	12
19/10/2022	07:45	10:45	3	4	E	2	8	1	2	0	0	12
01/11/2022	14:00	17:00	1	2	SW	0	8	2	2	0	0	10
01/11/2022	14:00	17:00	2	2	W	0	6	2	2	0	0	10
01/11/2022	14:00	17:00	3	2	W	1	8	2	2	0	0	9
15/11/2022	13:45	16:45	1	2	S	0	3	2	2	0	0	9
15/11/2022	13:45	16:45	2	2	S	2	6	2	2	0	0	9
15/11/2022	13:45	16:45	3	2	S	0	3	2	2	0	0	8

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27 Key**:** None = 0; Drizzle = 1; Light showers/snow = 2; Heavy showers/snow = 3; Heavy rain/snow = 4.
28 Expressed in oktas (n/8)
29 Key: Height of cloud above average height of viewshed. <150m = 0; 150-500m = 1; >500m = 2.
30 Key: Poor (<1km) = 0; Moderate (1-3km) = 1; Good (>3km) = 2.
31 Key: Lying snow. None = 0; On site = 1; On higher ground = 2.
32 Key: None = 0; Ground = 1; All day = 2.

Date	Survey Start	Survey End	Hr	Wind Speed	Wind Direction	Rain[27]	Cloud Cover[28]	Cloud Height[29]	Visibility[30]	Snow[31]	Frost[32]	Temp (°c)
01/12/2022	13:30	16:30	1	2	S	0	6	2	2	0	0	10
01/12/2022	13:30	16:30	2	2	S	0	5	2	2	0	0	10
01/12/2022	13:30	16:30	3	2	S	0	5	2	2	0	0	10
15/12/2022	13:45	16:45	1	2	NW	0	5	1	2	2	2	1
15/12/2022	13:45	16:45	2	2	NW	0	4	1	2	2	2	0
15/12/2022	13:45	16:45	3	2	NW	0	7	1	2	2	2	-1
04/01/2023	13:20	16:20	1	4	SW	0	7	1	2	0	0	10
04/01/2023	13:20	16:20	2	4	SW	1	6	1	2	0	0	10
04/01/2023	13:20	16:20	3	4	SW	0	4	2	2	0	0	9
26/01/2023	11:05	14:05	1	1	N	0	7	1	2	0	0	5
26/01/2023	11:05	14:05	2	1	N	0	8	1	2	0	0	7
26/01/2023	11:05	14:05	3	1	N	0	8	1	2	0	0	7
31/01/2023	14:15	17:15	1	4	W	0	5	2	2	0	0	8
31/01/2023	14:15	17:15	2	4	W	1	6	1	2	0	0	7
31/01/2023	14:15	17:15	3	4	W	1	6	1	2	0	0	7
15/02/2023	15:00	18:00	1	3	SW	0	8	2	2	0	0	9
15/02/2023	15:00	18:00	2	3	SW	2	8	2	2	0	0	9
15/02/2023	15:00	18:00	3	3	SW	2	8	1	2	0	0	8
15/03/2023	13:40	16:40	1	4	SE	3	8	1	1	0	0	8

Date	Survey Start	Survey End	Hr	Wind Speed	Wind Direction	Rain[27]	Cloud Cover[28]	Cloud Height[29]	Visibility[30]	Snow[31]	Frost[32]	Temp (°c)
15/03/2023	13:40	16:40	2	4	SE	3	8	0	0	0	0	8
15/03/2023	13:40	16:40	3	4	SE	3	8	1	1	0	0	8
16/03/2023	09:55	12:55	1	3	S	0	6	1	2	0	0	12
16/03/2023	09:55	12:55	2	3	S	1	8	1	2	0	0	12
16/03/2023	09:55	12:55	3	3	S	2	8	2	2	0	0	12

Table C-4: Weather During Feeding Distribution Surveys

Date	Start	End	Hr	Wind Speed	Wind Direction	Rain[15]	Cloud Cover[16]	Cloud Height[17]	Visibility[18]	Snow[19]	Frost[20]	Temp (°c)
05/10/2022	10:40	13:00	1	3	SW	0	4	2	2	0	0	11
05/10/2022	10:40	13:00	2	3	SW	2	5	1	2	0	0	12
05/10/2022	10:40	13:00	3	3	SW	2	7	2	2	0	0	12
21/10/2022	13:25	15:30	1	3	SE	2	6	2	2	0	0	14
21/10/2022	13:25	15:30	2	3	SE	1	6	2	2	0	0	14
03/11/2022	08:50	11:20	1	2	SE	0	3	2	2	0	0	6
03/11/2022	08:50	11:20	2	2	SE	0	3	2	2	0	0	7
03/11/2022	08:50	11:20	3	2	SE	0	5	2	2	0	0	8
16/11/2022	14:30	16:00	1	1	SE	0	2	2	2	0	0	9

Date	Start	End	Hr	Wind Speed	Wind Direction	Rain[15]	Cloud Cover[16]	Cloud Height[17]	Visibility[18]	Snow[19]	Frost[20]	Temp (°c)
16/11/2022	14:30	16:00	2	1	SE	0	2	2	2	0	0	8
02/12/2022	12:10	13:45	1	1	SE	0	6	2	2	0	0	9
02/12/2022	12:10	13:45	2	1	SE	0	8	2	2	0	0	10
16/12/2022	13:55	15:30	1	0	NA	0	2	2	2	0	2	2
16/12/2022	13:55	15:30	2	0	NA	0	2	2	2	0	2	2
04/01/2023	11:50	13:15	1	4	SW	1	7	1	2	0	0	11
04/01/2023	11:50	13:15	2	4	SW	0	8	1	2	0	0	11
20/01/2023	10:00	11:50	1	2	W	0	8	2	2	0	0	7
20/01/2023	10:00	11:50	2	3	W	1	8	2	2	0	0	8
02/02/2023	14:20	15:30	1	3	SW	0	8	2	2	0	0	10
16/02/2023	12:45	13:50	1	2	W	0	6	2	2	0	0	9
03/03/2023	11:30	12:45	1	1	NE	0	8	2	2	0	0	6
03/03/2023	11:30	12:45	2	1	NE	0	8	2	2	0	0	6
14/03/2023	13:40	15:15	1	4	NW	0	4	2	2	0	0	6
14/03/2023	13:40	15:15	2	4	NW	0	4	2	2	0	0	6

Table C-5: Weather During Nocturnal Golden Plover Surveys

Date	Start	End	Hr	Wind Speed	Wind Direction	Rain[15]	Cloud Cover[16]	Cloud Height[17]	Visibility[18]	Snow[19]	Frost[20]	Temp (°c)
03/01/2023	16:45	18:30	1	3	S	2	8	1	0	0	0	11
03/01/2023	16:45	18:30	2	3	S	2	8	1	0	0	0	10
13/03/2023	19:20	21:00	1	2	W	0	4	2	0	0	0	3
13/03/2023	19:20	21:00	2	2	W	0	4	2	0	0	0	3

Appendix D Flight activity survey data[33]

Bird Survey Report Non-Breeding 2022/23

Cush Wind Farm

Galetech Energy Developments Ltd

SLR Project No.: 501.V64760.00001

5 September 2023

[33] Surveyor initials are given in Section 2.1 and BTO code information is given in Section 5.0

Table D-1:Primary target species recorded during flight activity surveys undertaken at VP1

Date	Surveyor	Flight ID	BTO Code	No. Birds	Age (Ad = adult; Imm = immature)	Sex (M = male; F = female; U = unknown)	Start Time (hr:min)	Flight duration (s)
04/10/2022	AK	1	GP	250	U	U	16:28	173
04/10/2022	AK	2	WN	13	U	U	17:04	31
04/10/2022	AK	3	MA	2	AD	M&F	17:39	18
20/10/2022	AK	1	GP	36	U	U	16:10	230
20/10/2022	AK	2	K.	1	U	U	16:23	50
20/10/2022	AK	3	GP	24	U	U	17:11	186
20/10/2022	AK	4	HH	1	Ringtail	Ringtail	17:15	58
20/10/2022	AK	5	GP	15	U	U	17:44	190
20/10/2022	AK	6	K.	1	U	U	18:00	70
20/10/2022	AK	7	WS	9	U	U	18:06	205
01/11/2022	AK	1	GP	56	U	U	10:42	270
01/11/2022	AK	2	GP	29	U	U	10:56	180
01/11/2022	AK	3	GP	26	U	U	11:09	56
01/11/2022	AK	4	K.	1	AD	M	11:14	62
01/11/2022	AK	5	K.	1	AD	M	11:59	59
01/11/2022	AK	6	K.	1	AD	M	12:09	190
01/11/2022	AK	7	K.	1	U	U	12:57	37

Date	Surveyor	Flight ID	BTO Code	No. Birds	Age (Ad = adult; Imm = immature)	Sex (M = male; F = female; U = unknown)	Start Time (hr:min)	Flight duration (s)
16/11/2022	AK	1	GP	88	U	U	08:09	173
16/11/2022	AK	2	L.	8	U	U	09:14	195
16/11/2022	AK	3	L.	13	U	U	09:23	94
16/11/2022	AK	4	PE	1	U	U	09:56	50
29/11/2022	AK	1	K.	1	U	U	13:29	62
29/11/2022	AK	2	WS	4	U	U	13:41	93
29/11/2022	AK	3	L.	250	U	U	14:01	173
29/11/2022	AK	4	GP	3500	U	U	14:48	236
29/11/2022	AK	5	L.	58	U	U	14:49	265
29/11/2022	AK	6	CA	1	U	U	15:31	137
12/12/2022	AK	1	BH	1	AD	U	13:46	46
12/12/2022	AK	2	L.	11	U	U	14:06	37
12/12/2022	AK	3	BH	2	A YR 1	U	14:16	37
12/12/2022	AK	4	PE	1	U	U	14:56	24
12/12/2022	AK	5	L.	7	U	U	15:16	76
12/12/2022	AK	6	PE	1	A	F	15:18	12
12/12/2022	AK	7	GP	4	U	U	15:23	25
12/12/2022	AK	8	L.	12	U	U	15:23	48

Date	Surveyor	Flight ID	BTO Code	No. Birds	Age (Ad = adult; Imm = immature)	Sex (M = male; F = female; U = unknown)	Start Time (hr:min)	Flight duration (s)
12/12/2022	AK	9	L.	2	U	U	15:30	39
12/12/2022	AK	10	PE	1	A	F	16:04	26
12/12/2022	AK	11	L.	22	U	U	16:07	47
03/01/2023	AK	1	K.	1	A	M	13:29	119
03/01/2023	AK	2	K.	1	A	M	13:47	18
03/01/2023	AK	3	T.	42	U	U	14:36	508
03/01/2023	AK	3	T.	42	U	U	14:36	508
03/01/2023	AK	4	MA	2	A	M&F	14:40	33
03/01/2023	AK	5	K.	1	U	U	14:46	48
26/01/2023	AK	1	K.	1	U	U	15:26	90
26/01/2023	AK	2	BH	23	U	U	15:33	196
02/02/2023	AK	1	CA	1	A	U	09:36	53
02/02/2023	AK	2	GP	27	U	U	10:26	127
14/03/2023	AK	1	K.	1	A	M	11:29	90
14/03/2023	AK	2	K.	1	A	M	12:07	185
14/03/2023	AK	3	K.	1	U	U	12:14	136
14/03/2023	AK	4	L.	48	U	U	12:19	68
14/03/2023	AK	5	BH	3	U	U	12:36	36

Date	Surveyor	Flight ID	BTO Code	No. Birds	Age (Ad = adult; Imm = immature)	Sex (M = male; F = female; U = unknown)	Start Time (hr:min)	Flight duration (s)
14/03/2023	AK	6	L.	8	U	U	12:27	78
14/03/2023	AK	7	L.	36	U	U	12:29	126
14/03/2023	AK	10	L.	1	U	U	12:36	18
14/03/2023	AK	11	L.	1	U	U	12:41	26
14/03/2023	AK	12	BH	8	U	U	12:52	152
14/03/2023	AK	13	K.	1	U	U	13:04	166
16/03/2023	AK	1	GP	250	U	U	07:38	41
16/03/2023	AK	2	L.	2	U	U	08:11	49
16/03/2023	AK	3	L.	2	U	U	08:31	52
16/03/2023	AK	4	L.	4	U	U	08:49	76

Table D-2: Primary target species recorded during flight activity surveys undertaken at VP2

Date	Surveyor	Flight ID	BTO Code	No. Birds	Age (Ad = adult; Imm = immature)	Sex (M = male; F = female; U = unknown)	Start Time (hr:min)	Flight duration (s)
04/10/2022	AK	1	MA	1	AD	F	13:20	8
21/10/2022	AK	1	HH	1	Ringtail	U	11:38	20
21/10/2022	AK	2	K.	1	AD	U	12:23	23
21/10/2022	AK	3	K.	1	AD	U	12:29	26
21/10/2022	AK	4	GP	18	U	U	13:07	156
15/11/2022	AK	1	K.	1	AD	F	12:08	32
15/11/2022	AK	2	K.	1	AD	F	12:24	11
15/11/2022	AK	3	K.	1	AD	F	12:30	26
16/11/2022	AK	1	CA	1	U	U	13:14	77
16/11/2022	AK	2	ET	2	U	U	13:54	50
16/11/2022	AK	3	ET	2	U	U	14:13	196
02/12/2022	AK	1	K.	1	AD	M	09:41	24
02/12/2022	AK	2	K.	1	AD	M	09:48	26
02/12/2022	AK	3	GP	160	U	U	09:49	194
02/12/2022	AK	4	K.	1	AD	F	10:24	26
02/12/2022	AK	5	L.	6	U	U	10:37	97

Date	Surveyor	Flight ID	BTO Code	No. Birds	Age (Ad = adult; Imm = immature)	Sex (M = male; F = female; U = unknown)	Start Time (hr:min)	Flight duration (s)
02/12/2022	AK	6	CA	1	U	U	10:59	107
02/12/2022	AK	7	CA	1	U	U	11:14	46
02/12/2022	AK	8	K.	1	AD	F	11:53	12
16/12/2022	AK	1	L.	1	U	U	11:19	42
16/12/2022	AK	2	WS	5	3 A,2 Imm	U	11:22	78
16/12/2022	AK	3	L.	2	U	U	11:43	58
16/12/2022	AK	4	HH	1	A	M	12:06	33
16/12/2022	AK	5	L.	15	U	U	12:12	72
16/12/2022	AK	6	L.	3	U	U	12:13	78
16/12/2022	AK	7	SN	1	U	U	12:14	17
16/12/2022	AK	8	L.	1	U	U	12:38	43
16/12/2022	AK	9	L.	5	U	U	12:43	62
16/12/2022	AK	10	SN	1	U	U	13:15	27
16/12/2022	AK	11	SN	1	U	U	13:23	72
16/12/2022	AK	12	L.	1	U	U	13:28	34
16/12/2022	AK	13	ET	1	A	U	13:37	99
16/12/2022	AK	14	SN	1	U	U	13:40	36

Date	Surveyor	Flight ID	BTO Code	No. Birds	Age (Ad = adult; Imm = immature)	Sex (M = male; F = female; U = unknown)	Start Time (hr:min)	Flight duration (s)
04/01/2023	AK	1	CA	1	A	U	09:32	33
04/01/2023	AK	2	CA	1	A	U	10:03	16
04/01/2023	AK	3	GJ	3	U	U	10:36	126
04/01/2023	AK	4	CA	1	A	U	11:29	58
02/02/2023	AK	1	CA	1	U	U	12:55	32
16/02/2023	AK	1	K.	1	A	M	10:58	28
16/02/2023	AK	2	K.	2	A	M&F	10:22	176
03/03/2023	AK	1	L.	93	U	U	07:33	176
15/03/2023	AK	1	L.	36	U	U	11:44	84
15/03/2023	AK	2	MA	3	U	U	12:58	81

Table D-3: Primary target species recorded during flight activity surveys undertaken at VP3

Date	Surveyor	Flight ID	BTO Code	No. Birds	Age (Ad = adult; Imm = immature)	Sex (M = male; F = female; U = unknown)	Start Time (hr:min)	Flight duration (s)
18/10/2022	AK	1	K.	1	AD	U	16:21	63
18/10/2022	AK	2	SN	1	AD	U	16:23	46
18/10/2022	AK	3	K.	1	AD	F	16:36	196
18/10/2022	AK	4	GP	56	U	U	16:37	510
18/10/2022	AK	4	GP	56	U	U	16:37	510
18/10/2022	AK	5	GP	5	U	U	16:48	90
18/10/2022	AK	6	GP	11	U	U	16:53	53
18/10/2022	AK	7	K.	1	AD	F	16:53	110
18/10/2022	AK	8	GP	16	U	U	16:59	76
18/10/2022	AK	9	GP	24	U	U	17:05	109
18/10/2022	AK	10	GP	4	U	U	17:31	200
18/10/2022	AK	11	K.	1	AD	F	18:03	74
18/10/2022	AK	12	K.	1	AD	F	18:07	139
18/10/2022	AK	13	K.	1	AD	F	18:17	136
19/10/2022	AK	1	ML	1	U	U	07:40	5
19/10/2022	AK	2	SN	1	U	U	08:33	37

Date	Surveyor	Flight ID	BTO Code	No. Birds	Age (Ad = adult; Imm = immature)	Sex (M = male; F = female; U = unknown)	Start Time (hr:min)	Flight duration (s)
19/10/2022	AK	3	GP	10	U	U	09:06	156
19/10/2022	AK	4	GP	36	U	U	09:20	86
19/10/2022	AK	5	SN	1	U	U	09:49	50
19/10/2022	AK	6	GP	16	U	U	10:19	199
19/10/2022	AK	7	HW	1	U	U	10:36	15
01/11/2022	AK	1	PE	1	AD	F	14:03	63
01/11/2022	AK	2	K.	1	AD	M	14:09	37
01/11/2022	AK	3	K.	1	AD	M	14:24	330
01/11/2022	AK	3	K.	1	AD	M	14:24	330
01/11/2022	AK	4	K.	1	AD	M	14:34	85
15/11/2022	AK	1	ML	1	U	U	14:08	35
15/11/2022	AK	2	MA	5	U	U	14:36	128
15/11/2022	AK	3	L.	12	U	U	16:24	99
01/12/2022	AK	1	CA	1	AD	U	14:04	74
01/12/2022	AK	2	CA	1	AD	U	14:32	34
01/12/2022	AK	3	ML	1	AD	U	15:28	64
15/12/2022	AK	1	L.	1	U	U	14:12	26

Date	Surveyor	Flight ID	BTO Code	No. Birds	Age (Ad = adult; Imm = immature)	Sex (M = male; F = female; U = unknown)	Start Time (hr:min)	Flight duration (s)
15/12/2022	AK	2	L.	3	U	U	14:46	38
15/12/2022	AK	3	L.	6	U	U	15:22	43
15/12/2022	AK	4	L.	8	U	U	15:45	47
15/12/2022	AK	5	K.	1	A	F	15:47	22
15/12/2022	AK	6	ML	1	U	U	16:12	8
15/12/2022	AK	7	L.	5	U	U	16:27	34
15/12/2022	AK	8	SN	1	U	U	16:28	22
26/01/2023	AK	1	WS	2	A	U	13:02	21
31/01/2023	AK	1	HH	1	A	M	14:56	110
31/01/2023	AK	2	HH	1	A	M	15:02	184
31/01/2023	AK	3	HH	1	A	M	15:06	148
31/01/2023	AK	4	SN	2	U	U	15:06	51
31/01/2023	AK	5	HH	1	A	M	15:17	194
31/01/2023	AK	6	SN	1	U	U	15:18	36
31/01/2023	AK	7	K.	1	U	U	15:18	41
31/01/2023	AK	8	HH	1	A	M	15:26	105
31/01/2023	AK	9	K.	1	U	U	15:38	12

Date	Surveyor	Flight ID	BTO Code	No. Birds	Age (Ad = adult; Imm = immature)	Sex (M = male; F = female; U = unknown)	Start Time (hr:min)	Flight duration (s)
16/03/2023	AK	1	L.	1	U	U	09:56	18
16/03/2023	AK	2	L.	6	U	U	10:10	62
16/03/2023	AK	3	SN	1	U	U	10:10	11
16/03/2023	AK	4	L.	2	U	U	10:18	58
16/03/2023	AK	5	L.	1	U	U	10:41	39
16/03/2023	AK	6	L.	3	U	U	10:42	34

Table D-4: Secondary target species recorded during flight activity surveys undertaken at VP1

Date	Survey start	Survey end	5 min period start time	5 min period end time	Species	Count Max	Height band	Location (on site, in buffer or beyond)
04/10/2022	16:00	19:00	16:45	16:50	BZ	1	1	1
20/10/2022	15:30	18:30	15:45	15:50	BZ	1	1	2
01/11/2022	10:15	13:15	11:05	11:10	H.	1	1	1
01/11/2022	10:15	13:15	11:55	12:00	BZ	1	1	1
16/11/2022	07:50	10:50	08:20	08:25	BZ	2	2	1
16/11/2022	07:50	10:50	08:30	08:35	SH	1	1	1
16/11/2022	07:50	10:50	10:15	10:20	RN	1	1	1
16/11/2022	07:50	10:50	10:25	10:30	H.	1	1	2
29/11/2022	13:20	16:20	13:40	13:45	BZ	1	1	2
29/11/2022	13:20	16:20	14:05	14:10	BZ	1	1	1
29/11/2022	13:20	16:20	14:10	14:15	BZ	1	1	1
29/11/2022	13:20	16:20	14:10	14:15	RN	1	1	1,2
29/11/2022	13:20	16:20	14:25	14:30	BZ	1	1	2
29/11/2022	13:20	16:20	14:25	14:30	RN	1	1	2
03/01/2023	13:15	16:15	14:40	14:45	RN	1	1	1
03/01/2023	13:15	16:15	15:30	15:35	SH	1	1	1
15/02/2023	11:30	14:30	11:30	11:35	BZ	3	3	2

Date	Survey start	Survey end	5 min period start time	5 min period end time	Species	Count Max	Height band	Location (on site, in buffer or beyond)
15/02/2023	11:30	14:30	12:30	12:35	BZ	3	3	2, 3
15/02/2023	11:30	14:30	13:30	13:35	RN	3	3	2
14/03/2023	10:30	13:30	10:35	10:40	BZ	1	1	2
14/03/2023	10:30	13:30	10:55	11:00	BZ	3	3	2
14/03/2023	10:30	13:30	12:25	12:30	BZ	2	2	2
14/03/2023	10:30	13:30	12:45	12:50	BZ	3	3	2
14/03/2023	10:30	13:30	12:50	12:55	BZ	1	1	2
14/03/2023	10:30	13:30	12:55	13:00	RN	2	2	2
14/03/2023	10:30	13:30	12:55	13:00	BZ	3	3	2, 3
14/03/2023	10:30	13:30	13:00	13:05	RN	5	5	2, 3
14/03/2023	10:30	13:30	13:00	13:05	BZ	1	1	2, 3
14/03/2023	10:30	13:30	13:05	13:10	BZ	1	1	3
14/03/2023	10:30	13:30	13:05	13:10	H.	1	1	2
14/03/2023	10:30	13:30	13:20	13:25	BZ	2	2	2
14/03/2023	10:30	13:30	13:25	13:30	BZ	1	1	1
16/03/2023	06:35	09:35	08:40	08:45	H.	1	1	2
16/03/2023	06:35	09:35	09:15	09:20	BZ	1	1	2

Table D-5: Secondary target species recorded during flight activity surveys undertaken at VP2

Date	Survey start	Survey end	5 min period start time	5 min period end time	Species	Count Max	Height band	Location (on site, in buffer or beyond)
04/10/2022	12:30	15:30	12:45	12:50	SH	1	1	1
04/10/2022	12:30	15:30	14:40	14:45	SH	1	1	1
21/10/2022	10:15	13:15	11:45	11:50	RN	7	7	1, 2
21/10/2022	10:15	13:15	11:50	11:55	BZ	1	1	2, 3
21/10/2022	10:15	13:15	12:30	12:35	BZ	1	1	2
21/10/2022	10:15	13:15	12:30	12:35	RN	2	2	2
15/11/2022	10:15	13:15	11:10	11:15	BZ	2	2	2
15/11/2022	10:15	13:15	12:15	12:20	BZ	2	2	1, 2
16/11/2022	11:20	14:20	12:10	12:15	BZ	2	2	3
16/11/2022	11:20	14:20	12:15	12:20	BZ	2	2	1, 2
16/11/2022	11:20	14:20	12:20	12:25	BZ	2	2	1, 2
16/11/2022	11:20	14:20	12:25	12:30	SH	1	1	1
16/11/2022	11:20	14:20	12:30	12:35	SH	1	1	3
16/11/2022	11:20	14:20	12:40	12:45	BZ	2	2	1
02/12/2022	09:00	12:00	09:55	10:00	SH	2	2	2
02/12/2022	09:00	12:00	09:55	10:00	RN	1	1	1
02/12/2022	09:00	12:00	11:05	11:10	BZ	1	1	2

Date	Survey start	Survey end	5 min period start time	5 min period end time	Species	Count Max	Height band	Location (on site, in buffer or beyond)
02/12/2022	09:00	12:00	11:10	11:15	BZ	1	1	1
02/12/2022	09:00	12:00	11:30	11:35	SH	1	1	1,2
02/12/2022	09:00	12:00	11:45	11:50	BZ	1	1	1
02/12/2022	09:00	12:00	11:45	11:50	RN	1	1	1
02/12/2022	09:00	12:00	11:50	11:55	RN	2	2	2
02/12/2022	09:00	12:00	11:55	12:00	RN	2	2	2
16/12/2022	10:45	13:45	11:40	11:45	RN	1	1	1
16/12/2022	10:45	13:45	11:45	11:50	RN	2	2	1
16/12/2022	10:45	13:45	12:25	12:30	RN	2	2	1
16/12/2022	10:45	13:45	13:40	13:45	SH	1	1	1
04/01/2023	08:40	11:40	09:25	09:30	SH	1		2
04/01/2023	08:40	11:40	09:40	09:45	RN	2		1
04/01/2023	08:40	11:40	10:00	10:05	SH	2		2
04/01/2023	08:40	11:40	11:00	11:05	RN	1		2
04/01/2023	08:40	11:40	11:00	11:05	BZ	1		1, 2
04/01/2023	08:40	11:40	11:05	11:10	BZ	1		2
04/01/2023	08:40	11:40	11:10	11:15	BZ	1		2
04/01/2023	08:40	11:40	11:15	11:20	BZ	2		1, 2

Date	Survey start	Survey end	5 min period start time	5 min period end time	Species	Count Max	Height band	Location (on site, in buffer or beyond)
04/01/2023	08:40	11:40	11:20	11:25	BZ	1		2
04/01/2023	08:40	11:40	11:20	11:25	RN	2		2
04/01/2023	08:40	11:40	11:25	11:30	BZ	2		2, 3
02/02/2023	11:15	14:15	12:10	12:15	BZ	1	1	2
02/02/2023	11:15	14:15	12:25	12:30	BZ	1	1	2
02/02/2023	11:15	14:15	13:50	13:55	BZ	1	1	2
16/02/2023	09:30	12:30	09:55	10:00	RN	1	1	2
16/02/2023	09:30	12:30	10:55	11:00	BZ	1	1	2
16/02/2023	09:30	12:30	11:05	11:10	BZ	2	2	2
16/02/2023	09:30	12:30	11:30	11:35	BZ	1	1	2
16/02/2023	09:30	12:30	11:40	11:45	RN	3	3	2
16/02/2023	09:30	12:30	11:45	11:50	RN	2	2	1, 2
16/02/2023	09:30	12:30	11:50	11:55	BZ	1	1	2
16/02/2023	09:30	12:30	11:55	12:00	BZ	3	3	2, 3
16/02/2023	09:30	12:30	12:15	12:20	BZ	3	3	2, 3
03/03/2023	07:00	10:00	09:35	09:40	BZ	1	1	2
14/03/2023	15:30	18:30	15:35	15:40	BZ	1	1	3
14/03/2023	15:30	18:30	15:55	16:00	BZ	1	1	3

Date	Survey start	Survey end	5 min period start time	5 min period end time	Species	Count Max	Height band	Location (on site, in buffer or beyond)
14/03/2023	15:30	18:30	16:10	16:15	H.	1	1	1
14/03/2023	15:30	18:30	16:15	16:20	RN	2	2	2
14/03/2023	15:30	18:30	16:20	16:25	BZ	1	1	3
14/03/2023	15:30	18:30	16:25	16:30	BZ	1	1	3
15/03/2023	10:30	13:30	11:35	11:40	SH	1	1	1
15/03/2023	10:30	13:30	12:05	12:10	H.	1	1	2

Table D-6: Secondary target species recorded during flight activity surveys undertaken at VP3

Date	Survey start	Survey end	5 min period start time	5 min period end time	Species	Count Max	Height band	Location (on site, in buffer or beyond)
18/10/2022	15:25	18:25	16:55	17:00	H.	1	1	1
18/10/2022	15:25	18:25	17:05	17:10	BZ	1	1	2
18/10/2022	15:25	18:25	17:40	17:45	H.	1	1	1, 2
19/10/2022	07:45	10:45	09:10	09:15	RN	1	1	1
19/10/2022	07:45	10:45	09:30	09:35	BZ	1	1	1
19/10/2022	07:45	10:45	10:20	10:25	BZ	2	2	1, 2
19/10/2022	07:45	10:45	10:25	10:30	BZ	2	2	1, 2
15/11/2022	13:45	16:45	13:05	13:10	H.	1	1	1
15/11/2022	13:45	16:45	15:00	15:05	BZ	1	1	2
15/11/2022	13:45	16:45	16:10	16:15	RN	1	1	1
01/12/2022	13:30	16:30	13:50	13:55	BZ	1	1	2
01/12/2022	13:30	16:30	14:20	14:25	BZ	1	1	2
01/12/2022	13:30	16:30	14:40	14:45	RN	3	3	2
01/12/2022	13:30	16:30	15:00	15:05	BZ	1	1	1,2
15/12/2022	13:45	16:45	14:15	14:20	BZ	1	1	1
04/01/2023	13:20	16:20	14:35	14:40	BZ	1	1	2

Date	Survey start	Survey end	5 min period start time	5 min period end time	Species	Count Max	Height band	Location (on site, in buffer or beyond)
04/01/2023	13:20	16:20	14:50	14:55	H.	1	1	1
04/01/2023	13:20	16:20	16:00	16:05	RN	2	2	1
26/01/2023	11:05	14:05	11:05	11:10	H.	1	1	1
26/01/2023	11:05	14:05	11:20	11:25	H.	1	1	1
26/01/2023	11:05	14:05	11:55	12:00	H.	1	1	1
26/01/2023	11:05	14:05	12:00	12:05	H.	1	1	1
26/01/2023	11:05	14:05	12:10	12:15	H.	1	1	1
26/01/2023	11:05	14:05	13:20	13:25	H.	1	1	1
26/01/2023	11:05	14:05	13:30	13:35	H.	1	1	1
26/01/2023	11:05	14:05	13:30	13:35	BZ	1	1	2
26/01/2023	11:05	14:05	13:35	13:40	BZ	3	3	1, 2
26/01/2023	11:05	14:05	13:45	13:50	BZ	2	2	2
26/01/2023	11:05	14:05	13:50	13:55	BZ	1	1	1
26/01/2023	11:05	14:05	13:50	13:55	H.	1	1	1
26/01/2023	11:05	14:05	13:50	13:55	H.	1	1	1
31/01/2023	14:15	17:15	14:15	17:15	H.	2	2	1
31/01/2023	14:15	17:15	15:45	15:50	BZ	1	1	2
15/03/2023	13:40	16:40	13:40	13:45	H.	1	1	1

Date	Survey start	Survey end	5 min period start time	5 min period end time	Species	Count Max	Height band	Location (on site, in buffer or beyond)
16/03/2023	09:55	12:55	10:00	10:05	BZ	1	1	1
16/03/2023	09:55	12:55	10:45	10:50	BZ	1	1	2

Making Sustainability Happen

Appendix C Aquatic Survey Reports

Natura Impact Statement

Cush Wind Farm

Cush Wind Limited

SLR Project No.: 501.00581.00005

17 December 2023

Aquatic baseline report for Cush wind farm, Co. Offaly

Prepared by Triturus Environmental Ltd. for SLR Consulting

November 2022

Please cite as:

Triturus (2022). Aquatic baseline report for Cush wind farm, Co. Offaly. Report prepared by Triturus Environmental Ltd. for SLR Consulting. November 2022.

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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 Cush wind farm project. 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 Cush wind farm, located approx. 5km north of Birr, Co. Offaly.

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 pearl mussel (*Margaritifera margaritifera*) (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 vicinity of the proposed project (**Figure 2.1**). Aquatic surveys were undertaken in August 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*=25 riverine sites, *n*=1 canal site and *n*=1 lake site was 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 Woodfield River (EPA code: 25W29), Little Brosna River (25L02), Rapemills River (25R01), Eglish Stream (25E18), West Galros Stream (25W44), Mullaghakaraun Bog Stream (25M48), Milltown Stream (25M79), Feeghroe River (25F41), Whigsborough Stream (25W43), Grant's Island River (25Y47), Bullock Island Stream (25I23), Park River (25P28), Little [Cloghan] River (25L01), River Brosna (25B09), Blackwater River (25B27) and Silver River (25S02), in addition to the Grand Canal and an unnamed quarry lake (**Table 2.1**).

The *n*=27 aquatic survey sites were located within the Shannon[Lower]_SC_060, Shannon[Lower]_SC_040, Shannon[Lower]_SC_030, Brosna_SC_070 and Brosna_SC_080 river sub-catchments. The proposed wind farm site was not located within a European site. However, grid connection route (GCR) option C crossed 3 no. watercourses within the River Shannon Callows SAC (000216) and Middle Shannon Callows SPA (004096). There was also potential downstream hydrological connectivity between the proposed project and River Little Brosna Callows SPA (004086) and Dovegrove Callows SPA (004137).

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 Tuesday 23rd to Thursday 25th August 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*=2 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*). Furthermore, a composite water sample was also analysed for white-clawed crayfish, crayfish plague, European eel (*Anguilla anguilla*) and smooth newt (*Lissotriton vulgaris*) eDNA at a single quarry lake site adjoining the proposed site boundary. A composite water sample from the proposed GCR crossing of the Grand Canal was analysed for white-clawed crayfish, crayfish plague and invasive quagga mussel (*Dreissena bugensis rostriformis*). 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 Cush wind farm in August 2022, following notification to Inland Fisheries Ireland, under the conditions of a Department of the Environment, Climate and Communications (DECC) licence. Electro-fishing was undertaken at all riverine survey sites containing water or where prohibitive depths meant electro-fishing was not viable. Sites A1 (Woodfield River), B2 (Eglish Stream) and B11 (Milltown Stream) were dry at the time of survey, whilst sites B5 (West Galros Stream), B6 (West Galros Stream) and D4 (Grand Canal) were found to not be suitable for electro-fishing due to prohibitive depths. In a similar fashion the quarry lake site (L1) was not suitable for electrofishing. Therefore, a total of *n*=20 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**) was undertaken to establish their importance for salmonid, lamprey, European eel and other fish species. This was also undertaken at sites where electro-fishing was not feasible due to prohibitive depths (i.e. D4, Grand Canal & L1, Quarry Lake). 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 Cush wind farm survey area was completed.

Table 2.1 Location of n=27 aquatic survey sites in the vicinity of Cush wind farm, Co. Offaly (* indicates eDNA sampling)

Site no.	Watercourse	EPA code	Location	X (ITM)	Y (ITM)
A1	Woodfield River	25W29	Banagher Road R439 crossing	605395	708239
A2	Woodfield River	25W29	Clondallow	605352	707970
A3*	Little Brosna River	25L02	Derrinasallow Bridge	603240	707953
L1*	Quarry lake	n/a	Eglish	608806	709567
B1	Rapemills River	25R01	Eglish	608544	709346
B2	Eglish Stream	25E18	Eglish	608194	709857
B3	Rapemills River	25R01	Boolinarig Bridge	607478	709372
B4	Rapemills River	25R01	Cush	606559	709867
B5	West Galros Stream	25W44	Eglish	608047	710214
B6	West Galros Stream	25W44	N62 road crossing	607627	710485
B7	West Galros Stream	25W44	Cush	606664	710294
B8*	Rapemills River	25R01	Banagher Road R439 crossing	604773	710211
B9	Mullaghakaraun Bog Stream	25M48	Ballyneena	603822	711896
B10	Rapemills River	25R01	All Saints Bridge	602588	711394
B11	Milltown Stream	25M79	Ballyneena	603454	712240
B12	Feeghroe River	25F41	Five Roads Cross	603610	713632
B13	Rapemills River	25R01	Lusmagh Bridge	600120	714650
C1	Whigsborough Stream	25W43	Clooneen	608877	713034
D1	Grants Island River	25Y47	L7014 road crossing	603109	717415
D2	Bullock Island Stream	25I23	L7014 road crossing	603118	717707
D3	Park River	25P28	L7014 road crossing	603143	718403
D4*	Grand Canal	n/a	Griffith Bridge, Shannon Harbour	603604	719282
D5	Little [Cloghan] River	25L01	L7014 road crossing	604150	719834
D6	River Brosna	25B09	Moystown Bridge	604710	720913
D7	Blackwater River	25B27	Blackwater Bridge, R357	601538	723464
E1	Silver River	25S02	Wooden Bridge	612676	714360
E2	Silver River	25S02	Millbrook Bridge	613497	718834

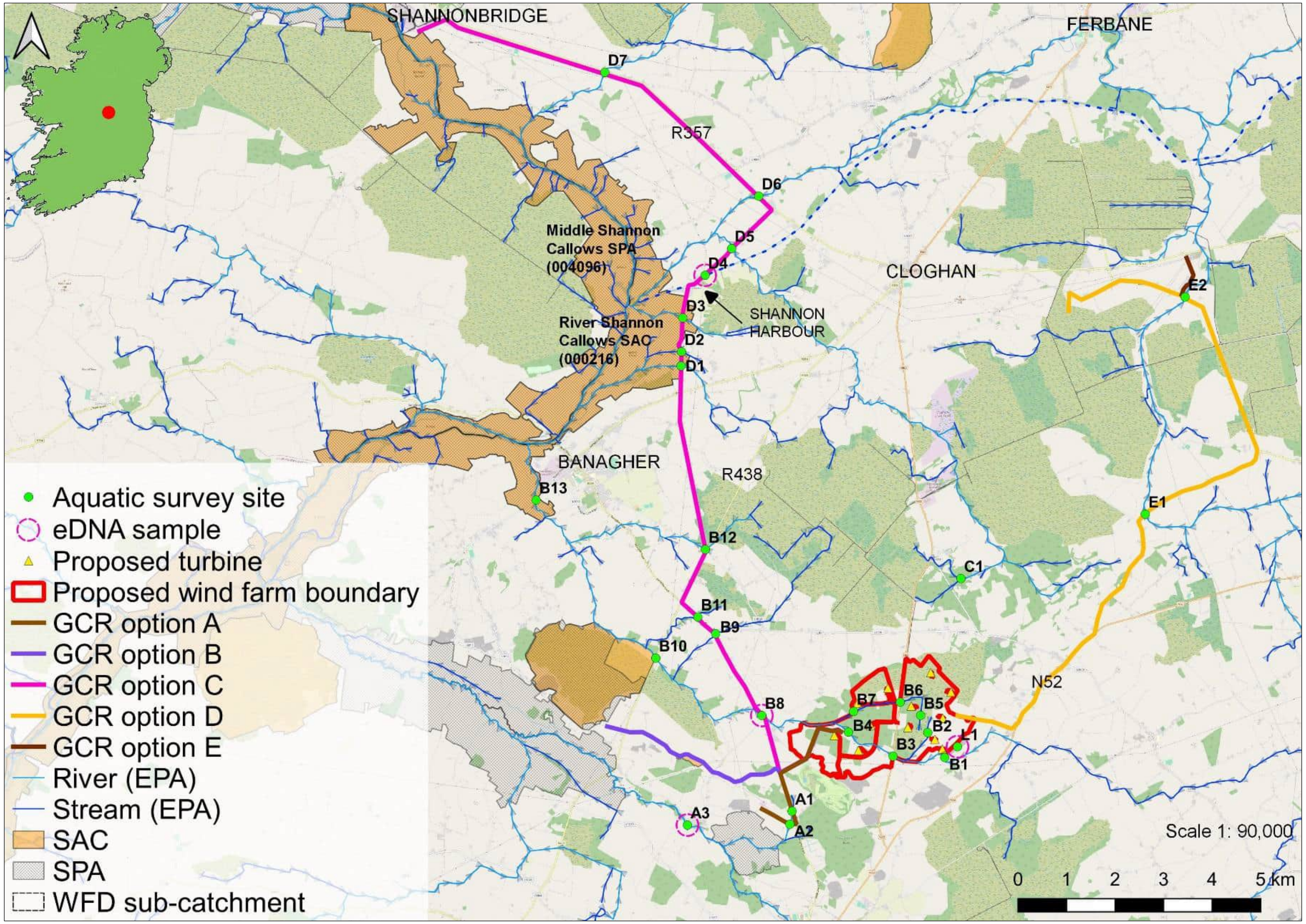

Figure 2.1 Overview of the *n*=27 aquatic survey site locations for Cush wind farm, Co. Offaly

2.5 Freshwater pearl mussel survey (eDNA only)

There are no known freshwater pearl mussel (*Margaritifera margaritifera*) records in the Shannon[Lower]_SC_060, Shannon[Lower]_SC_040, Shannon[Lower]_SC_030, Brosna_SC_070 or Brosna_SC_080 river sub-catchments. This was based on an extensive literature review and also examination of NPWS sensitive species data. However, following to the precautionary principle and to account for any lacunae in data for the species, environmental DNA (eDNA) samples were collected from the Little Brosna River and Rapemills 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.

2.6 eDNA analysis

To validate site surveys and to detect potentially cryptically-low populations of sensitive aquatic receptors within the study area, *n*=3 composite water samples were collected from the Little Brosna River (site A3) and Rapemills River (B8) and analysed for freshwater pearl mussel, white-clawed crayfish and crayfish plague environmental DNA (eDNA) (**Figure 2.1**). The water samples were collected on 25th August 2022, with the sites strategically chosen to maximise longitudinal (instream) coverage within the catchment (i.e. facilitating a greater likelihood of species detection). A composite water sample was also collected from the Grand Canal at Shannon Harbour (D4) and analysed for white-clawed crayfish, crayfish plague and invasive quagga mussel[1]. Further, a composite water sample from the small quarry lake at site L1 was analysed for white-clawed crayfish, crayfish plague, European eel (*Anguilla anguilla*) and smooth newt (*Lissotriton vulgaris*).

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.

[1] recently discovered in the Shannon system, in Loughs Ree and Derg and the interconnecting River Shannon (Baars & Minchin, 2021)

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)

A total of 22. no riverine survey sites were assessed for biological water quality through Q-sampling in August 2022 (sites A1, B2 & B11 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 Lake & Canal macro-invertebrate communities

The lake survey site (L1) and the Grand Canal (D4) was sampled for macro-invertebrates via sweep netting. A standard pond net (250mm width, mesh size 500µm) was used to sweep macrophytes to capture macro-invertebrates. The net was also moved along the lake bed to collect epibenthic and epiphytic invertebrates from the substratum (as per Cheal et al., 1993). A 3-minute sampling period was employed. To ensure appropriate habitat coverage, the sampling period was also divided amongst the range of meso-habitats present at the survey sites to get a representative sample for sub-habitats.

2.10 Macrophytes and aquatic bryophytes

Surveys of the macrophyte and aquatic bryophyte community were conducted by instream wading at *n*=25 riverine, *n*=1 canal and *n*=1 lake survey sites, 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').

2.11 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).

2.12 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 (*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 Cush wind farm catchment and survey area description

The proposed Cush wind farm is located in a lowland area within the townlands of Cush, Conspark, Garbally, Pollaghoole, Ballyslavin, Boolinarig Big, Galros West, Galros East and Eglish, approximately 5km north of Birr, Co. Offaly (**Figure 2.1**). The proposed wind farm site is within the Shannon River Basin District and within hydrometric area 25 (Lower Shannon).

The aquatic survey sites were located within the Shannon[Lower]_SC_060, Shannon[Lower]_SC_040, Shannon[Lower]_SC_030 and Brosna_SC_080 river sub-catchments (**Figure 2.1**). The proposed wind farm site is drained by the Rapemills River (25R01), Eglish Stream (25E18), West Galros Stream (25W44), with numerous other watercourses crossed by the proposed GCR alignments.

The watercourses and aquatic surveys sites in the vicinity of Cush wind farm are typically small, lowland depositing channels which have been historically modified for land drainage purposes (FW2; Fossitt, 2000). Predominantly, the watercourses flow over areas of Tournaisian limestone and Visean limestone & calcareous shale (Geological Survey of Ireland data). Land use practices in the wider survey area comprise mixed forests (CORINE 313), agricultural areas (CORINE 242), land principally occupied by agriculture with significant areas of natural vegetation (CORINE 243), peat bogs (CORINE 412) and pastures (CORINE 231).

3.2 Fisheries asset of the survey area

The Little Brosna River is known to support Atlantic salmon (*Salmo salar*), brown trout (*Salmo trutta*), European eel, lamprey (*Lampetra* sp.), minnow (*Phoxinus phoxinus*) and stone loach (*Barbatula barbatula*) (Kelly et al., 2010, 2015).

The Silver [Kilcormac] River (crossed by proposed GCR) is known to support brown trout, European eel, gudgeon (*Gobio gobio*), minnow, perch (*Perca fluviatilis*), three-spined stickleback (*Gasterosteus aculeatus*), stone loach and (occasional) Atlantic salmon (Kelly et al., 2010, 2015). Both the Little Brosna and Silver Rivers also support spawning 'Croneen', a genetically distinct migratory population of potadromous brown trout indigenous to Lough Derg (Igoe et al., 2003).

The Little [Cloghan] River, a tributary of the Brosna River, is known to support stocks of brown trout, minnow, *Lampetra* sp., gudgeon, roach (*Rutilus rutilus*), stone loach and three-spined stickleback (*Gasterosteus aculeatus*) (Kelly et al., 2010, 2015; IFI 2020 data[2]).

The Grand Canal is known to support a range of coarse fish species, including perch, pike (*Esox lucius*), bream (*Abramis brama*), roach, rudd (*Scardinius erythropthalmus*) and their respective hybrids, European eel, tench (*Tinca tinca*) and highly localised common carp (*Cyprinus carpio*) and brown trout (IFI data; McLoone, 2011; Tierney et al., 1999; pers. obs.). *Lampetra* sp. lamprey have also been recorded at a low number of locations, e.g. 11th lock, ROD, 2016; 7th lock, Caffrey et al., 2006; 5th lock, MKO, 2019).

[2] 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/

Fisheries data for the other watercourses within the survey area was not available at the time of survey.

3.3 Protected aquatic species

A comprehensive desktop review of available data (NPWS, NBDC & BSBI data) for 10km grid squares containing and adjoining the project (i.e. M91, M92, N00, N01, N02, N11 & N12) identified records for a low number of rare and or protected aquatic species within the vicinity of the proposed wind farm.

A low number of records for Annex II white-clawed crayfish (*Austropotamobius pallipes*) were available for the Little Brosna River, River Brosna, Silver River and Blackwater [Shannonbridge] River (**Figure 3.1**). The Feeghroe River is also known to support white-clawed crayfish (Triturus, 2019). The Grand Canal supports white-clawed crayfish throughout much of its length (NBDC & NPWS data; Swords et al., 2020). No white-clawed crayfish records were available for the 10km grid square N01 (containing the northern extent of the proposed site boundary).

Records for Annex II 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 Rapemills River, Silver River, Little [Cloghan] River and Blackwater [Shannonbridge] River (**Figure 3.1**).

A high number of records (>50) for the Flora Protection Order species opposite-leaved pondweed (*Groenlandia densa*) were available for back channels of the River Shannon in the vicinity of Meelick near Eyecourt, Co. Galway (grid square M91, data not shown). These records ranged from 1991 to 2021.

A low number of records for the near threatened (Wyse-Jackson et al., 2016) macrophyte tubular water-dropwort (*Oenanthe fistulosa*) were available for the River Shannon callows both north and west of Shannon Harbour and downstream of Friar's Island (NPWS & NBDC data). The species occupies a limited Irish distribution and is found in of damp, often seasonally inundated wetland habitats (Stroh, 2015).

Common frog (*Rana temporaria*) records were widespread in the M91, M92, N00, N01, N02, N11 & N12 grid squares, although none overlapped with the proposed wind farm site (data not shown). A low number of contemporary records for smooth newt (*Lissotriton vulgaris*) were available but these also did not overlap with the proposed project.

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. There was no contemporary EPA biological monitoring data available for numerous surveyed watercourses, namely the Woodfield River (25W29), Eglish Stream (25E18), West Galros Stream (25W44), Mullaghakaraun Bog Stream (25M48), Milltown Stream (25M79), Feeghroe River (25F41), Whigsborough Stream (25W43), Grant's Island River (25Y47), Bullock Island Stream (25I23) or Park River (25P28).

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 A** of this report.

3.4.1 Little Brosna River

Two contemporary EPA biological monitoring stations were located on the Little Brosna River (25L02). The river achieved **Q3-4 (moderate status)** at Riverstown Bridge near Birr (station RS25L020700) in 2021 (i.e. upstream of proposed project). The river achieved **Q4 (good status)** at station RS25L021000, 2.4km downstream of survey site A3, in 2017.

The middle reaches of Little Brosna River (Little Brosna_060 river waterbody) achieved good status in the 2013-2018 period and was not considered at risk of achieving target good status water quality. However, the upper reaches (Little Brosna_060) and the lower reaches (Incherky_010) both achieved moderate status in the 2013-2018 period. The Little Brosna_060 river waterbody was considered 'at risk' of not achieving good status water quality, primarily due to eutrophication (agriculture) and hydromorphology (EPA, 2019a). The river waterbodies risk of the Incherky_010 was under review at the time of survey.

3.4.2 Rapemills River

A single contemporary EPA biological monitoring station was located on the Rapemills River (25R01). The river achieved **Q3-4 (moderate status)** at survey site B8 (station RS25R010300) in 2017.

The Rapemills River (Rapemills_010 and Rapemills _020 river waterbody) achieved **moderate status** in the 2013-2018 period with both considered 'at risk' of not achieving target good status water quality, primarily due to eutrophication (agriculture) and hydromorphology (EPA, 2019b).

3.4.3 Little [Cloghan] River

Two contemporary EPA biological monitoring stations were located on the Little Brosna River (25L02). The river achieved **Q4-5 (high status)** at station RS25L010200 and RS25L010400 (survey site D5) in 2017.

The upper reaches of Little [Cloghan] River (Little (Cloghan)_010 and Little (Cloghan)_020 river waterbody) achieved poor status in the 2013-2018 period, with the Little (Cloghan)_020 'at risk' of achieving target good status water quality, primarily due to forestry and peat extraction pressures (EPA, 2022). However, the lower reaches (Little (Cloghan)_030) achieved good status in the 2013-2018 period and was not at risk of failing to achieve good status.

3.4.4 Silver River

A number of contemporary EPA biological monitoring stations were located on the Silver River. The river achieved **Q3-4 (moderate status)** at station RS25S020400 (upstream of the project) in 2017 but **Q4 (good status)** at station RS25S020500 (survey site E1) and station RS25S020700 (1.3km downstream of E2).

The upper reaches of Silver River (Silver (Kilcormac)_020 & Silver (Kilcormac)_030 river waterbodies) achieved moderate status in the 2013-2018 period, with both 'at risk' of not achieving target good status water quality. The Silver (Kilcormac)_040 river waterbody achieved good status in the 2013-2018 period and was not at risk of failing to achieve target good status water quality. Moving downstream, the Silver (Kilcormac)_040 river waterbody achieved moderate status in the 2013-2018 period and was at risk of not achieving target good status water quality. The lower reaches of the Silver River (Brosna_120 river waterbody) achieved good status in the 2013-2018 period with a river waterbodies risk of 'not at risk'.

3.4.5 River Brosna

A number of contemporary EPA biological monitoring stations were located on the lower reaches of the River Brosna. The river achieved **Q3-4 (moderate status)** at station RS25B091000 (upstream of the project) in 2017 but **Q4 (good status)** at station RS25B091100 (survey site D6) in 2021.

The lower reaches of River Brosna (Brosna_130 & Brosna_140 river waterbodies) achieved moderate status in the 2013-2018 period, with both 'at risk' of not achieving target good status water quality.

3.4.6 Blackwater [Shannonbridge] River

Two contemporary EPA biological monitoring stations were located on the Blackwater River (25B27). The river achieved **Q2-3 (poor status)** at station RS25B270110 (upstream of the project) and **Q3-4 (moderate status)** at Blackwater Bridge (station RS25B270200, survey site and RS25L010400 (survey site D7) in 2021

The Blackwater River (Blackwater (Shannonbridge)_010 and Blackwater (Shannonbridge)_020 river waterbodies) achieved **good status** in the 2013-2018 period and were 'under review' and 'not at risk' of achieving good water quality, respectively. The lowermost reaches (Shannon (Lower)_010 river waterbody) were unassigned in terms of water quality and under review at the time of survey.

3.4.7 Grand Canal

The Grand Canal in the vicinity of the project (survey site D4) achieved **good status** in the 2013-2018 period (Grand Canal Main Line (Lower Shannon) waterbody) and were considered 'not at risk' of achieving good status water quality.

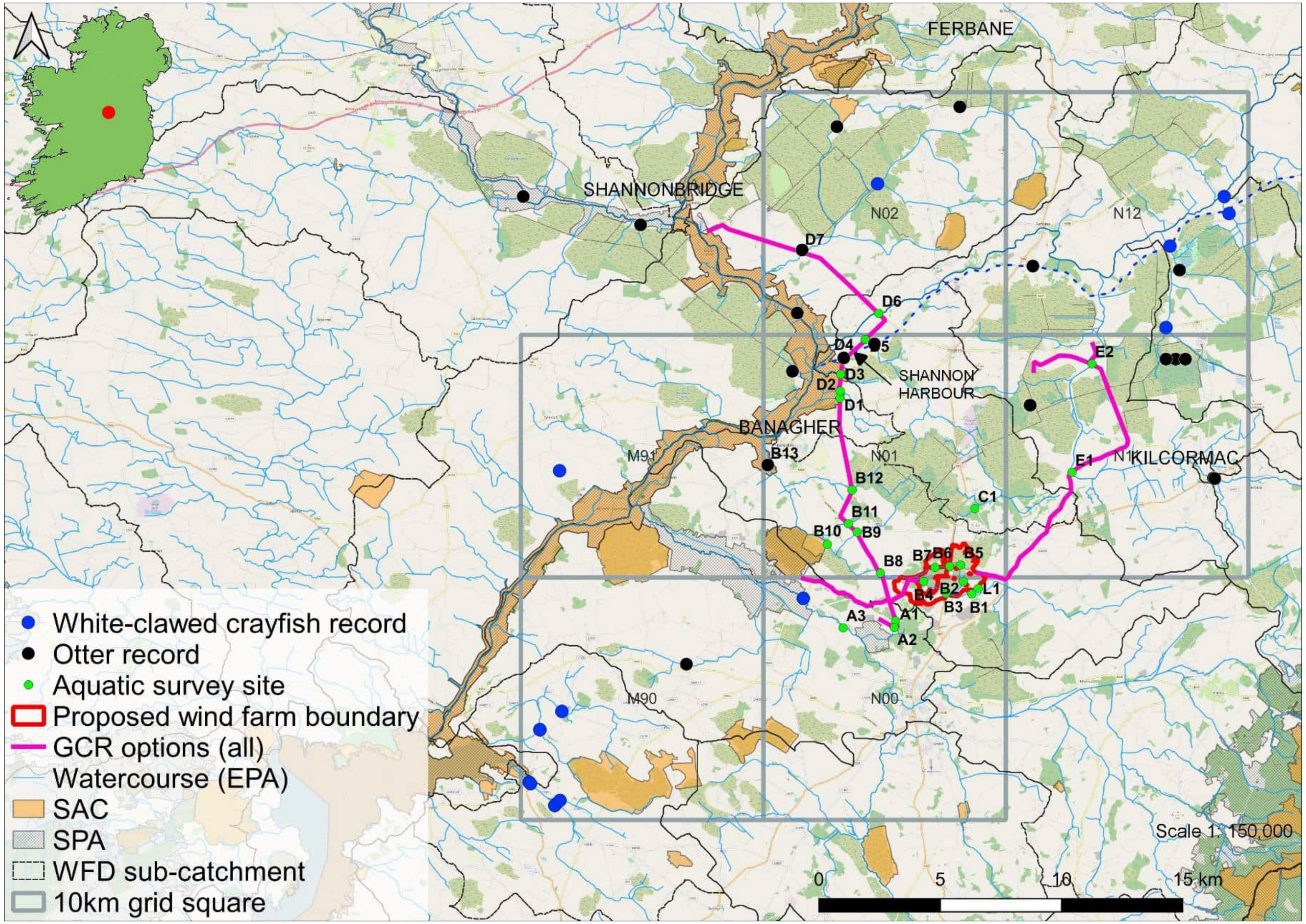

Figure 3.1 Distribution of white-clawed crayfish and otter records in the vicinity of the proposed Cush wind farm (NPWS & NBDC data, 2000 onwards)

4. Results of aquatic surveys

The following section summarises each of the *n*=25 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*=20) and in **Appendix A**. 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. An evaluation of the aquatic ecological importance of each survey site based on these aquatic surveys is provided and summarised in **Table 4.1**.

4.1 Aquatic survey site results

4.1.1 Site A1 – Woodfield River, R439 road crossing

Site A1 was located on the uppermost reaches of the Woodfield River (25W29) at the R439 road and proposed GCR crossing. The river at this location was 100% dry at the time of survey, with a damp mud base indicative of its ephemeral nature. The shallow U-shaped channel (1.5m bankfull heights) had been historically straightened and deepened with a bed comprised exclusively of deep mud/peat. The channel passed under the R438 via a pipe culvert and was straightened through an agricultural field downstream of the road. The river channel was very heavily tunnelled by dense scrub vegetation supporting blackthorn (*Prunus spinosa*), spindle (*Euonymus europaeus*), elder (Sambucus nigra) and hazel (*Corylus avellana*) with abundant bramble (*Rubus fruticosus* agg.). The site was bordered by scrubby mixed broad-leaved woodland (WD1) and (often wet) improved agricultural grassland (GA1).

Site A1 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 A1 was of **local importance (lower value) (Table 4.4).**

Plate 4.1 Representative image of site A1 on the upper reaches of the Woodfield River, August 2022 (dry, ephemeral channel)

4.1.2 Site A2 – Woodfield River, Clondallow

Site A2 was located on the upper reaches of the Woodfield River at a local road crossing, approx. 0.3km downstream of site A1. The river passed under the local road via a twin-bore pipe culvert with a 0.75m fall on the downstream side. The small river (FW2) suffered from very low seasonal water levels at the time of survey, with localised pool of water (0.2m deep) located immediately below to road culvert (i.e. no flow). Upstream of the culvert, the river represented a drainage channel, being 1-1.5m wide and semi-dry in a straightened and deepened heavily silted channel dominated by common reed (*Phragmites australis*). Downstream, the channel averaged 2m wide in a deep, historically modified trapezoidal channel with a mud base. Given the semi-dry, ephemeral nature, no macrophytes or aquatic bryophytes were recorded. The channel was heavily tunnelled by scrub/hedgerow vegetation supporting abundant blackthorn and ivy (Hedera sp.) with elder, hawthorn (*Crataegus monoygna*), dog rose (*Rosa canina*) and bramble. The site was bordered by improved agricultural grassland (GA1).

With the exception of ten-spined stickleback (*Pungitius pungitius*), site A2 was not of fisheries value given its semi-dry, evidently ephemeral nature. A low density of fish were recorded from a shallow, isolated stagnant ($1m^2$) pool immediately below the road culvert. The species is highly tolerant of low oxygen conditions and is often found in very shallow channels exposed to seasonal flow pressures (Lewis et al., 1972). 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 poor status water quality, the aquatic ecological evaluation of site A2 was of **local importance (lower value)** (**Table 4.4**).

Plate 4.2 Representative image of site A2 on the upper reaches of the Woodfield River, August 2022

4.1.3 Site A3 – Little Brosna River, Derrinasallow Bridge

Site A3 was located on the Little Brosna River (25L02) at Derrinasallow Bridge, approx. 2.8km downstream of site A2. The large high energy river (FW1 with some depositing characteristics) retained a high degree of naturalness in the vicinity of the bridge, despite some local bank and hydromorphological modifications as part of a derelict mill. The river averaged 12-14m wide and 0.3-0.7m deep. Fast-flowing glide predominated with frequent small pool (to 1.2m) associated with large boulders. The substrata were dominated by cobble and boulder which were compacted due to high flow rates and significant calcification (with abundant cyanobacterial crusts). Small patches of fine and medium interstitial gravels were frequent. Soft sediment deposits were sparse and shallow/flocculent where present. Given the calcified bed, aquatic vegetation was sparse. However, water crowfoot (*Ranunculus* sp.) and variable-leaved pondweed (*Potamogeton gramineus*) were both occasional (small stands). Lesser water parsnip (*Berula erecta*) was present in both emergent and submerged forms but rare overall. Branched bur reed (*Sparganium erectum*), water starwort (*Callitriche* sp.), blue water speedwell (*Veronica anagallis-aquatica*), ivy-leaved duckweed (*Lemna trisulca*) and common duckweed (*Lemna minor*) were present but also rare. Aquatic bryophyte coverage was high with abundant *Leptodictyum riparium* and more occasional submerged *Fissidens crassipes*. *Fontinalis antipyretica* was present but rare. The calcicolous liverwort *Pellia endiviifolia* was frequent, particularly in the vicinity of the bridge. *Marchantia polymorpha* was present but rare. Given low coverage of indicator species, the aquatic vegetation community did not represent Annex I habitat 'Water courses of plain to montane levels, with submerged or floating vegetation of *Ranunculion fluitantis* and *Callitricho-Batrachion* or aquatic mosses [3260]'. The shaded boulder zone under the bridge supported freshwater sponge (*Porifera* sp.). The riparian zone supported mature treelines of ash (*Fraxinus excelsior*), sycamore (*Acer pseudoplatanus*), hazel and willow (*Salix* spp.) with reed canary grass (*Phalaris arundinacea*), hedge bindweed (*Calystegia sepium*) and pendulous sedge (*Carex pendulata*), with localised water mint (*Mentha aquatica*) and bittersweet (*Solanum dulcamara*). The site was bordered by mixed broad-leaved woodland (WD1), amenity grassland (GA2) and improved grassland (GA1).

Site A3 was of high value for salmonids, with a mixed-cohort population of brown trout (*Salmo trutta*) and a low density of Atlantic salmon (*Salmo salar*) parr recorded via electro-fishing (**Appendix A**). European eel (*Anguilla anguilla*), stone loach (*Barbatula barbatula*) and minnow (*Phoxinus phoxinus*) were also recorded. The site was of most value as a habitat for adult trout, with frequent deeper pool and glide present in addition to naturally scoured banks and occasional overhanging willow. Given high flow rates and compaction/calcification of the bed (which reduced the number of accessible refugia), the site provided sub-optimal nursery conditions, being better suited to Atlantic salmon than trout. The site provided some good spawning habitat for both salmonids and lamprey although suitable substrata were highly localised. Larval lamprey habitat was not present. European eel habitat was moderate overall given a general paucity of accessible instream refugia. Despite some suitability for white-clawed crayfish (*Austropotamobius pallipes*), none were recorded via hand-searching and suitability was sub-optimal given a paucity of accessible instream refugia. However, eDNA sampling at the site detected crayfish (**Table 4.1**) and crayfish remains were identified in old otter spraint on a marginal boulder upstream of the bridge (ITM 603243, 707933). Suitability for otter was high.

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), in addition to otter utilisation and detection of white-clawed crayfish, the aquatic ecological evaluation of site A3 was of **local importance (higher value) (Table 4.4).**

Plate 4.3 Representative image of site A3 on the Little Brosna River, August 2022 (facing upstream to bridge)

4.1.4 Site L1 – unnamed quarry lake, Eglish

Site L1 was located at an unnamed lake to the north-west of an active quarry ([redacted]. The small quarry lake covered a surface area of 1.2ha, although the northern end of the lake was being back-filled at the time of survey. The substrata was dominated by hard substrata with flocculent soft sediment deposits in the margins. The lake shelved very steeply in the rocky, compacted margins to an unknown depth. As a result, macrophyte growth was sparse, being limited to narrow fringes of bulrush (*Typha latifolia*), mostly along the western bank, and very occasional broad-leaved pondweed (*Potamogeton natans*). Lesser spearwort (*Ranunculus flammula*) and jointed rush (*Juncus articulatus*) were occasional along the littoral zones. Filamentous algal mats were frequent in the lake margins, indicating enrichment. Calcification of submerged substrata was evident, indicating highly alkaline conditions. Furthermore, the narrow outflowing stream (which adjoined the Rapemills River at site B1) was heavily calcified, averaging 2m wide and <0.2m deep with a compacted cobble bed. The eastern shoreline of the lake supported recolonising bare ground habitat (ED3) and supported typical species such as coltsfoot (*Tussilago farfara*), weld (*Reseda luteola*), wild marjoram (*Origanum vulgare*), yellow wort (*Blackstonia perfoliata*), wild carrot (*Daucus carota*) and purple loosestrife (*Lythrum salicaria*) with scattered shrubby willow (*Salix* sp.). The west bank supported a narrow treeline of mature willow, elder and dense bramble scrub.

Site L1 was of low fisheries value given poor connectivity with downstream habitats, evident enrichment and high turbidity. However, three-spined stickleback (*Gasterosteus aculeatus*) were observed during the site visit. Environmental DNA sampling indicated the absence of European eel, white-clawed crayfish, crayfish plague and smooth newt (*Lissotriton vulgaris*) (**Table 4.1**). Despite some suitability for otter, no signs were recorded around the lake's perimeter.

The lake site 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 absence of habitats or species of high conservation value, the aquatic ecological evaluation of site L1 was of **local importance (lower value)** (**Table 4.4**).

Plate 4.4 Representative image of the quarry lake at site L1, August 2022 (taken from southern shoreline)

4.1.5 Site B1 – Rapemills River, Eglish

Site B1 was located on the upper reaches of the Rapemills River (25R01) near [redacted] at the confluence with the site L1 lake outflow. The lowland depositing watercourse (FW2) had been historically straightened and deepened but retained some good semi-natural characteristics and showed some good instream recovery. The river flowed in a deep U-shaped channel with bankfull heights of 1-2m. The river averaged 2.5m wide and 0.2-0.3m deep. The profile comprised swift-flowing glide with occasional shallow pool (maximum depth 0.6m). Riffle habitat was limited. The substrata were dominated by fine and medium gravels with abundant soft sediment accumulations in association with macrophyte beds and pool slacks. Sand was also present in slower-flowing areas. Cobble was present but rare and exposed to moderate calcification (with cyanobacterial crusts). Boulder was almost entirely absent. The site was heavily vegetated with abundant fool's watercress (Apium nodiflorum) and watercress (*Nasturtium officinale*) and frequent branched bur-reed (*Sparganium erectum*) and heterophyllus lesser water parsnip (*Berula erecta*). Ivy-leaved duckweed (*Lemna trisulca*) and localised stands of iris (*Iris psuedacorus*) were also present occasionally instream. Water mint was present along the channel margins. Aquatic bryophytes were limited to occasional *Fontinalis antipyretica* and the calcicolous liverwort *Pellia endiviifolia*. The moss *Leptodictyum* *riparium* was also present on larger substrata. The mature riparian zone supported abundant reed canary grass, great willowherb (*Epilobium hirsutum*), iris, hedge bindweed and bramble with scattered ash, spindle, blackthorn and hawthorn. Livestock poaching and grazing was present along the south bank near the bridge. The site was bordered by intensive agricultural pasture (GA1) and mixed woodland (WD1) with abundant hazel.

Brown trout, lamprey (*Lampetra* sp.) and three-spined stickleback were recorded via electro-fishing at site B1 (**Appendix A**). The site was of high value to salmonids, supporting a moderate density of mixed-cohort brown trout. The population was dominated by adult fish. Fine gravel spawning habitat for both salmonids and lamprey, whilst widespread, was compromised by moderate siltation. The site provided good quality salmonid nursery and holding habitat. The site was a high value lamprey habitat, with excellent quality nursery habitat by way of abundant soft sediment deposits. These supported high densities of c.20 per m^2. Despite high suitability for European eel (abundant instream refugia), none were recorded. Suitability for white-clawed crayfish was high given clay banks for burrowing and abundant macrophytes. However, none were recorded via hand searching. Two regular otter spraint sites (ITM 608547, 709348 and 608550, 709346) were recorded on a clay ledge underneath the bridge. These contained abundant crayfish remains.

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 and Annex II lamprey (*Lampetra* sp.) and utilisation by otter, the aquatic ecological evaluation of site B1 was of **local importance (higher value)** (**Table 4.4**).

Plate 4.5 Representative image of site B1 on the upper reaches of the Rapemills River, August 2022 (taken from quarry access road bridge)

4.1.6 Site B2 – Eglish Stream, Eglish

Site B2 was located on the upper reaches of the Eglish Stream (25E18), approx. 0.7km upstream of the Rapemills River confluence. The channel had been extensively straightened and deepened was dry at the time of survey. The stream represented a 1m-wide peat drainage channel with a dry mud (peat) base with steep trapezoidal banks. These were heavily scrubbed by bramble, bracken (*Pteridium aquilinum*) and willow, with high levels of terrestrial encroachment in the channel indicating an ephemeral nature. The site was bordered by scrubby woodland (WN7) dominated by willow and downy birch (*Betula pubescens*) to the west and intensive pasture (GA1) and arable crops (BC1) to the east.

Site B2 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 B2 was of **local importance (lower value) (Table 4.4).**

Plate 4.6 Representative image of site B2 on the Eglish Stream, August 2022 (dry channel)

4.1.7 Site B3 – Rapemills River, Boolinarig Bridge

Site B3 was located on the Rapemills River at Boolinarig Bridge (N62 road crossing). The lowland depositing river (FW2) had been historically straightened and deepened in vicinity of the road crossing (cobbled bridge apron). The river averaged 3-4m wide and 0.5-1m deep, with locally deeper pool to 1.6m downstream of the bridge apron. The deep U-shaped channel featured bankfull heights of 2m and steeply sloping margins. The profile was dominated by deep slow-flowing glide with riffle habitat confined to the installed cobbles at the bridge. The substrata were dominated by organic-rich silt underlain by compacted cobble, gravels and clay. Installed angular cobbles and occasional boulder were present in vicinity of the bridge, with boulder rare elsewhere. Mixed exposed gravels were very occasional along channel margins. Siltation was high overall given the predominance of deep depositional glide habitat, with frequent deep deposits (some up to 0.5m deep). Given high shading, macrophyte growth was sparse However, heterophyllus fool's watercress was occasional, with infrequent branched bur-reed. Ivy-leaved duckweed was also occasional, with rare common duckweed. Aquatic bryophyte coverage was low overall although the boulder/cobble area downstream of the bridge supported the liverwort *Pellia endiviifolia* (submerged form) and the moss species *Rhynchostegium riparioides* and *Leptodictyum riparium*. Filamentous algal cover (primarily *Vaucheria* sp.) was high (20%), indicating significant enrichment. The river at this location was heavily shaded by mature ash-dominated treelines with frequent grey willow and bramble-dominated understories. The site was bordered by improved agricultural grassland (GA1).

Brown trout and lamprey (*Lampetra* sp.) were the only two fish species recorded via electro-fishing at site B3 (**Appendix A**). Despite evident hydromorphological modifications, site B3 was of good value for salmonids, supporting a moderate density of mixed-cohort brown trout. Spawning habitat for salmonids and lamprey was present but highly localised in the vicinity of the bridge and exposed to moderate to high siltation pressures. The installed cobbles on the bridge apron provided some good quality nursery habitat for juvenile trout (habitat which is rare within the Rapemills River; pers. obs.). Holding habitat was of excellent quality given the predominance of deep glide and pool, with frequent undercut/scoured banks and floating macrophyte vegetation. Despite an abundance of soft sediment accumulations, lamprey nursery habitat was considered of moderate quality only given low flow rates and the generally flocculent nature of the silt. However, a low density of ammocoetes was recorded via targeted electro-fishing. European eel habitat was good given ample refugia although none were recorded. The site provided some good suitability for white-clawed crayfish although none were recorded via sweep netting and hand-searching. However, crayfish remains were identified in otter spraint under the road bridge on marginal boulders (ITM 607476, 709372).

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 and Annex II *Lampetra* sp., in addition to utilisation by otter, the aquatic ecological evaluation of site B3 was of **local importance (higher value)** (**Table 4.4**).

Plate 4.7 Representative image of site B3 on the Rapemills River, August 2022 (facing downstream from bridge)

4.1.8 Site B4 – Rapemills River, Cush

Site B4 was located on the Rapemills River, approx. 1.1km downstream of site B3 (Boolinarig Bridge). The lowland depositing river (FW2) had been extensively historically straightened and deepened throughout, with resulting poor hydromorphology, poor connectivity and poor instream recovery. The river averaged a homogenous 3-4m wide and 0.5-1m deep, with locally deeper glide and pool to 2m. The clay-dominated banks were up to 2m high throughout. The profile was dominated by very slow-flowing depositional glide throughout and this had resulted in a bed comprised almost entirely of deep silt (often >0.5m deep). Widespread livestock poaching also contributed to the silt loads. Hard substrata were almost entirely absent for long sections upstream and downstream of the survey site. Sand accumulations (with a high silt component) were occasional near faster flowing areas. Gravels, where present, were heavily bedded in silt. The river was also very heavily vegetated with >95% cover of macrophytes including frequent branched bur-reed, fool's watercress and water mint, with occasional watercress. Blue water speedwell, ivy-leaved duckweed, common duckweed and water starwort (*Callitriche* sp.) were all occasional. Stands of iris and floating sweet grass (*Glyceria fluitans*) were occasional both instream and along channel margins. Filamentous algae were frequent (*Cladophora* sp.), indicative of the high nutrient conditions. The narrow riparian zones (historically cleared) supported a typical low-diversity nitrophilous community dominated by reed canary grass with occasional meadowsweet (*Filipendula ulmaria*), great willowherb and scattered grey willow. The site was bordered by improved agricultural grassland (GA1) with coniferous afforestation present to the north (WD3).

Brown trout, lamprey (*Lampetra* sp.) and three-spined stickleback were recorded via electro-fishing at site B4 (**Appendix A**). The site was a poor salmonid habitat given gross siltation and very poor hydromorphology, supporting a very low density of adult brown trout only (no juveniles). Salmonid spawning habitat was not present given siltation pressures, with nursery habitat also of poor quality. The site had some value as a holding habitat given the predominance of deep glide with frequent scoured banks and overhanging vegetation (providing valuable thermal refugia in the near absence of riparian trees). Whilst the site featured abundant soft sediment, few areas were considered optimal for lamprey ammocoetes given poor flows/hydromorphology, However, a low density of ammocoetes were recorded from localised faster-flowing areas (typically associated with instream debris). Despite some low suitability for European eel and white-clawed crayfish, none were recorded. No otter signs were recorded in vicinity of the site (poor marking opportunities).

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 Annex II *Lampetra* sp., the aquatic ecological evaluation of site B4 was of **local importance (higher value)** (**Table 4.4**).

Plate 4.8 Representative image of site B4 on the Rapemills River, August 2022

4.1.9 Site B5 – West Galros Stream, Eglish

Site B5 was located on the upper reaches of the West Galros Stream (25W44). The stream had been extensively straightened and over-deepened historically (peat drainage) and represented a canal habitat throughout with no observable flow. The heavily modified U-shaped channel featured bankfull heights of 2-2.5m and averaged 5-6m wide and 1.5-1.8m deep. The bed comprised exclusively clay-dominated silt, with very steeply-sloping clay banks. Clay agglomerations (from bank slumping) were frequent instream. Macrophyte cover was low within the channel given historical excavations. However, the canalised channel was fringed by narrow stands of common reed with very occasional water mint and common duckweed. Greater bladderwort (*Utricularia vulgaris* agg.) was present but rare. The liverwort *Pellia endiviifolia* was frequent on the sloping clay banks. The riparian zone supported abundant herbaceous vegetation including bramble, purple loosestrife, meadowsweet, hedge bindweed, common knapweed (*Centaurea nigra*), bracken and common reed. To the west the channel was lined by very dense (impenetrable) scrubby woodland of downy birch and grey willow. Coniferous afforestation was present upstream. Cutover bog (PB4), with two mature peat settlement ponds, bordered the site to the north.

Electro-fishing was not undertaken at site B5 given prohibitive depths of >1.5m and a deep silt base. With the exception of three-spined stickleback, site B5 was of poor fisheries value given poor hydromorphology, low flows and heavy siltation. However, whilst salmonid spawning and nursery habitat was absent, the site had some low value as a holding habitat for adult trout given the high average depth. Suitability for European eel was high. Whilst no white-clawed crayfish were recorded by sweep netting, burrows in the soft clay banks were evident and frequent throughout the site. Furthermore, the remains of an adult crayfish was identified on the sloping clay banks (possible otter prey remains, see Plate 4.10). In light of the crayfish prey resource, otter suitability was good although no otter signs were recorded in the vicinity of the site (no marking opportunities).

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 presence of Annex II white-clawed crayfish, in addition to suitability for Red-listed European eel and Annex II otter, the aquatic ecological evaluation of site B5 was of **local importance (higher value)** (**Table 4.4**).

Plate 4.9 Representative image of site B5 on the upper reaches of the West Galros Stream, August 2022

Plate 4.10 Remains of an adult white-clawed crayfish on the sloping clays banks of site B5

4.1.10 Site B6 – West Galros Stream, N62 road crossing

Site B6 was located on the West Galros Stream at the N62 road crossing, approx. 0.5km downstream of site B5. The stream had been extensively straightened and over-deepened historically and represented a canal habitat upstream of the road culvert. Downstream, given a slight gradient, the stream featured slight flow (as opposed to imperceptible flow upstream). The heavily modified U-shaped channel featured bankfull heights of 1.5-2m and averaged 5-6m wide and 1.5-2m deep. The bed comprised exclusively clay-dominated silt, with steeply-sloping clay banks. Clay agglomerations (from bank slumping) were frequent instream. Some localised sand and peat (silt) accumulations were present downstream (alongside abundant fly tipping and instream trash). Macrophyte cover was low within the channel given historical excavations. However, the canalised channel was fringed by narrow stands of common reed with frequent broad-leaved pondweed. Water starwort (*Callitriche* sp.) was present but rare. The liverwort *Pellia endiviifolia* was frequent on the sloping clay banks. The channel was bordered by herbaceous vegetation supporting purple loosestrife, meadowsweet, hedge bindweed, common reed and rank grasses, with scattered bracken scrub (HD1). Blackthorn and grey willow were scattered along the channel. The site was bordered by an immature plantation (WS2) of sycamore on the south bank with scrub on the north. Cutover bog (PB4) was present upstream.

Electro-fishing was not undertaken at site B6 given prohibitive depths of >1.5-2m. With the exception of three-spined stickleback, site B5 was of poor fisheries value given poor hydromorphology, low flows and heavy siltation. However, whilst salmonid spawning and nursery habitat was absent, the site had some low value as a holding habitat for adult trout given the high average depth. Suitability for European eel was high. Whilst no white-clawed crayfish were recorded by sweep netting, burrows in the soft clay banks were evident and frequent throughout the site (as per upstream site B5). In light of this prey resource, otter suitability was good although no signs were recorded in the vicinity of the site (poor marking opportunities).

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 suitability for Annex II white-clawed crayfish, Annex II otter and Red-listed European eel, the aquatic ecological evaluation of site B6 was of **local importance (higher value)** (**Table 4.4**).

Plate 4.11 Representative image of site B6 on the West Galros Stream, August 2022 (facing upstream from road crossing)

4.1.11 Site B7 – West Galros Stream, Cush

Site B7 was located on the West Galros Stream approx. 0.6km downstream of B6 and 0.8km upstream of the Rapemills River confluence. The lowland depositing stream (FW2) represented a drainage channel and had been extensively historically straightened and deepened throughout, with resulting poor hydromorphology, poor connectivity and poor instream recovery. The stream had a trapezoidal shape and averaged a homogenous 2.5m wide and 0.6-0.8m deep with approx. 2m bankfull heights. Flows were imperceptible at the time of survey. The substrata consisted of a 0.2m deep layer of peat-derived silt on top of a compacted clay / gravel bed. The site supported a very high coverage of macrophytes dominated by common reed with rare water mint, water starwort (*Callitriche* sp.) and common duckweed. Shading was high. The liverwort *Pellia endiviifolia* was occasional on the steeply-sloping banks. The riparian zone supported scattered willow, great willowherb, hedge bindweed and wild angelica (*Angelica sylvestris*). The stream was bordered by improved grassland (GA1), cutover bog (PB4) and coniferous afforestation (WD3).

Three-spined stickleback was the only species recorded via electro-fishing at site B7 (**Appendix A**). With the exception of low densities of three-spined stickleback, the site was not of fisheries value given poor hydromorphology, low flows and heavy siltation, in addition to poor connectivity with downstream habitats. No white-clawed crayfish were recorded by sweep netting and suitability was poor (much improved upstream). 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 poor status water quality, the aquatic ecological evaluation of site B7 was of **local importance (lower value)** (**Table 4.4**).

Plate 4.12 Representative image of site B7 on the West Galros Stream, August 2022

4.1.12 Site B8 – Rapemills River, R439 road crossing

Site B8 was located on the Rapemills River at the R439 road and proposed GCR crossing, approx. 2km downstream of site B4 and at the confluence with a small unmapped stream. With the exception of some local bank modifications in vicinity of the pipe culvert and along the roadside, the river had not been modified and retained a largely natural profile. The upland eroding watercourse (FW1) averaged 4m wide and 0.3-0.6m deep. Downstream of the road crossing, the profile of the high energy site was dominated by swift glide with occasional small pool and localised riffle. The substrata were dominated by boulder and cobble, with only localised interstitial mixed gravels. These were compacted due to high flows and also heavily calcified (with cyanobacterial crusts). With the exception of the road culvert area, soft sediment deposits were not present and siltation was low overall (in stark contrast to upstream sites). Livestock poaching was present downstream of the survey site. Due to high flows and high shading, macrophyte growth was sparse and limited to occasional fool's watercress, water mint and lesser water parsnip (including the submerged form of the latter). However, the site featured a high coverage of aquatic bryophytes (70%) with abundant *Leptodictyum riparium* and *Pellia endiviifolia*. *Rhynchostegium riparioides* was present but rare overall. The site was shaded on the west bank by a narrow mature treeline of sycamore, ash, elder and hawthorn. Upstream of the culvert, the channel was heavily scrubbed (also with mature trees). The site was bordered by the R498 road and improved agricultural grassland (GA1).

Brown trout was the only species recorded via electro-fishing at site B8 (**Appendix A**). The site was of high value for salmonids, supporting a moderate density of mixed-cohort brown trout. The site was considered a good quality salmonid nursery although the value was reduced given the paucity of accessible instream refugia due to calcification of the bed. Spawning habitat was largely absent given compaction and calcification of the substrata. Some excellent quality holding habitat was present in deeper shaded pool and glide areas, many of which were adjoined by scoured banks and tree root systems. These areas also provided good refugia for European eel although none were recorded via electro-fishing. Suitability for lamprey was low due to the high energy nature of the site and more flocculent nature of any soft sediment deposits. The site provided some suitability for white-clawed crayfish although the poor accessibility of many cobble and boulder refugia reduced the value considerably. Environmental DNA sampling at the site did not detect white-clawed crayfish but did detect crayfish plague (**Table 4.1**). Despite good suitability, 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 A**). 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 high otter suitability, the aquatic ecological evaluation of site B8 was of **local importance (higher value) (Table 4.4).**

Plate 4.13 Representative image of site B8 on the Rapemills River, August 2022 (facing downstream from road culvert)

4.1.13 Site B9 –Mullaghakaraun Bog Stream, Ballyneena

Site B9 was located on the Mullaghakaraun Bog Stream (25M48) at the R439 road and proposed GCR crossing, approx. 1.3km upstream of the Rapemills River confluence. The small upland eroding stream (FW1) had been historically straightened in the vicinity of the bridge but not elsewhere. The stream suffered from low seasonal flows at the time of survey and flowed over a slight gradient in a shallow U-shaped channel (1m bank heights). The stream averaged 2-2.5m wide and 0.1-0.15m deep, with only very localised deeper areas (maximum of 0.3m). The profile was of very slow-flowing glide with occasional near-stagnant pool. Given low water levels, glide habitat had become riffle-like near the bridge (box culvert). The substrata were dominated by angular cobble and boulder in the vicinity of the bridge although deep soft sediment deposits were abundant elsewhere. These areas had a very high content of leaf litter and woody debris. Mixed gravels were present downstream of the bridge but highly localised and heavily silted. Siltation was high (exacerbated by low seasonal flows) with low levels of calcification also present. Given high shading upstream of the bridge, macrophytes and aquatic bryophytes were absent. However, downstream of the bridge (and a livestock access point), fool's watercress and branched bur-reed was occasional. The stream was heavily shaded by mature sycamore and hazel dominated treelines upstream of the bridge, with abundant bramble and ivy scrub. Downstream, due to historical clearance, the narrow riparian zones supported herbaceous vegetation and bramble scrub. The site was bordered by improved pasture (GA1).

Lamprey (*Lampetra* sp.) and ten-spined stickleback were the only to fish species recorded via electro-fishing at site B9 (**Appendix A**). The site was of poor value for salmonids (none recorded) given evident siltation and hydromorphological pressures (i.e. poor seasonal flows, forestry upstream etc.). Despite some low suitability as a brown trout nursery and holding habitat, none were recorded via electro-fishing. Likewise, no European eel were recorded despite some low suitability. The site was of moderate value for *Lampetra* sp., with a low density (4.6 per m^2) of ammocoetes recorded from deep organic-rich soft sediment upstream of the bridge. However, the site was considered sub-optimal for the species given low seasonal flows and a lack of spawning gravels (siltation). Site B9 supported juvenile white-clawed crayfish (hatchlings) which were recorded at low densities in angular cobble and boulder nursery habitat. 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**). 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 Annex II *Lampetra* sp. and Annex II white-clawed crayfish, the aquatic ecological evaluation of site B9 was of **local importance (higher value)** (**Table 4.4**).

Plate 4.14 Representative image of site B9 on the Mullaghakaraun Bog Stream, August 2022 (upstream of road crossing)

4.1.14 Site B10 – Rapemills River, All Saints Bridge

Site B10 was located on the Rapemills River at All Saints Bridge (R468 road crossing). As per upstream, the lowland depositing river (FW2) had been historically straightened and deepened throughout. The canalised channel averaged 6-7m wide and >1.2m deep, with shallower areas in the vicinity of the bridge only (0.7m). Deep, very slow-flowing glide predominated with deeper areas representing pool habitat. Riffles were absent. The site was very heavily silted, with deep deposits on the bed of up to 0.2m deep. Harder substrata were limited to localised mixed gravels and very occasional boulder and cobble on the rendered bridge apron. These were heavily silted and also calcified. The site was heavily vegetated with abundant branched-bur-reed with frequent lesser water parsnip and ivy-leaved duckweed. Water starwort (*Callitriche* sp.), fool's watercress and water mint were present occasionally. The liverwort species *Pellia endiviifolia* and *Riccardia chamedryfolia* were present locally.

Filamentous algae coverage was high (>30%) indicating significant enrichment. The riparian zones supported abundant common reed, hedge bindweed, cleavers (*Galium aparine*) and nettle (*Urtica dioica*) with scattered hawthorn, grey willow and osier (*Salix viminalis*). The site was bordered by improved grassland (GA1) and cutover bog (PB4).

Brown trout, European eel, three-spined stickleback and minnow were recorded via electro-fishing at site B10 (**Appendix A**). The site was of moderate value for salmonids only given hydromorphological and gross siltation pressures. The site supported a very low density of adult brown trout, with no juveniles recorded. Spawning habitat was almost entirely absent and sub-optimal where present given calcification and siltation of the bed. The site was not of value as a salmonid nursery (i.e. more suited to coarse fish). European eel habitat was of good quality given abundant instream refugia. However, only a single large adult eel (62.4cm TL) was recorded via electro-fishing. Despite abundant soft sediment deposits, no lamprey ammocoetes were recorded. This was considered reflective of low flows at the (depositional) site. Despite some good suitability, no white-clawed crayfish were recorded. Otter suitability was high although no signs were recorded in the vicinity of the bridge (few marking opportunities).

Biological water quality, based on Q-sampling, was calculated as **Q3-4 (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 Red-listed European eel, in addition to high otter suitability, the aquatic ecological evaluation of site B10 was of **local importance (higher value) (Table 4.4).**

Plate 4.15 Representative image of site B10 on the Rapemills River at All Saints Bridge, August 2022 (taken from bridge, facing upstream)

4.1.15 Site B11 – Milltown Stream, Ballyneena

Site B11 was located on the upper reaches of the Milltown Stream (25E18) at the R439 road and proposed GCR crossing, approx. 1.5km upstream of the Rapemills River confluence. The channel had been locally straightened and deepened and was dry at the time of survey. The deep U-shaped channel averaged 3m wide with bankfull heights of up to 2m. The bed featured damp mud with frequent scattered cobble and boulder with localised mixed gravels. The presence of dried-out cased caddis species (Glossosomatidae and Sericostomatidae) within the channel, in addition to bank scouring, was indicative of an ephemeral/seasonal watercourse. The site was bordered by mature linear mixed broad-leaved woodland (WD1) supporting ash, hazel, hawthorn, and sycamore with adjoining improved pasture (GA1).

Site B11 was not of fisheries value at the time of survey given its dry, ephemeral nature and absence of aquatic habitats. However, there was some low physical habitat suitability for salmonids and European eel under higher flow periods and such species may migrate from the downstream-connecting Rapemills 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 B11 was of **local importance (lower value) (Table 4.4).**

Plate 4.16 Representative image of site B11 on the Milltown Stream, August 2022 (downstream of road culvert)

4.1.16 Site B12 – Feeghroe River, Five Roads Cross

Site B12 was located on the Feeghroe River (25F41) at Five Roads Cross on the R438, a proposed GCR crossing. The river had been historically straightened and deepened and also recently realigned (2021) with the installation of an upgraded precast box culvert under the R438 road (Plate 4.17). The lowland depositing river (FW2) suffered from low flows at the time of survey and averaged 2-2.5m wide and 0.2-0.4m deep. The rendered culvert apron was 0.6m deep. The profile was of very slow-flowing glide (near imperceptible flow) with steep, unstable (slumping) banks up to 2m in height. The river was heavily silted throughout (given that it drained cutover bog upstream) with peat-dominated silt deposits of up to 0.3m deep on the bed. Whilst mixed gravels and cobbles were present historically between the R438 and Shannon Harbour road (Triturus, 2019), these had been excavated during culvert installation and hard substrata were no longer present. The heavily-silted channel supported sparse growth of macrophytes although some lesser pondweed (*Potamogeton pusillus*) was present in addition to very occasional branched bur-reed and water starwort (*Callitriche* sp.). Aquatic bryophytes were absent. The modified riparian zones supported grey willow and blackthorn with bramble scrub. The site was bordered by local roads with scrub (WS1) and improved pasture (GA1), with cutover bog (PB4) present upstream.

Brown trout, three-spined stickleback and ten-spined stickleback were recorded via electro-fishing at site B12 (**Appendix A**). The site was of moderate value only for salmonids given gross siltation (from peat escapement), poor hydromorphology and poor seasonal flows. However, the site supported a small population of adult brown trout, with the box culvert providing some suitable holding habitat. Spawning substrata were absent from the site (present in 2019) and nursery habitat was very poor. Suitability for European eel was also poor (none recorded). Poor flows and peat-dominated substrata precluded the presence of lamprey. Despite gross siltation and poor suitability, white-clawed crayfish were present, with a low density of juveniles recorded via hand-searching of silt and woody debris refugia (no other refugia present). No otter signs were recorded in the vicinity of the bridge and suitability was poor.

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 presence of salmonids and Annex II white-clawed crayfish, the aquatic ecological evaluation of site B12 was of **local importance (higher value)** (**Table 4.4**).

Plate 4.17 Representative image of site B12 on the Feeghroe River at Five Roads Cross, August 2022 (facing upstream to upgraded box culvert)

4.1.17 Site B13 – Rapemills River, Lusmagh Bridge

Site B13 was located on the lower reaches of the Rapemills River at Lusmagh Bridge, approx. 4.4km downstream of site B7 and 1.2km upstream of the River Shannon confluence. The lowland depositing river (FW2) had been straightened, deepened and realigned historically and flowed in an open channel with low-lying banks (up to 2m high). The river averaged a homogenous 6-8m wide and >1.5m deep. Shallower water (ranging from 0.2-0.5m) was present in the vicinity of the bridge. The substrata comprised of cobble and boulder with occasional coarse gravels that were heavily silted. Elsewhere, in deeper, more depositing habitat, the bed was dominated by silt with occasional boulder. Siltation was high overall. Calcification of hard substrata was also evident. Given the site characteristics, macrophyte growth was diverse and profuse with frequent unbranched bur-reed (*Sparganium emersum*), lesser water parsnip and water starwort (*Callitriche* sp.). Common clubrush (*Schoenoplectus lacustris*), blue water speedwell, fool's watercress, water mint and invasive Canadian pondweed (*Elodea canadensis*) were all occasional. Beds of yellow lily (*Nuphar lutea*) were present in deeper glide upstream and downstream of the bridge. Amphibious bistort (*Persicaria amphibia*) and water plantain (*Alisma plantago-aquatica*) were present but rare. The margins supported abundant reed canary grass with occasional iris and water forget-me-not (*Myosotis scorpioides*) with great yellow cress (*Rorippa amphibia*) being rare. Aquatic bryophyte coverage was low overall although the harder substrata in vicinity of the bridge supported *Leptodictyum riparium* and rare *Fontinalis antipyretica*. Filamentous algae and floc[3] were abundant, indicating significant enrichment. The banks were typically open and grazed with occasional patches of bramble scrub with scattered hawthorn.

[3] 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)

The site was bordered by agricultural grassland (GA1), with frequent livestock poaching. A total of n=6 species were recorded via electro-fishing at site B13, namely brown trout, European eel, minnow, three-spined stickleback, stone loach and pike (*Esox lucius*) (**Appendix A**). This was the highest fish species diversity recorded during the survey. The site was of moderate value to salmonids, supporting a low density of primarily adult brown trout. The predominant deeper glide habitat provided some good holding habitat for large trout (e.g. overhanging aquatic vegetation). Some limited nursery habitat was present in the vicinity of the bridge but this was reduced in value given significant siltation pressures. Spawning habitat for salmonids and lamprey was also confined to the bridge area and also impacted by siltation and filamentous algae. Despite abundant soft sediment, no larval lamprey were recorded. The site was of most value for coarse fish habitat given the predominance of heavily vegetated, depositional glide and pool. European eel habitat was good overall given abundant instream refugia (mostly macrophyte beds), although only a low density were recorded via electro-fishing. Despite some suitability for white-clawed crayfish, none were recorded from boulder and cobble refugia via hand searching. 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 location of the site within the River Shannon Callows SAC (000216) and Middle Shannon Callows SPA (004096), the aquatic ecological evaluation of site B13 was of **international importance** (**Table 4.4**). The site also supported salmonids and Red-listed European eel.

Plate 4.18 Representative image of site B13 on the lower reaches of the Rapemills River at Lusmagh Bridge, August 2022 (facing downstream from bridge)

4.1.18 Site C1 – Whigsborough Stream, Clooneen

Site C1 was located on the Whigsborough Stream (25W43) at a local road crossing approx. 1.7km north-east of the proposed site boundary. The small stream had been historically straightened and deepened with resulting poor hydromorphology. The stream represented a peat drainage channel and averaged 1-1.5m wide and <0.1m deep with no flows at the time of survey (stagnant pools only). The substrata comprised exclusively deep peat-derived silt, with deposits up to 1m in depth. Peat blockages to flow were frequent instream resulting in intermittent fluvial connectivity. Given very high shading, macrophytes were limited to occasional water mint, fool's watercress and common duckweed in more open areas of channel. Aquatic bryophytes were not recorded. Terrestrial encroachment of the channel was high with abundant reed canary grass, great willowherb and bramble along channel margins. The site was located in an area of heavily-scrubbed, wet mixed broad-leaved woodland supporting abundant sycamore with ash, hawthorn, alder, hazel, elder and grey willow. Coniferous plantations (WD3) were present upstream.

No fish species were recorded via electro-fishing at site C1 (**Appendix A**). The site was not of fisheries value given gross siltation, poor hydromorphology and low flows, in addition to poor connectivity with downstream habitats (frequent peat blockages instream). No white-clawed crayfish were recorded by sweep netting and there was no suitability. 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 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 poor status water quality, the aquatic ecological evaluation of site C1 was of **local importance (lower value)** (**Table 4.4**).

Plate 4.19 Representative image of site C1 on the Whigsborough Stream, August 2022

4.1.19 Site D1 – Grant's Island River, L7014 road crossing

Site D1 was located on the Grant's Island River (25W43) at a local road and proposed GCR crossing approx. 0.8km upstream of the confluence with a River Shannon backwater (i.e. Bullock Island). The small channel had been historically straightened and deepened with resulting poor hydromorphology and evidently intermittent flows. The river represented a peat drainage channel and averaged <1.5m wide and <0.1m deep with no flows at the time of survey (stagnant pools only). The substrata comprised exclusively deep peat-derived silt, with deposits up to 0.5m in depth. Peat and large woody debris blockages to flow were frequent instream resulting in intermittent fluvial connectivity with the River Shannon. Given very high shading, macrophytes were limited to occasional water mint in more open areas of channel. Aquatic bryophytes were not recorded. The site was located in an area of dense (often impenetrable) wet willow-dominated woodland, with abundant osier, grey willow and bramble scrub. The site was bordered by improved (often wet) pasture (GA1).

No fish species were recorded via electro-fishing at site D1 (**Appendix A**). The site was not of fisheries value given gross siltation, poor hydromorphology and low flows, in addition to poor connectivity with downstream habitats (frequent blockages instream). No white-clawed crayfish were recorded by sweep netting and there was no suitability. No otter signs were recorded in the vicinity of the site.

Biological water quality, based on Q-sampling, was calculated as **Q1 (bad 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 location of the site within the River Shannon Callows SAC (000216) and Middle Shannon Callows SPA (004096), the aquatic ecological evaluation of site D1 was of **international importance** (**Table 4.4**). However, the site supported poor quality aquatic habitats and bad status water quality.

Plate 4.20 Representative image of site D1 on the Grant's Island River, August 2022

4.1.20 Site D2 –Bullock Island Stream, L7014 road crossing

Site D2 was located on the Bullock Island Stream (25I23) at a local road and proposed GCR crossing, approx. 0.7km upstream of the confluence with a River Shannon backwater (i.e. Bullock Island). The stream had been extensively straightened and deepened historically and represented a drainage channel that was dry at the time of survey. However, the damp mud base supporting planorbid snails and the presence of macrophyte species such as common duckweed, indicated the channel held water in the recent past, i.e. an ephemeral channel which can dry out seasonally. The 1.5m wide U-shaped channel supported occasional stands of iris, lesser water parsnip, water mint and fool's watercress instream. The nationally uncommon greater water parsnip (*Sium latifolium*) was also recorded downstream of the road crossing (ITM 603093, 717714). The channel was heavily shaded by a mature treeline of grey willow and osier, with abundant bramble, nettle, ivy and dog rose scrub. The site was bordered by improved grassland (GA1).

Site D2 was not of fisheries value at the time of survey given its dry, ephemeral nature and absence of aquatic habitats. However, given evidence that it supports water seasonally, the channel may be of some low value as a coarse fish and European eel habitat during (winter) higher water 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 location of the site within the River Shannon Callows SAC (000216) and Middle Shannon Callows SPA (004096), the aquatic ecological evaluation of site D2 was of **international importance** (**Table 4.4**). However, aquatic habitats were absent in the ephemeral channel at the time of survey and the site was not of any aquatic value.

Plate 4.21 Representative image of site D2 on the Bullock Island Stream, August 2022 (dry channel)

4.1.21 Site D3 – Park River, L7014 road crossing

Site D3 was located on the Park River (25P28) at a local road and proposed GCR crossing, approx. 0.7km upstream of the confluence with a River Shannon backwater. The stream had been extensively straightened and deepened historically and represented a drainage channel that was dry at the time of survey. However, the damp mud base and presence of macrophyte species indicated an ephemeral channel which can dry out seasonally. The 2-3m wide U-shaped channel supported abundant wetland herbaceous vegetation including frequent bulrush, water mint, water horsetail (*Equisetum fluviatile*) and occasional lesser water parsnip and water forget-me-not. The riparian areas supported abundant reed sweet grass (*Glyceria maxima*). Terrestrial encroachment was high with frequent grey willow, great willowherb, iris, marsh woundwort (*Stachys palustris*), wild angelica and meadowsweet within the channel. The site was bordered by wet improved grassland (GA1).

Site D3 was not of fisheries value at the time of survey given its dry, ephemeral nature and absence of aquatic habitats. However, given evidence that it supports water seasonally, the channel may be of some low value as a coarse fish and European eel habitat in its lower reaches during (winter) higher water 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 location of the site within the River Shannon Callows SAC (000216) and Middle Shannon Callows SPA (004096), the aquatic ecological evaluation of site D3 was of **international importance** (**Table 4.1**). However, aquatic habitats were absent in the ephemeral channel at the time of survey and the site was not of any aquatic value.

Plate 4.22 Representative image of site D3 on the Park River, August 2022 (dry, ephemeral channel)

4.1.22 Site D4 – Grand Canal, Griffith Bridge

Site D4 was located on the Grand Canal at Griffith Bridge near Shannon Harbour at a local road and proposed GCR crossing, approx. 1km from the River Brosna/Shannon confluence. The canal (FW3) averaged 14-18m wide and >2m deep. In the vicinity of the bridge the canal banks had been modified with retaining (quay) walls on either bank (i.e. a harbour). However, a more natural bank form was present eastwards of the bridge. The substrata were dominated by silt and clay with occasional boulder and cobble. Typical of the canal, the site supported a diverse range of macrophytes including frequent spiked water-milfoil (*Myriophyllum spicatum*) and arrowhead (*Sagittaria sagittifolia*). Beds of yellow lily, whorled water-milfoil (*M. verticillatum*), shining pondweed (*Potamogeton lucens*), broad-leaved pondweed, water starwort (*Callitriche* sp.), mare's-tail (*Hippuris vulgaris*) and the non-native invasive Nuttall's pondweed (*Elodea nuttallii*) were all occasional. Greater bladderwort (*Utricularia vulgaris* agg.) and the nationally scarce rigid hornwort (*Ceratophyllum demersum*) were present but rare. Shallower littoral areas supported water plantain and bottle sedge (*Carex rostrata*) with riparian fringes dominated by reed sweet grass, common reed and common clubrush. The moss *Fontinalis antipyretica* was abundant on quay walls, with occasional *Platyhypnidium riparioides*. Filamentous algal mats were present along the channel margins. The narrow riparian zones were dominated by amenity grassland (GA2) and towpaths (BL3) although strips of dry meadows habitat (GS2) supporting herbaceous vegetation were present. The site was bordered by buildings (BL3), improved pasture (GA1) and scattered treelines of sycamore, ash and willow species.

Electro-fishing was not undertaken at site C4 given prohibitive depths of >1.5-2m. Site D4 was of high value to European eel and a range of coarse fish species. The site was of highest value as a coarse fish spawning and nursery habitat given an abundance of macrophytes. The site was not considered of value to salmonids given poor connectivity with the River Shannon and River Brosna (i.e. upstream of 36th lock). Suitability for white-clawed crayfish was high and eDNA analysis detected the species at the site (see section 4.3). However, crayfish plague eDNA was also detected in the sample. Despite some good foraging and commuting suitability, no otter signs were recorded in vicinity of the bridge.

The canal site 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**). The invasive zebra mussel (*Dreissena polymorpha*) was locally abundant at the site, with a low abundance of the non-native amphipod *Chelicorophium curvispinum*.

Given the location of the site within the Grand Canal pNHA (002104), the aquatic ecological evaluation of site D4 was of **national importance** (**Table 4.1**). The site was of high value for Red-listed European eel and coarse fish and also supported Annex II white-clawed crayfish (detected via eDNA analysis).

Plate 4.23 Representative image of site D4 on the Grand Canal at Griffith Bridge, August 2022 (facing westwards from bride)

4.1.23 Site D5 – Little River, L7014 road crossing

Site D5 was located on the Little [Cloghan] River (25L01) at the L7014 road and proposed GCR crossing, approx. 0.5km upstream of the River Brosna confluence. The lowland depositing watercourse (FW2) had been extensively straightened and over-deepened in the vicinity of the road crossing, with a deep trapezoidal bank and 3m bankfull heights. The river averaged 2-2.5m wide and 0.2-0.4m deep. The water width reduced to <1.5m downstream of the bridge in a heavily vegetated channel of up to 3m wide. The profile comprised slow-flowing glide with frequent small pool. Riffle was confined to a short section upstream of the bridge (resulting from instream debris). The substrata were dominated by mixed gravels and cobble with frequent boulder. However, these were heavily silted and soft sediment deposits were abundant throughout, particularly in deeper depositional glide downstream of the road crossing. Sediment accumulations were humic in nature and featured a high proportion of leaf litter and woody debris. Upstream of the bridge, macrophyte growth was limited to marginal stands of fool's watercress with occasional water mint. Downstream, the river was more heavily vegetated with abundant branched bur-reed and reed sweet grass instream, in addition to abundant water mint and frequent fool's watercress. Water forget-me-not was occasional. Common duckweed was present but confined to pool areas. Aquatic bryophytes were limited to occasional *Pellia* sp. The steeply-sloping banks supported abundant herbaceous vegetation comprising hedge bindweed, nettle, hogweed (*Heracleum sphondylium*), great willowherb and purple loosestrife with scattered sycamore and willow. Dense hawthorn, blackthorn and willow hedgerows (WL1) lined the channel upstream, providing a greater degree of shading compared with downstream. The site was bordered by improved agricultural grassland (GA1) and private residential areas.

A total of *n*=6 species were recorded via electro-fishing at site D5, namely brown trout, lamprey (*Lampetra* sp.), European eel, minnow, stone loach and roach (*Rutilus rutilus*) (**Appendix A**). This was the highest fish species diversity recorded during the survey. Site D5 was of moderate value to salmonids only given significant siltation pressures and poor hydromorphology resulting from historical arterial drainage. However, the site supported a low density of adult brown trout. Spawning habitat for both salmonids and lamprey was present but highly localised and significantly impacted by siltation. Occasional deeper pool and deeper glide habitat provided some good holding opportunities for adult trout. The site was a poor quality salmonid nursery, as reflected in the absence of juveniles recorded during electro-fishing. In contrast, the site was of high value as a lamprey nursery, with high densities of larvae recorded from abundant soft sediment areas (average >10 per m^2). European eel habitat was moderate overall, with a low density present. The site was of greater value as a coarse fish habitat and supported roach, stone loach and minnow. Despite some low suitability for white-clawed crayfish, none were recorded. No otter signs were recorded in the vicinity of the bridge. However, a non-native mink (*Neovison vison*) spraint site was recorded on a marginal boulder upstream of the bridge.

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, Annex II *Lampetra* sp. and Red-listed European eel, the aquatic ecological evaluation of site B12 was of **local importance (higher value)** (**Table 4.4**).

Plate 4.24 Representative image of site D5 on the Little River, August 2022 (facing downstream towards bridge)

4.1.24 Site D6 – River Brosna, Moystown Bridge

Site D6 was located on the River Brosna (25B09) at Moystown Bridge at the R357 road and proposed GCR crossing, approx. 4km upstream from the River Shannon confluence. With the exception of some local bank modifications (e.g. boulder revetment) in the vicinity of the bridge, the large lowland depositing watercourse (FW2) was natural in profile. The river averaged 20-25m wide and 0.5-0.8m deep, with frequent small pool to 1.4m in association with natural boulder and bedrock. The profile comprised swift-glide and pool with riffle present downstream of the rendered bridge apron. The substrata of the undulating, high-energy site were dominated by calcareous bedrock and cobble with frequent large boulder. However, these were heavily calcified and compacted. Localised patches of fine and medium gravels with some sands were present in pool slacks but these were rare. Soft sediment deposits were frequent along treelined margins (sand dominated). Siltation was low overall given high flow rates. Macrophyte growth was largely restricted to channel margins, with occasional small stands of heterophyllous common clubrush instream. The margins supported abundant reed canary grass with occasional branched bur-reed and common clubrush in addition to water mint, lesser water parsnip and water forget-me-not. Great yellow cress was also occasional. The site was dominated by aquatic bryophytes with very high coverage of *Rhynchostegium riparoides* and frequent *Fontinalis antipyretica.* The mosses *Leptodictyum riparium* and *Fissidens crassipes* were present but rare overall. The liverwort species *Pellia endiviifolia* and *Riccardia chamedryfolia* were locally frequent along channel margins. The river was lined by mature treelines dominated by grey willow, with frequent ash and sycamore. The site was bordered by improved pasture (GA1).

Electro-fishing was not undertaken at site D6 given the large width, prohibitive depths and high flow rates. However, the site was of high value for salmonids being most suited to adults given a predominance of deeper glide and pool. Overhanging willow-dominated treelines provided valuable shading and cover. Whilst some spawning substrata was present for both salmonids and lamprey, this was highly localised (rare overall). Salmonid nursery habitat was superficially good although closer inspection of instream substrata revealed a paucity of accessible refugia due to substrate compaction and calcification. Furthermore, macrophyte refugia cover was low. The high-energy site was largely unsuitable as a lamprey nursery habitat (high flow rates), though some sub-optimal habitat was present away from main flow channels. The site was of relatively poor value for European eel given a paucity of instream refugia. However, the River Brosna is known to support European eel in addition Atlantic salmon, brown trout, lamprey (*Lampetra* sp.), minnow and stone loach (Kelly et al., 2010, 2015). Two gudgeon (*Gobio gobio*) were recorded during kick sampling. Suitability for white-clawed crayfish was moderate, at best, given a paucity of instream refugia. None were recorded via hand-searching. A single otter spraint site was recorded on a marginal boulder underneath the eastern arch of the bridge (ITM 604731, 720911, no crayfish remains identified).

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 suitability for salmonids, Red-listed European eel, Annex II *Lampetra* sp. and utilisation by Annex II otter, the aquatic ecological evaluation of site D6 was of **local importance (higher value) (Table 4.4).**

Plate 4.25 Representative image of site D6 on the River Brosna at Moystown Bridge, August 2022 (facing downstream from bridge)

4.1.25 Site D7 – Blackwater River, Blackwater Bridge

Site D7 was located on the lower reaches of the Blackwater River (25B27) at Blackwater Bridge (R357), a proposed GCR crossing approx. 2km upstream from the River Shannon confluence. The lowland depositing river (FW2) had been extensively straightened and deepened in the vicinity of the bridge. The site featured a trapezoidal channel with steep excavated banks of up to 2.5m. The river suffered from very low flows at the time of survey and averaged a homogenous 6-7m and 0.1-0.3m deep (in a channel of up to 10m wide). The profile was of very slow flowing glide, with small pools created by occasional large woody debris (i.e. fallen trees and debris dams). The river at this location suffered from gross siltation, with deep peat-dominated deposits of up 0.3m deep on the bed. Peat agglomerations were frequent instream. Boulder was present locally but heavily bedded in silt (except on the rendered bridge apron). Given gross siltation and high riparian shading, macrophyte growth was sparse with only very localised yellow lily and variable-leaved pondweed. Scattered fool's watercress, water plantain and water forget-me-not grew along the muddy paludal. Instream bryophytes were absent with abundant *Conocephalum conicum* and *Pellia* sp. on muddy banks. The riparian zones supported mature narrow treelines of ash and hawthorn with occasional sycamore. The site was bordered by improved agricultural grassland (GA1) with cutover bog (PB4) upstream.

A total of *n*=4 fish species were recorded via electro-fishing at site D7, namely brown trout, lamprey (*Lampetra* sp.), minnow and stone loach (**Appendix A**). The site was of very poor value for salmonids given poor hydromorphology and gross siltation. However, a single adult brown trout was recorded via electro-fishing alongside a very low density of stone loach and minnow. The site was of very high value for *Lampetra* sp., with abundant soft sediment habitat and high densities of ammocoetes (>15 per m^2). Lamprey spawning habitat was almost entirely absent in the vicinity of the bridge (superficial gravels at one location only near a debris dam), indicating superior spawning habitat was present upstream. Despite some suitability for European eel, none were recorded. The site had poor suitability for white-clawed crayfish given very high levels of siltation and none were recorded via sweep sampling of hand-searching of instream refugia. However, fresh crayfish remains were identified in otter spraint recorded near the bridge (ITM 601536, 723473). A second otter spraint site (ITM 601536, 723479) was recorded on the bridge ledge (west bank). A third, regular spraint site, containing abundant crayfish remains, with prints, was recorded on a marginal muddy ledge and willow trunk (ITM 601529, 723448). Crayfish burrows were also identified in soft loamy banks.

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 and Annex II *Lampetra* sp., utilisation by Annex II otter and likely presence of Annex II white-clawed crayfish, the aquatic ecological evaluation of site D7 was of **local importance (higher value) (Table 4.4).**

Plate 4.26 Representative image of site D7 on the Blackwater River at Blackwater Bridge, August 2022 (downstream of bridge)

4.1.26 Site E1 – Silver River, Wooden Bridge

Site E1 was located on the Silver River (25S02) at Wooden Bridge, a proposed GCR crossing. The lowland depositing watercourse (FW2) had been extensively straightened and deepened historically, with a deep trapezoidal channel and bankfull heights of up to 5-6m in vicinity of the bridge. However, some good instream recovery was evident. The river averaged 12m wide and 0.3-0.5m deep near the bridge in shallower glide habitat, although upstream and downstream areas were dominated by deeper, depositional glide and pool to 2.5m in depth. In vicinity of the bridge the bed comprised mixed gravels and cobble with frequent sand accumulations and occasional boulder. However, these were heavily silted. Elsewhere, in deeper glide and pool, silt dominated the bed. Siltation was moderate to high overall. The bridge apron was rendered and supported marginal silt beds. The site featured a relatively high cover of macrophytes with frequent stands of common clubrush, unbranched bur-reed and variable-leaved pondweed. Water mint, fool's watercress and blue water speedwell were occasional. Aquatic bryophyte coverage was low with only very occasional *Leptodictyum riparium* and *Riccardia chamedryfolia*. Freshwater sponge (*Porifera* sp.) was occasional on larger boulder and cobble. Filamentous algae and floc cover was high, indicating significant enrichment. The steep banks supported abundant hedge bindweed with iris, water figwort (*Scrophularia umbrosa*), nettle, thistles (*Cirsium* spp.), bramble and scattered grey willow and osier. The site was bordered by improved grassland (GA1).

A total of *n*=5 fish species were recorded via electro-fishing at site E1, namely brown trout, lamprey (*Lampetra* sp.), minnow, three-spined stickleback and stone loach (**Appendix A**). Despite significant siltation pressures, site E1 was of good value to salmonids, supporting a moderate density of primarily adult trout. The site was of most value as an adult trout habitat given an abundance of deep glide with high instream cover. The site was of moderate value as a nursery given compaction of instream refugia. Whilst mixed gravels and small cobble present downstream of the bridge provided some localised spawning habitat for salmonids and lamprey, the value was reduced given siltation pressures. Despite frequent sand and silt accumulations, the site supported only a low density of lamprey ammocoetes (<1 per m^2). Whilst no European eel were recorded, the site provided some good suitability (e.g. deep, macrophyte-rich glide). The site also provided good suitability for white-clawed crayfish but none were recorded via hand-searching. 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 and Annex II *Lampetra* sp., the aquatic ecological evaluation of site E1 was of **local importance (higher value) (Table 4.4).**

Plate 4.27 Representative image of site E1 on the Silver River at Wooden Bridge, August 2022 (facing downstream from bridge)

4.1.27 Site E2 – Silver River, Millbrook Bridge

Site E2 was located on the Silver River at Millbrook Bridge, a proposed GCR crossing approx. 5km downstream of site E1. The lowland depositing watercourse (FW2) had been extensively straightened and deepened historically, with a deep trapezoidal channel and steep bankfull heights of up to 5-6m in vicinity of the bridge. The river averaged 10m wide and 0.5-0.8m deep near the bridge in shallower glide habitat, although upstream and downstream areas featured deeper glide and pool to >2m. In the vicinity of the bridge the bed comprised abundant cobble and frequent boulder with interstitial mixed gravels (including on the bridge apron). Areas of finer gravels were present but sparse. Soft sediment accumulations were occasional along the steeply-sloping margins upstream of the bridge and also in association with frequent instream macrophyte beds. Siltation was moderate to high overall with locally high calcification. The site featured a relatively high cover of macrophytes with frequent stands of heterophyllus common clubrush and variable-leaved pondweed. Unbranched bur-reed was present but rare. Fool's watercress and water mint were very occasional along the rocky margins. The duckweed species *Lemna trisulca* and *L. minor* were present but rare. Aquatic bryophyte coverage was high with abundant *Chiloscyphus polyanthos* and frequent *Fissidens crassipes*. The mosses *Fontinalis antipyretica* and *Leptodictyum riparium* were present but localised. *Riccardia chamedryfolia* was also localised. Freshwater sponge (*Porifera* sp.) was very occasional on larger boulder and cobble. Filamentous algae and floc cover was low to moderate. The steep banks supported dense hedgerows and treelines of sycamore, alder, blackthorn and willow with dense bramble-dominated scrub. The site was bordered by improved grassland (GA1).

A total of *n*=4 fish species were recorded via electro-fishing at site E2, namely Atlantic salmon, brown trout, lamprey (*Lampetra* sp.) and stone loach (**Appendix A**). Site E2 was of good value for salmonids, supporting a moderate density of primarily adult brown trout. A single Atlantic salmon parr was also captured. The site was of highest value as an adult holding habitat given the predominance of deeper glide and pool with frequent macrophyte beds. These areas also provided some good quality nursery although densities of juveniles were low given the reduced spawning capacity of the site due to bedding, siltation and calcification pressures. Nevertheless, some good quality spawning habitat was present locally for both salmonids and lamprey. Good quality larval lamprey habitat was also present locally although these areas supported only low densities of ammocoetes (<4 per m^2). Despite some good suitability for both European eel and white-clawed crayfish, none were recorded, likely reflecting the relative paucity of accessible boulder and cobble refugia. No otter signs were recorded in vicinity of the site. However, non-native mink spraint was recorded c.5m upstream of the bridge on a marginal mound (west bank).

Biological water quality, based on Q-sampling, was calculated as **Q3 (poor status)** (**Appendix A**). 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 4.28 Representative image of site E2 on the Silver River at Millbrook Bridge, August 2022 (facing upstream from bridge)

4.2 White-clawed crayfish

Live white-clawed crayfish were recorded from sites on the Mullaghakaraun Bog Stream (B9) and Feeghroe River (B12). Both sites supported low densities of juveniles only.

Crayfish remains were identified in otter spraint at sites on the Little Brosna River (site A3), Rapemills River (B1 & B3) and Blackwater River (D7). The remains on an adult crayfish (possibly preyed upon by otter) were also recorded at site B5 on the West Galros Stream, in addition to widespread crayfish burrows in sloping clay banks. Crayfish burrows were also visibly widespread at site B6 on the West Galros Stream.

Environmental DNA analysis detected white-clawed crayfish in the Little Brosna River (site A3) and Grand Canal (site D4) (see below section 4.3).

4.3 eDNA analysis

Composite water samples collected from the from the Little Brosna River (site A3) and Rapemills River (B8) 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 D**). 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.

Both the Little Brosna River (Site A3) and Grand Canal (D4) tested positive for white-clawed crayfish eDNA (7 and 2 positive qPCR replicates out of 12, respectively) (**Table 4.1**; **Appendix C).** However, no crayfish eDNA was detected in the quarry lake at site L1 or the Rapemills River (site B8), i.e. eDNA not present or was present below the limit of detection in a series of 12 qPCR replicates**.** This was despite crayfish remains being recorded in otter spraint at two sites on the Rapemills River during August 2022 (sites B1 & B3).

Crayfish plague eDNA was detected in the Little Brosna River (12 positive qPCR replicates out of 12), Rapemills River (1 positive qPCR replicates out of 12) and Grand Canal (1 positive qPCR replicates out of 12) (**Table 4.1**; **Appendix C).** These results were considered as evidence of the species' presence at and or upstream of the sampling locations. Crayfish plague eDNA was not detected in quarry site L1 (0 positive qPCR replicates out of 12).

The quarry lake (site L1) sample tested negative for European eel and smooth newt eDNA (0 positive qPCR replicates out of 12) (**Table 4.1**). These results were considered as evidence of the species' absence within the lake.

The Grand Canal sample (site D4) tested negative for invasive quagga mussel (*Dreissena rostriformis bugensis*) eDNA (0 positive qPCR replicates out of 12) (**Table 4.1**).

4.4 Otter signs

Despite some good suitability at numerous survey locations, otter signs were only recorded at a total of *n*=5 sites during the course of aquatic surveys undertaken in August 2022.

Regular otter spraint sites were recorded at sites on the Rapemills River (B1 & B3), River Brosna (D6) and Blackwater River (D7). An old otter spraint site (not regularly used) was also recorded on the Little Brosna River at site A3. With the exception of site D6 on the River Brosna, all spraint sites recorded contained identifiable white-clawed crayfish remains. Fresh otter prints were recorded on littoral mud alongside regular spraint sites at site D7 on the Blackwater River.

No breeding (holts) or resting (couch) areas were identified in the 150m vicinity of the survey sites in August 2022.

4.5 Invasive aquatic species

Zebra mussel (*Dreissena polymorpha*) was recorded in high abundances at site D4 on the Grand Canal in August 2022. This invasive bivalve is well-established in the Shannon catchment, having proliferated in the mid to late 1990's (Minchin et al., 2002). Zebra mussel is both considered a high-risk impact species in Ireland (O' Flynn et al., 2014) and is subject to restrictions under Regulations 49 and 50 of the Third Schedule of the European Communities (Birds and Natural Habitats) Regulations 2011-2021 (S.I. 477/2011).

The non-native (potentially invasive) amphipod species Caspian mud shrimp (*Chelicorophium curvispinum*) was also recorded, in low numbers, at site D4 on the Grand Canal. The species is commonly found associated with the druses[4] of the zebra mussel and has been known in the Shannon system since 2003 (Lucey et al., 2004).

[4] Druses are aggregates of live mussels

The New Zealand mud snail (*Potamopyrgus antipodarum*) was the most widespread non-native invertebrate recorded in the study being recorded at sites A2, B1, B3, B4, B5, B6, B7, B8, B10, B12, D6, D7, E1 and E2. The species is thought to have been introduced to Ireland in the early 19th century and has a ubiquitous distribution nationally (Anderson, 2016). The species can dominate molluscan communities and reduce the growth rates of native molluscs while also resulting in weight loss to fish species that consume it in abundance, given it survives passage through the digestive tract (CABI, 2020 & references therein).

Environmental DNA analysis (site D4 only) and macro-invertebrate sampling did not detect quagga mussel (*Dreissena bugensis rostriformis*), an invasive bivalve mollusc recently discovered in the Shannon system, in the vicinity of Loughs Ree and Derg (Baars & Minchin, 2021). However, eDNA analysis did detect the non-native pathogen crayfish plague (*Aphanomyces astaci*) in the Little Brosna River, Rapemills River and Grand Canal (**Table 4.1**; see section 4.3 above).

Roach (*Rutilus rutilus*) is a medium impact invasive fish species in Ireland (O'Flynn et al., 2014) also listed on the Third Schedule of the European Communities (Birds and Natural Habitats) Regulations 2011-2021 (S.I. 477/2011) and was recorded via electro-fishing at site D5 on the Little [Cloghan} River.

The invasive macrophyte Nuttall's pondweed (*Elodea nuttallii*) was recorded at site D4 on the Grand Canal. The closely related Canadian pondweed (*Elodea canadensis*) was recorded at site B13 on the lower Rapemills River. Both species are very widespread in Ireland and are listed on the Third Schedule of the European Communities (Birds and Natural Habitats) Regulations 2011-2021 (S.I. 477/2011). Both are considered a high-risk invasive species in Ireland (O' Flynn et al., 2014).

Spraint of the invasive mink (*Neovison vison*) was recorded at sites D5 (Little River) and E2 (Silver River).

Table 4.1 eDNA results in the vicinity of the proposed Cush wind farm, Co. Offaly (positive qPCR replicates out of 12 in parentheses)

Sample	Watercourse	Freshwater pearl mussel	White-clawed crayfish	Crayfish plague	European eel	Quagga mussel	Smooth newt
FK628	Little Brosna River (site A3)	Negative (0/12)	**Positive (7/12)**	**Positive (12/12)**	n/a	n/a	n/a
FK604	Rapemills River (site B8)	Negative (0/12)	Negative (0/12)	**Positive (1/12)**	n/a	n/a	n/a
FK597	Grand Canal (site D4)	n/a	**Positive (2/12)**	**Positive (1/12)**	n/a	Negative (0/12)	n/a
FK620	Quarry lake (L1)	n/a	Negative (0/12)	Negative (0/12)	Negative (0/12)	n/a	Negative (0/12)

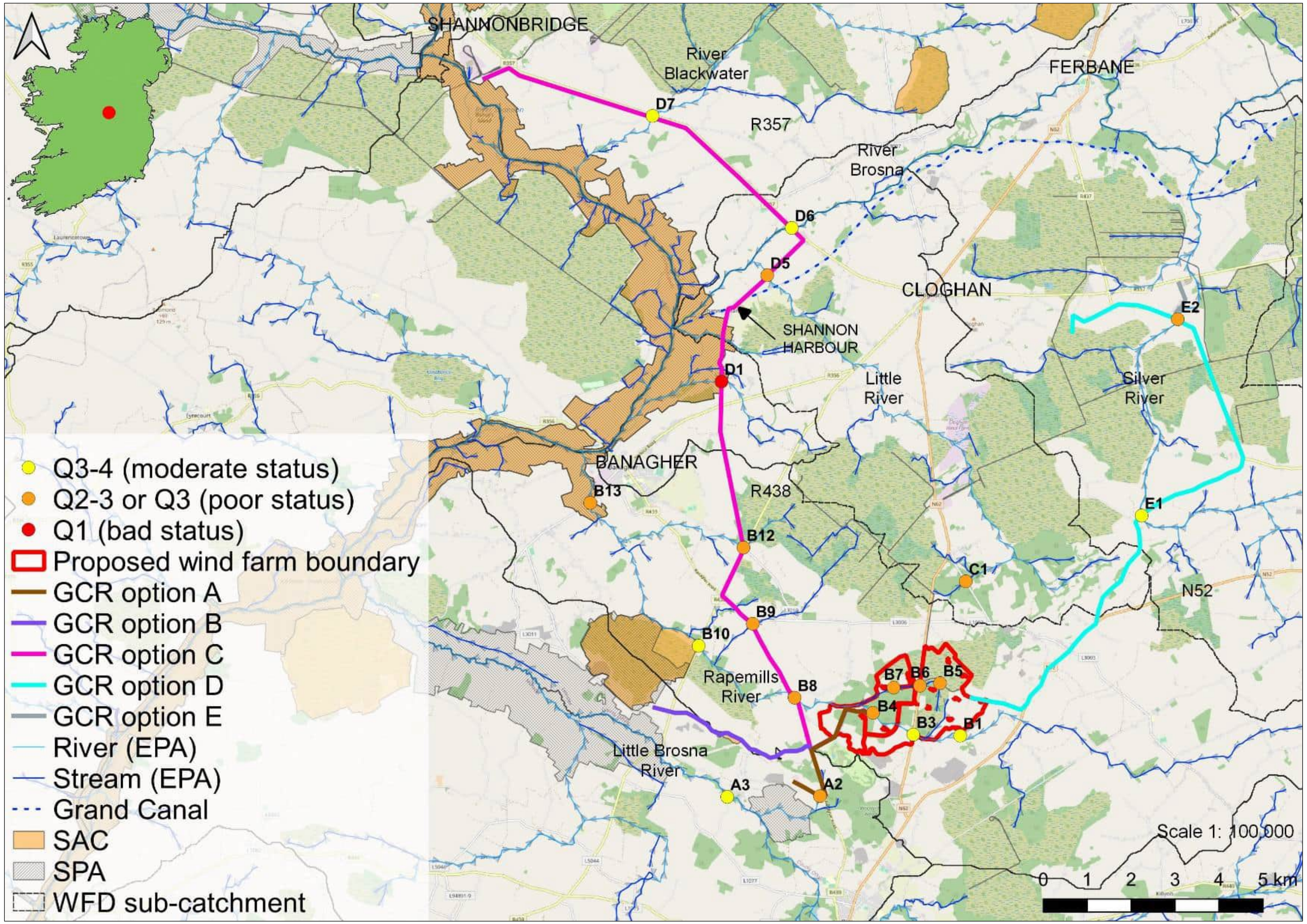

Figure 4.1 Overview of the biological water quality status in the vicinity of the proposed Cush wind farm project, Co. Offaly, August 202

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*=20 riverine sites in August 2022 (**Appendix A**).

None of the survey sites achieved 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).

Sites on the Little Brosna River (A3), Rapemills River (B1, B3 & B10), River Brosna (D6), Blackwater River (D7) and Silver River (E1) achieved **Q3-4 (moderate status)** water quality. This was given the low numbers (<5%) of group A species, such as the mayfly *Ecdyonurus dispar*, low numbers of group B species such as the mayfly *Alainites muticus* and Limnephilid cased caddis, and a dominance of group C species such as the mayflies *Baetis rhodani* and *Serratella ignita*, New Zealand mud snail (*Potamopyrgus antipodarum*), freshwater shrimp (*Gammarus duebeni*) and blackfly (Simuliidae) larvae. Site B10 on the Rapemills River was the only site to support the group A mayfly *Ephemera danica* (**Appendix B**).

With the exception of site D1 (see below), all other sites achieved **Q3 (poor status)** (i.e. sites A2, B4, B5, B6, B7, B8, B9, B12, B13, C1, D5 & E2). This rating was based on an absence of group A species, low numbers of group B species (such as the caddis *Halesus radiatus* and *Potamophylax cingulatus* and the damselfly *Calopteryx splendens*), and a dominance of group C species, particularly the freshwater shrimp *Gammarus duebeni* and the non-native snail *Potamopyrgus antipodarum*. Group D species, chiefly *Asellus aquaticus*, were also common at most of these sites.

Site D1 on Grant's Island River achieved **Q1 (bad status)** given the macro-invertebrate community comprised exclusively group E Chironomid and Tubificid species (**Appendix B**). However, it should be noted that due to poor flows and or an absence of suitable riffle areas for sampling, the Q-ratings for this site, in addition to sites B10 (moderate status) and sites A2, B5, B6, B12, B13, C1 (poor status), are tentative.

4.7 Lake and canal macro-invertebrates

No rare or protected macro-invertebrate species were recorded in the sweep samples taken from the quarry lake at site L1 or Grand Canal at site D4 (**Appendix B**).

The quarry lake supported a low diversity of low-abundance species, with the sample dominated by the lake olive mayfly (*Cloeon simile*) and *Coenagrion* sp. damselfly. The lake also supported several beetle species, water mites (Hydrachnidiae), water boatmen (Corixidae), pond skaters (Gerridae), non-biting midge larvae (*Chironomus* spp.), wandering snail (*Ampullaceana balthica*) and the aquatic larvae of a terrestrial moth (Pyralidae).

The Grand Canal at site D4 (Griffith Bridge) supported a low diversity of typically lentic species including *Coenagrion* sp. damselfly, the caseless caddis *Plectrocnemia conspersa*, Chironomid larvae, water mites (Hydrachnidiae), hoglouse (*Asellus aquaticus*) and a low diversity of common molluscan species (**Appendix B**).

4.8 Macrophytes and aquatic bryophytes

No rare or protected macrophytes or aquatic bryophytes were recorded at the *n*=27 survey sites. Similarly, no examples 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 recorded during the surveys.

4.9 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 DAN 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).

Sites B13 (Rapemills River), D1 (Grant's Island River), D2 (Bullock Island Stream) and D3 (Park River) were evaluated as **international importance** given their location within the River Shannon Callows SAC (000216) and Middle Shannon Callows SPA (004096).

Site D4 on the Grand Canal was evaluated as **national importance** given the location of the site within the Grand Canal pNHA (002104).

The majority of the remaining aquatic survey sites were evaluated as **local importance (higher value)**. The higher value sites were present on the Little Brosna River (A3), Rapemills River (B1, B3, B4, B8, B10 & B13), West Galros Stream (B5 & B6), Mullaghakaraun Bog Stream (B9), Feeghroe River (B12), Little River (D5), River Brosna (D6), River Blackwater (D7) and Silver River (E1 & E2) (**Table 4.4**). This evaluation was due to the presence of salmonids, Annex II *Lampetra* sp. and or other aquatic species of high conservation value, such as Annex II white-clawed crayfish or Annex II otter.

Sites on the Woodfield River (A2), West Galros Stream (B7), Whigsborough Stream (C1) and the quarry lake at site L1 were evaluated as **local importance (lower value)** in terms of their aquatic ecology given an absence of species or habitats of high conservation value. Sites on the Woodfield River (A1), Eglish Stream (B2) and Milltown Stream (B11) were also evaluated as **local importance (lower value)** in terms of their aquatic ecology given an absence of aquatic habitats at the time of survey (i.e. dry, ephemeral channels).

Table 4.2 Summary of fish species of higher conservation value recorded via electro-fishing per survey site in the vicinity of the proposed Cush wind farm, August 2022

Site	Watercourse	Atlantic salmon	*Lampetra* sp.	Brown trout	European eel	Other species
A1	Woodfield River	No fish recorded – dry channel				
A2	Woodfield River					Ten-spined stickleback
A3	Little Brosna River	✓		✓	✓	Stone loach, minnow
L1	Quarry lake	No electro-fishing undertaken (negative eDNA result for European eel)				

Site	Watercourse	Atlantic salmon	*Lampetra* sp.	Brown trout	European eel	Other species
B1	Rapemills River		✓	✓		Three-spined stickleback
B2	Eglish Stream	No fish recorded – dry channel				
B3	Rapemills River		✓	✓		
B4	Rapemills River		✓	✓		Three-spined stickleback
B5	West Galros Stream	No electro-fishing undertaken (prohibitive depths)				
B6	West Galros Stream	No electro-fishing undertaken (prohibitive depths)				
B7	West Galros Stream					Three-spined stickleback
B8	Rapemills River			✓		
B9	Mullaghakaraun Bog Stream		✓			Ten-spined stickleback
B10	Rapemills River			✓	✓	Ten-spined stickleback, minnow
B11	Milltown Stream	No fish recorded – dry channel				
B12	Feeghroe River			✓		Three-spined stickleback, ten-spined stickleback
B13	Rapemills River			✓	✓	Pike, minnow, stone loach, three-spined stickleback
C1	Whigsborough Stream	No fish recorded				
D1	Grants Island River	No fish recorded				
D2	Bullock Island Stream	No fish recorded – dry channel				
D3	Park River	No fish recorded – dry channel				
D4	Grand Canal	No electro-fishing undertaken (prohibitive depths)				
D5	Little [Cloghan] River		✓	✓	✓	Roach, minnow, stone loach
D6	River Brosna	No electro-fishing undertaken (prohibitive depth, width & flow)				
D7	Blackwater River		✓	✓		Minnow, stone loach
E1	Silver River		✓	✓		Minnow, stone loach, three-spined stickleback
E2	Silver River	✓	✓	✓		Stone loach

*** Conservation value:** Atlantic salmon (*Salmo salar*), sea lamprey (*Petromyzon marinus*), brook lamprey (La*mpetra 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 Fisheries Acts 1959 to 2019, 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 Cush 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	Woodfield River	None recorded		None recorded	Not present	None recorded	None recorded	None recorded
A2	Woodfield River	None recorded		None recorded	Not present	None recorded	None recorded	None recorded
A3	Little Brosna River	**Positive eDNA result at site; remains in otter spraint**	Negative eDNA result at site, no records in catchment	None recorded	Not present	None recorded	None recorded	None recorded
L1	Quarry lake	None recorded; negative eDNA result at site		None recorded	Not present	None recorded	None recorded	None recorded
B1	Rapemills River	**Remains in otter spraint**		**Regular spraint site**	Not present	None recorded	None recorded	None recorded
B2	Eglish Stream	None recorded		None recorded	Not present	None recorded	None recorded	None recorded
B3	Rapemills River	**Remains in otter spraint**		**Regular spraint site**	Not present	None recorded	None recorded	None recorded
B4	Rapemills River	None recorded		None recorded	Not present	None recorded	None recorded	None recorded
B5	West Galros Stream	**Remains found on bank**		None recorded	Not present	None recorded	None recorded	None recorded
B6	West Galros Stream	None recorded; negative eDNA result at site		None recorded	Not present	None recorded	None recorded	None recorded
B7	West Galros Stream	None recorded		None recorded	Not present	None recorded	None recorded	None recorded
B8	Rapemills 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	None recorded
B9	Mullaghakaraun Bog Stream	**Juveniles present**		None recorded	Not present	None recorded	None recorded	None recorded
B10	Rapemills River	None recorded		None recorded	Not present	None recorded	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
B11	Milltown Stream	None recorded		None recorded	Not present	None recorded	None recorded	None recorded
B12	Feeghroe River	**Juveniles present**		None recorded	Not present	None recorded	None recorded	None recorded
B13	Rapemills River	None recorded		None recorded	Not present	None recorded	None recorded	None recorded
C1	Whigsborough Stream	None recorded		None recorded	Not present	None recorded	None recorded	None recorded
D1	Grants Island River	None recorded		None recorded	Not present	None recorded	None recorded	None recorded
D2	Bullock Island Stream	None recorded		None recorded	Not present	None recorded	None recorded	None recorded
D3	Park River	None recorded		None recorded	Not present	None recorded	None recorded	None recorded
D4	Grand Canal	None recorded; **positive eDNA result at site**		None recorded	Not present	None recorded	None recorded	None recorded
D5	Little [Cloghan] River	None recorded		None recorded	Not present	None recorded	None recorded	None recorded
D6	River Brosna	None recorded		**Regular spraint site**	Not present	None recorded	None recorded	None recorded
D7	Blackwater River	**Remains in otter spraint**		**Regular spraint site**	Not present	None recorded	None recorded	None recorded
E1	Silver River	None recorded		None recorded	Not present	None recorded	None recorded	None recorded
E2	Silver River	None recorded		None recorded	Not present	None recorded	None recorded	None recorded

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*** 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. Common frog (*Rana temporaria*) and smooth newt (*Lissotriton vulgaris*) are protected under the Irish Wildlife Acts 1976-2021. Common frog are also afforded protection under Annex V of the Habitats Directive [92/42/EEC].

[4] Otter signs within 150m of the survey site

Table 4.4 Aquatic ecological evaluation summary of the Cush wind farm survey sites according to NRA (2009) criteria

Site no.	Watercourse	EPA code	Evaluation of importance	Rationale summary
A1	Woodfield River	25W29	Local importance (lower value)	Upper reaches of 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
A2	Woodfield River	25W29	Local importance (lower value)	Upper reaches of modified ephemeral channel with intermittent flows, poor fisheries & poor aquatic value (semi-dry at time of survey); ten-spined stickleback recorded via electro-fishing; no otter suitability; Q3 (poor status) water quality (tentative rating); no aquatic species or habitats of high conservation value
A3	Little Brosna River	25L02	**Local importance (higher value)**	Large high-energy calcareous river with high fisheries value; Atlantic salmon, brown trout, European eel, stone loach & minnow recorded via electro-fishing; good quality salmonid spawning & holding habitat but moderate quality nursery; poor quality lamprey habitat, moderate quality European eel; sub-optimal for white-clawed crayfish given high rates of calcification & compaction, none recorded but detected via eDNA at site; high otter suitability with old spraint site present; Q3-4 (moderate status) water quality
L1	Quarry lake	n/a	Local importance (lower value)	Small 1.2ha quarry lake with high average depth and poor fisheries value; three-spined stickleback observed during survey; eDNA did not detect brown trout, European eel, white-clawed crayfish or smooth newt; some otter suitability but no signs recorded; no aquatic species or habitats of high conservation value
B1	Rapemills River	25R01	**Local importance (higher value)**	Upper reaches of semi-natural lowland watercourse of high salmonid & lamprey value; brown trout, *Lampetra* sp. & three-spined stickleback recorded via electro-fishing; good quality salmonid nursery & holding habitat but reduced by siltation pressures; excellent quality lamprey nursery with some good quality spawning; high suitability for European eel & white-clawed crayfish but none recorded; two regular otter spraint sites contained abundant crayfish remains; Q3-4 (moderate status) water quality
B2	Eglish Stream	25E18	Local importance (lower value)	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
B3	Rapemills River	25R01	**Local importance (higher value)**	Historically modified, heavily silted lowland watercourse of good value to salmonids & moderate value to lamprey; brown trout & low density of *Lampetra* sp. recorded via electro-fishing; high suitability for European eel & white-clawed crayfish but none recorded; two regular otter spraint sites contained abundant crayfish remains; Q3-4 (moderate status) water quality
B4	Rapemills River	25R01	**Local importance (higher value)**	Heavily modified, heavily vegetated & heavily silted lowland depositing river of poor value to salmonids; brown trout, *Lampetra* sp. & three-spined stickleback recorded via electro-fishing; poor quality salmonid habitat but of some low value as a

Site no.	Watercourse	EPA code	Evaluation of importance	Rationale summary
				lamprey nursery; low suitability for European eel & white-clawed crayfish but none recorded; some otter suitability but no signs recorded; Q3 (poor status) water quality
B5	West Galros Stream	25W44	**Local importance (higher value)**	Heavily modified & heavily silted lowland depositing river with poor hydromorphology & of poor value to salmonids; electro-fishing not undertaken (prohibitive depths); some low value as a holding habitat for salmonids, moderate European eel suitability; remains of white-clawed crayfish recorded, frequent crayfish burrows identified; some otter suitability but no signs recorded; Q3 (poor status) water quality (tentative rating)
B6	West Galros Stream	25W44	**Local importance (higher value)**	Heavily modified & heavily silted lowland depositing river with poor hydromorphology of poor value to salmonids; electro-fishing not undertaken (prohibitive depths); some low value as a holding habitat for salmonids, moderate European eel suitability; frequent white-clawed crayfish burrows identified; some otter suitability but no signs recorded; Q3 (poor status) water quality (tentative rating)
B7	West Galros Stream	25W44	Local importance (lower value)	Heavily modified & heavily silted lowland depositing river with poor hydromorphology of poor fisheries value; only three-spined stickleback recorded via electro-fishing; low suitability for white-clawed crayfish & otter (none recorded); Q3 (poor status) water quality (tentative rating)
B8	Rapemills River	25R01	**Local importance (higher value)**	Semi-natural, high-energy calcareous river of high value to salmonids; only brown trout recorded via electro-fishing; excellent quality salmonid holding & moderate quality nursery habitat with poor spawning opportunities (due to calcification of bed); good suitability for European eel & poor suitability for lamprey (none recorded); some suitability for white-clawed crayfish but none recorded via survey or eDNA analysis; high otter suitability but no signs recorded; Q3 (poor status) water quality
B9	Mullaghakaraun Bog Stream	25M48	**Local importance (higher value)**	Heavily silted, semi-natural upland eroding stream with low seasonal flows; only *Lampetra* sp. & ten-spined stickleback recorded via electro-fishing; some value as lamprey nursery (low density present) but poor quality spawning habitat; some suitability for salmonids & European eel but none recorded; white-clawed crayfish present in low densities (juveniles only); Q3 (poor status) water quality
B10	Rapemills River	25R01	**Local importance (higher value)**	Heavily modified, heavily vegetated & heavily silted lowland depositing river of moderate value to salmonids; brown trout, European eel & three-spined stickleback recorded via electro-fishing; poor quality salmonid habitat (holding only) but good quality European eel habitat; abundant soft sediment for larval lamprey but none recorded (likely due to poor flows); good suitability for white-clawed crayfish & otter but none recorded; Q3 (poor status) water quality

Site no.	Watercourse	EPA code	Evaluation of importance	Rationale summary
B11	Milltown Stream	25M79	Local importance (lower value)	Ephemeral (seasonal) modified channel with no aquatic value at the time of survey (dry channel); no electro-fishing or biological water quality sample possible; no aquatic species or habitats of high conservation value
B12	Feeghroe River	25F41	**Local importance (higher value)**	Heavily modified & heavily silted lowland depositing river of moderate value to salmonids (holding habitat only); brown trout, three-spined and ten-spined stickleback recorded via electro-fishing; poor suitability for European eel (none recorded); no suitability for lamprey given poor flows; white-clawed crayfish present in low densities (juveniles only); Q3 (poor status) water quality (tentative rating)
B13	Rapemills River	25R01	**International importance**	Located within the River Shannon Callows SAC (000216) and Middle Shannon Callows SPA (004096); heavily vegetated lower reaches of modified lowland depositing river of moderate value to salmonids & high value to coarse fish; brown trout, European eel, minnow, three-spined stickleback, stone loach & pike recorded via electro-fishing; good quality salmonid holding habitat but poor nursery & spawning; good quality European eel habitat; poor lamprey suitability (none recorded); good suitability for white-clawed crayfish & otter but none recorded; Q3 (poor status) water quality (tentative rating)
C1	Whigsborough Stream	25W43	Local importance (lower value)	Heavily modified, heavily silted channel with very poor hydromorphology & connectivity; not of 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
D1	Grants Island River	25Y47	**International importance**	Located within the River Shannon Callows SAC (000216) and Middle Shannon Callows SPA (004096); heavily modified & silted channel with no flow and poor quality aquatic habitats; no fish recorded via electro-fishing; Q1 (bad status) biological water quality (tentative rating); no aquatic species or habitats of high conservation value
D2	Bullock Island Stream	25I23	**International importance**	Located within the River Shannon Callows SAC (000216) and Middle Shannon Callows SPA (004096); ephemeral (seasonal) modified channel with no aquatic value at the time of survey (dry channel); no electro-fishing or biological water quality sample possible; no aquatic species or habitats of high conservation value
D3	Park River	25P28	**International importance**	Located within the River Shannon Callows SAC (000216) and Middle Shannon Callows SPA (004096); ephemeral (seasonal) modified channel with no aquatic value at the time of survey (dry channel); no electro-fishing or biological water quality sample possible; no aquatic species or habitats of high conservation value
D4	Grand Canal	n/a	**National importance**	Located within Grand Canal pNHA (002104); also of high value as an aquatic ecological corridor; high value for European eel and coarse fish species; known to support foraging/commuting otter (NPWS/NBDC data); invasive zebra mussel abundant; crayfish plague also recorded via eDNA

Site no.	Watercourse	EPA code	Evaluation of importance	Rationale summary
D5	Little [Cloghan] River	25L01	**Local importance (higher value)**	Heavily modified & heavily silted lowland depositing river of moderate value to salmonids but high value for lamprey; brown trout, *Lampetra* sp., European eel, minnow, stone loach & roach recorded via electro-fishing; good quality salmonid holding habitat but poor nursery & spawning; poor quality lamprey spawning but excellent value nursery; moderate quality European eel habitat; despite suitability, no white-clawed crayfish or otter recorded; Q3 (poor status) water quality
D6	River Brosna	25B09	**Local importance (higher value)**	Large 20-25m-wide high-energy lowland river of high value to salmonids; electro-fishing not undertaken (prohibitive depths & flows); river known to support Atlantic salmon, brown trout, European eel, *Lampetra* sp., minnow & stone loach; excellent quality salmonid holding habitat but poor spawning & nursery; site of low suitability for lamprey, European eel & white-clawed crayfish; otter spraint site recorded
D7	Blackwater River	25B27	**Local importance (higher value)**	Heavily modified, very heavily silted lowland river with low seasonal flows & high value as lamprey nursery; brown trout, *Lampetra* sp., minnow & stone loach recorded via electro-fishing; poor fisheries value due to gross siltation but high densities of *Lampetra* sp. ammocoetes recorded; white-clawed crayfish not recorded but abundant (fresh) crayfish remains in numerous otter spraint sites; Q3-4 (moderate status) water quality
E1	Silver River	25S02	**Local importance (higher value)**	Straightened & deepened lowland river with good instream recovery of good value for salmonids; brown trout, *Lampetra* sp., minnow, three-spined stickleback & stone loach recorded via electro-fishing; high value as salmonid holding habitat but moderate quality nursery & spawning; sub-optimal lamprey nursery with low density of ammocoetes present; good suitability for European eel, white-clawed crayfish & otter but none recorded; Q3-4 (moderate status) water quality
E2	Silver River	25S02	**Local importance (higher value)**	Straightened & deepened lowland river with good instream recovery of good value for salmonids; Atlantic salmon, brown trout, *Lampetra* sp. & stone loach recorded via electro-fishing; high value as salmonid holding habitat with good quality nursery & spawning; good quality lamprey nursery with low density of ammocoetes present; good suitability for European eel, white-clawed crayfish & otter but none recorded; Q3 (poor status) water quality

Conservation value: Atlantic salmon (*Salmo salar*), sea lamprey (*Petromyzon marinus*), brook lamprey (La*mpetra 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 Fisheries Acts 1959 to 2019, brown trout and coarse fish species have no legal protection in Ireland.

5. Discussion

5.1 Most valuable areas for aquatic ecology

Sites B13 (Rapemills River), D1 (Grant's Island River), D2 (Bullock Island Stream) and D3 (Park River) were evaluated as **international importance** given their location within the River Shannon Callows SAC (000216) and Middle Shannon Callows SPA (004096). However, sites D1, D2 and D3 were ephemeral channels and did not support aquatic habitats at the time of survey (August 2022) but may act as ecological corridors for species movement. The lower reaches of the Rapemills River at site B13 supported salmonids and Red-listed European eel.

Site D4 on the Grand Canal was evaluated as **national importance** given the location of the site within the Grand Canal pNHA (002104). The heavily vegetated site was of high value for a range of coarse fish species, Red-listed European eel and foraging/commuting Annex II otter, with the presence of Annex II white-clawed crayfish detected via eDNA analysis (see 5.2 below). The Grand Canal is also an important ecological corridor for a range of aquatic species.

None of the remaining 22 no. aquatic survey sites were evaluated as greater than **local importance (higher value)**. The higher value sites were present on the Little Brosna River (A3), Rapemills River (B1, B3, B4, B8, B10 & B13), West Galros Stream (B5 & B6), Mullaghakaraun Bog Stream (B9), Feeghroe River (B12), Little River (D5), River Brosna (D6), River Blackwater (D7) and Silver River (E1 & E2) (**Table 4.4**). This evaluation was due to the presence of salmonids, Annex II *Lampetra* sp. and or other aquatic species of high conservation value, such as Annex II white-clawed crayfish or Annex II otter.

Salmonids were recorded from a total of 11 no. sites via electro-fishing (**Table 4.2; Appendix A**). However, these populations comprised brown trout only, with the exception of sites A3 on the Little Brosna River and E2 on the Silver River which also supported Atlantic salmon. This restricted distribution of Atlantic salmon in the vicinity of the proposed project is unsurprising given widespread historical modifications in the Shannon [Lower]_SC_060, Shannon [Lower]_SC_040, Shannon [Lower]_SC_030 and Brosna_SC_080 river sub-catchments (which have evidently reduced the quality of salmonid habitat), in addition to significant downstream barriers on the River Shannon (i.e. hydro-electric dams).

Lamprey ammocoetes (*Lampetra* sp., likely *L. planeri* given known catchment barriers) were recorded from a total of 8 no. sites on the Rapemills River (B1, B3 & B4), Mullaghakaraun Bog Stream (B9), Little River (D5) and the Silver River (E1 & E2) (**Table 4.2; Appendix A**). Moderate densities of ammocoetes were recorded at sites B1 (20 per m^2), D5 (13.2 per m^2) and D7 (11 per m^2), where optimal soft sediment habitat was abundant. Suitability was typically poor in the survey area as a result of historical modifications to hydromorphology which have resulted in often poor quality lamprey habitats. This was especially so with reference to spawning habitats which were heavily silted or even absent at many of the survey sites.

Whilst live Annex II white-clawed crayfish were only recorded from sites B9 on the Mullaghakaraun Bog Stream and B12 on the Feeghroe River (both juveniles only), crayfish remains were identified in otter spraint at sites on the Little Brosna River (site A3), Rapemills River (B1, B3) and Blackwater River (D7), with a predated adult crayfish also recorded on the West Galros Stream at site B5 (**Table 4.3**). These findings, in addition to the detection of white-clawed crayfish eDNA (see 5.2 below), indicate a wider distribution of cryptic populations within the vicinity of the proposed wind farm. In light of ongoing national outbreaks of crayfish plague (*Aphanomyces astaci*) and resulting declines in the species (Swords, 2021), these sites are therefore of even greater importance in terms of white-clawed crayfish conservation.

Despite widespread foraging and commuting suitability, otter signs were only recorded at sites B1 & B3 on the Rapemills River, D6 on the River Brosna and D7 on the Blackwater River. This paucity of signs may reflect the low number of observed marking opportunities (Sittenthaler et al., 2020) and or local otter population demographics. These sites supported regular sprainting locations, all of which contained abundant crayfish remains. The correlation between crayfish distribution and otter utilisation (foraging) of watercourses has been repeatedly observed across many Irish river catchments, particularly where fish abundances are below average (pers. obs.). No breeding (holts) or resting (couch) areas were identified in the vicinity of the survey sites in August 2022.

No rare or protected macro-invertebrate species (according to national red lists) were recorded in the biological water quality samples taken from *n*=20 riverine sites in August 2022 (**Appendix A**). None of the survey sites achieved 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** above). Siltation (peat extraction pressures), eutrophication and alterations to hydromorphology are known to be the major pressures within the survey area (EPA, 2019a, 2019b, 2022) and this was supported by observations made during the aquatic surveys.

No examples of the Annex I habitats were recorded during the aquatic surveys undertaken in August 2022.

5.2 eDNA analysis

White-clawed crayfish eDNA was detected in both the Little Brosna River (Site A3) and Grand Canal (D4) samples (7 and 2 positive qPCR replicates out of 12, respectively) but not in the Rapemills River sample from site B8 (**Table 4.1**; **Appendix C).** This was in spite of the identification of abundant crayfish remains in otter spraints at two survey sites (B1 & B3) located on the river >3km upstream of this point. 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 seasonal flows present on the Rapemills River at the time of survey, in addition to poor hydromorphology and heavy vegetation cover, may have limited the flow of eDNA and thus influenced detection rates (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 detection probability (Sint et al., 2022). This result highlights the importance of a multifaceted approach to crayfish surveying, i.e. a combination of crayfish surveys, inspection of otter spraint and eDNA.

No freshwater pearl mussel eDNA was detected in the Little Brosna River or Rapemills River samples collected in August 2022, in keeping with the known distribution of these species in the survey area. Whilst known from the Shannon catchment (Baars & Minchin, 2021), no quagga mussel eDNA was detected from site D4 on the Grand Canal at Shannon Harbour. However, eDNA analysis did detect the non-native pathogen crayfish plague (*Aphanomyces astaci*) in the Little Brosna River, Rapemills

River and Grand Canal samples (**Table 4.1**). Crayfish plague is listed at one of the world's 100 worst invasive species (GISD, 2022; Lowe et al., 2000) and is becoming widespread in the River Shannon catchment (pers. obs.).

5.3 Aquatic ecology summary

In summary, the majority of watercourses in the vicinity of the proposed Cush wind farm were of at least **local importance (higher value)** in terms of their aquatic ecology. However, historical drainage pressures (hydromorphology) and or siltation (primarily from peat escapement) have significantly reduced the quality of aquatic habitats on most watercourses in the vicinity of the proposed project.

Typically, larger watercourses with higher flow rates, greater water volumes and better connectivity, such as the Little Brosna River, River Brosna and Silver River, are better able to buffer against water quality impacts and these watercourses supported the better quality aquatic habitats and water dependant species of high conservation value, This included salmonids, *Lampetra* sp., otter and white-clawed crayfish populations.

None of the 20 no. sites sampled achieved 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) (i.e. all sites **≤Q3-4 (moderate status)**. Primarily, this was considered to reflect the widespread hydromorphological pressures within the respective catchments adjoining the proposed project.

Triturus

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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) & sweep samples

Table 8.1 Macro-invertebrate Q-sampling results for sites A2, A3, B1 & B3-B10, August 2022 (* species marked with an Asterix are invasive)

Group	Family	Species	A2	A3	B1	B3	B4	B5	B6	B7	B8	B9	B10	EPA class
Ephemeroptera	Ephemeridae	*Ephemera danica*											1	A
Ephemeroptera	Heptageniidae	*Ecdyonurus dispar*		1	1									A
Ephemeroptera	Heptageniidae	*Heptagenia sulphurea*		3										A
Ephemeroptera	Heptageniidae	*Rhithrogena semicolorata*				1								A
Ephemeroptera	Baetidae	*Alainites muticus*		2							5	1		B
Plecoptera	Leuctridae	*Leuctra hippopus*				1							1	B
Trichoptera	Glossosomatidae	*Agapetus fuscipes*										8		B
Trichoptera	Lepidostomatidae	*Lepidostoma hirtum*			8									B
Trichoptera	Limnephilidae	*Halesus radiatus*							1	5	1	8		B
Trichoptera	Limnephilidae	*Limnephilus lunatus*					7						6	B
Trichoptera	Limnephilidae	*Potamophylax cingulatus*		10							5	1		B
Trichoptera	Limnephilidae	sp. indet.			1								1	B
Trichoptera	Odontoceridae	*Odontocerum albicorne*				5								B
Trichoptera	Phryganeidae	*Agrypnia varia*						12	9	4			2	B
Trichoptera	Sericostomatidae	*Sericostoma personatum*			6	22							4	B
Odonata	Calopterygidae	*Calopteryx splendens*					1			8			1	B
Odonata	Coenagrionidae	*Coenagrion sp.*							4					B
Ephemeroptera	Ephemerellidae	*Serratella ignita*		13	26	2	2				3	4		C
Ephemeroptera	Baetidae	*Baetis rhodani*		29	33	4	37				15	8	9	C
Trichoptera	Hydropsychidae	*Hydropsyche instabilis*			2	27								C
Trichoptera	Philopotamidae	*Wormaldia occipitalis*										3		C
Trichoptera	Polycentropodidae	*Holocentropus dubius*										1		C
Trichoptera	Polycentropodidae	*Polycentropus kingi*									1			C
Trichoptera	Rhyacophilidae	*Rhyacophila dorsalis*		6		1					1			C
Mollusca	Lymnaeidae	*Stagnicola fuscus*					1	9	1					C

Group	Family	Species	A2	A3	B1	B3	B4	B5	B6	B7	B8	B9	B10	EPA class
Mollusca	Planorbidae	*Ancylus fluviatilis*			3	6								C
Mollusca	Tateidae	***Potamopyrgus antipodarum**	4		22	124	1	57	2	88	21		4	C
Crustacea	Gammaridae	*Gammarus duebeni*		11	25	25	11	22		23	13	11	12	C
Coleoptera	Dytiscidae	Dytiscidae larva						1				2		C
Coleoptera	Dytiscidae	*Ilybius fuliginosus*						1						C
Coleoptera	Dytiscidae	*Oreodytes sanmarkii*						1						C
Coleoptera	Elmidae	*Elmis aenea*		15	6	32	2				24	8	4	C
Coleoptera	Elmidae	*Limnius volckmari*				3								C
Coleoptera	Gyrinidae	*Gyrinus substriatus*						21	8					C
Coleoptera	Halipliidae	*Brychius elevatus*				2					1			C
Coleoptera	Halipliidae	*Haliplus ruficollis group*						1						C
Coleoptera	Hydraenidae	*Limnebius truncatellus*					1							C
Coleoptera	Hydrophilidae	*Hydrobius fuscipes*					1							C
Coleoptera	Hydrophilidae	*Laccobius bipunctatus*			1									C
Diptera	Chironomidae	*non-Chironomus* spp.	8	4			1	1		2			11	C
Diptera	Culicidae	sp. indet.				1							1	C
Diptera	Dixidae	sp. indet.			1		2							C
Diptera	Pediciidae	*Dicranota* sp.				1						1	1	C
Diptera	Simuliidae	sp. indet.		58	18	12	13				17			C
Hemiptera	Corixidae	Corixid nymph							1					C
Hemiptera	Corixidae	*Hesperocorixa linnaei*							19					C
Hemiptera	Corixidae	*Hesperocorixa sahlbergi*						1						C
Hemiptera	Gerridae	*Gerris* sp.	12					15	1				8	C
Hemiptera	Gerridae	*Gerridae nymph*	1											C
Arachnida	Hydrachnidiae	sp. indet.		2		1	7					1	7	C
Mollusca	Lymnaeidae	*Ampullacaena balthica*						10						D
Mollusca	Lymnaeidae	*Lymnaea stagnalis*					8	4						D

Group	Family	Species	A2	A3	B1	B3	B4	B5	B6	B7	B8	B9	B10	EPA class
Mollusca	Sphaeriidae	sp. indet.				1								D
Megaloptera	Sialidae	*Sialis lutaria*						2		4				D
Crustacea	Asellidae	*Asellus aquaticus*			1	13	8	18	10	3		3	33	D
Hirudinidae	Glossiphoniidae	sp. indet.			1	1							3	D
Diptera	Chironomidae	*Chironomus* spp.	3			4	5						2	E
Annelidae	Oligochaeta	sp. indet.		4	1		1							n/a
Abundance			**28**	**158**	**156**	**289**	**109**	**176**	**56**	**137**	**107**	**60**	**111**	
Q-rating			*Q3	Q3-4	Q3-4	Q3-4	Q3	*Q3	*Q3	Q3	Q3	Q3	*Q3-4	
WFD status			Poor	Mod	Mod	Mod	Poor	Poor	Poor	Poor	Poor	Poor	Mod	

* 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 B12, B13, C1, D1, D5, D6, D7, E1 & E2, August 2022 (* species marked with an Asterix are invasive)

Group	Family	Species	B12	B13	C1	D1	D5	D6	D7	E1	E2	EPA class
Ephemeroptera	Heptageniidae	*Ecdyonurus dispar*						2	3	3		A
Ephemeroptera	Heptageniidae	*Heptagenia sulphurea*							1			A
Ephemeroptera	Baetidae	*Alainites muticus*					1		3	6		B
Ephemeroptera	Baetidae	*Cloeon dipterum*	3									B
Plecoptera	Leuctridae	*Leuctra hippopus*					1	2		3		B
Trichoptera	Glossosomatidae	*Agapetus fuscipes*								5	23	B
Trichoptera	Limnephilidae	*Halesus radiatus*		17								B
Trichoptera	Limnephilidae	*Potamophylax cingulatus*					4	6		3	1	B
Trichoptera	Limnephilidae	sp. indet.									1	B
Trichoptera	Sericostomatidae	*Sericostoma personatum*							4		1	B
Odonata	Calopterygidae	*Calopteryx splendens*	6	1			1				2	B
Odonata	Coenagrionidae	*Coenagrion sp.*										B

Group	Family	Species	B12	B13	C1	D1	D5	D6	D7	E1	E2	EPA class
Hemiptera	Aphelochiridae	*Aphelocheirus aestivalis*					6	19	7			B
Ephemeroptera	Ephemerellidae	*Serratella ignita*		1			5	15		9	22	C
Ephemeroptera	Baetidae	*Baetis rhodani*		4			3	36	21	26	23	C
Trichoptera	Hydropsychidae	*Hydropsyche instabilis*					3					C
Trichoptera	Hydropsychidae	*Hydropsyche siltalai*							1	1		C
Trichoptera	Polycentropodidae	*Plectrocnemia conspersa*										C
Trichoptera	Polycentropodidae	*Polycentropus kingi*					1					C
Mollusca	Bithnyiidae	*Bithynia tentaculata*		1								C
Mollusca	Lymnaeidae	*Stagnicola fuscus*		9								C
Mollusca	Neritidae	*Theodoxus fluviatilis*		4						3	2	C
Mollusca	Planorbidae	*Ancylus fluviatilis*						4	2	4	4	C
Mollusca	Planorbidae	*Gyraulus albus*					1					C
Mollusca	Tateidae	*Potamopyrgus antipodarum*	38					1	12	1	18	C
Crustacea	Gammaridae	*Gammarus duebeni*	18	3			22	31	61	33	53	C
Crustacea	Corophiidae	***Chelicorophium curvispinum***										C
Coleoptera	Dytiscidae	Dytiscidae larva		1	2							C
Coleoptera	Dytiscidae	*Ilybius fuliginosus*	4									C
Coleoptera	Elmidae	*Elmis aenea*					3			11	20	C
Coleoptera	Elmidae	*Esolus parallelepipedus*								1		C
Coleoptera	Elmidae	*Limnius volckmari*					1	2		5		C
Coleoptera	Halipliidae	*Brychius elevatus*					2			1	3	C
Coleoptera	Halipliidae	*Haliplus ruficollis group*		1								C
Diptera	Chironomidae	*non-Chironomus* spp.	1							3		C
Diptera	Culicidae	sp. indet.	1									C
Diptera	Pediciidae	*Dicranota* sp.									1	C
Diptera	Simuliidae	sp. indet.							1	55	37	C
Hemiptera	Corixidae	Corixidae nymph	11	3								C

Group	Family	Species	B12	B13	C1	D1	D5	D6	D7	E1	E2	EPA class
Hemiptera	Corixidae	*Siagara* sp.	8	42								C
Hemiptera	Gerridae	*Gerris* sp.	3	2	16		1		8			C
Hemiptera	Gerridae	*Gerridae nymph*	2		2		1			1		C
Hemiptera	Veliidae	*Veliidae nymph*		1								C
Platyhelminthes	Planariidae	*Polycelis* sp.							7			C
Arachnida	Hydrachnidiae	sp. indet.		13							1	C
Mollusca	Lymnaeidae	*Ampullacaena balthica*		2								D
Mollusca	Lymnaeidae	*Lymnaea stagnalis*		6								D
Mollusca	Physidae	*Physa fontinalis*		2								D
Mollusca	Sphaeriidae	sp. indet.						6				D
Crustacea	Asellidae	*Asellus aquaticus*	15	41	14		13		3		12	D
Hirudinidae	Glossiphoniidae	sp. indet.	1									D
Diptera	Chironomidae	*Chironomus* spp.			7	12	1	1	1	1		E
Annelidae	Tubificidae	sp. indet.			5	18						E
Annelidae	Oligochaeta	sp. indet.			1			2				n/a
Abundance			**111**	**154**	**47**	**30**	**70**	**127**	**135**	**175**	**224**	
Q-rating			*Q3	*Q3	*Q2-3	*Q1	Q3	Q3-4	Q3-4	Q3-4	Q3	
WFD status			Poor	Poor	Poor	Bad	Poor	Mod	Mod	Mod	Poor	

* tentative Q-rating due to poor flows and or absence of suitable riffle areas for sampling (Toner et al., 2005)

Table 8.3 Macro-invertebrate community recorded at site L1 (quarry lake) & Grand Canal (D4), August 2022 (* species marked with an Asterix are invasive)

Group	Family	Species	L1	D4
Ephemeroptera	Baetidae	*Cloeon simile*	12	
Trichoptera	Polycentropodidae	*Plectrocnemia conspersa*		3
Odonata	Coenagrionidae	*Coenagrion sp.*	8	4
Crustacea	Corophiidae	***Chelicorophium curvispinum****		1
Crustacea	Asellidae	*Asellus aquaticus*		26
Arachnida	Hydrachnidiae	sp. indet.	4	11
Coleoptera	Dytiscidae	*Oreodytes sanmarkii*	1	
Coleoptera	Halipliidae	*Haliplus ruficollis group*	2	
Coleoptera	Halipliidae	*Haliplus linneatocollis*	2	
Coleoptera	Hydrophilidae	*Laccobius minutus*	1	
Hemiptera	Corixidae	Corixidae nymph	1	
Hemiptera	Gerridae	Gerridae nymph	5	
Mollusca	Physidae	*Physa fontanalis*		1
Mollusca	Bithnyiidae	*Bithynia tentaculata*		2
Mollusca	Lymnaeidae	*Ampullacaena balthica*	1	
Mollusca	Dreissenidae	***Dreissena polymorpha****		8
Diptera	Chironomidae	*Chironomus spp.*	2	4
Diptera	Chironomidae	*Non-Chironomus spp.*		32
Diptera	Culicidae	sp. indet.		1
Lepidoptera	Pyralidae	sp. indet.	1	
Oligochaeta	Lumbriculidae	sp. indet		1
Taxon Richness n			**12**	**12**

9. Appendix C – eDNA analysis lab report

Folio No: E15388
Report No: 1
Client: Triturus Environmental Limited
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: 12/09/2022
Date results reported: 21/09/2022
Matters affecting result: None

TARGET SPECIES: Crayfish plague *(Aphanomyces astaci)*

Lab ID	Site Name	OS Reference	SIC	DC	IC	Result	Positive Replicates
FK597	D4 – Grand Canal Cush Wind Farm	-	Pass	Pass	Pass	Positive	1/12
Fk604	B8 – Rapemills River Cush Wind Farm	ITM 604773, 710211	Pass	Pass	Pass	Positive	1/12
Fk620	L1 – Quarry Lake Cush Wind Farm	ITM 608806, 709567	Pass	Pass	Pass	Negative	0/12
FK628	A3 – Little Brosna River Cush Wind Farm	ITM 603240, 707953	Pass	Pass	Pass	Positive	12/12

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SureScreen Scientifics

TARGET SPECIES: European eel *(Anguilla anguilla)*

Lab ID	Site Name	OS Reference	SIC	DC	IC	Result	Positive Replicates
FK620	L1 – Quarry Lake Cush Wind Farm	ITM 608806, 709567	Pass	Pass	Pass	Negative	0/12

TARGET SPECIES: Freshwater pearl mussel *(Margaritifera margaritifera)*

Lab ID	Site Name	OS Reference	SIC	DC	IC	Result	Positive Replicates
FK604	B8 – Rapemills River Cush Wind Farm	ITM 604773, 710211	Pass	Pass	Pass	Negative	0/12
FK628	A3 – Little Brosna River Cush Wind Farm	ITM 603240, 707953	Pass	Pass	Pass	Negative	0/12

TARGET SPECIES: Quagga mussel *(Dreissena bugensis)*

Lab ID	Site Name	OS Reference	SIC	DC	IC	Result	Positive Replicates
FK597	D4 – Grand Canal Cush Wind Farm	-	Pass	Pass	Pass	Negative	0/12

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TARGET SPECIES: Smooth Newt *(Lissotriton vulgaris)*

Lab ID	Site Name	OS Reference	SIC	DC	IC	Result	Positive Replicates
FK620	L1 – Quarry Lake Cush Wind Farm	ITM 608806, 709567	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
FK597	D4 – Grand Canal Cush Wind Farm	-	Pass	Pass	Pass	Positive	2/12
Fk604	B8 – Rapemills River Cush Wind Farm	ITM 604773, 710211	Pass	Pass	Pass	Negative	0/12
Fk620	L1 – Quarry Lake Cush Wind Farm	ITM 608806, 709567	Pass	Pass	Pass	Negative	0/12
FK628	A3 – Little Brosna River Cush Wind Farm	ITM 603240, 707953	Pass	Pass	Pass	Positive	7/12

If you have any questions regarding results, please contact us: ForensicEcology@surescreen.com

Reported by: **Jennifer Higginbottom** 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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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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Fisheries assessment of Cush wind farm, Co. Offaly

Prepared by Triturus Environmental Ltd. for SLR Consulting

November 2022

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1. Introduction

1.1 Background

Triturus Environmental Ltd. were commissioned by Inis Environmental Consultants Ltd. to undertake a baseline fisheries assessment of numerous watercourses in the vicinity of the proposed Cush wind farm, located approx. 5km north of Birr, Co. Offaly.

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*=25 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 Cush wind farm. Permission was granted on Monday 27th June 2022 and the survey was undertaken on Tuesday 23rd to Thursday 25th August 2022.

1.2 Fisheries asset of the survey area

The survey sites were located within the Shannon[Lower]_SC_060, Shannon[Lower]_SC_040, Shannon[Lower]_SC_030, Brosna_SC_070 and Brosna_SC_080 river sub-catchments. The proposed wind farm was not located within a European site. Fisheries survey sites were present on the Woodfield River (EPA code: 25W29), Little Brosna River (25L02), Rapemills River (25R01), Eglish Stream (25E18), West Galros Stream (25W44), Mullaghakaraun Bog Stream (25M48), Milltown Stream (25M79), Feeghroe River (25F41), Whigsborough Stream (25W43), Grant's Island River (25Y47), Bullock Island Stream (25I23), Park River (25P28), Little [Cloghan] River (25L01), River Brosna (25B09), Blackwater River (25B27) and Silver River (25S02) (**Table 2.1**).

The Little Brosna River is known to support Atlantic salmon (*Salmo salar*), brown trout (*Salmo trutta*), European eel, lamprey (*Lampetra* sp.), minnow (*Phoxinus phoxinus*) and stone loach (*Barbatula barbatula*) (Kelly et al., 2010, 2015).

The Silver [Kilcormac] River (crossed by proposed GCR) is known to support brown trout, European eel, gudgeon (*Gobio gobio*), minnow, perch (*Perca fluviatilis*), three-spined stickleback (*Gasterosteus aculeatus*), stone loach and (occasional) Atlantic salmon (Kelly et al., 2010, 2015). Both the Little Brosna and Silver Rivers also support spawning 'croneen', a genetically-distinct migratory population of potadromous brown trout indigenous to Lough Derg (Igoe et al., 2003).

The Little [Cloghan] River, a tributary of the Brosna River, is known to support stocks of brown trout, minnow, *Lampetra* sp., gudgeon, roach (*Rutilus rutilus*), stone loach and three-spined stickleback (*Gasterosteus aculeatus*) (Kelly et al., 2010, 2015; IFI, 2020 data[1]).

Fisheries data for the other watercourses within the survey area was not available at the time of survey.

[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/

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 Cush wind farm on the 23rd to 25th August 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).

The catchment-wide electro-fishing (CWEF) survey was undertaken across *n*=25 riverine 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. 40-100m 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 moderate conductivity waters of the sites (most draining calcareous geologies) a voltage of 200-230v, frequency of 35-45Hz 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 box 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 (EA, 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 (*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.

Table 2.1 Location of *n*=25 electro-fishing survey sites in the vicinity of Cush wind farm, Co. Offaly

Site no.	Watercourse	EPA code	Location	X (ITM)	Y (ITM)
A1	Woodfield River	25W29	Banagher Road R439 crossing	605395	708239
A2	Woodfield River	25W29	Clondallow	605352	707970
A3	Little Brosna River	25L02	Derrinasallow Bridge	603240	707953
B1	Rapemills River	25R01	Eglish	608544	709346
B2	Eglish Stream	25E18	Eglish	608194	709857
B3	Rapemills River	25R01	Boolinarig Bridge	607478	709372
B4	Rapemills River	25R01	Cush	606559	709867
B5	West Galros Stream	25W44	Eglish	608047	710214
B6	West Galros Stream	25W44	N62 road crossing	607627	710485
B7	West Galros Stream	25W44	Cush	606664	710294
B8	Rapemills River	25R01	Banagher Road R439 crossing	604773	710211
B9	Mullaghakaraun Bog Stream	25M48	Ballyneena	603822	711896
B10	Rapemills River	25R01	All Saints Bridge	602588	711394
B11	Milltown Stream	25M79	Ballyneena	603454	712240
B12	Feeghroe River	25F41	Five Roads Cross	603610	713632
B13	Rapemills River	25R01	Lusmagh Bridge	600120	714650
C1	Whigsborough Stream	25W43	Clooneen	608877	713034
D1	Grants Island River	25Y47	L7014 road crossing	603109	717415
D2	Bullock Island Stream	25I23	L7014 road crossing	603118	717707
D3	Park River	25P28	L7014 road crossing	603143	718403
D5	Little [Cloghan] River	25L01	L7014 road crossing	604150	719834
D6	River Brosna	25B09	Moystown Bridge	604710	720913
D7	Blackwater River	25B27	Blackwater Bridge, R357	601538	723464
E1	Silver River	25S02	Wooden Bridge	612676	714360
E2	Silver River	25S02	Millbrook Bridge	613497	718834

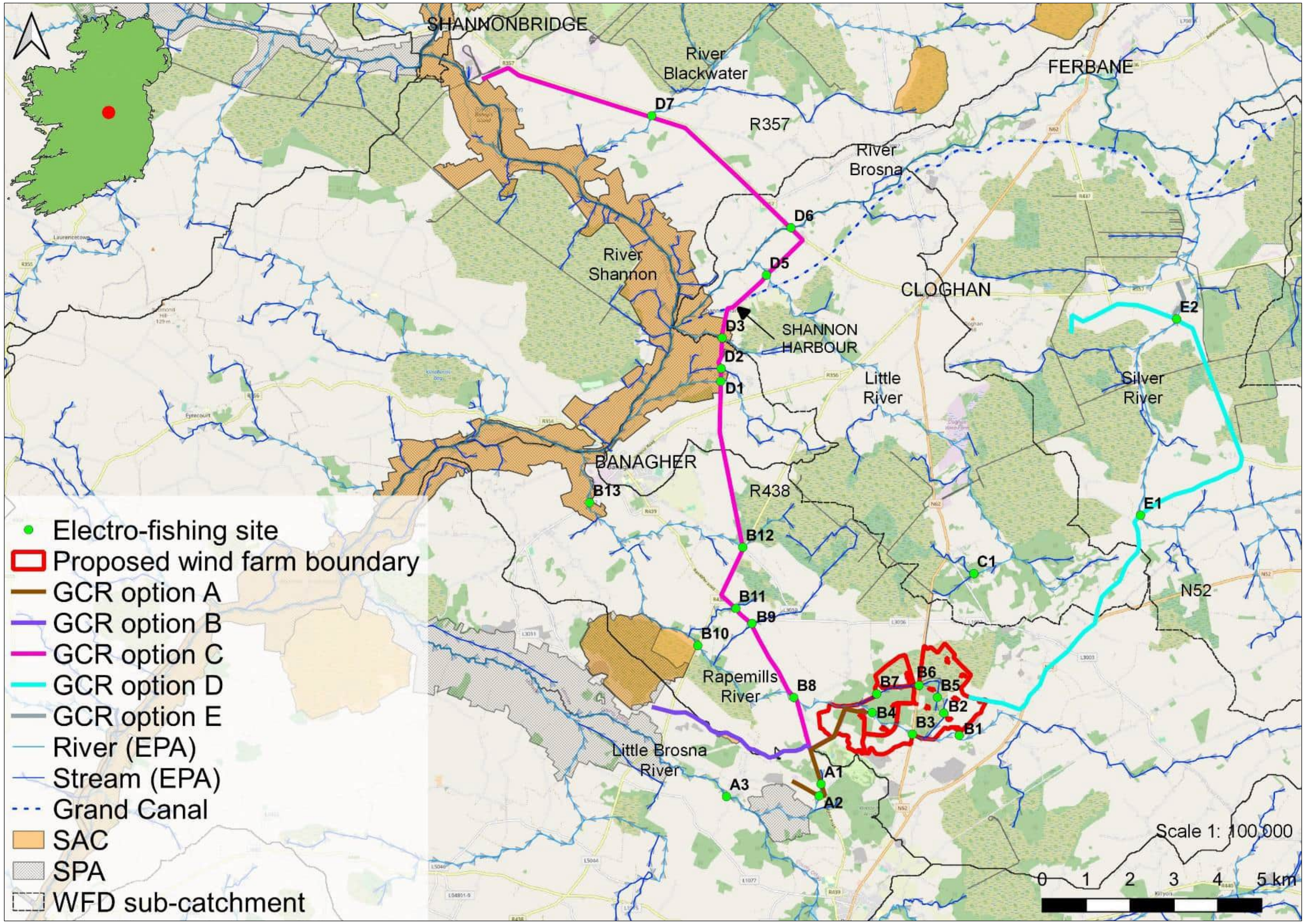

Figure 2.1 Overview of the *n*=25 electro-fishing survey site locations for Cush wind farm, Co. Offaly

3. Results

A catchment-wide electro-fishing survey of *n*=25 riverine sites in the vicinity of the proposed Cush wind farm was conducted on the 23rd to 25th August 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 – Woodfield River, R439 road crossing

Site A1 was not of fisheries value given its dry, ephemeral nature and absence of aquatic habitats at the time of survey. It was not possible to undertake electro-fishing at this site.

Plate 3.1 Representative image of site A1 on the upper reaches of the Woodfield River, August 2022 (dry, ephemeral channel)

3.1.2 Site A2 – Woodfield River, Clondallow

Ten-spined stickleback (*Pungitius pungitius*) was the only fish species recorded via electro-fishing at site A2 (**Figure 3.1**).

With the exception of this species, the site was not of fisheries value given its semi-dry, evidently ephemeral nature. A low density of fish (*n*=4) were recorded from a shallow, isolated stagnant (1m^2) pool immediately below the road culvert.

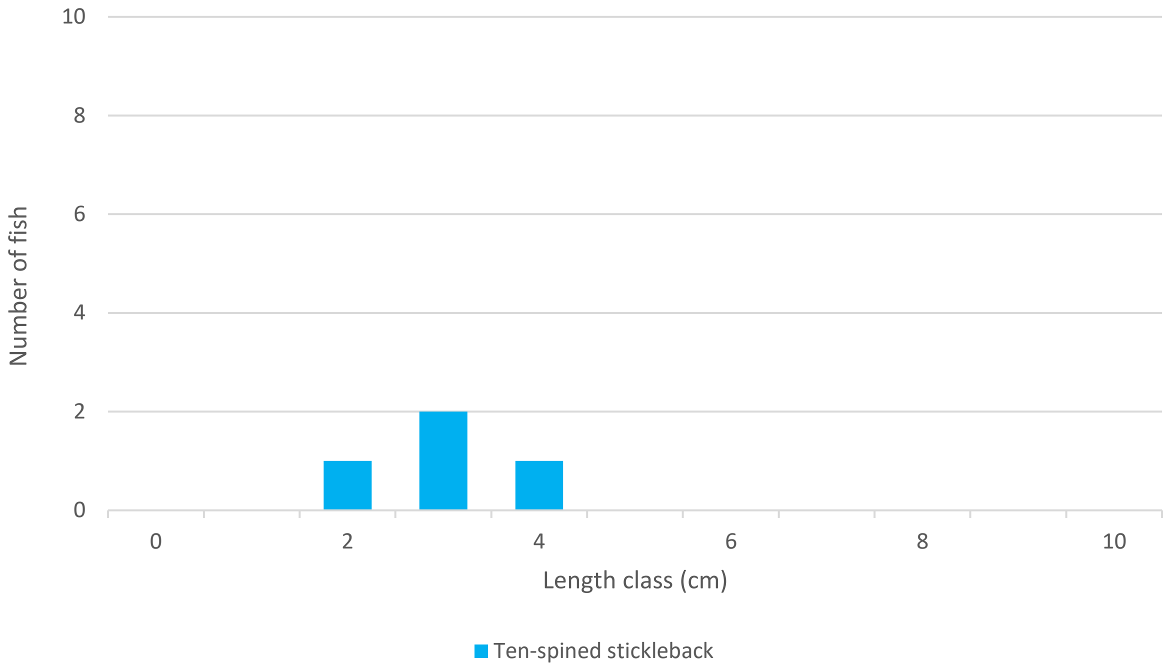

Figure 3.1 Length frequency distribution of fish recorded at site A2 on the Woodfield River, August 2022

Plate 3.2 Ten-spined stickleback recorded at site A2 on the Woodfield River, August 2022

3.1.3 Site A3 – Little Brosna River, Derrinasallow Bridge

Atlantic salmon (*Salmo salar*), brown trout (*Salmo trutta*), European eel (*Anguilla anguilla*), stone loach (*Barbatula barbatula*) and minnow (*Phoxinus phoxinus*) were recorded via electro-fishing at site A3 (**Figure 3.2**).

The site was of high value for salmonids, with a mixed-cohort population of brown trout (*n*=17) and a low density of Atlantic salmon parr (*n*=5) recorded. The site was of most value as a habitat for adult trout, with frequent deeper pool and glide present in addition to naturally scoured banks and occasional overhanging willow. Given high flow rates and compaction/calcification of the bed (which reduced the number of accessible refugia), the site provided sub-optimal nursery conditions, being better suited to Atlantic salmon than trout. The site provided some good spawning habitat for both salmonids and lamprey although suitable substrata were highly localised. Larval lamprey habitat was not present. European eel habitat was moderate overall given a general paucity of accessible instream refugia and a single adult was recorded.

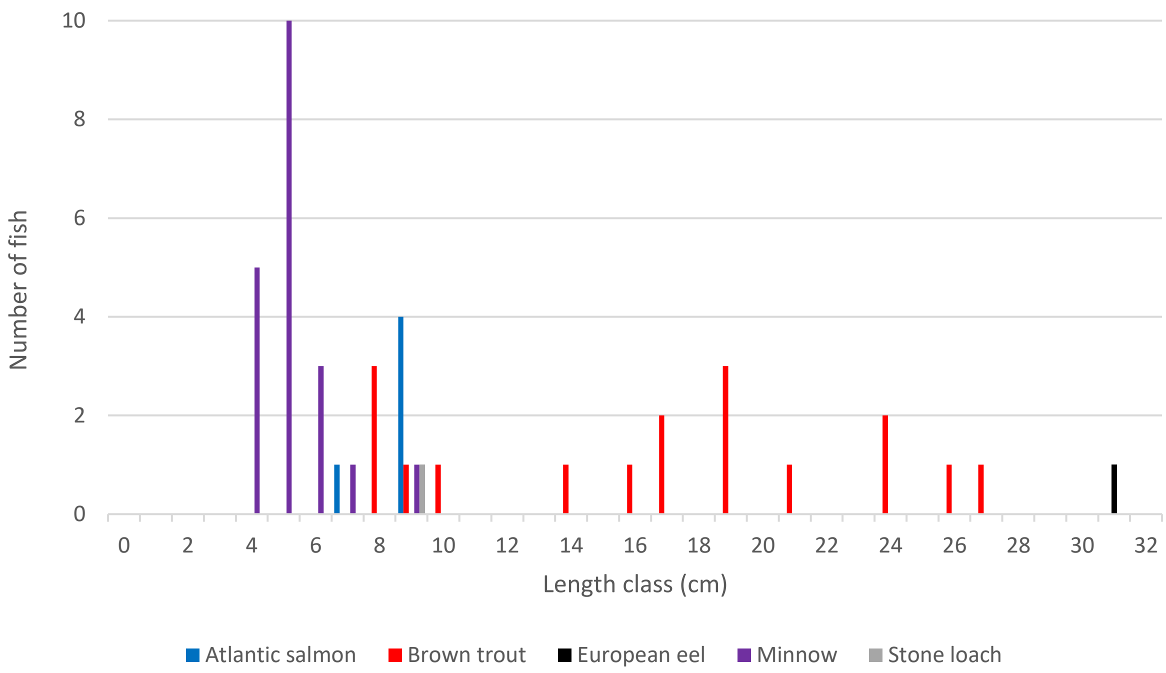

Figure 3.2 Length frequency distribution of fish recorded at site A3 on the Little Brosna River, August 2022

Plate 3.3 Juvenile Atlantic salmon (top) and brown trout (bottom) recorded at site A3 on the Little Brosna River, August 2022

3.1.4 Site B1 – Rapemills River, Eglish

Brown trout, lamprey (*Lampetra* sp.) and three-spined stickleback were recorded via electro-fishing at site B1 (**Figure 3.3**).

The site was of high value to salmonids, supporting a moderate density of mixed-cohort brown trout (*n*=45). The population was dominated by adult fish. Fine gravel spawning habitat for both salmonids and lamprey, whilst widespread, was compromised by moderate siltation. The site provided good quality salmonid nursery and holding habitat. The site was a high value lamprey habitat, with excellent quality nursery habitat by way of abundant soft sediment deposits of 5-10cm deep. These supported high densities of ammocoetes (20 per m^2), the highest recorded during the survey. Despite high suitability for European eel (abundant instream refugia), none were recorded.

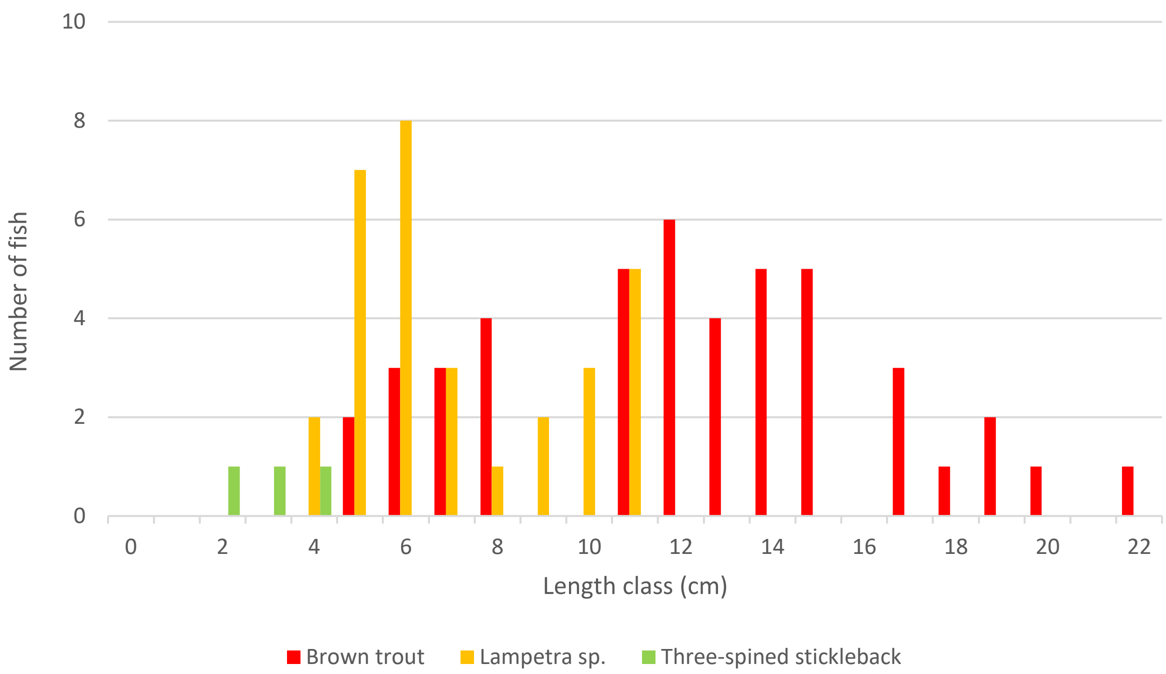

Figure 3.3 Length frequency distribution of fish recorded at site B1 on the Rapemills River, August 2022

Plate 3.4 Mixed-cohort *Lampetra* sp. ammocoetes recorded at site B1 on the Rapemills River, August 2022

3.1.5 Site B2 – Eglish Stream, Eglish

Site B2 was not of fisheries value given its dry, ephemeral nature and absence of aquatic habitats at the time of survey. It was not possible to undertake electro-fishing at this site.

Plate 3.5 Representative image of site B2 on the Eglish Stream, August 2022 (dry channel)

3.1.6 Site B3 – Rapemills River, Boolinarig Bridge

Brown trout and lamprey (*Lampetra* sp.) were the only two fish species recorded via electro-fishing at site B3 (**Figure 3.4**).

Despite evident hydromorphological modifications, site B3 was of good value for salmonids, supporting a moderate density of mixed-cohort brown trout (*n*=44). Spawning habitat for salmonids and lamprey was present but highly localised in the vicinity of the bridge and exposed to moderate to high siltation pressures. The installed cobbles on the bridge apron provided some good quality nursery habitat for juvenile trout (habitat which is rare within the Rapemills River; pers. obs.). Holding habitat was of excellent quality given the predominance of deep glide and pool, with frequent undercut/scoured banks and floating macrophyte vegetation. Despite an abundance of soft sediment accumulations, lamprey nursery habitat was considered of moderate quality only given low flow rates and the generally flocculent nature of the silt. However, a low density of ammocoetes (2 per m^2) was recorded via targeted electro-fishing. European eel habitat was good given ample refugia although none were recorded.

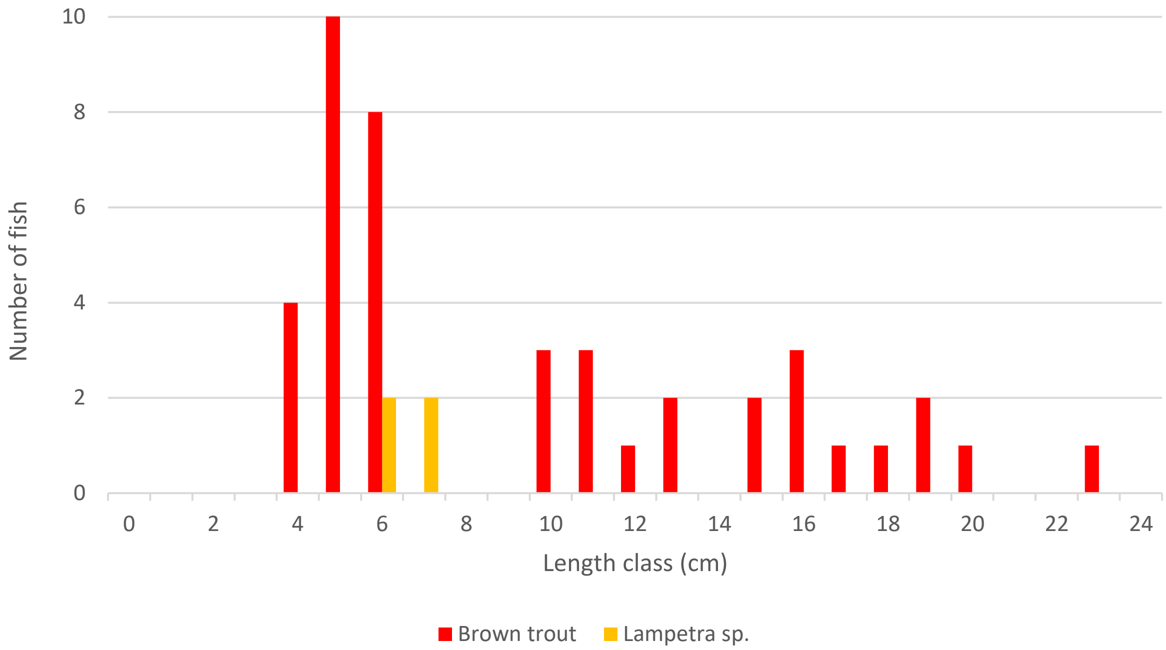

Figure 3.4 Length frequency distribution recorded via electro-fishing at site B3 on the Rapemills River, August 2022

Plate 3.6 Mixed-cohort brown trout recorded at site B3 on the Rapemills River, August 2022

3.1.7 Site B4 – Rapemills River, Cush

Brown trout, lamprey (*Lampetra* sp.) and three-spined stickleback were recorded via electro-fishing at site B4 (**Figure 3.5**).

The site was a poor salmonid habitat given gross siltation and very poor hydromorphology, supporting a very low density of adult brown trout only (no juveniles). Salmonid spawning habitat was not present given siltation pressures, with nursery habitat also of poor quality. The site had some value as a holding habitat given the predominance of deep glide with frequent scoured banks and overhanging vegetation (providing valuable thermal refugia in the near absence of riparian trees). Whilst the site featured abundant soft sediment, few areas were considered optimal for lamprey ammocoetes given poor flows/hydromorphology, However, a low density of ammocoetes (2 per m^2) were recorded from localised faster-flowing areas (typically associated with instream debris). Despite some low suitability for European eel, none were recorded.

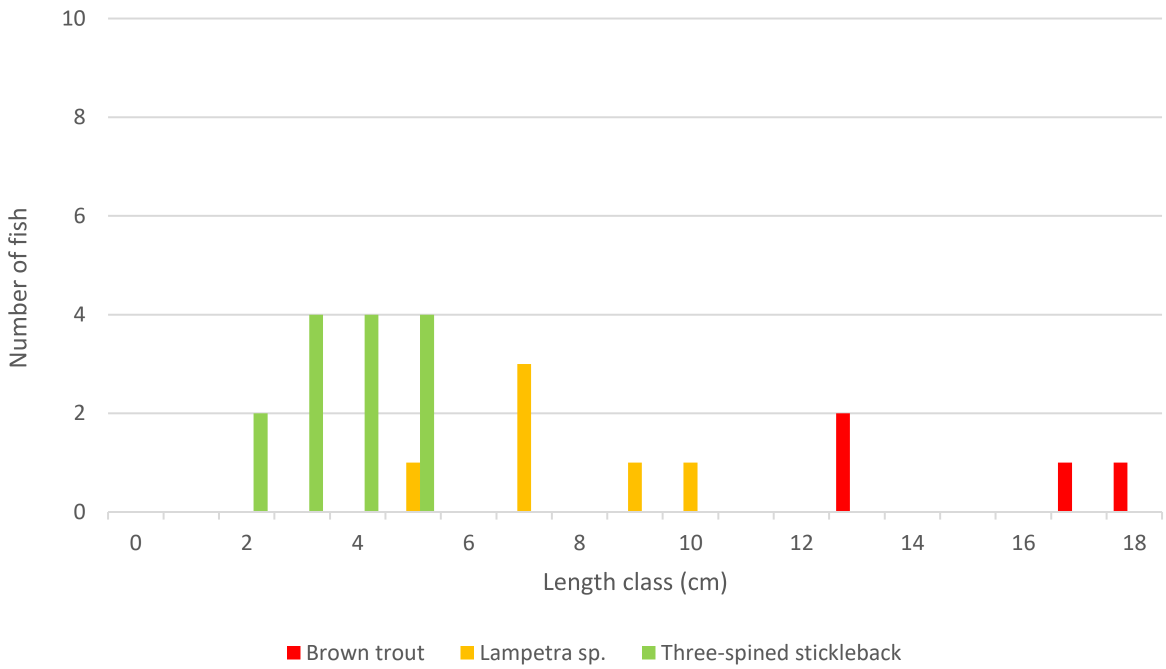

Figure 3.5 Length frequency distribution recorded via electro-fishing at site B4 on the Rapemills River, August 2022

Plate 3.7 Three-spined stickleback recorded at site B4 on the Rapemills River, August 2022

3.1.8 Site B5 – West Galros Stream, Eglish

Electro-fishing was not undertaken at site B5 given prohibitive depths of >1.5m and a deep silt base. With the exception of three-spined stickleback (Observed during the survey), site B5 was of poor fisheries value given poor hydromorphology, low flows and heavy siltation. However, whilst salmonid spawning and nursery habitat was absent, the site had some low value as a holding habitat for adult brown trout given the high average depth. Suitability for European eel was high.

3.1.9 Site B6 – West Galros Stream, Eglish

Electro-fishing was not undertaken at site B6 given prohibitive depths of >1.5-2m. With the exception of three-spined stickleback, site B5 was of poor fisheries value given poor hydromorphology, low flows and heavy siltation. However, whilst salmonid spawning and nursery habitat was absent, the site had some low value as a holding habitat for adult trout given the high average depth. Suitability for European eel was high.

Plate 3.8 Representative image of site B5 on the upper reaches of the West Galros Stream, August 2022

Plate 3.9 Representative image of site B6 on the West Galros Stream, August 2022 (facing upstream from road crossing)

3.1.10 Site B7 – West Galros Stream, Cush

Three-spined stickleback was the only species recorded via electro-fishing at site B7 (**Figure 3.6**).

With the exception of low densities of three-spined stickleback (*n*=23), the site was not of fisheries value given poor hydromorphology, low flows and heavy siltation, in addition to poor connectivity with downstream habitats.

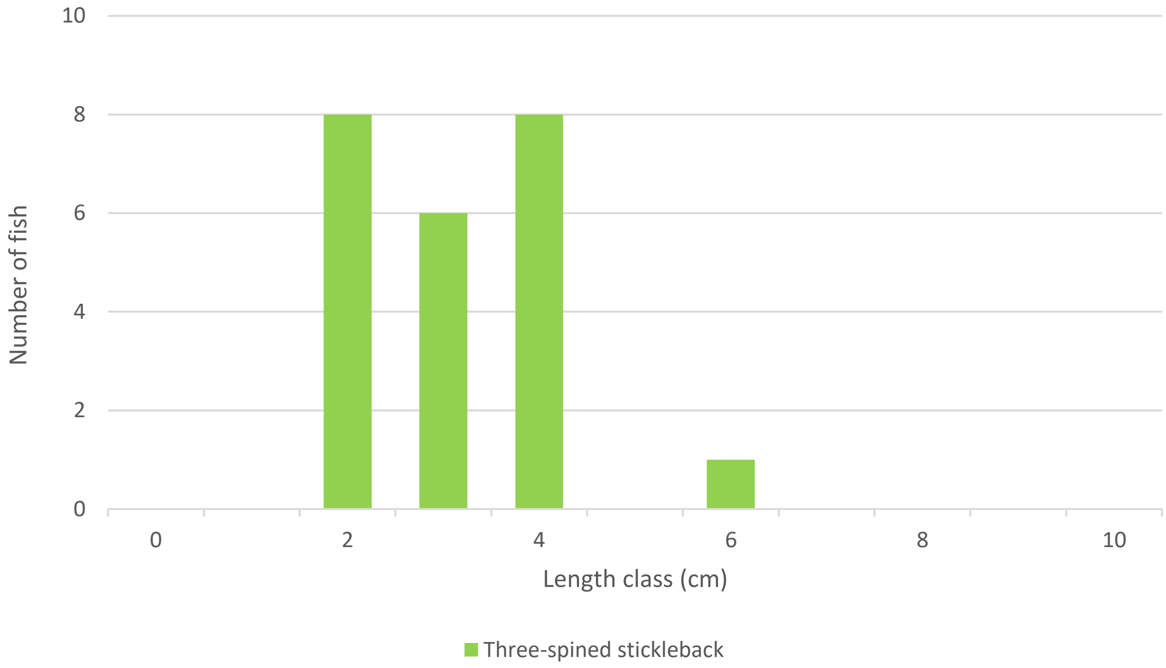

Figure 3.6 Length frequency distribution recorded via electro-fishing at site B7 on the West Galros Stream, August 2022

Plate 3.10 Representative image of site B7 on the West Galros Stream, August 2022

3.1.11 Site B8 – Rapemills River, R439 road crossing

Brown trout was the only species recorded via electro-fishing at site B8 (**Figure 3.7**).

The site was of high value for salmonids, supporting a moderate density of mixed-cohort brown trout (*n*=42). The site was considered a good quality salmonid nursery although the value was reduced given the paucity of accessible instream refugia due to calcification of the bed. Spawning habitat was largely absent given compaction and calcification of the substrata. Some excellent quality holding habitat was present in deeper shaded pool and glide areas, many of which were adjoined by scoured banks and tree root systems. These areas also provided good refugia for European eel although none were recorded. Suitability for lamprey was low due to the high energy nature of the site and more flocculent nature of any soft sediment deposits.

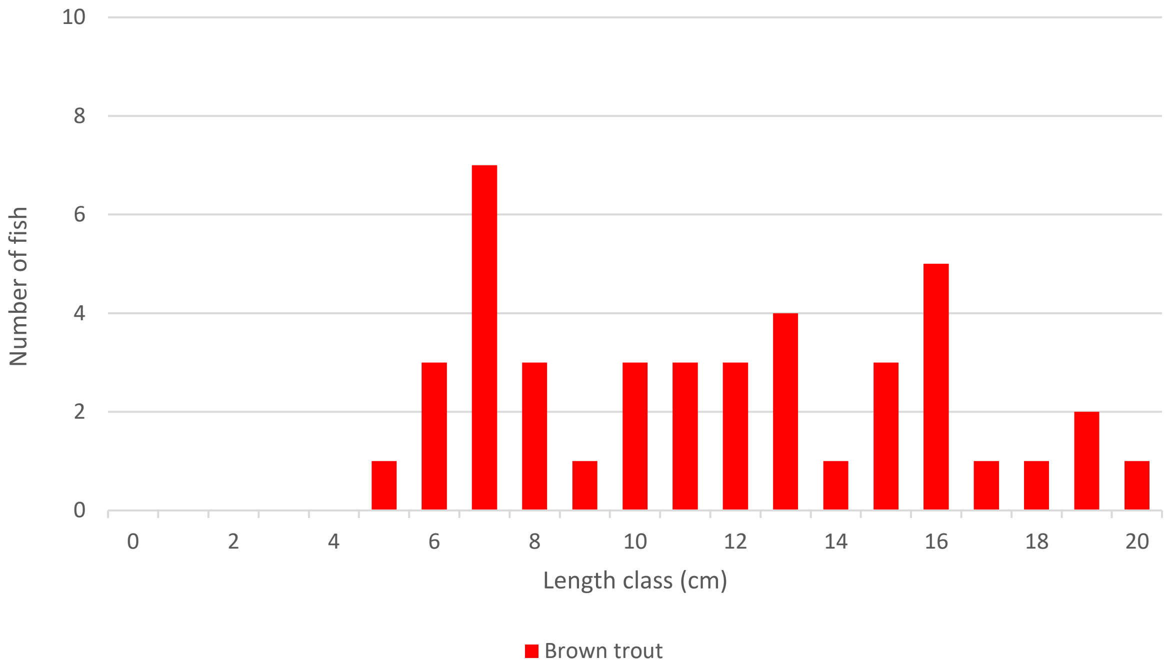

Figure 3.7 Length frequency distribution recorded via electro-fishing at site B8 on the Rapemills River, August 2022

Plate 3.11 Small adult brown trout recorded at site B8 on the Rapemills River, August 2022

3.1.12 Site B9 – Mullaghakaraun Bog Stream, Ballyneena

Lamprey (*Lampetra* sp.) and ten-spined stickleback were the only to fish species recorded via electro-fishing at site B9 (**Figure 3.8**).

The site was of poor value for salmonids (none recorded) given evident siltation and hydromorphological pressures (i.e. poor seasonal flows, forestry upstream etc.). Despite some low suitability as a brown trout nursery and holding habitat, none were recorded via electro-fishing. Likewise, no European eel were recorded despite some low suitability. The site was of moderate value for *Lampetra* sp., with a low density (4.6 per m^2) of ammocoetes recorded from deep organic-rich soft sediment upstream of the bridge. However, the site was considered sub-optimal for the species given low seasonal flows and a lack of spawning gravels (siltation).

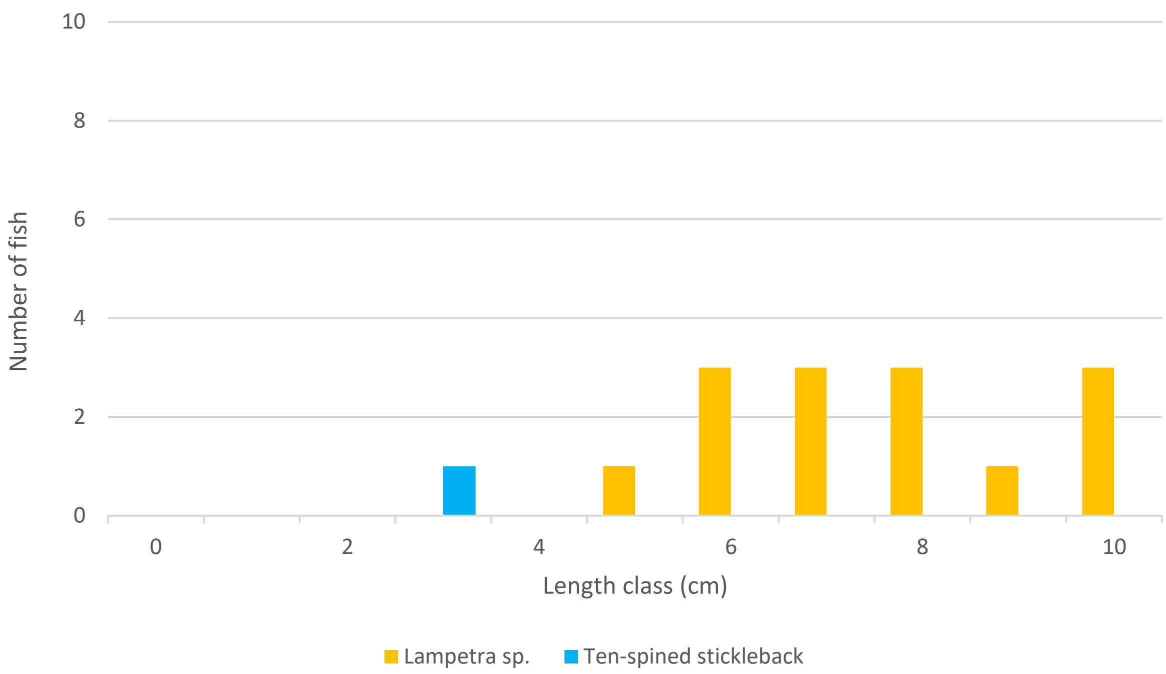

Figure 3.8 Length frequency distribution recorded via electro-fishing at site B9 on the Mullaghakaraun Bog Stream, August 2022

Plate 3.12 Mixed-cohort Lampetra sp. ammocoetes recorded at site B9 on the Mullaghakaraun Bog Stream, August 2022

3.1.13 Site B10 – Rapemills River, All Saints Bridge

Brown trout, European eel, three-spined stickleback and minnow were recorded via electro-fishing at site B10 (**Figure 3.9**).

The site was of moderate value for salmonids only given hydromorphological and gross siltation pressures. The site supported a very low density of adult brown trout (*n*=3), with no juveniles recorded. Spawning habitat was almost entirely absent and sub-optimal where present given calcification and siltation of the bed. The site was not of value as a salmonid nursery (i.e. more suited to coarse fish). European eel habitat was of good quality given abundant instream refugia. However, only a single large adult eel (62.4cm TL) was recorded via electro-fishing. Despite abundant soft sediment deposits, no lamprey ammocoetes were recorded. This was considered reflective of low flows at the (depositional) site.

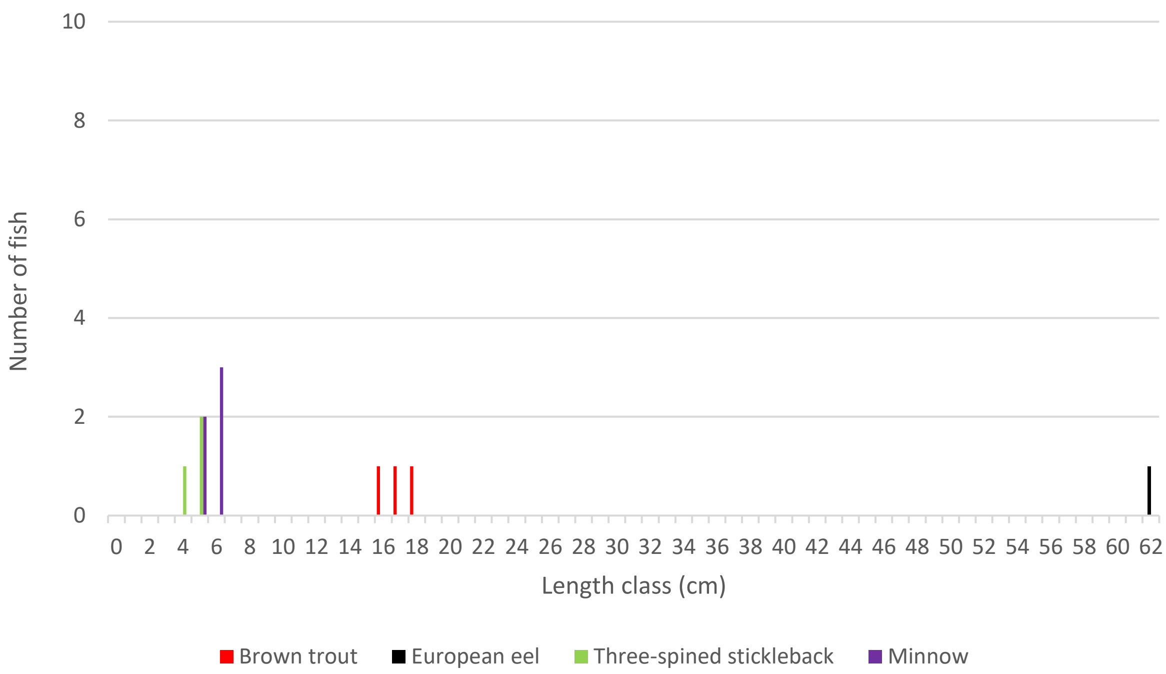

Figure 3.9 Length frequency distribution recorded via electro-fishing at site B10 on the Rapemills River, August 2022

Plate 3.13 Large adult European eel recorded at site B10 on the Rapemills River, August 2022

3.1.14 Site B11 – Milltown Stream, Ballyneena

Site B11 was not of fisheries value at the time of survey given its dry, ephemeral nature and absence of aquatic habitats. However, there was some low physical habitat suitability for salmonids and European eel under higher flow periods and such species may migrate from the downstream-connecting Rapemills River. It was not possible to undertake electro-fishing at this site.

Plate 3.14 Representative image of site B11 on the Milltown Stream, August 2022

3.1.15 Site B12 – Feeghroe River, Five Roads Cross

Brown trout (*n*=8), three-spined stickleback (*n*=18) and ten-spined stickleback (*n*=3) were recorded via electro-fishing at site B12 (**Figure 3.10**).

The site was of moderate value only for salmonids given gross siltation (from peat escapement), poor hydromorphology and poor seasonal flows. However, the site supported a small population of adult brown trout, with the box culvert providing some suitable holding habitat. Spawning substrata were absent from the site (present in 2019; Triturus, 2019) and nursery habitat was very poor. Suitability for European eel was also poor (none recorded). Poor flows and peat-dominated substrata precluded the presence of lamprey.

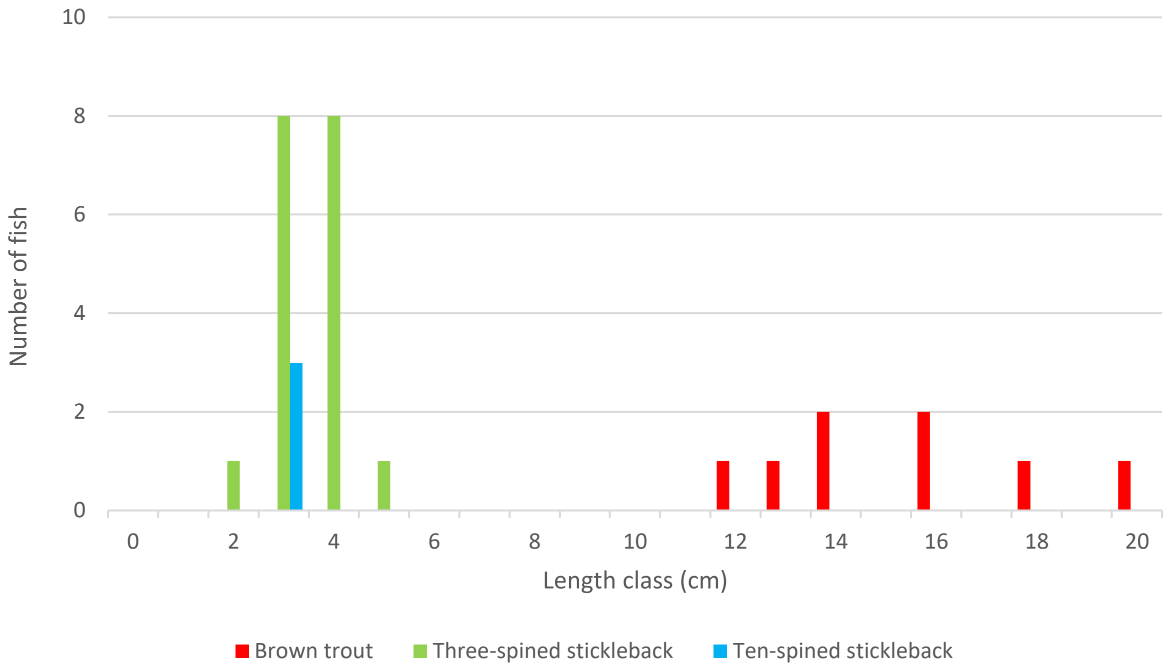

Figure 3.10 Length frequency distribution recorded via electro-fishing at site B12 on the Feeghroe River, August 2022

Plate 3.15 Small adult brown trout recorded at site B12 on the Feeghroe River, August 2022

3.1.16 Site B13 – Rapemills River, Lusmagh Bridge

A total of *n*=6 species were recorded via electro-fishing at site B13, namely brown trout (*n*=5), European eel (*n*=2), minnow (*n*=39), three-spined stickleback (*n*=23), stone loach (*n*=5) and pike (*Esox lucius*) (*n*=1) (**Figure 3.11**). This was the highest fish species diversity recorded during the survey.

The site was of moderate value to salmonids, supporting a low density of primarily adult brown trout. The predominant deeper glide habitat provided some good holding habitat for large trout (e.g. overhanging aquatic vegetation). Some limited nursery habitat was present in the vicinity of the bridge but this was reduced in value given significant siltation pressures. Spawning habitat for salmonids and lamprey was also confined to the bridge area and also impacted by siltation and filamentous algae. Despite abundant soft sediment, no larval lamprey were recorded. The site was of most value for coarse fish habitat given the predominance of heavily vegetated, depositional glide and pool. European eel habitat was good overall given abundant instream refugia (mostly macrophyte beds), although only a low density were recorded.

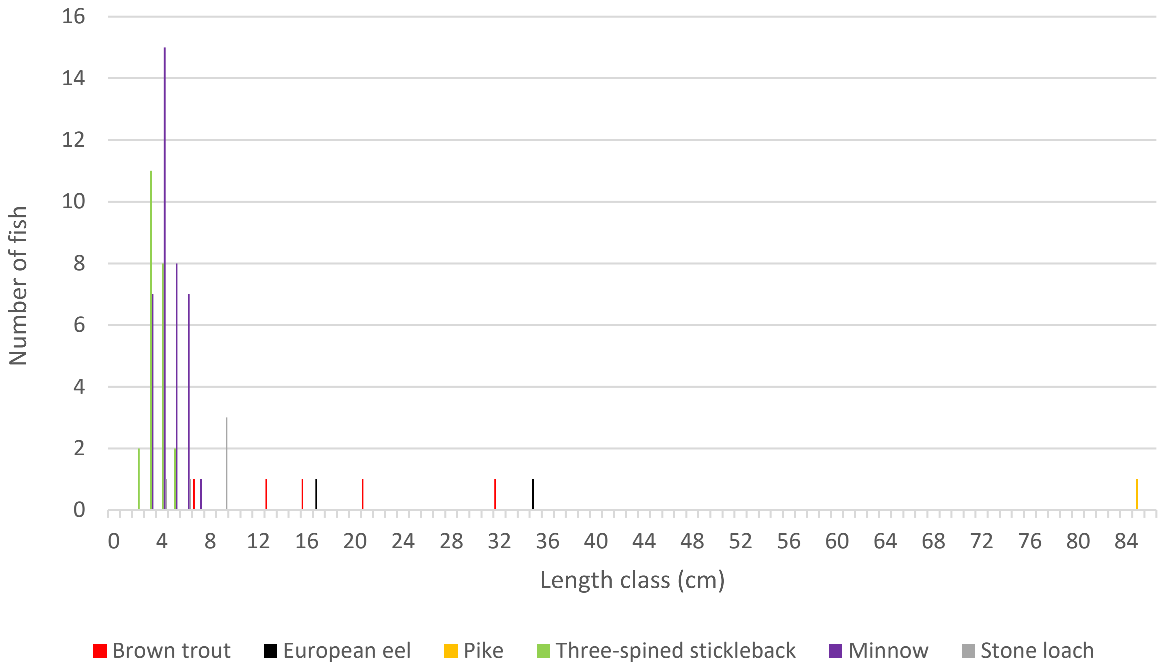

Figure 3.11 Length frequency distribution recorded via electro-fishing at site B13 on the Rapemills River, August 2022

Plate 3.16 Adult pike (85cm FL) recorded via electro-fishing at site B13 on the Rapemills River

3.1.17 Site C1 – Whigsborough Stream, Clooneen

No fish species were recorded via electro-fishing at site C1. The site was not of fisheries value given gross siltation, poor hydromorphology and low flows, in addition to poor connectivity with downstream habitats (frequent peat blockages instream).

Plate 3.17 Representative image of site C1 on the Whigsborough Stream, August 2022

3.1.18 Site D1 – Grant's Island River, L7014 road crossing

No fish species were recorded via electro-fishing at site D1. The site was not of fisheries value given gross siltation, poor hydromorphology and low flows, in addition to poor connectivity with downstream habitats (frequent blockages instream).

Plate 3.18 Representative image of site D1 on the Grant's Island River, August 2022

3.1.19 Site D2 – Bullock Island Stream, L7014 road crossing

Site D2 was not of fisheries value at the time of survey given its dry, ephemeral nature and absence of aquatic habitats. However, given evidence that it supports water seasonally, the channel may be of some low value as a coarse fish and European eel habitat during (winter) higher water periods. It was not possible to undertake electro-fishing at this site.

Plate 3.19 Representative image of site D2 on the Bullock Island Stream, August 2022 (dry channel)

3.1.20 Site D3 – Park River, L7014 road crossing

Site D3 was not of fisheries value at the time of survey given its dry, ephemeral nature and absence of aquatic habitats. However, given evidence that it supports water seasonally, the channel may be of some low value as a coarse fish and European eel habitat in its lower reaches during (winter) higher water periods. It was not possible to undertake electro-fishing at this site.

Plate 3.20 Representative image of site D3 on the Park River, August 2022 (dry, ephemeral channel)

3.1.21 Site D5 - Little River, L7014 road crossing

A total of *n*=6 species were recorded via electro-fishing at site B13, namely brown trout (n=5), lamprey (*Lampetra* sp.) (*n*=33), European eel (*n*=1), minnow (*n*=27), stone loach (*n*=4) and roach (*Rutilus rutilus*) (*n*=1) (**Figure 3.12**). This was the highest fish species diversity recorded during the survey.

Site D5 was of moderate value to salmonids only given significant siltation pressures and poor hydromorphology resulting from historical arterial drainage. However, the site supported a low density of adult brown trout. Spawning habitat for both salmonids and lamprey was present but highly localised and significantly impacted by siltation. Occasional deeper pool and deeper glide habitat provided some good holding opportunities for adult trout. The site was a poor quality salmonid nursery, as reflected in the absence of juveniles recorded during electro-fishing. In contrast, the site was of high value as a lamprey nursery, with moderate densities of larvae recorded from abundant soft sediment areas (13.2 per m^2). European eel habitat was moderate overall, with a low density present. The site was of greater value as a coarse fish habitat.

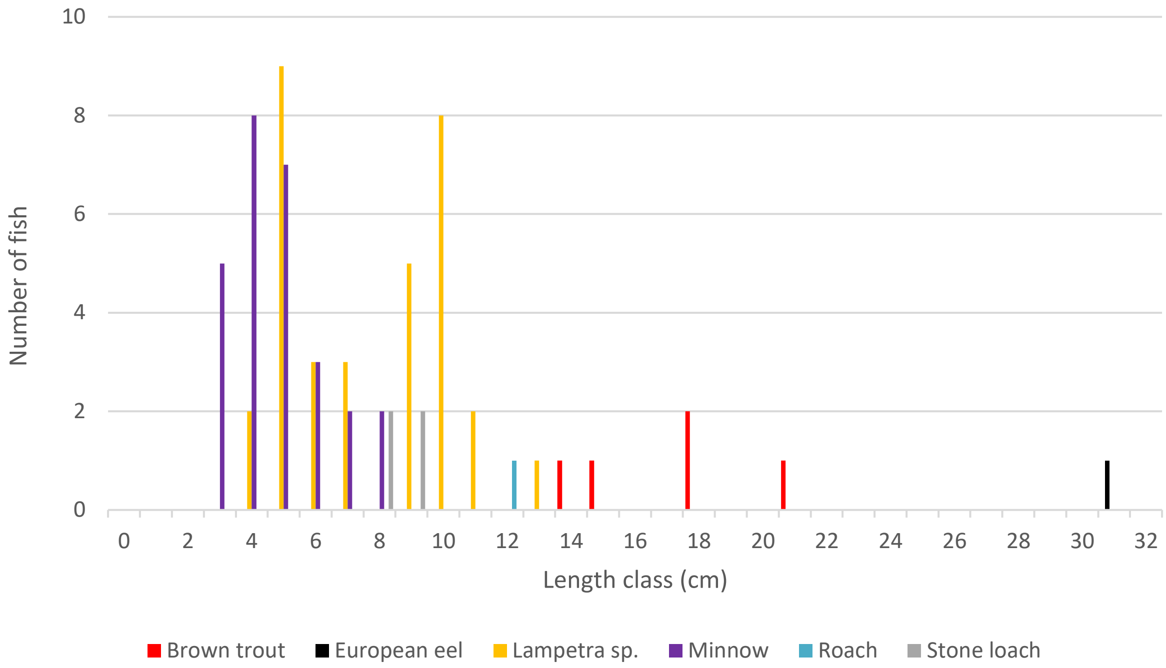

Figure 3.12 Length frequency distribution recorded via electro-fishing at site D5 on the Little River, August 2022

Plate 3.21 Juvenile roach and *Lampetra* sp. ammocoetes recorded at site D5 on the Little River, August 2022

3.1.22 Site D6 - River Brosna, Moystown Bridge

Electro-fishing was not undertaken at site D6 given the large width, prohibitive depths and high flow rates. However, the site was of high value for salmonids being most suited to adults given a predominance of deeper glide and pool. Overhanging willow-dominated treelines provided valuable shading and cover. Whilst some spawning substrata was present for both salmonids and lamprey, this was highly localised (rare overall). Salmonid nursery habitat was superficially good although closer inspection of instream substrata revealed a paucity of accessible refugia due to substrate compaction and calcification. Furthermore, macrophyte refugia cover was low. The high-energy site was largely unsuitable as a lamprey nursery habitat (high flow rates), though some sub-optimal habitat was present away from main flow channels. The site was of relatively poor value for European eel given a paucity of instream refugia. However, the River Brosna is known to support European eel in addition Atlantic salmon, brown trout, lamprey (*Lampetra* sp.), minnow and stone loach (Kelly et al., 2010, 2015). Two gudgeon (*Gobio gobio*) were recorded during kick sampling.

Plate 3.22 Two gudgeon recorded via kick sampling at site D6 on the Little River, August 2022

3.1.23 Site D7 - Blackwater River, Blackwater Bridge

A total of *n*=4 fish species were recorded via electro-fishing at site D7, namely brown trout (*n*=1), lamprey (*Lampetra* sp.) (*n*=54), minnow (*n*=3) and stone loach (*n*=4) (**Figure 3.13**).

The site was of very poor value for salmonids given poor hydromorphology and gross siltation. However, a single adult brown trout was recorded via electro-fishing alongside a very low density of stone loach and minnow. The site was of very high value for *Lampetra* sp., with abundant soft sediment habitat and moderate densities of ammocoetes (11 per m^2). Lamprey spawning habitat was almost entirely absent in the vicinity of the bridge (superficial gravels at one location only near a debris dam), indicating superior spawning habitat was present upstream. Despite some suitability for European eel, none were recorded.

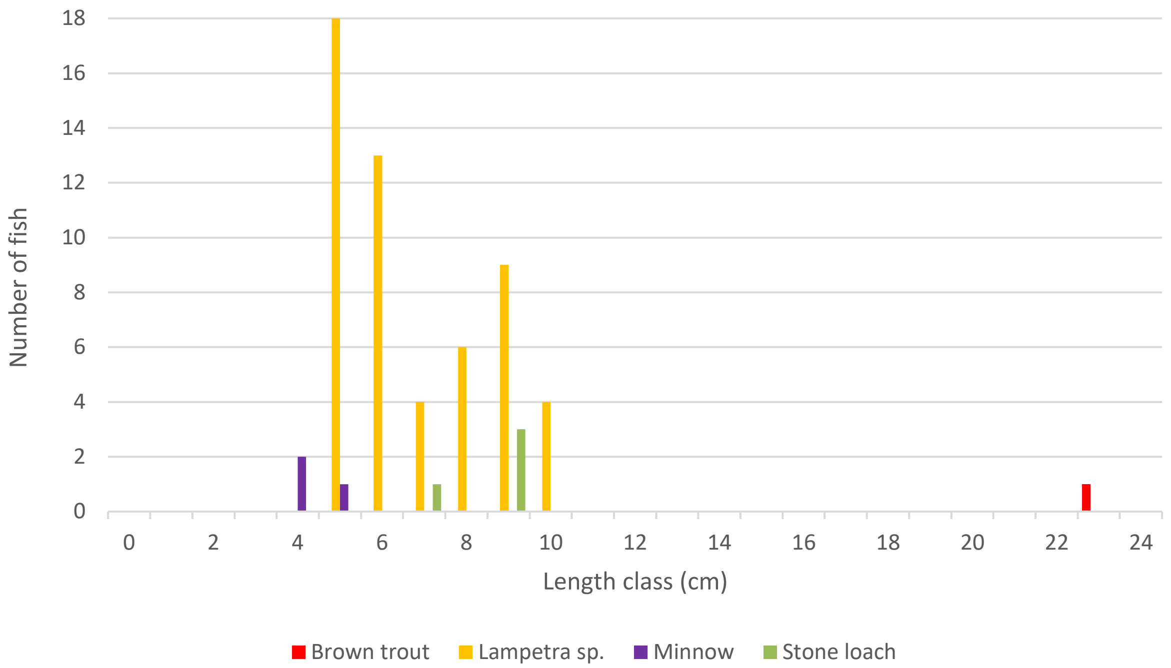

Figure 3.13 Length frequency distribution recorded via electro-fishing at site D5 on the Little River, August 2022

Plate 3.23 Mixed-cohort *Lampetra* sp. ammocoetes recorded at site D7 on the Blackwater River, August 2022

3.1.24 Site E1 - Silver River, Wooden Bridge

A total of *n*=5 fish species were recorded via electro-fishing at site E1, namely brown trout (*n*=14), lamprey (*Lampetra* sp.) (*n*=1), minnow (*n*=21), three-spined stickleback (*n*=1) and stone loach (*n*=9) (**Figure 3.14**).

Despite significant siltation pressures, site E1 was of good value to salmonids, supporting a moderate density of primarily adult trout. The site was of most value as an adult trout habitat given an abundance of deep glide with high instream cover. The site was of moderate value as a nursery given compaction of instream refugia. Whilst mixed gravels and small cobble present downstream of the bridge provided some localised spawning habitat for salmonids and lamprey, the value was reduced given siltation pressures. Despite frequent sand and silt accumulations, the site supported only a low density of lamprey ammocoetes (0.5 per m^2). Whilst no European eel were recorded, the site provided some good suitability (e.g. deep, macrophyte-rich glide).

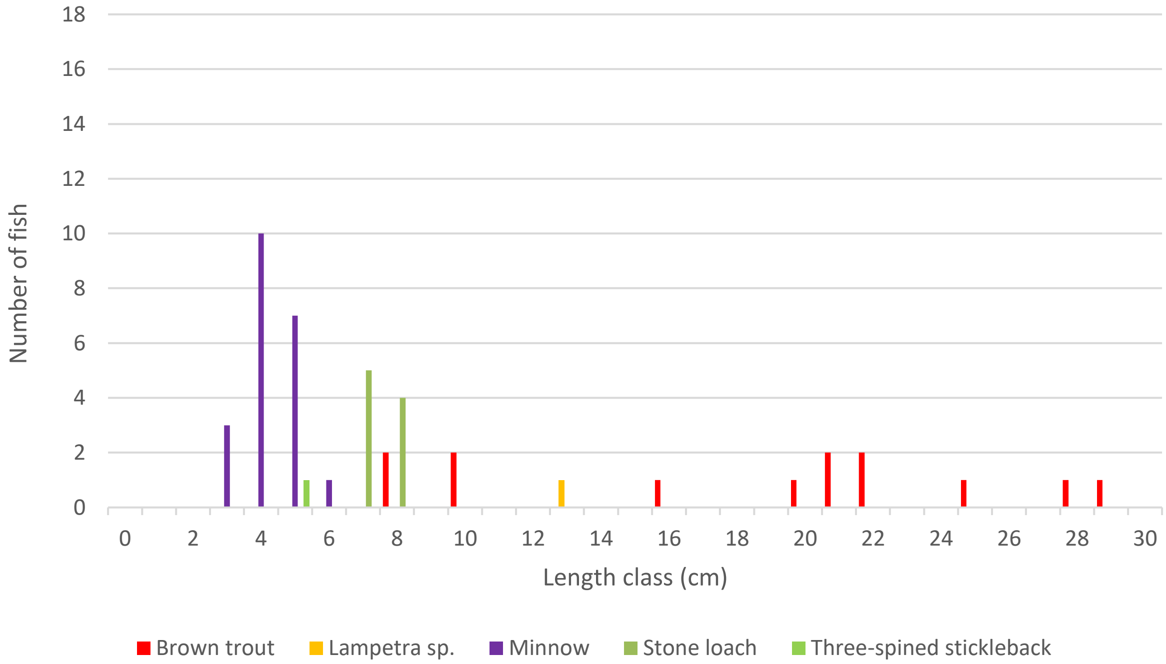

Figure 3.14 Length frequency distribution recorded via electro-fishing at site E1 on the Silver River, August 2022

Plate 3.24 Large adult brown trout recorded at site E1 on the Silver River, August 2022

3.1.25 Site E2 - Silver River, Millbrook Bridge

A total of *n*=4 fish species were recorded via electro-fishing at site E2, namely Atlantic salmon (*n*=1), brown trout (*n*=34), lamprey (*Lampetra* sp.) (*n*=1) and stone loach (*n*=7) (**Figure 3.15**).

Site E2 was of good value for salmonids, supporting a moderate density of primarily adult brown trout. A single Atlantic salmon parr was also captured. The site was of highest value as an adult holding habitat given the predominance of deeper glide and pool with frequent macrophyte beds. These areas also provided some good quality nursery although densities of juveniles were low given the reduced spawning capacity of the site due to bedding, siltation and calcification pressures. Nevertheless, some good quality spawning habitat was present locally for both salmonids and lamprey. Good quality larval lamprey habitat was also present locally although these areas supported only low densities of ammocoetes (3.5 per m^2). Despite some good suitability for European eel, none were recorded, likely reflecting the relative paucity of accessible boulder and cobble refugia

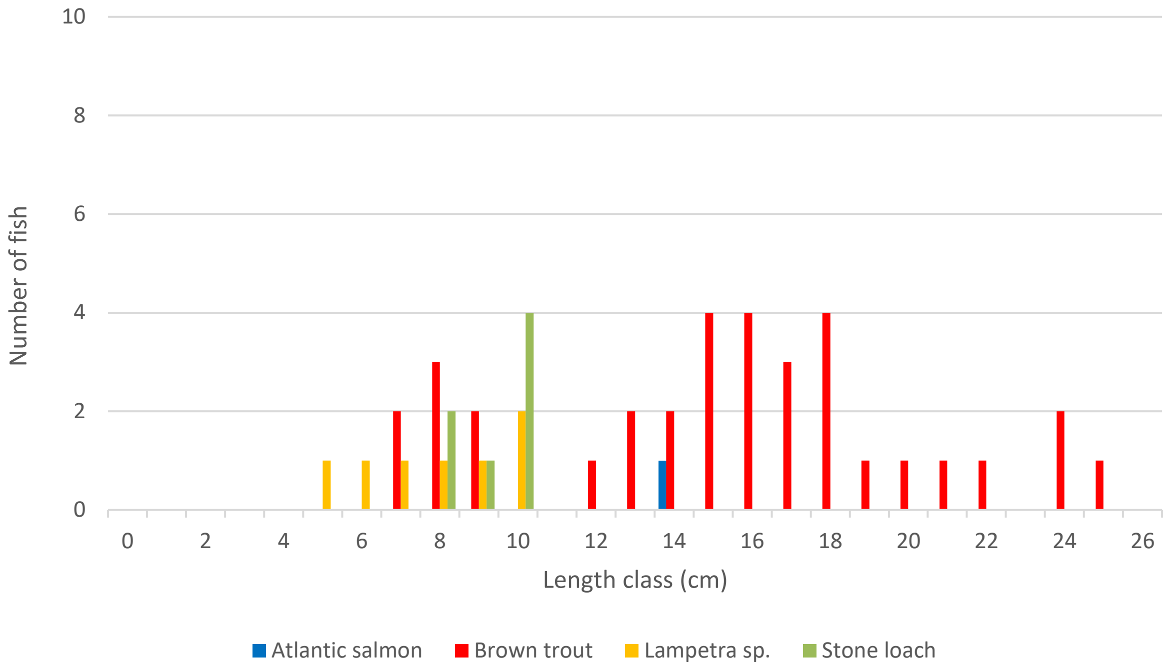

Figure 3.15 Length frequency distribution recorded via electro-fishing at site E2 on the Silver River, August 2022

Plate 3.25 Atlantic salmon parr (14.2cm FL) recorded at site E2 on the Silver River, August 2022

Table 3.1 Fish species densities per m^2 recorded at sites in the vicinity of the proposed Cush wind farm via electro-fishing in August 2022 (values in bold represent the highest densities recorded for each species, respectively)

Site	Watercourse	CPUE (elapsed time)	Approx. area fished (m^2)	Atlantic salmon	Brown trout	Lampetra sp.	European eel	Three-spined stickleback	Ten-spined stickleback	Minnow	Stone loach	Pike	Roach
A1	Woodfield River	Dry channel		n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
A2	Woodfield River	5	10	0.000	0.000	0.000	0.000	0.000	**0.400**	0.000	0.000	0.000	0.000
A3	Little Brosna River	10	240	**0.021**	0.071	0.000	0.004	0.000	0.000	0.079	0.004	0.000	0.000
B1	Rapemills River	10	87.5	0.000	**0.514**	**20 per m^2**	0.000	0.034	0.000	0.000	0.000	0.000	0.000
B2	Eglish Stream	Dry channel		n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
B3	Rapemills River	10	135	0.000	0.326	2 per m^2	0.000	0.000	0.000	0.000	0.000	0.000	0.000
B4	Rapemills River	5	75	0.000	0.053	2 per m^2	0.000	0.187	0.000	0.000	0.000	0.000	0.000
B5	West Galros Stream	Too deep for electro-fishing		n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
B6	West Galros Stream	Too deep for electro-fishing		n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
B7	West Galros Stream	5	50	0.000	0.000	0.000	0.000	**0.460**	0.000	0.000	0.000	0.000	0.000
B8	Rapemills River	10	140	0.000	0.300	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
B9	Mullaghakaraun Bog Stream	5	112.5	0.000	0.000	4.6 per m^2	0.000	0.000	0.009	0.000	0.000	0.000	0.000
B10	Rapemills River	10	80	0.000	0.038	0.000	**0.013**	0.038	0.000	0.063	0.000	0.000	0.000
B11	Milltown Stream	Dry channel		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
B12	Feeghroe River	5	80	0.000	0.100	0.000	0.000	0.225	0.038	0.000	0.000	0.000	0.000
B13	Rapemills River	10	180	0.000	0.028	0.000	0.011	0.128	0.000	0.217	0.028	**0.006**	0.000

Site	Watercourse	CPUE (elapsed time)	Approx. area fished (m^2)	Atlantic salmon	Brown trout	Lampetra sp.	European eel	Three-spined stickleback	Ten-spined stickleback	Minnow	Stone loach	Pike	Roach
C1	Whigsborough Stream	5	5	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
D1	Grants Island River	Dry channel		n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
D2	Bullock Island Stream	Dry channel		n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
D3	Park River	Dry channel		n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
D5	Little [Cloghan] River	10	110	0.000	0.045	13.2 per m^2	0.009	0.000	0.000	**0.245**	0.036	0.000	**0.009**
D6	River Brosna	Too deep for electro-fishing		n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
D7	Blackwater River	10	300	0.000	0.000	11 per m^2	0.000	0.000	0.000	0.010	0.013	0.000	0.000
E1	Silver River	10	240	0.000	0.058	0.5 per m^2	0.000	0.004	0.000	0.088	**0.038**	0.000	0.000
E2	Silver River	10	250	0.004	0.136	3.5 per m^2	0.000	0.000	0.000	0.000	0.028	0.000	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 Cush wind farm, August 2022

Site	Watercourse	Atlantic salmon	*Lampetra* sp.	Brown trout	European eel	Other species
A1	Woodfield River	No fish recorded – dry channel				
A2	Woodfield River					Ten-spined stickleback
A3	Little Brosna River	✓		✓	✓	Stone loach, minnow
B1	Rapemills River		✓	✓		Three-spined stickleback
B2	Eglish Stream	No fish recorded – dry channel				
B3	Rapemills River		✓	✓		
B4	Rapemills River		✓	✓		Three-spined stickleback
B5	West Galros Stream	No electro-fishing undertaken (prohibitive depths)				
B6	West Galros Stream	No electro-fishing undertaken (prohibitive depths)				
B7	West Galros Stream					Three-spined stickleback
B8	Rapemills River			✓		
B9	Mullaghakaraun Bog Stream		✓			Ten-spined stickleback
B10	Rapemills River			✓	✓	Ten-spined stickleback, minnow
B11	Milltown Stream	No fish recorded – dry channel				
B12	Feeghroe River			✓		Three-spined stickleback, ten-spined stickleback
B13	Rapemills River			✓	✓	Pike, minnow, stone loach, three-spined stickleback
C1	Whigsborough Stream	No fish recorded				
D1	Grants Island River	No fish recorded				
D2	Bullock Island Stream	No fish recorded – dry channel				
D3	Park River	No fish recorded – dry channel				
D5	Little [Cloghan] River		✓	✓	✓	Roach, minnow, stone loach
D6	River Brosna	No electro-fishing undertaken (prohibitive depth, width & flow)				
D7	Blackwater River		✓	✓		Minnow, stone loach
E1	Silver River		✓	✓		Minnow, stone loach, three-spined stickleback
E2	Silver River	✓	✓	✓		Stone loach

*** Conservation value:** Atlantic salmon (*Salmo salar*), sea lamprey (*Petromyzon marinus*), brook lamprey (*Lampetra 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 Fisheries Acts 1959 to 2019, brown trout and coarse fish species have no legal protection in Ireland.

4. Discussion

The surveyed watercourses in the vicinity of the proposed Cush wind farm were typically small, heavily silted lowland depositing channels that had been historically modified, resulting in often poor hydromorphology. Most sites supported a low diversity of fish species and generally low abundances of fish. Sites B13 on the lower reaches of the Rapemills River and site D5 on Little River supported a total of *n*=6 species, respectively, the highest diversity recorded during the survey. Sites A1 (Woodfield River), B2 (Eglish River), D1 (Grant's Island River), Bullock Island Stream (D2) and the Park River (D3) were ephemeral channels that were dry at the time of survey and, therefore, did not support fish.

Salmonids were recorded from a total of 11 no. sites, namely sites on the Little Brosna River (site A3), Rapemills River (B1, B3, B4, B8 & B13), Feeghroe River (B12), Little River (D5) and the Silver River (E1 & E2) (**Table 3.1, 3.2**). However, these populations comprised brown trout only, with the exception of sites A3 on the Little Brosna River and E2 on the Silver River which also supported low numbers of Atlantic salmon parr. This restricted distribution of Atlantic salmon in the vicinity of the proposed project is unsurprising given widespread historical modifications in the Shannon [Lower]_SC_060, Shannon [Lower]_SC_040, Shannon [Lower]_SC_030 and Brosna_SC_080 river sub-catchments (which have evidently reduced the quality of salmonid habitat), in addition to significant downstream barriers on the River Shannon (i.e. hydro-electric dams). Other pressures within the wider survey area, such as hydromorphological modifications, eutrophication and, in particular, siltation, also reduced the quality of salmonid habitat in many watercourses in the vicinity of the proposed wind farm.

Diffuse siltation is one of the greatest threats to salmonid populations, particularly in agricultural catchments such as that of the proposed Cush wind farm. Sediment not only blocks interstitial spaces in substrata and limits oxygen supply to salmonid eggs (required for healthy embryonic project and 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). Sedimentation of salmonid habitat is a particular problem in Irish rivers flowing through agricultural and afforested catchments (Evans et al., 2006).

Lamprey ammocoetes (*Lampetra* sp., likely *L. planeri* given known catchment barriers) were recorded from a total of 8 no. sites on the Rapemills River (B1, B3 & B4), Mullaghakaraun Bog Stream (B9), Little River (D5) and the Silver River (E1 & E2) (**Table 3.1, 3.2**). Higher densities of ammocoetes were recorded at sites B1 (20 per m^2), D5 (13.2 per m^2) and D7 (11 per m^2). These sites featured the deposition of fine, organic-rich sediment ≥5cm in depth; areas considered optimal for larval *Lampetra* spp. (Aronsuu & Virkkala, 2014; Goodwin et al., 2008; Gardiner, 2003). However, suitability was typically poor elsewhere in the survey area as a result of historical modifications to hydromorphology which have resulted in often poor quality lamprey habitats. This was especially so with reference to spawning habitats which were heavily silted or even absent at many of the survey sites. *Lampetra* sp. generally fine, clean gravels required for spawning (Dawson et al., 2015; Rooney et al., 2013; Lasne et al., 2010). Larval lamprey distribution and settlement is passive and entirely regulated by local, dynamic hydrographical (flow) regimes (Kelly & King,, 2001; Potter, 1980; Hardisty & Potter 1971). Thus, a paucity of suitable spawning sites (i.e. sources of larvae) can often counteract the presence of even widespread ammocoete burial habitat (i.e. soft sediment) and limit the success of local populations. This was exemplified at surveys sites on the lower Rapemills River, where mean densities of 0-≤2 larvae per m^2 were recorded.

On both a global and Irish scale, the European eel is listed as 'critically endangered' (Pike et al., 2020; King et al., 2011). European eel were only recorded from sites on the Little Brosna River (A3), Rapemills River (B10, B13) and Little River (D5), and were present in low numbers only. As outlined above, the distribution of eel in the Shannon catchment is significantly impacted by instream barriers.

In summary, the best overall fisheries habitat was present on the larger watercourses surveyed, including the Little Brosna River, River Brosna and Silver River and less-modified reaches of smaller channels, such as the upper reaches of the Rapemills River. These areas featured greater levels of instream recovery from historical modifications (straightening, deepening etc.), lower rates of siltation and greater habitat heterogeneity, resulting in improved fisheries habitat for salmonids, lamprey, European eel and other fish species.

Triturus

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Appendix D Construction Environment Management Plan

Natura Impact Statement

Cush Wind Farm

Cush Wind Limited

SLR Project No.: 501.00581.00005

17 December 2023

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1.0 Introduction

Galetech Energy Services (GES), on behalf of Cush Wind Limited, has prepared this Planning-Stage Construction & Environmental Management Plan (CEMP) for the construction of the Cush Wind Farm.

1.1 Purpose of this Report

This CEMP has been prepared to outline the management of activities during the construction of the project to ensure that all construction activities are undertaken in an environmentally responsible manner. This CEMP summarises the environmental commitments made in respect of the project and the measures to be adopted to ensure compliance with legislation and the requirements of statutory bodies.

This CEMP (Planning-Stage/Preliminary) is a live document and will be updated by the appointed contractor prior to the commencement of development. Prior to the commencement of construction, the updated CEMP will be reviewed by the Environmental Manager (EM) and Ecological Clerk of Works (EcoW), as necessary, to confirm the appropriateness of the measures set out therein. This CEMP will form part of the main civil construction works contract. The contractor will take account of the structure, content, methods and requirements contained within the various sections of this CEMP when further developing this document (to include environmental plans and other related construction management plans and method statements) as required.

1.2 Objectives of this CEMP

This CEMP has been developed in accordance with the Institute of Environmental Management and Assessment (IEMA) *Practitioner Environmental Management Plans Best Practice Series Volume 12 (December 2008)* and has been designed to address the proposed environmental construction strategies that are to be implemented in advance of and during the construction of the project.

This CEMP aims to define good working practices as well as specific actions required to implement mitigation requirements as identified in the Environmental Impact Assessment Report (EIAR), Natura Impact Statement (NIS), the planning process, and/or other licensing or consenting processes.

1.3 Structure of this CEMP

The CEMP has been structured such that it can be read as consolidated document or as discreet documents addressing specific environmental topics. In particular, we refer to the technical annexes enclosed which address specific matters such as spoil management, surface water management, waste management, and emergency responses.

A copy of the CEMP will be maintained in the site offices for the duration of the construction phase and will be available for review at any time. The contractor's EM will be responsible for the continued development of the CEMP throughout the construction phase.

Where specific construction management plans or method statements are prepared by the contractor, these will be inserted into the relevant section of this CEMP.

1.4 Roles & Responsibilities

Cush Wind Limited, and its appointed Project Manager, will be responsible for the overall implementation of the environmental measures and procedures set out in the CEMP. The role of the Project Manager relates to compliance monitoring with the

CEMP and other planning/environmental/licensing requirements. Additionally, the Project Manager shall be empowered to halt works where he/she considers that continuation of the works would be likely to result in a substantial environmental risk.

The Project Manager will also carry out site checks that the works are being undertaken in accordance with the CEMP and will prepare a record of same.

The contractor will appoint an EM who will be responsible for coordination and development of the CEMP and any other surveys, reports or construction management plans necessary for the discharge of the requirements of the CEMP. The EM will also review the contractors construction management plans as required, carry out compliance auditing during the construction phase and coordinate the Environmental Management Group (see below) and required liaisons between Cush Wind Limited, the contractor, and other statutory authorities.

Prior to commencement of construction, the contractor will identify a core Environmental Management Group, comprising of specific project personnel and including the Project Manager, EM, and Ecological Clerk of Works (ECoW). The Environmental Management Group will meet monthly to discuss the monthly environmental report and will advise site personnel on areas where improvements may be made on site. The group will draw on technical expertise from relevant specialists where required and will liaise with other relevant external bodies as required.

1.5 Reporting Procedures

Appropriate reporting procedures are key to the proper implementation of the measures outlined within this CEMP and include reporting between parties involved in the construction of the project and also external stakeholders, such as the relevant local authorities.

Emergency and environmental incident reporting procedures are set out in the Environmental & Emergency Response Plan (see **Annex 1**).

2.0 Description of the Project

In summary, the project comprises the following main components:-

- 8 no. wind turbines with an overall tip height of 200m, and all associated ancillary infrastructure;
- All associated and ancillary site development, excavation, construction, landscaping and reinstatement works, including provision of site drainage infrastructure and forestry felling.
- Temporary alterations to the turbine component haul route; and,
- Construction of an electricity substation, Battery Electricity Storage System and installation of 5.6km of underground grid connection to facilitate connection of the proposed electricity substation to the existing 110kV substation at Clondallow, County Offaly;

The project site is located in rural Co. Offaly, approximately 4km north of the town of Birr and c. 28km south-west of Tullamore, County Offaly. Off-site and secondary developments; including the forestry replant lands and candidate quarries which may supply construction materials; also form part of the project.

The turbine component haul route, and associated temporary alteration works, are located within counties Galway, Roscommon, Westmeath, and Offaly. It is envisaged that the turbines will be transported from the Port of Galway, through the counties of Galway, Roscommon, Westmeath and Offaly, to the project site.

Various environmental reports have been prepared in respect of the project and have been utilised in the preparation of this CEMP, including:-

- Environmental Impact Assessment Report (Galetech Energy Services); and
- Natura Impact Statement (SLR Consulting).

3.0 General Construction Sequence

The construction phase is likely to last for approximately 15-18 months from commencement of detailed site investigations through to the installation and commissioning of the turbines and ending with site reinstatement and landscaping.

The construction phase of the development will comprise a six day week with normal working hours from 07:00 to 19:00 Monday to Friday and 07:00 to 13:00 on Saturdays. It may be necessary to undertake works outside of these hours to avail of favourable weather conditions (e.g. during time of low wind speed to facilitate turbine erection etc.) or during extended concrete pours (e.g. where turbine foundation pours must be completed within 24 hours). Where construction activities are necessary outside of the normal working hours, local residents and the Planning Authority will receive prior notification.

3.1 Construction Method

The construction method will consist of the following general sequence:-

- Preliminary traffic management and surface water protection measures to be implemented;
- Creation of the site entrances, to be commenced and completed, ensuring that adequate visibility splays are provided;
- Progressive installation of surface water protection measures;
- Establishment and continued management of spoil deposition areas;
- Progressive construction of internal on-site access tracks utilising material extracted from on-site, where possible, and imported from local quarries;
- Construction of the temporary construction compounds for offloading materials and equipment, and to accommodate temporary site offices;
- Construction of bunded areas for oil, fuel and lubricant storage tanks;
- As the internal access tracks progress to each turbine location, tree felling will be completed and foundation excavations for the turbines will commence, and foundations laid. The hardstand areas will be constructed as track construction advances;
- Temporary alteration works along the turbine component haul route will be commenced;
- Once the on-site access tracks are completed, the trenching and laying of underground cabling will begin;
- Site preparatory and groundworks associated with the wind farm control building, construction of the building followed by the installation of electrical and ancillary equipment;
- Installation of turbines will commence once the on-site access tracks, hardstands, foundations and drainage measures are in place and the road upgrade works are complete. It is anticipated that each turbine will take approximately one week to install. Two cranes will be used for this operation. As each turbine is completed, the electrical connections will be made;

- Decommissioning of the temporary meteorological mast and installation of the permanent meteorological mast will then take place; and,
- Progressive site reinstatement, restoration and landscaping including re-profiling of spoil deposition areas, removal of turbine storage areas; erection of post-and-wire fencing around turbines, access tracks and at site entrances; decommissioning of construction phase site entrances; establishment of operational site entrances; erection of gates and vegetation at site entrances; and decommissioning of the temporary construction compounds.

The construction method for the proposed substation and grid connection will consist of the following general sequence (to be completed concurrently with wind farm construction):-

- Site preparatory and groundworks associated with the substation compound footprint including control buildings;
- Construction of the IPP and EirGrid buildings;
- Construction of bases or plinths for electrical apparatus, including battery energy storage system containers;
- Erection of palisade fencing around substation;
- Installation of internal and external electrical apparatus in control buildings and within compound area;
- Installation of underground electricity cables (including joint bays and communication chambers,) between substation and Dallow 110kV electricity substation;
- Connection of underground electricity cables to the respective substations;
- Commissioning of electrical apparatus and underground electricity cables; and
- Progressive site reinstatement, restoration, landscaping and planting proposals including the installation of stockproof fencing and the erection of gates.

Once the turbines are installed, and the substation and electrical system completed, the turbines will be tested and commissioned.

In addition to the roles of the EM and ECoW described above, the construction phase will be supervised by a range of environmental and engineering specialist personnel; including a Project Supervisor for the Construction Stage (PSCS), Archaeological Clerk of Works (ACoW), and Geotechnical Clerk of Works (GCoW), among others; who will liaise closely with the appointed contractor's EM to monitor and to ensure that all applicable measures are implemented.

3.2 Site Entrances

During the construction phase, 2 no. temporary site entrances will be required to facilitate temporary access to the project site (wind farm), directly opposite each other on either side of the N62. The existing agricultural/forestry entrances at these locations will be upgraded in order to provide the construction phase entrances to the project. Each entrance will be appropriately designed to ensure all visibility splays (sightlines) are provided[1].

Following the construction phase, the specifications of the temporary construction phase site entrances will no longer be needed to accommodate abnormal-sized loads. These entrances will be fenced off and will only be used in rare occasions in the

[1] Visibility onto National Road to be provided in accordance with TII Publication *Geometric Design of Junctions (priority junctions, direct accesses, roundabouts, grade separated and compact grade separated junctions)* – DN-GEO-03060.

event of a major turbine component replacement during the operational phase of development (e.g. replacing a turbine blade or gearbox/generator).

Both operational phase site entrances from the L30033 and L300321 will also be constructed in accordance with the requirements of the Planning Authority regarding the provision of appropriate site visibility splays to ensure traffic safety.

3.3 Hardstanding Areas and On-Site Access Tracks

The areas of hardstanding for crane operations and on-site access tracks will generally be constructed as follows:-

- Topsoil and subsoil will be removed and stored in separate mounds in appropriate areas adjacent to the crane site/access tracks;
- Rock/stone will be laid on a geo-textile mat (where required) and compacted in layers to an appropriate depth. The sub-layers of the hardstanding areas and access tracks will be constructed of rock/stone, sourced from local and appropriately licenced quarries, with the upper layer comprising capping material (also sourced locally). All such areas of hardstanding will be permeable to avoid significant volumes of surface water run-off;
- Where access tracks are required to cross manmade drainage ditches, these will be piped or spanned with an appropriate bridging structure. Where access tracks cross a natural watercourse, bottomless culverts will be installed (where possible) to prevent any interference with the hydraulic capacity of the watercourse. Crossing the Rapemills River will be fully clear span, negating the need for any in-river culvert structures; and,
- Areas of temporary hardstanding (for turbine component storage and crane assembly) will be reinstated following the construction phase by removing aggregates, replacing the excavated spoil and reseeding. The crane hardstandings and on-site access tracks will be retained during the operational phase to facilitate access for maintenance personnel and in the event of a major component change-out.

3.4 Temporary Construction Compounds

Topsoil will be removed from the required areas and side cast for temporary storage adjacent to the compound areas. The compound bases will be made up of well graded aggregates, compacted as necessary. A designated waste management area and fuels and chemicals storage area will be provided along with site offices, parking, staff welfare facilities and equipment storage areas. The compounds will be fenced with temporary security fencing to restrict access. Following the completion of the construction phase, the temporary construction compounds will be fully removed and the compounds will be reinstated with excavated material and reseeded or allowed to revegetate naturally, where appropriate to do so.

3.5 Chemical Storage and Refuelling

Storage areas for oils, chemicals and fuels will comprise bunded areas of hardstand of sufficient capacity within the temporary construction compound. Bunds will have a watertight roof structure and will be supplied by a licensed manufacturer to enable adequate safe storage for the quantities of material required. An adequate supply of spill kits will be readily available in order to clean up any minor spillages should they occur. A hydrocarbon interceptor will be installed within the surface water drainage system during the construction phase to trap any hydrocarbons that may be present. As part of the design process, a 50m buffer has been observed around all surface water features and no fuel/chemicals shall be handled or stored within this zone.

From the construction compound, fuel will be transported to works area by a 4x4 in a double skinned bowser with drip trays under a strict protocol and carried out by suitably trained personnel. The bowser/4x4 will be fully stocked with spill kits and absorbent material, with delivery personnel being fully trained to deal with any accidental spills. The bowser will be bunded appropriately for its carrying capacity. As above, a 50m buffer will be observed around all surface water features and no refuelling will be permitted within this zone.

3.6 Construction Waste Management

Waste will be generated during the construction phase and the main items of anticipated construction waste are as follows:-

- Hardcore, stone, gravel, concrete, plaster, topsoil, subsoil, timber, concrete blocks and miscellaneous building materials;
- Waste from chemical portaloo toilets;
- Plastics; and
- Oils and chemicals.

Waste disposal measures proposed include:-

- On-site segregation of all waste materials into appropriate categories including, for example, topsoil, bedrock, concrete, bricks, tiles, oils /diesels, metals, dry recyclables e.g. cardboard, plastic, timber;
- All waste materials will be stored in skips or other suitable and sealed receptacles in a designated area of the construction compound;
- Wherever possible, left over materials (e.g. timber off-cuts) and any suitable demolition materials shall be re-used on-site;
- Uncontaminated excavated material (rock, topsoil, sub-soil, etc.) will be re-used on-site in preference to importation of clean inert fill;
- Bedrock may be encountered during foundation excavation. If bedrock is encountered it will be utilised for infill during construction;
- All waste leaving the site will be transported by permitted contractors and taken to suitably licensed or permitted facilities and will be recycled, recovered or reused, where possible; and
- All waste leaving the site will be recorded in accordance with legal requirements and copies of relevant documentation maintained.

3.7 Construction Employment

It is estimated that up to 100 no. people will be employed during the 15-18 month construction phase. The actual number will depend on the activities being undertaken at any given time and will vary throughout the course of the construction programme. Employment will be the responsibility of the construction contractor but it is likely that the workforce will include labour from the local area.

3.8 Construction Traffic

Vehicular traffic required for the construction phase is likely to include:-

- Articulated trucks (HGVs) to bring initial equipment onto site and later to bring the turbine components, electrical cables, steel reinforcement for foundations, anemometer mast, and ancillary equipment;
- Tipper trucks and excavation plant involved in site development and excavation works;
- Cranes to erect the turbines;

- Miscellaneous vehicles and handling equipment, including vehicles associated with construction workforce.

Effects from construction traffic could include temporarily increased local traffic levels and traffic noise. Construction traffic on the local road network will be managed in accordance with a Traffic Management Plan and the requirements of the Planning Authority (Authorities). This may include the installation of temporary road signage and traffic lights, as appropriate. Noise arising from construction traffic would be localised, temporary and of a short term duration.

Deliveries of turbine components will take place at times to avoid peak traffic periods, and are likely to occur during night-time hours. All abnormal loads will be accompanied by an advance escort vehicle.

Traffic mitigation measures will be implemented during the construction phase, as follows:-

- Signage at site entrances giving access information;
- Temporary traffic restrictions kept to minimum duration and extent;
- Diversions put in place to facilitate continued use of roads, where restrictions have to be put in place (e.g. along the UGL route) ;
- Construction traffic management – one way systems where possible and strictly enforced speed limits;
- Provision of a designated person to manage access arrangements and act as a point of contact to the public; and
- All temporary road alterations and public road upgrades to be carried out in full consultation with the Planning Authority.

Once the turbines are operational, the traffic movements will be greatly reduced to, on average, once/twice per week by a light commercial vehicle for maintenance purposes. There may be an occasional need to replace some turbine components, but these are unlikely to be frequent.

4.0 Environmental Management Measures

4.1 'Designed-In' Measures

The following measures will be implemented, as standard, as part of the construction of the project:-

- Vegetation, soil, subsoil and rock (where encountered) removed during the construction of turbine foundations will be side-cast and appropriately stockpiled and, in so far as is practicable, re-used to reinstate the foundation and provide additional ballast. Any excess material arising will be utilised, firstly, for reinstatement purposes elsewhere within the project site (e.g. landscaping of hardstands and access tracks or reinstatement) or, as required, deposited at the dedicated spoil deposition areas;
- Temporary set down areas will be located immediately adjacent to each hardstand during the construction phase to accommodate the temporary storage of turbine components following their delivery to the project site, and crane components during crane assembly. Following the erection of the turbines, these set-down areas will be reinstated with excavated material, re-seeded and allowed to revegetate;
- A geotextile layer may be needed in some locations to avoid any subsequent vehicle access problems. Some cut/fill in the construction of the access tracks will be necessary to ensure that horizontal and vertical alignments are suitable

to accommodate abnormal HGV loads and to provide adequate drainage, however this is unlikely due to the flat nature of the project site. The wind turbine manufacturer shall be consulted during the post-consent detailed design process to ensure that the access tracks are suitable to accommodate turbine components. This may necessitate some immaterial deviations in the precise alignment of the access tracks;

- Following the construction phase, access tracks, passing bays and turning heads that are not required during the operational phase will be reinstated, wherever possible. It is likely, however, that the majority of the tracks will be required during the operational phase for maintenance operations and will be used as part of ongoing agricultural activities within the subject site;
- Where it is necessary for access tracks to cross drains/watercourses, the relevant bodies (e.g. Inland Fisheries Ireland, Office for Public Works (OPW), etc.) will be consulted prior to construction. As appropriate, a Section 50 Licence application will be made to the OPW prior to the installation of culverts/bridging structures over relevant watercourses;
- Site entrances, both construction phase (temporary) and operational, will be constructed in accordance with the requirements of the Planning Authority regarding the provision of appropriate site visibility splays to ensure traffic safety. A Road Safety Audit has been prepared in respect of works at the site entrance locations, as well as the temporary alteration works to the haul route at the N62/N52 Junction;
- The temporary construction compounds have been located and designed such that all cabins, storage containers, waste management facilities and bunded areas will be located a minimum distance of 50m from all natural watercourses in order to minimise the risk of pollution and the discharge of deleterious matter to watercourses. Stormwater which may arise from the roofs of cabins, containers or from sealed bunds will be passed through an oil interceptor prior to being discharged to the local environment;
- Prior to the commencement of development at the site, a detailed Peat and Spoil Management Plan will be prepared following the post-consent detailed design process and will address the re-use, reinstatement, storage and restoration of all material excavated during the construction phase including detailed methodologies regarding the establishment and management of the spoil deposition areas for the project;
- Following the completion of construction, the deposition areas will be graded to match the profile of surrounding land. Works at the spoil deposition areas will be monitored, on a weekly basis during the construction phase and monthly for a 6-month period thereafter, by an appropriately qualified geotechnical engineer;
- In the event that material is generated which is unsuitable for storage within the deposition areas (e.g. tarmac cuttings), this shall be removed from site and disposed of at a licensed waste disposal facility;
- A micrositing allowance of 20m in any direction is proposed for wind turbines in accordance with Section 5.3 of the *Wind Energy Development Guidelines for Planning Authorities 2006*[2]. It is anticipated that the agreed micrositing distance will form a condition accompanying a grant of planning permission. It is also proposed that hardstands, access tracks, meteorological mast, and

[2] Flexibility regarding wind turbine positioning is also referred to at Section 7.5 of the Draft Revised Wind Energy Development Guidelines 2019.

underground cables may be immaterially micro-sited subject to compliance with the mitigation measures included in the EIAR;

- During the delivery of turbine components to site, all HGVs will be accompanied by escort vehicles. An Garda Síochána will also be informed prior to turbine component transportation as it will be necessary to temporarily close junctions as the components pass through;
- Only fully licensed quarries which have been subject to EIA and have appropriate planning permission for the volumes of material to be extracted will be used. These aggregates are slated for extraction in the normal course of the relevant quarry's business and therefore will have no additional likely significant environmental impacts above and beyond those normally entailed in the operation of the quarry;
- All trenching works will be undertaken to ensure that only short sections of trench are open at any one time. Excavated materials will be stored separately (subsoil, topsoil, and aggregates) for use during the reinstatement of the trench/joint bays/communication chambers or disposal to an appropriate licensed facility as necessary;
- Prior to the commencement of construction, a detailed Method Statement will be prepared by the contractor outlining the precise methodology to be put in place during the trenching phase. This Method Statement will be reviewed by the Environmental Manager (EM; to be appointed by the contractor) to ensure that the environmental protective measures to be implemented are suitable and to the required standard;
- All tree felling to be undertaken will be the subject of a felling licence application to the Forest Service in accordance with the Forestry Act 2014 and the Forestry Regulations 2017;
- As described above, trees and hedgerows will be felled and removed to facilitate the physical footprint of the project. The extent of vegetation removal has, by design, been minimised and no vegetation will be unnecessarily removed. As part of the reinstatement process; all forestry felled will be replaced on a like for like basis on the identified replant lands (or an alternative site within the State, subject to necessary consents) and any hedgerow removed in the construction of wind farm infrastructure will be replaced elsewhere within the project site, particularly along arterial access tracks and behind visibility splays;
- A preliminary Surface Water Management Plan (SWMP) has been prepared for the construction phase of the project. This SWMP will be further developed prior to the commencement of development, following the post-consent detailed design process, and will incorporate the precise implementation and siting of surface water management infrastructure;
- The construction phase of the development will comprise a 6-day week with normal working hours from 07:00 to 19:00 Monday to Friday and 07:00 to 13:00 on Saturdays. It may be necessary to undertake works outside of these hours to avail of favourable weather conditions (e.g. during times of low wind speed to facilitate turbine erection etc.) or during extended concrete pours (e.g. where turbine foundation pours must be completed within 24-hours). Where construction activities are necessary outside of the normal working hours, local residents and the Planning Authority will receive prior notification;
- A detailed CEMP will be prepared in advance of all construction activities and will incorporate all mitigation measures proposed in this EIAR;
- The construction phase will be supervised by a range of environmental and engineering specialist personnel; including a Project Supervisor for the

Construction Stage (PSCS), Ecological Clerk of Works (ECoW), Archaeological Clerk of Works (ACoW), and Geotechnical Clerk of Works (GCoW), among others; who will liaise closely with the Environmental Manager to monitor and to ensure that all applicable measures are implemented;

- Following the delivery of turbine components, and following the construction phase, the specifications of the temporary construction phase site entrances will no longer be needed to accommodate abnormal-sized loads. These entrances will be fenced off and will only be used in rare occasions in the event of a major turbine component replacement during the operational phase of development (e.g. replacing a turbine blade or gearbox/generator);
- Following the completion of all turbine component deliveries, the temporary site entrances will be reinstated to their pre-existing condition, including the replanting of all removed hedgerows;
- Where access tracks are required to cross manmade drainage ditches, these will be piped or spanned with an appropriate bridging structure. Where access tracks cross a natural watercourse, bottomless culverts will be installed (where possible) to prevent any interference with the hydraulic capacity of the watercourse. Crossing the Rapemills River will be fully clear span, negating the need for any in-river culvert structures;
- Areas of temporary hardstanding (for turbine component storage and crane assembly) will be reinstated following the construction phase by removing aggregates, replacing the excavated spoil and reseeding. The crane hardstandings and on-site access tracks will be retained during the operational phase to facilitate access for maintenance personnel and in the event of a major component change-out; and
- Waste will be generated during the operational phase including, for example, cooling oils, lubricating oils and packaging from spare parts or equipment. All waste will be removed from site and reused, recycled or disposed of in accordance with best-practice and all regulations at a licensed facility.

4.2 Population & Human Health

No measures, specific to population and human health, are necessary during the construction phase. Local residents and communities will be protected through the implementation of measures provided for (and committed to) in other topics including the protection of water quality, minimisation of dust emissions, minimisation of noise emissions, and appropriate traffic management procedures.

4.3 Biodiversity

4.3.1 Designated Nature Conservation Sites, Fisheries and Aquatic Ecology

Mitigation measures to prevent adverse effects on downstream Natura 2000 sites during construction are provided in full in the Natura Impact Statement (NIS), **Chapter 7** of the EIAR, and at **Section 4.5** below. These will ensure no deterioration in the quality of water entering the River Shannon Callows Special Area of Conservation (SAC), Lough Derg North East Shore SAC, and Middle Callows Special Protection Area (SPA) and will ensure there will be no impacts on any QI habitats and species. The same is true for IEF non-QI aquatic habitats and species.

In order to mitigate potential impacts during the construction phase, best practice construction methods will be implemented in order to prevent water (surface water and groundwater) pollution. Good practice measures will be applied in relation to pollution risk, sediment management and management of surface runoff rates and volumes.

All personnel working on the project will be responsible for the environmental control of their work and will perform their duties in accordance with the requirements and procedures of this CEMP.

During the construction phase, all works associated with the construction of the project will be undertaken in accordance with the guidance contained within CIRIA Document C741 'Environmental Good Practice on Site' (CIRIA, 2015). Any groundwater encountered will be managed and treated in accordance with CIRIA C750, 'Groundwater control: design and practice' (CIRIA, 2016).

Clear Felling and Surface Water Quality Effects
Best practice methods related to water incorporated into the forestry management and mitigation measures have been derived from:-

- *Department of Agricultural, Food and the Marine (2019) Standards for Felling and Reforestation;*
- *Forestry Commission (2004) Forests and Water Guidelines, Fourth Edition. Publ. Forestry Commission, Edinburgh;*
- *Coillte (2009) Forest Operations and Water Protection Guidelines;*
- *Coillte (2009) Methodology for Clear Felling Harvesting Operations; and,*
- *Forest Service (2000: Forestry and Water Quality Guidelines. Forest Service, DAF, Johnstown Castle Estate, Co. Wexford.*

Mitigation by Avoidance

There is a requirement in the *Forest Service Code of Practice* and in the *FSC Certification Standard* for the installation of buffer zones adjacent to aquatic zones at planting stage.

During the construction phase, a self-imposed conservative buffer zone of 50m will be maintained for all Rapemills River and West Galros Stream where possible.

Of the 23 ha proposed for felling, only c.2.5ha are located inside the 50m buffer zone.

The large distance between the majority of the felling areas and sensitive aquatic zones means that any poor quality runoff arising from felling areas can be adequately managed and attenuated prior to even reaching the aquatic buffer zone and primary drainage routes. Where tree felling is required in the vicinity of streams, the additional mitigation measures outlined below will be employed.

Mitigation by Design

Mitigation measures which will reduce the risk of entrainment of suspended solids and nutrient release in surface watercourses comprise best practice methods, as follows:-

- Machine combinations (i.e. handheld or mechanical) will be chosen which are most suitable for ground conditions and which will minimise soils disturbance;
- Checking and maintenance of tracks and culverts will be ongoing through any felling operation. No tracking of vehicles through watercourses will occur. Where possible, existing drains will not be disturbed during felling works;
- Ditches which drain from the areas to be felled towards existing surface watercourses will be blocked, and temporary silt traps will be constructed. No direct discharge of such ditches to watercourses will occur. Drains and sediment traps will be installed during ground preparation. Collector drains will be excavated at an acute angle to the contour (~0.3%-3% gradient), to minimise flow velocities. Main drains to take the discharge from collector drains will include water drops and rock armour, as required, where there are steep gradients, and avoid being placed at right angles to the contour;

- Sediment traps will be sited in drains downstream of felling areas. Machine access will be maintained to enable the accumulated sediment to be excavated. Sediment will be carefully disposed of in the spoil disposal areas. All new silt traps will be constructed on even ground and not on sloping ground;
- In areas particularly sensitive to erosion or where felling inside the 50m buffer is required, it will be necessary to install double or triple sediment traps;
- All drainage channels will taper out before entering the 50m buffer zone. This ensures that discharged water gently fans out over the buffer zone before entering the aquatic zone, with sediment filtered out from the flow by ground vegetation within the zone. On erodible soils, silt traps will be installed at the end of the drainage channels, to the outside of the buffer zone;
- Drains and silt traps will be maintained throughout all felling works, ensuring that they are clear of sediment build-up and are not severely eroded. Correct drain alignment, spacing and depth will ensure that erosion and sediment build-up are minimized and controlled;
- Brash or bog mats will be used to support vehicles on soft ground, reducing topsoil and mineral soils erosion and avoiding the formation of rutted areas, in which surface water ponding can occur. Brash mat renewal will take place before they become heavily used and worn. Provision will be made for brash mats along all off-road routes, to protect the soil from compaction and rutting. Where there is risk of severe erosion occurring, extraction will be suspended during periods of high rainfall;
- Timber will be stacked in dry areas, and outside the 50m watercourse buffer. Straw bales and check dams will be emplaced on the down gradient side of timber storage/processing sites;
- Works will be carried out during periods of no, or low, rainfall in order to minimise entrainment of exposed sediment in surface water run-off;
- Checking and maintenance of roads/tracks and culverts will be ongoing through the felling operation;
- Refuelling or maintenance of machinery will not occur within 50m of a watercourse. Mobile bowser, drip kits, qualified personnel will be used where refuelling is required;
- A permit to refuel system will be adopted:
- Branches, logs or debris will not be allowed to build up in aquatic zones. All such material will be removed when harvesting operations have been completed, but care will be taken to avoid removing natural debris deflectors;
- Trees will be cut manually from along streams and using machinery to extract whole trees; and
- Travel will only be permitted perpendicular to and away from surface water features.

Silt Traps

Silt traps will be strategically placed down-gradient within forestry drains near streams. The main purpose of the silt traps and drain blocking is to slow water flow, increase residence time and allow settling of silt in a controlled manner.

Drain Inspection and Maintenance

The following items will be carried out during pre-felling inspections and regularly thereafter:-

- Communication with tree felling operatives in advance to determine whether any areas have been reported where there is unusual waterlogging or bogging of machines;
- Inspection of all areas reported as having unusual ground conditions;
- Inspection of main drainage ditches and outfalls. During pre-felling inspections, the main drainage ditches will be identified. Where possible, the pre-felling inspection will be carried out during rainfall;
- Following tree felling, all main drains will be inspected to ensure that they are functioning;
- Extraction tracks within 10m of drains will be broken up and diversion channels created to ensure that water in the tracks spreads out over the adjoining ground;
- Culverts on drains exiting the site, if impeded by silt or debris, will be unblocked; and
- All accumulated silt will be removed from drains and culverts, and silt traps, and this removed material will be deposited away from watercourses to ensure that it will not be carried back into the trap or stream during subsequent rainfall.

Surface Water Quality Monitoring

Sampling will be completed before, during (if the operation is conducted over a protracted time) and after the felling activity. The 'before' sampling will be conducted within 4-weeks of the felling activity commencing, preferably in medium-to-high water flow conditions. The 'during' sampling will be undertaken once a week or after rainfall events. The 'after' sampling will comprise as many samplings as necessary to demonstrate that water quality has returned to pre-activity status (i.e. where an impact has been shown).

Details of the proposed surface water quality monitoring programme are outlined in the Water Quality Monitoring Plan (**Annex 5**).

The surface water sampling locations used in this EIAR for the project site and grid connection (i.e. SW1 – SW4) will also be used as sampling locations during felling activities.

Also, daily surface water monitoring forms (for visual inspections and field chemistry measurements) will also be utilised at every works site near any watercourse. These will be taken daily and kept on site for record and inspection.

Earthworks (Removal of Vegetation Cover, Excavations and Stock Piling) Resulting in Suspended Solids Entrainment in Surface Water.

Mitigation by Avoidance

The key mitigation measure during the construction phase is the avoidance of sensitive aquatic areas by using a 50m buffer. From the constraints map (**Annex 7.4**) it is evident that; other than some sections of access tracks, watercourse crossings (4 no.), part of the crane hardstanding of turbine T7, the southern end of the main construction compound and the northern end of the spoil deposition area at turbine T5; the majority of the proposed wind farm infrastructure (including all turbine locations and the spoil deposition areas) is located outside of areas that have been assessed to be hydrologically sensitive. Additional mitigation in the form of double silt fencing will be placed around all infrastructure that encroaches the 50m buffer zone.

Specific mitigation measures, incorporated into the design of the project (embedded mitigation) and through implementation of best practice methodologies (discussed below) will be employed where work inside buffer zones is proposed.

The generally large setback distance from sensitive hydrological features ensures that sufficient space is provided for the installation of drainage mitigation measures (discussed below) and to ensure their effective operation. The proposed buffer zone will ensure:-

- Avoidance of physical damage to watercourses, and associated release of sediment;
- Avoidance of excavations within close proximity to surface water courses;
- Avoidance of the entry of suspended sediment from earthworks into watercourses; and,
- Avoidance of the entry of suspended sediment from the construction phase drainage system into watercourses, achieved in part by ending drain discharge outside the buffer zone and allowing percolation across the vegetation of the buffer zone.

Mitigation by Prevention

The following section details the measures which will be put in place during the construction phase to ensure that surface water features are protected from the release of silt or sediment and to ensure that all surface water runoff is fully treated and attenuated to avoid the discharge of dirty water.

Source controls to limit the likelihood for 'dirty water' to occur:-

- Interceptor drains, vee-drains, diversion drains, flume pipes, erosion and velocity control measures such as use of sand bags, oyster bags filled with clean washed gravel, filter fabrics, and other similar/equivalent or appropriate systems;
- Small working areas, covering stockpiles, weathering off stockpiles, cessation of works in certain areas or other similar/equivalent or appropriate measures.

In-Line controls to ensure appropriate management of silt laden water:

- Interceptor drains, vee-drains, oversized swales, erosion and velocity control measures such as check dams, sandbags, oyster bags, straw bales, flow limiters, weirs, baffles, silt bags, silt fences, sedimats, filter fabrics, and collection sumps, temporary sumps/attenuation lagoons, sediment traps, pumping systems, settlement ponds, temporary pumping chambers, or other similar/equivalent or appropriate systems.

Treatment systems to fully attenuate silt laden waters prior to discharge:

Temporary sumps and attenuation ponds, temporary storage lagoons, sediment traps, and settlement ponds, and proprietary settlement systems such as Siltbuster, and/or other similar/equivalent or appropriate systems. It should be noted that an extensive network of bog and forestry drains already exists, and these will be integrated and enhanced as required and used within the wind farm drainage system.

The main elements of interaction with existing drains will be as follows:-

- Apart from interceptor drains, which will convey clean runoff water to the downstream drainage system, there will be no direct discharge (without treatment for sediment reduction and attenuation for flow management) of runoff from the wind farm drainage into the existing site drainage network. This will reduce the likelihood of any increased risk of downstream flooding or sediment transport/erosion;

- Silt traps will be placed in the existing drains upstream of any streams where construction works is taking place, and these will be diverted into proposed interceptor drains, or culverted under/across the works area; and
- Buffered outfalls, which will be numerous over the site, will promote percolation of drainage waters across vegetation and close to the point at which the additional runoff is generated, rather than direct discharge to the existing drains of the site.

Water Treatment Train

While the silt/sediment ponds and lagoons are assessed as providing a sufficient level of protection to avoid any deterioration in downstream water quality; a final line of defence can be provided by a water treatment train such as a 'Siltbuster', if required. If the discharge water from construction areas fails to be of a high quality, then a filtration treatment system (such as a 'Siltbuster' or similar equivalent treatment train [sequence of water treatment processes]) will be used to filter and treat all surface discharge water collected in the dirty water drainage system. This water treatment train will apply for the entirety of the construction phase.

Silt Fences

Silt fences will be emplaced within drains down-gradient of all construction areas. Silt fences are effective at removing heavy settleable solids. This will act to prevent entry to watercourses of sand and gravel sized sediment, released from excavation of mineral sub-soils of glacial and glacio-fluvial origin, and entrained in surface water runoff. Inspection and maintenance of these structures during construction phase is critical to their functioning to stated purpose. They will remain in place throughout the entire construction phase. Double silt fences will be emplaced within drains down-gradient of all construction areas inside the 50m hydrological buffer zones to provide an additional layer of protection in these areas.

Silt Bags

Silt bags will be used where small to medium volumes of water need to be pumped from excavations. As water is pumped through the bag, most of the sediment is retained by the geotextile fabric allowing filtered water to pass through. Silt bags will be used with natural vegetation filters or sedimats (sediment entrapment mats, consisting of coir or jute matting) placed at the silt bag location to provide further treatment of the water outfall from the silt bag. Sedimats will be secured to the ground surface using stakes/pegs. The sedimat will extend to the full width of the outfall to ensure all water passes through this additional treatment measure.

Management of Runoff from the Spoil Deposition Areas

It is proposed that excavated overburden/spoil will be utilised for reinstatement of excavated areas etc. and for landscaping purposes. Excess material, or material which is unsuitable for this purpose, will be stored, permanently, at the dedicated spoil deposition areas.

The main spoil deposition areas are located outside the 50m stream buffer zone. A small section of the spoil deposition area at turbine T5 encroaches the 50m buffer zone. Additional mitigation in the form of double silt fencing will be placed around all infrastructure that encroaches the 50m buffer zone.

During the initial placement of spoil in the deposition areas, silt fences, straw bales and biodegradable matting will be used to control surface water runoff. Double silt fencing will be placed along the edge of the bog drain that intercepts the deposition area.

Drainage from the overburden deposition area will ultimately be into to the existing bog drain network where it is proposed that check dams will be installed every 20m or so to create a series of settlement ponds, before being discharged.

Spoil deposition areas will be sealed with a digger bucket and vegetated as soon possible to reduce sediment entrainment in runoff. Once re-vegetated and stabilised, spoil deposition areas will no longer be a likely source of silt laden runoff. Surface water protection infrastructure will be left in place until the areas have stabilised.

Grid Connection Installation Works

Temporary silt fencing/silt trap arrangements will be placed within existing roadside/field drainage features along the grid connection route to remove any suspended sediments from the works area. The trapped sediment will be removed and disposed of at an appropriate licenced facility. Any bare-ground will be re-seeded/reinstated immediately and silt fencing temporally left in place if necessary.

Pre-emptive Site Drainage Management

The works programme for the initial construction stage of the project will also take account of weather forecasts, and predicted rainfall in particular. Large excavations and movements of soil/subsoil or vegetation stripping will be suspended or scaled back if prolonged or intense rain is forecast. The extent to which works will be scaled back or suspended will relate directly to the amount of rainfall forecast.

The following forecasting systems are available and will be used on a daily basis at the site to direct proposed construction activities:-

- General Forecasts: Available on a national, regional and county level from the Met Eireann website (www.met.ie/forecasts). These provide general information on weather patterns including rainfall, wind speed and direction but do not provide any quantitative rainfall estimates;
- Meteo Alarm: Alerts to the possible occurrence of severe weather for the next 2 days. Less useful than general forecasts as only available on a provincial scale;
- 3 hour Rainfall Maps: Forecast quantitative rainfall amounts for the next 3 hours but does not account for possible heavy localised events;
- Rainfall Radar Images: Images covering the entire country are freely available from the Met Eireann website (www.met.ie/latest/rainfall_radar.asp). The images are a composite of radar data from Shannon and Dublin airports and give a picture of current rainfall extent and intensity. Images show a quantitative measure of recent rainfall. A 3 hour record is given and is updated every 15 minutes. Radar images are not predictive; and,
- Consultancy Service: Met Eireann provide a 24 hour telephone consultancy service. The forecaster will provide interpretation of weather data and give the best available forecast for the area of interest.

Using the safe threshold rainfall values will allow work to be safely controlled (from a water quality perspective) in the event of an impending high rainfall intensity event.

Works will be suspended if forecasting suggests either of the following is likely to occur:-

- >10 mm/hr (i.e. high intensity local rainfall events);
- >25 mm in a 24-hour period (heavy frontal rainfall lasting most of the day); or,
- >half monthly average rainfall in any 7 days.

Prior to works being suspended the following control measures will be completed:-

- Secure all open excavations;
- Provide temporary or emergency drainage to prevent back-up of surface runoff; and,
- Avoid working during heavy rainfall and for up to 24-hours after heavy events to ensure drainage systems are not overloaded.

Timing of Site Construction Works

The construction of the site drainage system will be carried out, at the respective locations, prior to other activities being commenced. The construction of the drainage system will only be carried out during periods of, where possible, no rainfall, therefore avoiding runoff. This will avoid the risk of entrainment of suspended sediment in surface water runoff, and transport via this pathway to surface watercourses. Construction of the drainage system during this period will also ensure that attenuation features associated with the drainage system will be in place and functional for all subsequent construction works.

Monitoring

Prior to the commencement of project, a detailed Site Drainage Plan and SWMP will be prepared to detail the siting and composition of the surface water management measures. The respective plans, which will form part of a detailed Construction Environmental Management Plan (CEMP), will be prepared prior to the commencement of project.

The CEMP will also include a detailed Water Quality Monitoring Plan for the monitoring of surface waters in the vicinity of the construction site by a designated Environmental Manager. The monitoring programme will comprise field testing and laboratory analysis of a range of agreed parameters. The civil works contractor, who will be responsible for the construction of the site drainage system, and Environmental Manager will undertake regular inspections of the drainage system to ensure that all measures are functioning effectively. The surface water sampling locations used in this EIAR (i.e. SW1 – SW4) will be used during construction activities. Regular inspections of all installed drainage systems will be undertaken, especially after heavy rainfall, to check for blockages, and ensure there is no build-up of standing water in parts of the systems where it is not intended.

Any excess build-up of silt levels that may decrease the effectiveness of the drainage feature, will be removed and disposed of in an appropriate manner.

Excavation Dewatering and Effects on Surface Water Quality

The management of excavation dewatering (pumping), particularly in relation to any accumulation of water in foundations or electricity line trenches, and subsequent treatment prior to discharge into the drainage network will be undertaken as follows:-

- Appropriate interceptor drainage, to prevent upslope surface runoff from entering excavations, will be put in place;
- The interceptor drainage will be discharged to the site constructed drainage system or onto natural vegetated surfaces and not directly to surface waters to ensure that Greenfield runoff rates are mimicked;

- If required, pumping of excavation inflows will prevent build-up of water in the excavation;
- The pumped water volumes will be discharged via volume and silt/sediment ponds and settlement lagoons adjacent to excavation areas, or via specialist treatment systems such as a Siltbuster unit;
- There will be no direct discharge to surface watercourses, and therefore no risk of hydraulic loading or contamination will occur;
- Daily monitoring of wind farm excavations by the Environmental Manager will occur during the construction phase. If high levels of seepage inflow occur, excavation work at this location will cease immediately and a geotechnical assessment undertaken; and,
- A mobile 'Siltbuster' or similar equivalent specialist treatment system will be available on-site for emergencies. Siltbusters are mobile silt traps that can remove fine particles from water using a proven technology and hydraulic design in a rugged unit. The mobile units are specifically designed for use on construction-sites. They will be used as final line of defence if needed.

Release of Hydrocarbons during Construction and Storage

Mitigation measures proposed to avoid release of hydrocarbons at the site are as follows:-

- The volume of fuels or oils stored on site will be minimised. All fuel and oil will be stored in an appropriately bunded area within the temporary construction compound. Only an appropriate volume of fuel will be stored at any given time. The bunded area will be roofed to avoid the ingress of rainfall and will be fitted with a storm drainage system and an appropriate oil interceptor;
- All bunded areas will have 110% capacity of the volume to be stored;
- On site refuelling of machinery will be carried out using a mobile double skinned fuel bowser. The fuel bowser, a double-axel custom-built refuelling trailer will be re-filled at the temporary compound and will be towed around the site by a 4x4 jeep to where plant and machinery is located. No refuelling will be permitted at works locations within the 50m hydrological buffer. The 4x4 jeep will also be fully stocked with fuel absorbent material and pads in the event of any accidental spillages. The fuel bowser will be parked on a level area in the construction compound when not in use and only designated trained and competent operatives will be authorised to refuel plant on site. Mobile measures such as drip trays and fuel absorbent mats will be used during all refuelling operations to avoid any accidental leakages;
- All plant and machinery used during construction will be regularly inspected for leaks and fitness for purpose;
- Spill kits will be readily available to deal with and accidental spillages;
- All waste tar material arising from road cuttings (from trenching or other works in public roads) will be removed off-site and taken to a licensed waste facility. Due to the potential for contamination of soils and subsoils, it is not proposed to utilise this material for any reinstatement works; and
- An outline emergency plan for the construction phase to deal with accidental spillages is contained within the Planning-Stage CEMP (**Annex 3.4**). This emergency plan will be further developed prior to the commencement of project, and will be agreed with the Planning Authority as part of the detailed CEMP.

Groundwater and Surface Water Contamination from Wastewater Disposal

Measures to avoid contamination of ground and surface waters by wastewaters will comprise:-

- Self-contained port-a-loos (chemical toilets) with an integrated waste holding tank will be installed at the site compound, maintained by the providing contractor, and removed from site on completion of the construction works;
- Water supply for the site office and other sanitation will be brought to site and removed after use to be discharged at a suitable off-site treatment location; and,
- No water will be sourced on the site, nor will any wastewater be discharged to the site.

Release of Cement-Based Products

The following mitigation measures are proposed to ensure that the release of cement-based products is avoided:-

- No batching of wet-cement products will occur on site. Ready-mixed concrete will be brought to site as required and, where possible, emplacement of pre-cast products will be utilised;
- All watercourse crossings will utilise pre-cast products and the use of wet-cement products within the hydrological buffer will be avoided;
- Where concrete is delivered on site, only the chute will be cleaned, using the smallest volume of water practicable. Chute cleaning will be undertaken at lined cement washout ponds with waters being stored in the temporary construction compound, removed off site and disposed of at an approved licensed facility. No discharge of cement contaminated waters to the construction phase drainage system or directly to any artificial drain or watercourse will be allowed;
- Weather forecasting will be used to ensure that prolonged or intense rainfall is not predicted during concrete pouring activities; and,
- The concrete pour site will be kept free of standing water and plastic covers will be ready in case of sudden rainfall event.
- *Morphological Changes to Surface Water Courses & Drainage Patterns*
- The following mitigation measures are proposed:-
- All proposed new stream crossings will be clear span bridges (bottomless culverts) and the stream beds will remain undisturbed. No in-stream excavation works at the crossing locations are proposed and therefore there will be no impact on the stream at the proposed crossing location;
- All internal wind farm electrical cabling or grid connection cabling will pass above or below the existing culvert and will not directly interfere with the culvert;
- At the time of construction, all guidance/best practice requirements of the OPW or Inland Fisheries Ireland will be incorporated into the design/construction of the proposed watercourse/culvert crossings;
- As a further precaution, in-stream construction work (if/where required) will only be carried out during the period permitted by Inland Fisheries Ireland for in-stream works according to *Guidelines on Protection of Fisheries During Construction Works in and Adjacent to Waters* (2016) (i.e., July to September inclusive). This time period coincides with the period of lowest expected rainfall, and therefore minimum runoff rates. This will minimise the risk of entrainment of

suspended sediment in surface water runoff, and transport via this pathway to surface watercourses (any deviation from this will be done in discussion with the IFI);
- During the near stream construction works (i.e. within the 50m buffer zone), double row silt fences will be emplaced immediately down-gradient of the construction area for the duration of the construction phase;
- The new watercourse crossings at the wind farm site will require a Section 50 license application to the OPW in accordance with the Arterial Drainage Act 1945. The river/stream crossings will be designed in accordance with OPW guidelines/requirements on applying for a Section 50 consent; and,
- No instream works are proposed at the grid connection watercourse crossings.

Hydrological Effects on Designated Sites

The proposed mitigation measures for protection of surface water quality, which will include buffer zones and robust drainage control measures (i.e. interceptor drains, swales, silt/settlement ponds, settlement lagoons), will ensure that the quality of runoff from development areas will be very high.

An "*imperceptible, temporary effect*" on local streams and rivers would, if it occurs, be extremely localised and of a very short duration (i.e. hours). Therefore, considering the imperceptible effects on local surface water quality along increased dilution capacity of downstream river waterbodies, significant indirect hydrological or water quality effects on the downstream designated sites will not occur.

4.3.2 Habitats

Except for bog woodland (non-Annex I), the majority of the proposed project layout does not overlap with high-value terrestrial habitats and is located almost entirely within commercial conifer or broadleaved plantation, and improved grassland. The grid connection are located almost entirely within existing roads and only small lengths will go through improved grassland. Construction for the majority of the proposed access tracks will mainly involve upgrading existing forestry and farm tracks.

Areas requiring felling to implement bat mitigation buffers has been mainly focused on commercial conifer plantation habitats and small amounts of highly modified/non-native mixed broadleaved woodland. There is also 3.81 ha of bog woodland WN7 to be felled. Also, the lengths of trees and hedgerows to be removed has been minimised.

Any treelines or hedgerows removed will be replaced in-situ elsewhere in the proposed project at appropriate locations (i.e. designed to maximise ecological connectivity and outside of bat mitigation buffers). All new treelines or hedgerows will be planted using native species and in a similar composition to treelines or hedgerows lost.

To avoid widespread disturbance to habitats, access within the proposed project will be restricted to the footprint of the proposed works corridor and no access between different parts of the proposed project will be permitted, except via the proposed works corridor. An Ecological Clerk of Works (ECoW) will be employed throughout the construction phase to ensure that construction activities do not encroach, unnecessarily, into any important habitats.

4.3.3 Invasive Plants

In order to prevent the spread of invasive alien species into the working areas of the proposed project site, the following biosecurity protocol shall be adopted at all times throughout the construction process.

Awareness

- Prior to working on the Site, all contractors will be briefed on invasive species and will be provided with information on identification, and of the need to prevent further spread of invasive species, as well as details of the biosecurity protocol.
- Any additional positive or suspected identification of invasive non-native species during Site works shall be reported to an ecologist for verification, so that appropriate advice can be given.

Machinery

- Cleaning operations will take place in a designated area to prevent further spread.
- Mud and organic debris will not be allowed to accumulate on tracks, tyres or under wheel arches.

Personnel

- Personnel shall check and clean their footwear and tools each day before leaving the area to work on other Sites, or other parts of the Site.

4.3.4 Birds

To avoid widespread disturbance to birds, access will be restricted to the footprint of the proposed works corridor. Measures proposed in **Chapter 7** of the EIAR and at **Section 4.5**, below, will prevent deterioration of water quality and adverse effects on birds relying on downstream habitats, such as kingfisher.

The following will be implemented to reduce the possibility of damage and destruction (and disturbance to sensitive species) to occupied bird nests:

- clearance of woodlands and uncultivated vegetation i.e. trees and hedgerows (including vegetation removal for creation/maintenance of bat mitigation buffers), will be undertaken outside the main breeding season from March to September inclusive;
- if other site clearance and construction activities are required to take place during the main breeding bird season, pre-commencement survey work will be undertaken to ensure that nest destruction and disturbance is avoided;
- once vegetation has been removed from the works corridor, these areas will be retained in a condition that limits suitability for nesting birds for the remainder of the construction phase e.g. cover for ground nesting species will be made unsuitable for cutting vegetation or tracking over with an excavator; and
- a suitably experienced Ecologist will be employed for the duration of the construction period to make contractors aware of the ornithological sensitivities of the Project and to undertake surveys for nesting birds throughout the construction period, enforcing exclusion areas as required.

4.3.5 Terrestrial Mammals (Excluding Bats)

Measures proposed in **Chapter 7** of the EIAR and at **Section 4.5**, below, will prevent deterioration of water quality and adverse effects on mammals relying on downstream habitats, such as otter. Habitat features important for mammals will be retained as much as possible (e.g. hedgerows, treelines and scrub). While commercial conifer plantation and mixed/broadleaved woodland will be removed, connectivity between woodland linear habitat features has been retained throughout all phases of the proposed project.

A pre-construction walkover survey of the proposed project will be undertaken. This will search for mammal resting/breeding places, which could change over time. If any are identified, then appropriate exclusion zone(s) will be implemented and construction activities timed to avoid sensitive periods, such as the breeding season or hibernation, as relevant.

The following will be implemented to reduce the possibility of direct and indirect effects on mammals:

- limiting constructions works to daylight hours;
- providing exit points for any excavations (e.g. escape planks or spoil runs) so mammals do not become trapped; and
- a suitably qualified Ecologist will be employed for the duration of the construction period to make contractors aware of the mammalian sensitivities of the Proposed Project and to undertake surveys for breeding or resting mammals throughout the construction period, enforcing exclusion areas as required. These are 50 m for red squirrel, 100 m for pine marten, 150 m for otter and 50 m for badger. If in the unlikely event that exclusion zones cannot be implemented, advice will be sought from NPWS, and appropriate mitigation and compensation measures will be put in place and an application will be made to NPWS for a derogation licence if required.

4.3.6 Bats

All hedgerows and treelines that will be lost due to construction will be replaced within the Proposed Project. This will ensure that there is no net loss of commuting and foraging routes for bats.

Along the grid connection, immediately in advance of construction works, an ecologist will undertake a comprehensive survey of bridges / structures / trees with moderate to high bat roosting potential (see **Annex 5.3** of the EIAR) and emergence surveys will be carried out to determine if bats are present following Collins (2023) guidelines.

No destruction or disturbance of active bat roosts is predicted. However, given that a period of time is likely to elapse prior to the commencement of construction, it is acknowledged that roosting bats could move and occupy new Potential Roost Features (PRFs), such as ivy clad trees with occasional holes/fissures. Therefore, pre-construction roost surveys will be undertaken to identify and protect any bats occupying roosts in vegetation earmarked for removal.

Any trees identified as supporting moderate to high potential roost features within the works corridor will be targeted with further surveys, including emergence/re-entry surveys and/or roost inspections (using endoscopes and thermal imaging cameras). Surveys will determine occupancy, the type of roost (e.g. maternity, hibernation, mating, transitional), species using the roost and the level of occupancy. Surveys will be conducted by appropriately experienced ecologists.

For any newly occupied roost sites, where vegetation removal is proposed, these surveys will inform a derogation license application process from the NPWS to undertake appropriate mitigation actions, as required, to ensure the conservation of bats. Such actions could include measures to exclude bats from potential roost holes prior to vegetation removal and provision of alternative roost sites.

Regarding felling of trees with moderate to high potential roost features, if emergence and roost inspection survey fail to detect bats, then 'soft felling' measures will be implemented (BCT, 2018). This will be carried out in suitable weather conditions and at appropriate times of year. Briefly, this involves the following:

- removal of the tree in sections, starting with the top branches and working down the trunk avoiding cutting through cavities;
- lowering of any sections with potential roost features with care, positioning them on the ground with potential entrances to roosts facing upwards to allow bats to exist the roost; and
- leaving these sections in place for at least 24 hours in suitable weather.

For occupied roost sites where no vegetation removal is proposed, an exclusion zone will be implemented to avoid disturbance. This exclusion zone will only be implemented according to when and how the roost is used and will be proportional to the disturbance levels from the construction activity. For example, 30 m is an appropriate exclusion zone for piling. In general the following applies:

- maternity roosts: works will be carried out between 1 October to 1 May inclusive;
- summer roost (not a maternity roost): works will be carried out between 1 September to 1 May inclusive;
- hibernation roost: works will be carried out between 1 May to 1 October inclusive; and
- mating/swarming roost: works will be carried out between 1 November to 1 August inclusive.

The following will also be implemented to reduce the possibility of direct and indirect effects on bat species: no night-time lighting will be used during construction.

4.3.7 Other Protected Fauna

Pre-construction checks will be undertaken for spawning frogs if construction works are undertaken in February. Adults and spawn will be translocated under NPWS licence to suitable alternative locations if present. Pitfall traps and drift fences will be used to capture adult frogs.

Amphibian-proof fencing close to any ponds/pools will be used to prevent frogs or smooth newts from accessing any parts of the Proposed Project most hazardous to amphibians during the construction phase.

4.4 Land & Soil

4.4.1 Peat, Soil, Subsoil and Bedrock Excavation

The excavation of peat, soil, subsoil and bedrock will have a direct effect on the geological environment and no specific mitigation measures are proposed. The excavation and long term storage of materials will be completed in accordance with best practice for the management and treatment of such materials.

4.4.2 Erosion of Exposed Peat, Soil and Subsoil at Excavation and Storage Areas

The following avoidance and design measures are proposed to reduce erosion effects at excavation and spoil storage/deposition areas:-

- Mats will be used, as necessary, to support construction plant and machinery on soft ground, thus reducing the likelihood of soil and subsoil erosion and avoiding the formation of rutted areas. This will substantially reduce the likelihood for surface water ponding to occur;
- Excavated material will be side cast and stored temporarily adjacent to excavation areas for use during reinstatement and landscaping. Where material is not required for reinstatement or landscaping, it shall be immediately transported to the spoil deposition areas;
- Silt fences, and all necessary surface water management measures (including upslope interceptor drains), will be installed around all temporary stockpiles to limit movement of entrained sediment in surface water runoff. All slopes will be sealed with the bucket of an excavator;
- In order to minimise erosion during the construction phase, works will not take place during periods of intense or prolonged rainfall (to prevent increased silt laden runoff). Drainage systems, as outlined in **Chapter 7** of the EIAR, will be implemented to limit runoff effects during the construction phase;
- At the designated spoil deposition areas, material will be placed in layers to ensure stability is maintained and works will be undertaken in accordance with best practice construction methodologies. Works at the spoil deposition areas will be monitored, on a weekly basis during the construction phase and monthly for a 6 no. month period thereafter, by an appropriately qualified Geotechnical Engineer. In the event that any ground stability issues arise, the Engineer will have the power to cease works until such time as remedial works have been completed to his/her satisfaction;
- Permanently mounded spoil; for example, berms surrounding turbines and hardstands, berms located along access tracks and at the spoil deposition areas; will be seeded and grassed over at the earliest opportunity to prevent erosion; and,
- The electricity line (grid connection) trench will be reinstated to the required specification and in accordance with landowner requirements and will be reseeded or allowed to vegetate naturally (on agricultural land) or topped with tarmacadam (or similar along public roads) at the earliest opportunity to prevent erosion.

4.4.3 Contamination of Soils and Subsoils by leakages, spillages of hydrocarbons or other chemicals

The following measures are proposed to specifically prevent contamination of soils and subsoils:-

- The volume of fuels or oils stored on site will be minimised. All fuel and oil will be stored in an appropriately bunded area within the temporary construction compound. Only an appropriate volume of fuel will be stored at any given time. The bunded area will be roofed to avoid the ingress of rainfall and will be fitted with a storm drainage system and an appropriate oil interceptor;
- All bunded areas will have 110% capacity of the volume to be stored;
- On site re-fuelling of machinery will be carried out using a mobile double skinned fuel bowser. The fuel bowser, a double-axel custom-built refuelling trailer will be re-filled at the temporary compound and will be towed around the site by a 4x4 jeep to where plant and machinery is located. The 4x4 jeep will also be fully stocked with fuel absorbent material and pads in the event of any accidental spillages. The fuel bowser will be parked on a level area in the construction compound when not in use and only designated, trained and competent

operatives will be authorised to refuel plant on site. Mobile measures such as drip trays and fuel absorbent mats will be used during all refuelling operations to avoid any accidental leakages;
- All plant and machinery used during construction will be regularly inspected for leaks and fitness for purpose;
- Spill kits will be available to deal with any accidental spillages within the temporary construction compound and during re-fuelling;
- All waste tar material arising from road cuttings (from trenching in public roads and haul route temporary alteration works) will be removed off-site and disposed of at a licensed waste facility. Due to the potential for contamination of soils and subsoils, it is not proposed to utilise this material for any reinstatement works or to store it within the spoil deposition areas; and
- An emergency plan for the construction phase to deal with accidental spillages accompanies this Planning-Stage Construction and Environmental Management Plan. This emergency plan will be further developed by the contractor prior to the commencement of construction.

4.4.4 Land and Land Use

23ha of forestry will be felled to accommodate wind farm infrastructure. However, all tree coverage felled will be replaced at a replanting site(s) which will be subject to technical approval through a separate consenting process. No specific measures, other than best-practice felling and replanting methodologies are proposed.

4.4.5 Peat Stability and Failure

The peat stability risk assessment report, which accompanies this EIAR (**Annex 6.1**), provides a number of mitigation/control measures to reduce the potential risk of peat failure at each infrastructure location. Sections of access roads to the nearest infrastructure element will be subject to the same mitigation/control measures that apply to the nearest infrastructure element.

The following control measures incorporated into the construction phase of the project will ensure the management of the risks for this site:

- Appointment of experienced and competent contractors;
- The site will be supervised by experienced and qualified personnel;
- Allocate sufficient time for the project (be aware that decreasing the construction time has the potential to increase the risk of initiating a localised peat movement);
- Prevent undercutting of slopes and unsupported excavations;
- Maintain a managed robust drainage system;
- Prevent placement of loads/overburden on marginal ground;
- Implementation of safety buffers around deep peat areas;
- Adhere to the spoil and peat storage restriction areas detailed in the Geotechnical and Peat Stability Risk Assessment (GDG, 2023);
- Set up, maintain and report findings from monitoring systems as outlined in the Geotechnical and Peat Stability Assessment (FT, 2023);
- Ensure construction method statements are developed and agreed before commencement of construction and are followed by the contractor; and,
- Revise and amend the Construction Risk Register as construction progresses to ensure that risks are managed and controlled for the duration of construction.

4.5 Water

4.5.1 Clear Felling & Surface Water Quality Effects

Best practice methods related to water incorporated into the forestry management and mitigation measures have been derived from:-

- Department of Agricultural, Food and the Marine (2019) *Standards for Felling and Reforestation*;
- Forestry Commission (2004) *Forests and Water Guidelines, Fourth Edition*. Publ. Forestry Commission, Edinburgh;
- Coillte (2009) *Forest Operations and Water Protection Guidelines*;
- Coillte (2009) *Methodology for Clear Felling Harvesting Operations*; and,
- Forest Service (2000: *Forestry and Water Quality Guidelines*. Forest Service, DAF, Johnstown Castle Estate, Co. Wexford.

Mitigation by Avoidance

There is a requirement in the *Forest Service Code of Practice* and in the *FSC Certification Standard* for the installation of buffer zones adjacent to aquatic zones at planting stage. Minimum buffer zone widths recommended in the Forest Service (2000) guidance document *Forestry and Water Quality Guidelines* are detailed at **Table 2**.

Average slope leading to the aquatic zone		Buffer zone width on either side of the aquatic zone	Buffer zone width for highly erodible soils
Moderate	(0 – 15%)	10 m	15 m
Steep	(15 – 30%)	15 m	20 m
Very steep	(>30%)	20 m	25 m

Table 2: Minimum Buffer Zone Widths (Forest Service, 2000)

During the construction phase, a self-imposed conservative buffer zone of 50m will be maintained for all Rapemills River and West Galros Stream where possible. These buffer zones are illustrated at **Chapter 7 - Figure 7.10** of the EIAR.

Of the 23ha proposed for felling, only ~2.5ha are located inside the 50m buffer zone.

The large distance between the majority of the felling areas and sensitive aquatic zones means that any poor-quality runoff arising from felling areas can be adequately managed and attenuated prior to even reaching the aquatic buffer zone and primary drainage routes. Where tree felling is required in the vicinity of streams, the additional mitigation measures outlined below will be employed.

Mitigation by Design

Mitigation measures which will reduce the risk of entrainment of suspended solids and nutrient release in surface watercourses comprise best practice methods, as follows:-

- Machine combinations (i.e. handheld or mechanical) will be chosen which are most suitable for ground conditions and which will minimise soils disturbance;
- Checking and maintenance of tracks and culverts will be ongoing through any felling operation. No tracking of vehicles through watercourses will occur. Where possible, existing drains will not be disturbed during felling works;
- Ditches which drain from the areas to be felled towards existing surface watercourses will be blocked, and temporary silt traps will be constructed. No

direct discharge of such ditches to watercourses will occur. Drains and sediment traps will be installed during ground preparation. Collector drains will be excavated at an acute angle to the contour (~0.3%-3% gradient), to minimise flow velocities. Main drains to take the discharge from collector drains will include water drops and rock armour, as required, where there are steep gradients, and avoid being placed at right angles to the contour;
- Sediment traps will be sited in drains downstream of felling areas. Machine access will be maintained to enable the accumulated sediment to be excavated. Sediment will be carefully disposed of in the spoil disposal areas. All new silt traps will be constructed on even ground and not on sloping ground;
- In areas particularly sensitive to erosion or where felling inside the 50m buffer is required, it will be necessary to install double or triple sediment traps;
- All drainage channels will taper out before entering the 50m buffer zone. This ensures that discharged water gently fans out over the buffer zone before entering the aquatic zone, with sediment filtered out from the flow by ground vegetation within the zone. On erodible soils, silt traps will be installed at the end of the drainage channels, to the outside of the buffer zone;
- Drains and silt traps will be maintained throughout all felling works, ensuring that they are clear of sediment build-up and are not severely eroded. Correct drain alignment, spacing and depth will ensure that erosion and sediment build-up are minimized and controlled;
- Brash or bog mats will be used to support vehicles on soft ground, reducing topsoil and mineral soils erosion and avoiding the formation of rutted areas, in which surface water ponding can occur. Brash mat renewal will take place before they become heavily used and worn. Provision will be made for brash mats along all off-road routes, to protect the soil from compaction and rutting. Where there is risk of severe erosion occurring, extraction will be suspended during periods of high rainfall;
- Timber will be stacked in dry areas, and outside the 50m watercourse buffer. Straw bales and check dams will be emplaced on the down gradient side of timber storage/processing sites;
- Works will be carried out during periods of no, or low, rainfall in order to minimise entrainment of exposed sediment in surface water run-off;
- Checking and maintenance of roads/tracks and culverts will be ongoing through the felling operation;
- Refuelling or maintenance of machinery will not occur within 50m of a watercourse. Mobile bowser, drip kits, qualified personnel will be used where refuelling is required;
- A permit to refuel system will be adopted:
- Branches, logs or debris will not be allowed to build up in aquatic zones. All such material will be removed when harvesting operations have been completed, but care will be taken to avoid removing natural debris deflectors;
- Trees will be cut manually from along streams and using machinery to extract whole trees; and
- Travel will only be permitted perpendicular to and away from surface water features.

Silt Traps

Silt traps will be strategically placed down-gradient within forestry drains near streams. The main purpose of the silt traps and drain blocking is to slow water flow, increase residence time and allow settling of silt in a controlled manner.

Drain Inspection and Maintenance

The following items will be carried out during pre-felling inspections and regularly thereafter:-

- Communication with tree felling operatives in advance to determine whether any areas have been reported where there is unusual waterlogging or bogging of machines;
- Inspection of all areas reported as having unusual ground conditions;
- Inspection of main drainage ditches and outfalls. During pre-felling inspections, the main drainage ditches will be identified. Where possible, the pre-felling inspection will be carried out during rainfall;
- Following tree felling, all main drains will be inspected to ensure that they are functioning;
- Extraction tracks within 10m of drains will be broken up and diversion channels created to ensure that water in the tracks spreads out over the adjoining ground;
- Culverts on drains exiting the site, if impeded by silt or debris, will be unblocked; and
- All accumulated silt will be removed from drains and culverts, and silt traps, and this removed material will be deposited away from watercourses to ensure that it will not be carried back into the trap or stream during subsequent rainfall.

Surface Water Quality Monitoring

Sampling will be completed before, during (if the operation is conducted over a protracted time) and after the felling activity. The 'before' sampling will be conducted within 4-weeks of the felling activity commencing, preferably in medium-to-high water flow conditions. The 'during' sampling will be undertaken once a week or after rainfall events. The 'after' sampling will comprise as many samplings as necessary to demonstrate that water quality has returned to pre-activity status (i.e. where an impact has been shown).

Details of the proposed surface water quality monitoring programme are outlined in the Water Quality Monitoring Plan (refer to **Annex 3.4** of the EIAR).

The surface water sampling locations used in this EIAR for the project site and grid connection (i.e. SW1 – SW4) will also be used as sampling locations during felling activities.

Also, daily surface water monitoring forms (for visual inspections and field chemistry measurements) will also be utilised at every works site near any watercourse. These will be taken daily and kept on site for record and inspection.

4.5.2 Earthworks (Removal of Vegetation Cover, Excavations and Stock Piling) Resulting in Suspended Solids Entrainment in Surface Water

Mitigation by Avoidance

The key mitigation measure during the construction phase is the avoidance of sensitive aquatic areas by using a 50m buffer. From the constraints map (**Chapter 7 - Figure 7.10** of the EIAR) it is evident that; other than some sections of access tracks, watercourse crossings (4 no.), part of the crane hardstanding of turbine T7, the southern end of the main construction compound and the northern end of the spoil deposition area at turbine T5; the majority of the proposed wind farm infrastructure (including all turbine locations and the spoil deposition areas) is located outside of areas that have been assessed to be hydrologically sensitive. Additional mitigation in the form of double silt fencing will be placed around all infrastructure that encroaches the 50m buffer zone.

As described above and at **Chapter 3** o the EIAR, specific mitigation measures, incorporated into the design of the project (embedded mitigation) and through implementation of best practice methodologies (discussed below) will be employed where work inside buffer zones is proposed.

The generally large setback distance from sensitive hydrological features ensures that sufficient space is provided for the installation of drainage mitigation measures (discussed below) and to ensure their effective operation. The proposed buffer zone will ensure:-

- Avoidance of physical damage to watercourses, and associated release of sediment;
- Avoidance of excavations within close proximity to surface water courses;
- Avoidance of the entry of suspended sediment from earthworks into watercourses; and,
- Avoidance of the entry of suspended sediment from the construction phase drainage system into watercourses, achieved in part by ending drain discharge outside the buffer zone and allowing percolation across the vegetation of the buffer zone.

Mitigation by Prevention

The following section details the measures which will be put in place during the construction phase to ensure that surface water features are protected from the release of silt or sediment and to ensure that all surface water runoff is fully treated and attenuated to avoid the discharge of dirty water.

Source controls to limit the likelihood for 'dirty water' to occur:-

- Interceptor drains, vee-drains, diversion drains, flume pipes, erosion and velocity control measures such as use of sand bags, oyster bags filled with clean washed gravel, filter fabrics, and other similar/equivalent or appropriate systems;
- Small working areas, covering stockpiles, weathering off stockpiles, cessation of works in certain areas or other similar/equivalent or appropriate measures.

In-Line controls to ensure appropriate management of silt laden water:-

- Interceptor drains, vee-drains, oversized swales, erosion and velocity control measures such as check dams, sandbags, oyster bags, straw bales, flow limiters, weirs, baffles, silt bags, silt fences, sedimats, filter fabrics, and collection sumps, temporary sumps/attenuation lagoons, sediment traps, pumping systems, settlement ponds, temporary pumping chambers, or other similar/equivalent or appropriate systems.

Treatment systems to fully attenuate silt laden waters prior to discharge:-

Temporary sumps and attenuation ponds, temporary storage lagoons, sediment traps, and settlement ponds, and proprietary settlement systems such as Siltbuster, and/or other similar/equivalent or appropriate systems.It should be noted for this site that an extensive network of bog and forestry drains already exists, and these will be integrated and enhanced as required and used within the wind farm drainage system. The integration of the existing land drainage network and the proposed wind farm network is common practice in wind energy developments and will also result in benefits to surrounding agricultural lands.

The main elements of interaction with existing drains will be as follows:-

- Apart from interceptor drains, which will convey clean runoff water to the downstream drainage system, there will be no direct discharge (without treatment for sediment reduction and attenuation for flow management) of runoff from the wind farm drainage into the existing site drainage network. This will reduce the likelihood of any increased risk of downstream flooding or sediment transport/erosion;
- Silt traps will be placed in the existing drains upstream of any streams where construction works is taking place, and these will be diverted into proposed interceptor drains, or culverted under/across the works area; and
- Buffered outfalls, which will be numerous over the site, will promote percolation of drainage waters across vegetation and close to the point at which the additional runoff is generated, rather than direct discharge to the existing drains of the site.

Water Treatment Train

While the silt/sediment ponds and lagoons are assessed as providing a sufficient level of protection to avoid any deterioration in downstream water quality; a final line of defence can be provided by a water treatment train such as a 'Siltbuster', if required. If the discharge water from construction areas fails to be of a high quality, then a filtration treatment system (such as a 'Siltbuster' or similar equivalent treatment train [sequence of water treatment processes]) will be used to filter and treat all surface discharge water collected in the dirty water drainage system. This water treatment train will apply for the entirety of the construction phase.

Silt Fences

Silt fences will be emplaced within drains down-gradient of all construction areas. Silt fences are effective at removing heavy settleable solids. This will act to prevent entry to watercourses of sand and gravel sized sediment, released from excavation of mineral sub-soils of glacial and glacio-fluvial origin, and entrained in surface water runoff. Inspection and maintenance of these structures during construction phase is critical to their functioning to stated purpose. They will remain in place throughout the entire construction phase. Double silt fences will be emplaced within drains down-gradient of all construction areas inside the 50m hydrological buffer zones to provide an additional layer of protection in these areas.

Silt Bags

Silt bags will be used where small to medium volumes of water need to be pumped from excavations. As water is pumped through the bag, most of the sediment is retained by the geotextile fabric allowing filtered water to pass through. Silt bags will be used with natural vegetation filters or sedimats (sediment entrapment mats, consisting of coir or jute matting) placed at the silt bag location to provide further treatment of the water outfall from the silt bag. Sedimats will be secured to the ground surface using stakes/pegs. The sedimat will extend to the full width of the outfall to ensure all water passes through this additional treatment measure.

Management of Runoff from the Spoil Deposition Areas

It is proposed that excavated overburden/spoil will be utilised for reinstatement of excavated areas etc. and for landscaping purposes. Excess material, or material which is unsuitable for this purpose, will be stored, permanently, at the dedicated spoil deposition areas.

The main spoil deposition area is located outside the 50m stream buffer zone (refer to **Chapter 7 - Figure 7.10** of the EIAR). A small section of the spoil deposition area at turbine T5 encroaches the 50m buffer zone. Additional mitigation in the form of double silt fencing will be placed around all infrastructure that encroaches the 50m buffer zone.

During the initial placement of spoil in the deposition areas, silt fences, straw bales and biodegradable matting will be used to control surface water runoff. Double silt fencing will be placed along the edge of the bog drain that intercepts the deposition areas.

Drainage from the overburden deposition areas will ultimately be into to the existing bog drain network where it is proposed that check dams will be installed every 20m or so to create a series of settlement ponds, before being discharged.

Spoil deposition areas will be sealed with a digger bucket and allowed to revegetate as soon possible to reduce sediment entrainment in runoff. Once re-vegetated and stabilised, spoil deposition areas will no longer be a likely source of silt laden runoff. Surface water protection infrastructure will be left in place until the areas have stabilised.

Grid Connection Installation Works

Temporary silt fencing/silt trap arrangements will be placed within existing roadside/field drainage features along the grid connection route to remove any suspended sediments from the works area. The trapped sediment will be removed and disposed of at an appropriate licenced facility. Any bare-ground will be re-seeded/reinstated immediately and silt fencing temporally left in place if necessary.

Pre-emptive Site Drainage Management

The works programme for the initial construction stage of the development will also take account of weather forecasts, and predicted rainfall in particular. Large excavations and movements of soil/subsoil or vegetation stripping will be suspended or scaled back if prolonged or intense rain is forecast. The extent to which works will be scaled back or suspended will relate directly to the amount of rainfall forecast.

The following forecasting systems are available and will be used on a daily basis at the site to direct proposed construction activities:-

- General Forecasts: Available on a national, regional and county level from the Met Eireann website (www.met.ie/forecasts). These provide general information on weather patterns including rainfall, wind speed and direction but do not provide any quantitative rainfall estimates;
- Meteo Alarm: Alerts to the possible occurrence of severe weather for the next 2 days. Less useful than general forecasts as only available on a provincial scale;
- 3 hour Rainfall Maps: Forecast quantitative rainfall amounts for the next 3 hours but does not account for possible heavy localised events;
- Rainfall Radar Images: Images covering the entire country are freely available from the Met Eireann website (www.met.ie/latest/rainfall_radar.asp). The images are a composite of radar data from Shannon and Dublin airports and give a picture of current rainfall extent and intensity. Images show a quantitative measure of recent rainfall. A 3 hour record is given and is updated every 15 minutes. Radar images are not predictive; and,
- Consultancy Service: Met Eireann provide a 24 hour telephone consultancy service. The forecaster will provide interpretation of weather data and give the best available forecast for the area of interest.

Using the safe threshold rainfall values will allow work to be safely controlled (from a water quality perspective) in the event of an impending high rainfall intensity event.

Works will be suspended if forecasting suggests either of the following is likely to occur:-

- >10 mm/hr (i.e. high intensity local rainfall events);
- >25 mm in a 24-hour period (heavy frontal rainfall lasting most of the day); or,
- >half monthly average rainfall in any 7 days.

Prior to works being suspended the following control measures will be completed:-

- Secure all open excavations;
- Provide temporary or emergency drainage to prevent back-up of surface runoff; and,
- Avoid working during heavy rainfall and for up to 24-hours after heavy events to ensure drainage systems are not overloaded.

Timing of Site Construction Works

The construction of the site drainage system will be carried out, at the respective locations, prior to other activities being commenced. The construction of the drainage system will only be carried out during periods of, where possible, no rainfall, therefore avoiding runoff. This will avoid the risk of entrainment of suspended sediment in surface water runoff, and transport via this pathway to surface watercourses. Construction of the drainage system during this period will also ensure that attenuation features associated with the drainage system will be in place and functional for all subsequent construction works.

Monitoring

Prior to the commencement of development, a detailed Site Drainage Plan and SWMP will be prepared to detail the siting and composition of the surface water management measures. The respective plans, which will form part of a detailed Construction Environmental Management Plan (CEMP), will be prepared prior to the commencement of development.

The CEMP will also include a detailed Water Quality Monitoring Plan for the monitoring of surface waters in the vicinity of the construction site by a designated Environmental Manager. The monitoring programme will comprise field testing and laboratory analysis of a range of agreed parameters. The civil works contractor, who will be responsible for the construction of the site drainage system, and Environmental Manager will undertake regular inspections of the drainage system to ensure that all measures are functioning effectively. The surface water sampling locations used in this EIAR (i.e. SW1 – SW4) will be used during construction activities. Regular inspections of all installed drainage systems will be undertaken, especially after heavy rainfall, to check for blockages, and ensure there is no build-up of standing water in parts of the systems where it is not intended.

Any excess build-up of silt levels that may decrease the effectiveness of the drainage feature, will be removed and disposed of in an appropriate manner.

4.5.3 Excavation Dewatering and Effects on Surface Water Quality

The management of excavation dewatering (pumping), particularly in relation to any accumulation of water in foundations or electricity line trenches, and subsequent treatment prior to discharge into the drainage network will be undertaken as follows:-

- Appropriate interceptor drainage, to prevent upslope surface runoff from entering excavations, will be put in place;

- The interceptor drainage will be discharged to the site constructed drainage system or onto natural vegetated surfaces and not directly to surface waters to ensure that Greenfield runoff rates are mimicked;
- If required, pumping of excavation inflows will prevent build-up of water in the excavation;
- The pumped water volumes will be discharged via volume and silt/sediment ponds and settlement lagoons adjacent to excavation areas, or via specialist treatment systems such as a Siltbuster unit;
- There will be no direct discharge to surface watercourses, and therefore no risk of hydraulic loading or contamination will occur;
- Daily monitoring of wind farm excavations by the Environmental Manager will occur during the construction phase. If high levels of seepage inflow occur, excavation work at this location will cease immediately and a geotechnical assessment undertaken; and,
- A mobile 'Siltbuster' or similar equivalent specialist treatment system will be available on-site for emergencies. Siltbusters are mobile silt traps that can remove fine particles from water using a proven technology and hydraulic design in a rugged unit. The mobile units are specifically designed for use on construction-sites. They will be used as final line of defence if needed.

4.5.4 Release of Hydrocarbons during Construction and Storage

Mitigation measures proposed to avoid release of hydrocarbons at the site are as follows:-

- The volume of fuels or oils stored on site will be minimised. All fuel and oil will be stored in an appropriately bunded area within the temporary construction compound. Only an appropriate volume of fuel will be stored at any given time. The bunded area will be roofed to avoid the ingress of rainfall and will be fitted with a storm drainage system and an appropriate oil interceptor;
- All bunded areas will have 110% capacity of the volume to be stored;
- On site refuelling of machinery will be carried out using a mobile double skinned fuel bowser. The fuel bowser, a double-axel custom-built refuelling trailer will be re-filled at the temporary compound and will be towed around the site by a 4x4 jeep to where plant and machinery is located. No refuelling will be permitted at works locations within the 50m hydrological buffer. The 4x4 jeep will also be fully stocked with fuel absorbent material and pads in the event of any accidental spillages. The fuel bowser will be parked on a level area in the construction compound when not in use and only designated trained and competent operatives will be authorised to refuel plant on site. Mobile measures such as drip trays and fuel absorbent mats will be used during all refuelling operations to avoid any accidental leakages;
- All plant and machinery used during construction will be regularly inspected for leaks and fitness for purpose;
- Spill kits will be readily available to deal with and accidental spillages;
- All waste tar material arising from road cuttings (from trenching or other works in public roads) will be removed off-site and taken to a licensed waste facility. Due to the potential for contamination of soils and subsoils, it is not proposed to utilise this material for any reinstatement works; and
- An outline emergency plan for the construction phase to deal with accidental spillages is contained within the Planning-Stage CEMP (**Annex 3.4** of the EIAR). This emergency plan will be further developed prior to the commencement of

development, and will be agreed with the Planning Authority as part of the detailed CEMP.

4.5.5 Groundwater and Surface Water Contamination from Wastewater Disposal

Measures to avoid contamination of ground and surface waters by wastewaters will comprise:-

- Self-contained port-a-loos (chemical toilets) with an integrated waste holding tank will be installed at the site compound, maintained by the providing contractor, and removed from site on completion of the construction works;
- Water supply for the site office and other sanitation will be brought to site and removed after use to be discharged at a suitable off-site treatment location; and,
- No water will be sourced on the site, nor will any wastewater be discharged to the site.

4.5.6 Release of Cement-Based Products

The following mitigation measures are proposed to ensure that the release of cement-based products is avoided:-

- No batching of wet-cement products will occur on site. Ready-mixed concrete will be brought to site as required and, where possible, emplacement of pre-cast products will be utilised;
- All watercourse crossings will utilise pre-cast products and the use of wet-cement products within the hydrological buffer will be avoided;
- Where concrete is delivered on site, only the chute will be cleaned, using the smallest volume of water practicable. Chute cleaning will be undertaken at lined cement washout ponds with waters being stored in the temporary construction compound, removed off site and disposed of at an approved licensed facility. No discharge of cement contaminated waters to the construction phase drainage system or directly to any artificial drain or watercourse will be allowed;
- Weather forecasting will be used to ensure that prolonged or intense rainfall is not predicted during concrete pouring activities; and,
- The concrete pour site will be kept free of standing water and plastic covers will be ready in case of sudden rainfall event.

4.5.7 Morphological Changes to Surface Water Courses & Drainage Patterns

The following mitigation measures are proposed:-

- All proposed new stream crossings will be clear span bridges (bottomless culverts) and the stream beds will remain undisturbed. No in-stream excavation works at the crossing locations are proposed and therefore there will be no impact on the stream at the proposed crossing location;
- All internal wind farm electrical cabling or grid connection cabling will pass above or below the existing culvert and will not directly interfere with the culvert;
- At the time of construction, all guidance/best practice requirements of the OPW or Inland Fisheries Ireland will be incorporated into the design/construction of the proposed watercourse/culvert crossings;
- As a further precaution, in-stream construction work (if/where required) will only be carried out during the period permitted by Inland Fisheries Ireland for in-stream works according to *Guidelines on Protection of Fisheries During Construction Works in and Adjacent to Waters* (2016) (i.e., July to September

inclusive). This time period coincides with the period of lowest expected rainfall, and therefore minimum runoff rates. This will minimise the risk of entrainment of suspended sediment in surface water runoff, and transport via this pathway to surface watercourses (any deviation from this will be done in discussion with the IFI);

- During the near stream construction works (i.e. within the 50m buffer zone), double row silt fences will be emplaced immediately down-gradient of the construction area for the duration of the construction phase;
- The new watercourse crossings at the wind farm site will require a Section 50 license application to the OPW in accordance with the Arterial Drainage Act 1945. The river/stream crossings will be designed in accordance with OPW guidelines/requirements on applying for a Section 50 consent; and,
- No instream works are proposed at the grid connection watercourse crossings.

4.5.8 Hydrological Impacts on Designated Sites

The proposed mitigation measures for protection of surface water quality, which will include buffer zones and robust drainage control measures (i.e. interceptor drains, swales, silt/settlement ponds, settlement lagoons), will ensure that the quality of runoff from development areas will be very high.

As stated in **Chapter 7** of the EIAR, an "*imperceptible, temporary effect*" on local streams and rivers would, if it occurs, be extremely localised and of a very short duration (i.e. hours). Therefore, considering the imperceptible effects on local surface water quality along increased dilution capacity of downstream river waterbodies, significant indirect hydrological or water quality effects on the downstream designated sites will not occur.

4.5.9 Water Framework Directive Status

No additional targeted measures are required or proposed in respect of the Water Framework Directive (WFD) assessment. The strict implementation of the measures set out in the preceding sections will ensure that the status of both surface water and groundwater bodies in the vicinity of the site will be maintained.

4.6 Air Quality & Climate

4.6.1 Air Quality

In order to minimise dust emissions during construction, a series of mitigation measures have been prepared in the form of an outline Dust Management Plan. A detailed Dust Management Plan will be formulated prior to the construction phase of the project, and will include the following measures:-

- On-site access tracks and public roads in the vicinity of the site shall be regularly cleaned to remove mud, aggregates and debris and maintained as appropriate. All road sweepers shall be water assisted;
- Any road that has the potential to give rise to fugitive dust shall be regularly watered, as appropriate, during dry and/or windy conditions;
- Public roads in the vicinity of the site shall be regularly inspected for cleanliness and cleaned as necessary;
- In the event of dust nuisance occurring outside the site boundary, movement of materials will be immediately terminated, and satisfactory procedures implemented to rectify the problem before the resumption of operations;

- If issues persist and the above measures are not satisfactorily control dust emissions, a wheel washing system with rumble grids to dislodge accumulated dust and mud prior to leaving the site should be installed;
- During movement of materials both on and off-site, trucks will be stringently covered with tarpaulin at all times. Before entrance onto public roads, trucks will be adequately inspected to ensure no potential for dust emissions;
- Material handling systems and site stockpiling of materials will be designed and laid out to minimise exposure to wind. Water misting or sprays will be used as required if particularly dusty activities are necessary during dry or windy periods; and
- The Dust Management Plan shall be reviewed at regular intervals during the construction phase to ensure the effectiveness of the procedures in place and to maintain the goal of minimisation of dust through the use of best practice and procedures.

4.6.2 Climate

Embodied carbon of materials and construction activities will be the primary source of climate impacts during the construction phase. Measures to reduce the embodied carbon of the construction works include:

- Creating a construction program which allows for sufficient time to determine reuse and recycling opportunities;
- Following IEMA mitigation hierarchy;
- Appointing a suitably competent contractor who will undertake waste audits detailing resource recovery best practice and identify materials can be reused/recycled;
- Materials will be reused on site within the new build areas where possible;
- Prevention of on-site or delivery vehicles from leaving engines idling, even over short periods;
- Ensure all plant and machinery are well maintained and inspected regularly;
- Minimising waste of materials due to poor timing or over ordering on site will aid to minimise the embodied carbon footprint of the site; and
- Sourcing materials locally where possible to reduce transport related CO_2 emissions.

4.7 Landscape

Aside from construction stage mitigation measures to minimise land and vegetation disturbance and dust emissions (which may reduce visual amenity), there are no specific mitigation measures to be implemented.

The appropriate management and reinstatement of excavations, in a timely manner, will ensure that any adverse effects caused, for example at site entrances or road upgrade locations, are minimised insofar as possible. Similarly, the progressive reinstatement and landscaping of the site will remediate any short term adverse effects on the local landscape.

Best practice construction methods including just in time delivery methods to prevent material waste, reuse of on-site materials, where possible; and the minimisation of fuel use, including generators, will reduce construction related climate emissions.

4.8 Cultural Heritage

Archaeological, architectural and cultural heritage resources will be protected through the following mitigation and monitoring measures:-

- Archaeological monitoring of all excavations associated with the construction of the wind farm shall be carried out. Monitoring will be carried out under licence to the Department of Housing, Local Government and Heritage and the National Museum of Ireland. Provision will be made for the full excavation and recording of any archaeological features or deposits that may be exposed during monitoring;
- Archaeological monitoring of all excavations associated with the grid connection infrastructure shall be carried out. Monitoring will be carried out under licence to the Department of Housing, Local Government and Heritage and the National Museum of Ireland. Provision will be made for the full excavation and recording of any archaeological features or deposits that may be exposed during monitoring;
- Archaeological monitoring of all excavations within the temporary haul route upgrade works at the N52/N62 junction shall be carried out. Monitoring will be carried out under licence to the Department of Housing, Local Government and Heritage and the National Museum of Ireland. Provision will be made for the full excavation and recording of any archaeological features or deposits that may be exposed during monitoring;
- Archaeological monitoring of all excavations at townland, parish and barony boundaries shall be carried out. Monitoring will be carried out under licence to the Department of Housing, Local Government and Heritage and the National Museum of Ireland. Provision will be made for the full excavation and recording of any archaeological features or deposits that may be exposed during monitoring; and
- Written and photographic records will be created of any townland, parish or barony boundaries that may be impacted on. The written and photographic records will be created in advance of excavations commencing on site.

4.9 Noise & Vibration

Construction activities will be completed in accordance with the provisions, where relevant, of *BS 5228-1:2009+A1:2014 Code of practice for noise and vibration control on construction and open sites – Noise* which offers detailed guidance on the control of noise & vibration from demolition and construction activities. The relevant practices to be adopted during construction shall include:-

- Limiting the hours during which site activities likely to create high levels of noise or vibration are permitted;
- Establishing channels of communication between the contractor/developer, Local Authorities and residents;
- Appointing a site representative responsible for matters relating to noise and vibration;
- Monitoring typical levels of noise and vibration during critical periods and at sensitive locations; and
- Keeping site access tracks even to mitigate the potential for vibration from HGVs.

Furthermore, a variety of practical noise control measures will be employed. These include:-

- Selection of plant with low inherent potential for generation of noise and/or vibration;
- Placing of noisy/vibratory plant as far away from sensitive properties as permitted by site constraints, and;
- Regular maintenance and servicing of plant items.

Noise

The various contractors involved in the construction phase will be obliged, under contract, to take specific noise abatement measures and comply with the recommendations of *BS 5228-1:2009+A1:2014 Code of practice for noise and vibration control on construction and open sites – Noise*. The following list of measures will be implemented, as relevant, to ensure compliance with the relevant construction noise criteria:

- No plant or machinery will be permitted to cause a public nuisance due to noise;
- The best means practicable, including proper maintenance of plant, will be employed to minimise the noise produced by on site operations.
- All vehicles and mechanical plant will be fitted with effective exhaust silencers and maintained in good working order for the duration of the contract;
- Compressors will be attenuated models fitted with properly lined and sealed acoustic covers which will be kept closed whenever the machines are in use and all ancillary pneumatic tools shall be fitted with suitable silencers;
- Machinery that is used intermittently will be shut down or throttled back to a minimum during periods when not in use;
- Any plant, such as generators or pumps, which may be required to operate outside of general construction hours will be surrounded by an acoustic enclosure or portable screen;
- During the course of the construction programme, supervision of the works will include ensuring compliance with the limits developed using methods outlined in *BS 5228-1:2009+A1:2014 Code of practice for noise and vibration control on construction and open sites – Noise*; and
- The hours of construction activity will be limited to avoid unsociable hours where possible. Construction operations, including the delivery of construction materials, shall generally be restricted to between 07:00hrs and 19:00hrs Monday to Friday and between 07:00hrs and 13:00hrs on Saturdays, with no operations on Sundays or public holidays. However, to ensure that optimal use is made of good weather periods, at occasional critical periods within the construction programme (i.e. concrete pours, turbine component deliveries and turbine erection) or in the event of an emergency; activities may be necessary outside out of these hours.

Based on assessment of the geological composition of the site undertaken to date, it is assessed that significant levels of rock are not present and that rock breaking is unlikely to be required. If rock breaking is required, the following measures will be implemented, where necessary, to mitigate noise emissions:-

- Fit suitably designed muffler or sound reduction equipment to the rock breaking tool to reduce noise without impairing machine efficiency;
- Ensure all air lines are sealed;
- Use a dampened bit to eliminate a 'ringing' sound;
- Erect an acoustic screen between compressors or generators and noise sensitive area. When possible, line of sight between top of machine and reception point will be obscured; and
- Enclose the breaker or rock drill in portable or fixed acoustic enclosure with suitable ventilation.

Vibration

Given the substantial distances between locations where notable levels of vibration may take place (e.g. at turbine locations or extensive use of vibration rollers in access track construction) and the nearest NSLs, no likely significant effect will be experienced. Therefore, no specific mitigation measures are proposed in respect of vibration.

4.10 Transport & Access

In order to ensure the avoidance of significant effects and reduce the predicted magnitude of effects to the greatest possible extent, a suite of mitigation measures are available which will reduce any likely effects during the construction phase. The following mitigation measures will be implemented:-

- Traffic movements will be limited to 07:00-19:00 Monday to Friday and 07:00–13:00 on Saturdays with no movements on Sundays or public holidays. It may be occasionally necessary to undertake works outside of these hours to avail of favourable weather conditions or during extended concrete pours. Where construction activities are necessary outside of the normal working hours, local residents and the Planning Authority will receive prior notification;
- A wheel washing facility will be provided, as necessary, to prevent any debris being transferred from site to the adjacent public roads. All drivers will be required to ensure that their vehicle is free from dirt and stones prior to departure from the project site. Where conditions exist for dust to become friable, techniques such as damping down of the affected areas will be employed and vehicles/loads will be covered to reduce dust emissions;
- A Traffic Management Plan shall be agreed as part of the Construction Environmental Management Plan (CEMP) with the Planning Authority prior to the commencement of development. The Traffic Management Plan shall include *inter alia* confirmed details of construction material haul routes; confirmed details of vehicle specifications; a materials delivery programme; traffic management measures including details of 'Stop/Go' systems, signage, road closures and diversionary routes; and road reinstatement details;
- All works to the public road shall be undertaken in consultation with, and agreed in advance with, the relevant local authority;
- All reasonable steps shall be taken to ensure that only national and regional routes are used to transport all materials to the site, in so far as is possible;
- Prior to, and post, construction; pavement condition surveys will be undertaken along all non-national access routes proposed to be utilised in the delivery of construction materials. Given the high-quality and well-maintained nature of motorways and national routes, it is not assessed as necessary to carry out surveys of these carriageways or structures. Following the completion of the pre-construction survey, any works which are assessed as necessary to facilitate the delivery of components and materials to the project site shall be undertaken, while any deterioration of carriageways or structures identified in the post-construction survey shall be put right at the expense of the developer and to the satisfaction of the relevant local authority;
- Appropriate and adequate signage shall be provided at all entrances providing access, safety and warning information;
- Speed limit compliance; particularly along the L30033, L70151, L701521, and L70152 grid connection route; will be emphasised to all staff and contractors prior to the commencement of construction during site induction, and will be strictly enforced throughout the construction phase;
- Sufficient car parking spaces will be available at the temporary construction compound during the construction phase. Additionally, during construction of the proposed grid connection, it is likely that agricultural premises will be used

for the temporary storage of materials (e.g. ducting, cabling, etc.) and for the parking of construction plant, machinery, and work vehicles (cars, vans, etc.). No parking of cars by persons associated with the project will be permitted on any part of the public road that is not closed to traffic. All staff will be instructed to ensure that private entrances remain unobscured (particularly along the grid connection route);
- Road sweeping, particularly along the proposed grid connection route, will be carried out as appropriate to ensure construction traffic does not adversely affect road conditions;
- Traffic restrictions shall be kept to minimum duration and extent;
- Appropriate traffic management; including maintenance of local access, pedestrian access (where safe to do so) and diversions (where required); shall be implemented to facilitate continued public use of roads where temporary traffic restrictions have to be put in place. Precise details of these measures will be detailed in the Traffic Management Plan to be agreed with the Planning Authority prior to the commencement of development;
- The timing of oversized/abnormal loads shall be agreed with the relevant local authorities and An Garda Síochána, and all relevant licenses and permits shall be obtained in advance. All oversized/abnormal loads shall be accompanied by escort vehicles to ensure the maintenance of public safety;
- Maximum axle loadings for abnormal/oversized loads shall be strictly enforced in accordance with the Road Traffic (Construction and Use of Vehicles) Regulations 2003 (S.I. No. 5 of 2003);
- A designated contact point and coordinator will be put in place to manage all access arrangements and to interface with the public and the respective local authorities; and,
- The site shall be closed, and strictly secured, to the public during the construction phase.

4.11 Aviation

As requested by the IAA in its consultation response, a minimum of 30 days prior notification will be provided in respect of the commencement of crane operations at the project site. Additionally, as is best practice and implemented as a general standard, warning lights will be fitted to cranes during the erection of the wind turbines.

4.12 Waste Management

The contractor shall ensure that all waste generated at the project site is managed in an appropriate manner. The precise methods to be implemented are detailed in the accompanying Waste Management Plan which shall ensure that waste is managed in accordance with all relevant legislation, best practice methods, and in accordance with the waste management priority hierarchy.

Excavated spoil material, which also constitutes 'waste', shall be managed in accordance with the provisions of the accompanying Spoil Management Plan. Only material which cannot be re-used for reinstatement or landscaping shall be removed from the project site and disposed of at an approved waste management facility.

5.0 Implementation of Environmental Management Measures

In the first instance, the construction phase of the project shall be undertaken in strict compliance with all measures set out in the EIAR and NIS; unless where revised or where required to be revised in order to ensure compliance which a condition of planning consent. All relevant conditions of consent shall be inserted at **Table 1** below.

Planning Conditions		
Condition No.	**Content**	**Relevance to Construction Phase (Yes/No)**

Table 1: Planning Conditions

This CEMP; which will be further developed prior to the commencement of construction; all associated documentation, construction management plans, and construction method statements shall be prepared to ensure strict accordance with each of the measures of the EIAR, NIS, and conditions of consent. As stated at **Section 1.4** above, it will be the responsibility of the EM to ensure coordination between this CEMP, all associated construction management plans & method statements, and the requirements set out in relation to the project.

6.0 Communication Plan

Given the multitude of stakeholders to be involved in the construction phase of the project, a clear and concise communications plan will be implemented to ensure that all matters arising are appropriately reported and recorded. The Communications Plan, which will be developed by the contractor will include a reporting strategy including, but not limited to, the following personnel:-

- Cush Wind Limited Project Manager;
- Contractor Project Manager;
- Cush Wind Limited Project Supervisor Construction Phase (PSCS);
- Contractor Site Foreman;
- Environmental Manager;
- Ecological Clerk of Works;
- Geotechnical Clerk of Works; and
- Archaeological Clerk of Works.

Additionally, Cush Wind Limited shall appoint a dedicated Community Liaison Officer (CLO) who shall be responsible for engaging with members of the local community regarding the provision of project updates, etc., and shall also be responsible for relaying any matters raised to the project team.

A list of project contacts, to be developed prior to the commencement of construction and included within the detailed CEMP, shall be made available to all construction staff while a copy shall also be provided at the site offices.

7.0 Staff Training & Environmental Awareness

Only staff who have received appropriate training and have the necessary safety training/certification shall be permitted on-site.

All construction phase personnel will receive environmental awareness information as part of their initial site induction. The extent of their induction shall be tailored to the scope of their work; however, as a minimum, all environmental protection matters will be addressed in full. This will ensure that staff are familiar with environmental obligations associated with the construction process and the procedures and measures to be implemented. Staff will also be advised of the likely effects of any non-compliance with the relevant environmental measure.

As described at **Section 1.4**, the EM shall provide regular environmental updates to personnel and shall advise of any improvements which can be implemented.

Tool box talks will be held by the EM, or other relevant personnel at the commencement of each day or at the commencement of new activities. The aims of the tool box talks are to identify the specific work activities that are scheduled for that day or phase of work. In addition, the necessary work method statements will be identified and discussed. Additionally, any non-compliance with a measures in this CEMP will also be discussed with the aim of avoiding a re-occurrence of the same non-compliance.

8.0 Emergency Response Procedures

Prior to the commencement of construction, the contractor shall prepare a comprehensive emergency response procedure to be implemented by on-site personnel. This on-site procedure shall be incorporated within the Environmental & Emergency Response Plan to ensure that appropriate procedures are in place to manage any incident and report same to the relevant stakeholders.

9.0 Recording & Reporting

Over the course of the construction phase, a significant volume of reporting will be undertaken to record the activities, methodologies, and measures implemented during the construction phase. With regards to environmental recording, the following is a non-exhaustive list of reports/records which are likely to be appended to the CEMP as the construction phase progresses:-

- Site Sign-In Records;
- Weekly Environmental Reports;
- Monthly Environmental Reports;
- Site Visual Inspection Checklists;
- Environmental Audits;
- Ecological Survey Reports;
- Water Quality Monitoring Reports;
- Archaeological Monitoring Reports;
- Geotechnical Monitoring Reports;
- Traffic Management Plans;
- Waste management documentation;
- All relevant licences, consents, and permits;
- All correspondence (internal and external) regarding environmental matters; and
- Staff Training Records.

10.0 Compliance & Review Procedures

10.1 Site Inspections & Environmental Audits

Routine inspections of construction activities will be carried out on a daily and weekly basis by the Contractor Project Manager, PSCS, Contractor Site Foreman, EM, and ECoW to ensure all environmental controls, relevant to the construction activities taking place at the time, are in place. Environmental inspections will ensure that the works are undertaken in accordance with this CEMP and all other relevant documentation.

10.2 Auditing

The contractor will be responsible for ensuring that all construction staff are aware of the requirement to, and understand the importance of, strictly implementing the procedures of the CEMP. Environmental audits will be undertaken during the construction phase of the project. In contrast to monitoring and inspection activities, audits are designed to identify the underlying causes of non-compliances, and not to merely detect the non-compliance itself.

Moreover, audits are the means by which system and performance improvement opportunities may be identified. Environmental audits will be carried out by the contractor or by external personnel acting on their behalf. The impartiality and objectivity of the audit process is crucial in the identification of improvements to the activities being undertaken at the project site. Environmental audits will be scheduled and conducted at regular intervals to determine whether the CEMP is being appropriately implemented. The findings of the audits will be provided to the Cush Wind Limited Project Manager, Contractor project Manager, PSCS, EM, and ECoW.

A sample Environmental Audit is included within the accompanying Environmental & Emergency Response Plan.

10.3 Environmental Compliance

As has been set out in the preceding sections, construction activities will be continuously and rigorously assessed to ensure that works are undertaken in accordance with the provisions of the detailed CEMP (to be prepared prior to construction). Where an environmental 'event/occurrence' has been identified, the following definitions shall apply:-

- Near-Miss: An event which has not resulted in an adverse environmental effect but which, if not addressed, could re-occur and result in adverse effects;
- Incident: An event which has occurred and which, if un-controlled, could result in substantial effects; however, on-site measures/procedures avoided such effects;
- Exceedance Event: Where an event has resulted in identifiable adverse effects which exceed the appropriate limit value (e.g. a deterioration of downstream water quality below acceptable limits). An exceedance event usually triggers the cessation of particular activities until an investigation has been completed and additional measures implemented; and
- Non-Compliance: The identification of an un-agreed deviation from prescribed procedures/measures set out in this CEMP.

10.4 Corrective Actions

A corrective action relates to the implementation of revised measures/procedures to rectify an identified environmental matter/concern/issue. Corrective actions will be implemented by the Contractor Project Manager, as advised by the PSCS and EM,

Corrective actions may be required as a consequence of:-

- Environmental Audits;
- Environmental Inspections; Environmental Monitoring;
- Environmental Incidents; and,
- Environmental Complaints.

A Corrective Action Notice will be used to communicate the details of the action required. A Corrective Action Notice will describe the cause and effect of the environmental issue/concern and will detail the recommended corrective action to be implemented.

If an environmental matter/concern/issue arises which requires immediate intervention; direct communications between the Contractor Project Manager, PSCS and EM will be conducted. A Corrective Action Notice will be completed subsequently.

Annex 1 –

Environmental & Emergency Response Plan

Cush Wind Farm

Planning-Stage Construction & Environmental Management Plan

Environmental & Emergency Response Plan

Cush Wind Limited

Galetech Energy Services

Clondargan, Stradone, Co. Cavan Ireland

Telephone +353 49 555 5050

www.galetechenergy.com

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1.0 Introduction

Galetech Energy Services (GES), on behalf of Cush Wind Limited, has prepared this Environmental and Emergency Response Plan (EERP) which should be instigated if an emergency or environmental incident occurs either within the project site or elsewhere linked to the construction of the Cush Wind Farm.

1.1 Purpose of this Report

Many construction and industrial sites have the potential to cause environmental harm which could pose threat to public health, water supplies and wildlife in the event of an environmental incident. The purpose of this report is to outline how, in the event of an emergency, impacts on humans and the local environment can be limited through quick action.

This EERP forms part of the pre-commencement requirement for the works and outlines conditions of work for staff, and for every contractor or sub-contractor at the site.

This document is a live document which will be updated regularly and forms part of the Planning-Stage Construction Environmental Management Plan (CEMP) for the Cush Wind Farm. Consequently, the majority of specific details can only be provided prior to the commencement of construction activities.

It contains details of:-

- Who should be contacted in an emergency;
- Procedures to be followed in an emergency; and
- Staff responsibilities in an emergency.

1.2 Environmental Incident

This EERP should be implemented once there has been an emergency or environmental incident on site or elsewhere linked to the construction of the Cush Wind Farm. Incidents can be a discharge to air, land or water that could cause environmental damage. Causes of environmental incidents on site include:-

- Land Slide;
- Vandalism;
- Fire;
- Leaking plant or equipment;
- Containment Failure;
- Overfilling of containment vessels;
- Discharge of raw or partially treated effluent;
- Wind-blown waste, litter or dust;
- Flooding on site;
- Leaking Portaloo;
- Fuel drips or spills during refuelling;
- Leak from fuel or chemical containers;
- Failure of pumps and pipelines; and
- Contaminated water or sediment/silt entering a waster course or drain.

Any of these incidents could affect drainage systems, surface waters, ecosystems, groundwater and soil. The production of toxic fumes and airborne pollutants could affect air quality which may damage human health, wild and domestic animals and ecosystems.

1.3 Reference Documents

The production of this EERP has been supported by current legislation and will be accounted for in the further development of the appointed contractor's detailed CEMP.

Other guidance documents have been used to develop this EERP; including a Planning-Stage Construction & Environmental Management Plan, Spoil Management Plan, Surface Water Management Plan, and Water Quality Management Plan.

2.0 Requirements of an EERP

This EERP provides guidance for environmental incidents and includes:-

- Summaries of local environmental sensitivities;
- An outline of the construction works and sources to relevant existing environmental plans;
- Key mapping reference points for the site;
- Contact information for key external bodies and emergency response numbers who will assist in the event of an emergency;
- An identification of key staff and 24-hour contact details for those who will assist in the event of an emergency;
- An identification of Inventory of Pollution Prevention Equipment;
- Details of an Inventory of Chemical Products and Waste Inventory on Site*;
- Details of reporting requirements;
- Details of staff who are trained in the use of spill kits and booms etc.;
- Procedures to be followed in the event of an emergency and an identification of those responsible for re-positioning and moving the plant; and
- A widely available summary sheet for operatives that outlines the key procedures in the event of an emergency.

3.0 Description of the Project

Cush Wind Limited intend to construct the Cush Wind Farm which will consist of:-

- 8 no. wind turbines with an overall tip height of 200m, and all associated ancillary infrastructure;
- All associated and ancillary site development, excavation, construction, landscaping and reinstatement works, including provision of site drainage infrastructure and forestry felling.
- Temporary alterations to the turbine component haul route; and,
- Construction of an electricity substation, Battery Electricity Storage System and installation of 5.6km of underground grid connection to facilitate connection of the proposed electricity substation to the existing 110kV substation at Clondallow, County Offaly;

The project site is located in rural Co. Offaly, approximately 4km north of the town of Birr and c. 28km south-west of Tullamore, County Offaly. Off-site and secondary developments; including the forestry replant lands and candidate quarries which may supply construction materials; also form part of the project.

The turbine component haul route, and associated temporary alteration works, are located within counties Galway, Roscommon, Westmeath, and Offaly. It is envisaged that the turbines will be transported from the Port of Galway, through the counties of Galway, Roscommon, Westmeath and Offaly, to the project site.

As well as the reference documents listed in **Section 1.3**, various environmental reports have been prepared for the development including:-

- Environmental Impact Assessment Report (Galetech Energy Services);
- Biodiversity Chapter (SLR Consulting);
- Land & Soil Chapter (Hydro Environmental Services);
- Water Chapter (Hydro Environmental Services); and
- Natura Impact Statement (SLR Consulting).

4.0 Incident and Hazard Reporting

To ensure that all environmental incidents or hazards are accurately recorded, a reporting system has been developed. The logging of environmental incident reports will ensure that regular revisions and reviews can be made. In the event of an accident/incident, a blank environmental incident report has been attached on the last page of this report that includes details of all non-compliance and corrective actions carried out as a result of any incidents.

5.0 Waste Disposal after Environmental Incidences

In the event of a pollution incident where a spill kit etc. may be used, operatives must dispose of the used equipment by placing them into a sealed bag or container. Used equipment will then be removed from site by a licensed waste contractor to a licensed waste facility.

6.0 Site Induction and Toolbox Talks

It is crucial that all contractors, sub-contractors and staff on site are fully familiar with this EERP. Toolbox talks will be regularly given to the workforce on the aspects of health and safety of this project and, during these talks, they will receive regular reminders of the importance of not only the local environment but of the necessary environmental controls that are in place on site.

7.0 Summary Sheet for Machinery & Plant Operators

This summary sheet is for all site personnel. A laminated copy will be kept on all site vehicles/machinery.

7.1 Procedures for an Incident

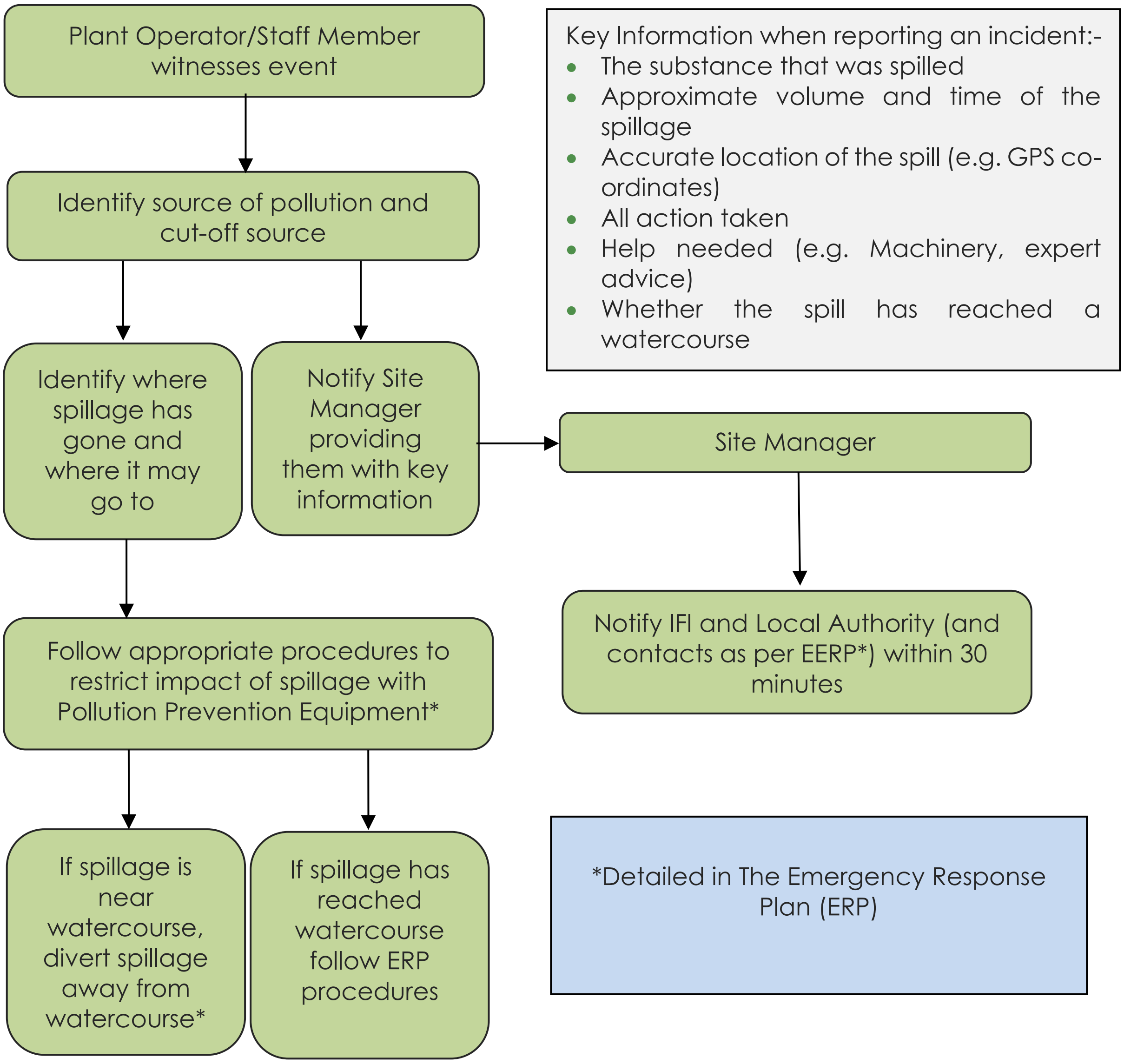
The following procedures are a guide when dealing with incidents. To ensure health and safety for yourself and others, this health and safety guidance should be followed at all times alongside applying common sense:-

1. Identify the source of the spillage and cut off source if possible through closing a valve or righting container etc.;
2. Discontinue all work on site and all operatives will assist in placing spill mats correctly on affected area. Immediately contact Site Manager/ main contact;
3. Identify the spillage route. If spillage is in close proximity to a watercourse (drainage/ditch/river), divert spillage away from the watercourse through the use of absorbent materials from the spill kit;
4. If a watercourse is at risk of contamination from suspended solids from a slope failure, do the following:-
    a. Place straws bales wrapped in geotextile or sand/gravel bags with geotextile curtains immediately in the watercourse(s) at regular intervals downstream from the incident. These sand/straw bags and bales will be removed and replaced with stone filters once water quality is stabilized;
    b. Stone check dams faced with a layer of geotextile will be constructed at critical points along the watercourse; and
    c. Small sumps will be formed intermittently between the check dams to reduce the amount of suspended solids contained in the water;

5. If there has been an Oil spill in the watercourse, do the following:-
   a. Place flexible absorbent booms across the watercourse, ahead of the contamination within a quiet stretch of water;
   b. Place absorbent cushions in the water immediately upstream of these booms as well as downstream of the booms; and
   c. Remove and replace saturated absorbent material as required. Please ensure removed cushions are placed in sealed polythene bags/containers and disposed of by the principal waste contractor;
6. Notify all parties in the order listed overleaf. Notification should be made by one member of staff whilst remaining staff present deal with the spill;
7. Dig up all contaminated ground as soon as possible. All contaminated materials should be placed in sealed polythene bags/containers and disposed of appropriately by a licensed waste contractor; and
8. Complete required record of incident and response into reporting system.

8.0 Communication Plan

A detailed Communication Plan will be provided by the Contactor, in liaison with relevant stakeholders, and will be included in the updated EERP prior to the commencement of construction. An outline Communication Plan is set out below.



8.1 Environmental Response Plan for Cush Wind Farm

<table>
<tr><th colspan="2">Incident Response Plan for Cush Wind Farm
Based on template provided in GPP 21 – Guidance for Pollution Prevention</th></tr>
<tr><td>Site Address:
Cush, Galros West, Boolinarig Big, and Eglish, Co. Offaly.
Official Company Address:
Cush Wind Limited, Greaghcrottagh, Tullyco, Cootehill, Co. Cavan

Key Holders for site (Name and Contact numbers):</td><td>Coordinates:

Map references:</td></tr>
<tr><td colspan="2">Overview of the activities on site:
Include number of employees at different times of the day:

Daylight hours:

Dusk to Dawn

Weekend Dusk to Dawn:

Bank Holidays:</td></tr>
<tr><td colspan="2">Description of surrounding area:</td></tr>
<tr><td>Date and Version of the plan:</td><td>Name & position of person responsible for compiling/approving the plan:</td></tr>
<tr><td>Review date:</td><td>Date of next exercise:</td></tr>
<tr><td colspan="2">Objectives of the plan:</td></tr>
<tr><td colspan="2">List of external organisations consulted in the preparation of this plan with contact details:</td></tr>
<tr><td colspan="2">Distribution list of who has received this plan and which version: Please note that it is recommended that you review and revise this plan regularly</td></tr>
</table>

8.2 External Contacts

External Contacts		
Contact	**Office Hours**	**Out of Office**
Emergency Services (Fire/Police/Ambulance)	999 or 112	999 or 112
Local Garda Station	Birr: +353579169710	
Local Hospital: Midland Regional Hospital, Tullamore	057 932 1501	
Environment Section Offaly County Council Áras an Chontae, Charleville Road, Tullamore, Co. Offaly R35 F893	057 934 6800	
EPA Regional Inspectorate Seville Lodge Callan Road Kilkenny	056 779 6700	
Inland Fisheries Ireland	01 8842600	1890 347 424 (24 hours)
ESB	01 8529534	
Telecommunications – Eircom/Eir	1800 475475	

8.3 Internal Contacts

Internal Contacts		
Names and position of staff authorised and trainers to activate and co-ordinate the plan. Staff to be contacted if needed to move or evacuate the site		
Other Staff:		
Managing Director		
Site Manager		
Environmental Manager		

8.4 Chemical Product & Waste Inventory

Chemical Product & Waste Inventory						
Trade name/ substance	Solid/liquid/gas or powder	UN number	Max amount	Location marked on site plan	Type of Containment	Relevant health & Environmental properties

8.5 Pollution Prevention Equipment Inventory

Pollution Prevention Equipment Inventory (On/Off-Site Resources)			
Type	Location	Amount	Staff contact

8.6 Site Environmental Incident Report Form

Site:		Date:	
Time:		Weather:	
Report By:		Position:	
Cush Wind Farm personnel present:		Position:	
Contractor personnel present:		Position:	

Description of Incident:

Item Spilled:	
Estimate of Volume of Spillage:	

List of actions followed once incident was noted	**Time:**	**Corrective Action** Action:	**By:**
Who first observed incident?			
First action			
Next action			
Time Pollution Hotline was contacted			
Other			

Details of Clean-Up contractor or how contamination was removed from site:	
Details of how this could be avoided in future:	
Details of review of internal procedures as result of this incident:	

Date of Report Completion: ______________________

Item	Questions	Yes	No	Corrective Action Action:	By:
1. Miscellaneous					
1.01	Does the contractor carry out regular internal environment audits on the site? Are recommendations recorded and is corrective action monitored?				
1.02	Have any environment incidents occurred and have these been reported as per on site procedure?				
1.03	Does the site induction contain a section on environmental requirements, including spill procedures, and is this communicated effectively?				
2. Land					
2.01	Are areas of hard standing (excluding bunded and refuelling areas) appropriately drained?				
2.02	Have local roads been inspected and cleaned where necessary?				
2.03	Has all test pitting and soil stripping been monitored by an archaeologist?				
2.04	Have all site clearance works been checked by an ecologist prior to works?				
3. Materials and Equipment					
3.01	Is there knowledge of the IFI Guidelines on protection of Fisheries During Construction Works in and Adjacent to Waters (2016) and OPW Environmental Guidance: Drainage Maintenance & Construction (2019)				
3.02	Are transformers/generators located in secondary containment bunds?				
3.03	Are all bunds capable of containing 110% of the				

	volume of the largest container?				
3.04	Is refuelling carried out in a designated refuelling bay?				
3.05	Does all site drainage on hard standing drain to an oil interceptor?				
3.06	Is the designated area for oil, fuel and chemical storage appropriately sited (i.e. on hard standing at least 10m from a watercourse)?				
3.07	Are there procedures in place to monitor bund integrity and manage bund rainwater levels? Are these followed and recorded?				
3.08	Is there awareness that oil or residue from contaminated water removed from bunds should be disposed of as special waste and not discharged to land or the water environment? (oil absorbent materials (pads etc.) should be used first)				
3.09	Are all drums and mobile plant (e.g. generators) placed on drip tray more than 10m from any watercourse?				
3.10	Is all plant maintained in a good state of leaks? Are there records of this?				
3.11	Are there adequate spill kits available and stored in close proximity to potential risks?				
3.12	Are all refuelling browsers double skinned, locked when not in use, and in a good state of repair?				
3.13	Is there evidence of unmanaged/unrecorded fuel/oil spillages on site?				

3.14	Are dry or wet wheel washing facilities fully operational and effective?				
3.15	If wet wheel washing facilities are required, are these closed systems with no discharge to the water environment?				
3.16	Are there laboratory certificates (accredited by the Irish National Accreditation Board) to confirm that imported material stone aggregate brought onto site is free from any contamination?				
4. Noise, Dust & Light					
4.01	Are there facilities to dampen stockpiles and site working areas/roads to suppress dust?				
4.02	Are vehicles carrying loose material sheeted at all times?				
4.03	Are construction works, or deliveries of materials to and from the department, audible at noise sensitive premises?				
4.04	Has all external construction lighting received the approval of the planning authority?				
5. Waste					
5.01	Is the site tidy and free from litter?				
5.02	Is there evidence of waste beyond the site boundary?				
5.03	Is waste segregated and kept securely in containers in clearly designated areas?				
5.04	Does all waste leaving the site have the appropriate duty of care paperwork?				
5.05	Is all waste leaving the site being taken to an appropriately licensed site?				

5.06	Does all special/hazardous waste (e.g. oil contaminated soils, waste oil) have the appropriate Special Waste Consignment Note?				
5.07	Is material re-used/recycled on site where possible?				
5.08	Are waste management practices in line with the site waste management plan?				
5.09	Are relevant Waste Management Exemptions in place for use of waste on site (e.g. use of waste concrete to create foundation sub-base)?				
5.10	Is there any evidence of burning on site?				
5.11	Is there any evidence of unlicensed burial of waste?				
6. Water					
6.01	Do all discharges to land or watercourses have appropriate authorization from Local Authorities/IFI?				
6.02	Do all watercourses engineering (bank protection, crossing etc.) have the appropriate authorization from Local Authorities/ IFI?				
6.03	Do any abstractions from a watercourse or groundwater body have the appropriate authorization from Local Authorities/ IFI?				
6.04	Has confirmation for the SUDS design for access roads been gained from Local Authorities/ IFI?				
6.05	Are cut-off ditches installed on the uphill side of the working area to avoid contaminated surface water run-off?				
6.06	Has vegetation removal/clearance of the site been minimized to				

	avoid unnecessary areas of bare-ground?				
6.07	Is adequate treatment (e.g. settlement tank/lagoons/discharge to land) provided to prevent silt contaminated water entering watercourses and groundwater?				
6.08	Has vegetation removal/clearance of the site been minimized to avoid unnecessary areas of bare-ground?				
6.09	Have buffer-strips been left between working area and watercourses?				
6.10	Is plant operating in the watercourse?				
6.11	Have all culverts been installed at the base of stockpiles situated within close proximity to watercourses?				
6.12	Have silt fences been installed at the base of stockpiles situated within close proximity to watercourses?				
6.13	Are there adequate controls on site construction roads to minimize sediment runoff into watercourses (in particular, are the adequate flow attention measures within surface drain?)				
6.14	Are there any sign of decaying straw bales in watercourses? (this could lead to organic pollution of the watercourse)				
6.15	Are silt traps regularly maintained?				
6.16	Has ease of maintenance been considered in the design of permanent drainage features?				
6.17	Is there evidence of contamination of any watercourse (e.g. with oil,				

	sediment, concrete, waste) in the vicinity of the works?				
6.18	Is monitoring of potential impacts on watercourses carried out on a regular basis and fully recorded?				
6.19	Are dewatering operations being carried out in such a way to minimize sediment contamination?				
6.20	Is drainage and run off in concrete batching areas adequate?				
6.21	Are adequate pollution prevention measures considered and put in place during concrete pours?				
7. Landscape					
7.01	Have earthworks been designed to promote successful re-instatement of vegetation?				
7.02	Are reinstatement and restoration works being implemented in a timely manner as per the requirements of the Contract?				
8. Ecology					
8.01	Have storage sites (soil, plant etc.) been sited on areas of lower quality habitat where possible?				
8.02	Have buffer zones been constructed and maintained around designated protected species exclusion areas (e.g. red squirrel dreys, water vole habitats, otter holts, badger holts etc.)?				
8.03	Have toolbox talks on the subject of ecology and environmental responsibilities on site been delivered? Have attendance records been maintained for these?				
9. Documentation Check					

9.01	Start-up meeting record				
9.02	Full contacts list in CEMP				
9.03	Induction records				
9.04	Pollution Prevention Measures Register				
9.05	Geotechnical Risk Register				
9.06	Weekly meeting minutes				
9.07	Records of environmental checks and routine monitoring of mitigation measures				
9.08	Water Quality Monitoring Results				
9.09	Safety and Environmental Awareness Reports (SEARs). Filed and entered in database?				
9.10	Safety and Environmental Audit Reports for the site. (If yes, insert date of last audit)				
9.11	Contractor's Environmental Plans (or Construction Method Statements)				

Annex 2 –

Waste Management Plan

Cush Wind Farm

Planning-Stage Construction & Environmental Management Plan

Waste Management Plan

Cush Wind Limited

Galetech Energy Services

Clondargan, Stradone, Co. Cavan Ireland

Telephone +353 49 555 5050

www.galetechenergy.com

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1.0 Introduction

Galetech Energy Services (GES), on behalf of Cush Wind Limited, has prepared this Waste Management Plan (WMP) to detail the measures to be implemented for the control, management and monitoring of waste associated with the Cush Wind Farm.

1.1 Purpose of this Report

The objective of this WMP is to minimise the quantity of waste generated by construction activities, to maximise the use of materials in an efficient manner and to maximise the segregation of construction waste materials on-site to produce uncontaminated waste streams for off-site recycling.

The WMP shall be implemented throughout the construction phase of the development to ensure:-

- That all site activities are effectively managed to minimise the generation of waste and to maximise the opportunities for on-site reuse and recycling of waste materials;
- To ensure that all waste materials are segregated into different waste factions and stored on-site in a managed and dedicated waste storage area; and
- To ensure that all waste materials generated by site activities are removed from site by appropriately permitted waste haulage contractors and that all wastes are disposed of at approved waste licensed / permitted facilities in compliance with the Waste Management Act 1996 and all associated waste management regulations.

1.2 Scope & Requirements

This WMP forms part of the pre-commencement requirement for the works and outlines conditions of work for staff, and for every contractor or sub-contractor at the site. The contractor will continually oversee changes to this document and will work alongside the Environmental Manager (EM) prior to any work commencing.

This document is a live document which will be updated regularly and forms part of the Planning-Stage Construction Environmental Management Plan (CEMP) for the Cush Wind Farm. Consequently, the majority of specific details can only be provided prior to the commencement of construction activities.

1.3 Waste Policies & Legislation

The Department of the Communications, Climate Action & Environment published *A Waste Action Plan for a Circular Economy – Ireland's National Waste Policy 2020-2025* in 2020. One of its guiding principles is to minimise waste and, therefore, it is key that the contractor has an efficient waste management plan in place.

The European Union (Waste Directive) (Amendment) Regulations 2016 infer a duty on all waste producers to take measures to apply the waste hierarchy priority order. In these Regulations, the "Act of 1996" means the Waste Management Act 1996 (No. 10 of 1996) and '"Principal Regulations" means the European Communities (Waste Directive) Regulations 2011 (S.I. No. 126 of 2011). The "Waste Directive" means Directive 2008/98/EC of the European Parliament and of the Council of 19 November 2019 on waste.

The Waste Management Priority Hierarchy, which contractors are obligated to apply, is as follows:-

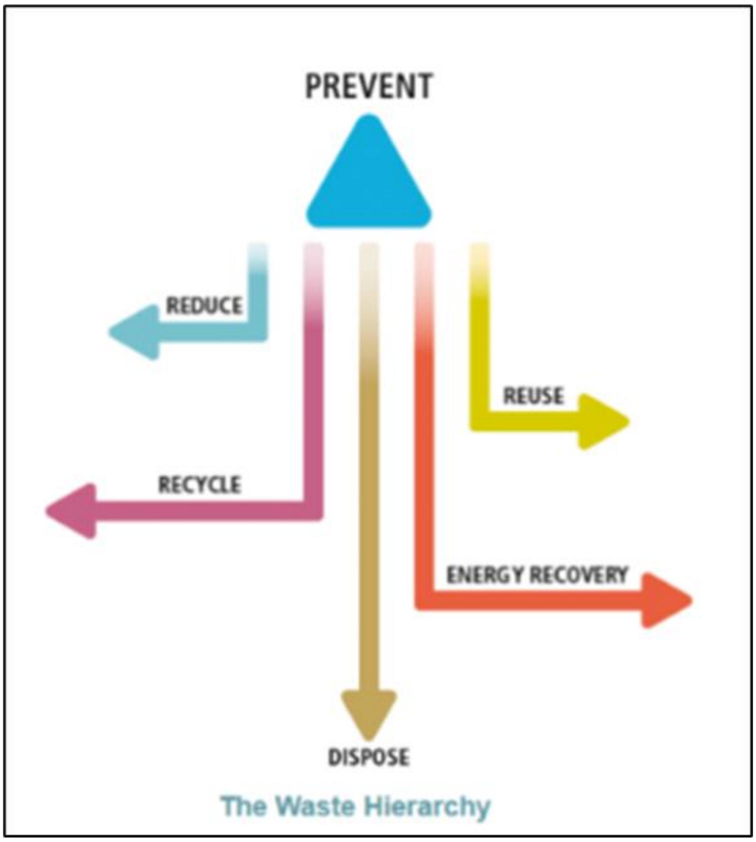

Figure 1: Waste Management Hierarchy

The waste management hierarchy shown above applies to all waste, including hazardous waste. The diagram conveys that above all, the prevention of waste production is the top priority.

The PCB/PCT Directive (Directive 96/59/ EC on the disposal of polychlorinated biphenyls and polychlorinated terphenyls) deals with the disposal of certain hazardous chemicals that represent a particular threat to the environment and to human health.

The European Communities (Carriage of Dangerous Goods by Road and Use of Transportable Pressure Equipment) (Amendment) (No. 2) Regulations 2017 (S.I No. 282 of 2017) shall be adhered to in the case of transportation to and from the site of any dangerous goods.

The contractor, in accordance with the abovementioned Directives, is legally required to:-

- Prevent waste disposal constituting a public nuisance through excessive noise levels or unpleasant odours, or to degrade places of special natural interest;
- Prohibit the dumping or uncontrolled disposal of waste;
- Ensure that the disposal and recovery of waste does not present a risk to water, air, soil, plants and animals;
- Ensure that waste treatment operations are licensed ;
- Prepare a Waste Management Plan;
- Require waste collectors to have special authorization and to keep records; and
- Ensure that the waste which cannot be prevented or recovered is disposed of without causing environmental pollution.

The EU Integrated Pollution Prevention and Control (IPPC) Directive (Directive 96/61/EC) provides for a permit system for activities including waste management. In adherence with this Directive, the contractor must:-

- Be in possession of a waste permit for waste disposal; and
- Be prepared at all times for inspection regarding monitoring of waste activities.

1.4 Reference Documents

The production of this WMP has been supported by best practice manuals and will be accounted for in the further development of the appointed contractor's detailed CEMP.

Other guidance documents have been used to develop this WMP; including a Planning-Stage Construction & Environmental Management Plan, Spoil Management Plan, Surface Water Management Plan, and Environmental & Emergency Response Plan.

2.0 Requirements of a WMP

There are four stages to be followed in the management of waste:-

- Planning;
- Implementation;
- Monitor; and
- Review.

2.1 Planning

During the planning/design/development stages of the Cush Wind Farm, the nature of the site has been accounted for as well as the environmental considerations and the design of the project. Insightful planning at the early stages will help minimise the quantity of waste produced.

2.2 Implementation

The detailed WMP, to be prepared prior to construction, will implement the management of the following:-

- A brief of waste types expected to be produced;
- Estimates of quantum of each type of waste expected to be produced;
- An explanation of how the contractor aims to minimise the different waste types produced prior to any activity that generates this waste; and
- Procedures for identification of the waste management actions proposed for each different waste type, including re-using, recycling, recovery and disposal (as per the waste hierarchy priorities).

All workers will be fully briefed of waste management procedures and aware of their requirements under the WMP. All site visitors will be briefed on appropriate waste storage and disposal units. Littering will not be tolerated and all personnel will have a duty to challenge those who do not comply with WMP procedures.

2.3 Monitoring

2.3.1 Checks and Records

All stores on site of oil, fuel and chemicals should be visually inspected on a regular basis, especially during extreme weather conditions. Visual inspections will reveal evidence of leaks, spills or contamination.

Records of all visual checks must be maintained and be made available upon request for inspection. The topic of waste management will be regularly discussed during team meetings and, as required, waste management practices should be continually revised.

2.3.2 Waste Inventory

A waste inventory should be continually updated and will include a list of all waste materials leaving the site for disposal as well as the name of the appropriately licensed operator and intended disposal facility. A waste inventory will be added to this plan by the contractor.

2.3.3 Monitoring of WMP

The contractor will appoint the EM to implement and monitor the WMP. The WMP should include an inventory of the types of estimates of the waste to be produced on site. The aim will be to keep the volumes of waste produced below the estimates of waste to be produced. The EM will ensure that a waste audit is carried out every 6-months.

2.4 Review

Upon completion of the construction phase, a waste management review will be undertaken. The aim will be to measure compliance with the WMP objectives and to consider lessons learnt. The review will be carried out by the EM in conjunction with the contractor.

3.0 General Waste Management Principles

- It is the contractors responsibility to avoid or minimise the volume of waste generated;
- Waste storage and disposal procedures will prevent pollution in compliance with legislation;
- Waste, including spoil, will be stored (regardless of whether it is permanent or temporary storage) a minimum of 10m from nearby watercourses or drain;
- All waste to be transported off-site shall only be removed to a licensed disposal site. Waste control dockets must be produced and filed on site with each load, and must detail:-
    - An adequate description of the waste;
    - Where the waste came from;
    - The appropriate code from the List of Wastes Regulations for the waste (commonly referred to as the EWC code);
    - Information on the quantity and nature of the waste and how it is contained;
    - Names and addresses of the transferor (the person currently in control of the waste) and the transferee (usually either a registered waste carrier or a waste management license holder (waste manager);
    - The Standard Industry Classification (SIC) CODE (2007 or 2003 for hazardous waste only) of the business from where the waste was received;
    - Where applicable, indicate that the waste hierarchy has been complied with;
    - The place, date and time of transfer of the waste. If using a season ticket, the period for which it is valid (i.e. valid from dd/mm/yyyy to dd/mm/yyyy); and
    - If the waste is being taken to landfill the transfer note must also contain details of any treatments or processes that have already been applied;
- Only trained operatives should handle hazardous substances. All stored hazardous waste will be clearly labelled;

- No storage of hydrocarbons or any toxic waste chemicals should occur within 50m of a watercourse/drainage ditch;
- All associated hazardous waste residuals (including use oil spill kits), such as oil, solvents, used absorbent materials on minor oi spills, glue and solvent based paint containers will be stored within appropriately covered skips prior to removal by a suitable Local Authority or EPA approved waste management contractor for off-site treatment/recycling/disposal;
- Rainwater, which has collected within bunded areas used for the storage of oils, chemicals and waste, will be collected and disposed off-site by suitably qualified waste contractors;
- Waste derived from the port-a-cabins (office and canteen facility) on-site will be placed in an appropriately designed waste storage area prior to collection a licensed contractor under the Waste Management Act, 1996;
- Port-a-loos will be regularly maintained by a suitably qualified waste contractor engaged by the supplier;
- Waste storage areas will be clearly located and signed. If space allows key waste streams will be separated;
- All waste should be transported from site at appropriate frequency by a registered waste contractor to prevent over-filling of waste containers; and
- Frequency of Checks: the contractor will ensure that all storage facilities are checked on a weekly basis. The checklist for completion is attached below.

Waste Checklist		
Waste area checked	Date Checked	Checked By
General office waste		
Bowser		
Portaloo		
Excavated soil		
Washings		
Concrete		
Oil		
Hazardous Waste		

4.0 Typical Waste Streams

4.1 Waste Inventory

The typical waste arising during the construction of the project is provided below. This inventory will be further expanded upon by the contractor prior to the commencement of construction.

Material Type	EWC	Predicted Quantity
Waste from Portaloo		
Concrete		
Hazardous Material (oil contaminated material, oily rags, etc.)		
Timber (pallets, shuttering, cable drums, packaging, etc.)		

Packaging (paper, plastic, etc.)		
Excavated Material (soil, subsoil, rock, road cuttings, etc.)		
Cable (electrical, etc.)		
Cardboard		
Metals (copper, aluminum, lead, iron, steel, etc.)		

4.2 Management of Waste

All waste will be segregated and securely stored at the temporary construction compound, in skips and receptacles, which will be covered to protect the contents from the weather. A licensed operator will collect and transfer the skips/receptacles of both recyclable and non-recyclable wastes as they are filled. Where this is not practicable, or where the quantity of waste is small, the contractor will remove the waste to his yard on a daily basis for onward disposal.

A list of licensed operators will be identified provided below.

Permit Number	Name of Permit Holder	Address of Waste Facility	Type of Waste Permitted

Annex 3 –

Spoil Management Plan

Cush Wind Farm

Planning-Stage Construction & Environmental Management Plan

Spoil & Peat Management Plan

Cush Wind Limited

Galetech Energy Services

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1.0 Introduction

Galetech Energy Services (GES), on behalf of Cush Wind Limited, has prepared this Spoil & Peat Management Plan (SPMP) to detail the appropriate management of excavated material arising from the construction of Cush Wind Farm.

1.1 Purpose of this Report

This SPMP provides the framework for the management of spoil and peat at the site of Cush Wind Farm for contractors and incorporates the measures set out in the various environmental assessment documents associated with the development. The purpose of this report is to ensure that spoil and peat is managed safely and re-used without resulting in any adverse environmental effects, and to ensure that all spoil handling/management activities are carried out in accordance with best practice methods.

This is a live document and will be updated by the appointed contractor prior to the commencement of development. Prior to the commencement of construction, the updated SPMP will be reviewed by the Environmental Manager (EM) to confirm the appropriateness of the measures set out therein.

1.2 Aims of this SPMP

The overall objective of this SPMP is to provide for the appropriate management of excavated material arising from the construction of Cush Wind Farm. In doing so, the re-use of excavated material, locally to its excavation, will be maximised through reinstatement and landscaping proposals.

The reinstatement of excavated materials will occur as close to the site of excavation as possible. Excavated material horizons (topsoil, peat, subsoil, etc.) will be stored separately to ensure appropriate re-use; and will be replaced in sequence and to depths similar to those recorded prior to excavation.

Excavated material may also be used in the landscaping of the site; for example, the creation of berms around crane hardstandings or along access tracks to reduce the visual effects of the infrastructure. Again, material will be placed close to its source and will be placed in a fashion which allows for vegetative re-growth thus allowing for spoil to be assimilated into the local environment.

Notwithstanding the fact that the project site area is generally flat, with little in the way of discernible variation in elevation throughout, this SPMP also includes a series of control measures specifically related to peat, including monitoring measures, which will be implemented during the construction phase of the wind farm and a contingency plan should peat instability/failure occur at the site. As work is carried out on site the contents of the SPMP and its peat stability monitoring programme will be updated, as appropriate.

A detailed engineering construction design must be carried out by the appointed construction stage designer prior to any construction work commencing on site. This must take account of the consented project details and any conditions imposed by that consent. This must include a detailed peat stability assessment to account for any changes in the environment which may have occurred in the time leading up to the commencement of construction and a peat and spoil management plan to allow for the most appropriate geotechnical and environmental led solutions to be developed for the management of peat and spoil.

1.3 Reference Documents

The production of this SPMP has been supported by best practice manuals and will be accounted for in the further development of the appointed contractor's detailed Construction & Environmental Management Plan (CEMP).

Other documents have been used to develop this SPMP; including a Planning-Stage CEMP, Surface Water Management Plan, Environmental & Emergency Response Plan, and a Geotechnical Peat Stability Report.

1.4 Peat Instability Definition

Peat instability in this SPMP is defined as a mass movement of a body of peat that would have a significant adverse impact on the surrounding environment. Peat instability excludes localised movement of peat that would occur below a floating access track, creep movement or localised erosion type events.

Adherence to the control measures included in this SPMP should reasonably minimise the potential for all such peat movements.

2.0 Description of the Project

In summary, the project comprises the following main components:-

- 8 no. wind turbines with an overall tip height of 200m, and all associated ancillary infrastructure;
- All associated and ancillary site development, excavation, construction, landscaping and reinstatement works, including provision of site drainage infrastructure and forestry felling.
- Temporary alterations to the turbine component haul route; and,
- Construction of an electricity substation, Battery Electricity Storage System and installation of 5.6km of underground grid connection to facilitate connection of the proposed electricity substation to the existing 110kV substation at Clondallow, County Offaly;

The project site is located in rural Co. Offaly, approximately 4km north of the town of Birr and c. 28km south-west of Tullamore, County Offaly. Off-site and secondary developments; including the forestry replant lands and candidate quarries which may supply construction materials; also form part of the project.

The turbine component haul route, and associated temporary alteration works, are located within counties Galway, Roscommon, Westmeath, and Offaly. It is envisaged that the turbines will be transported from the Port of Galway, through the counties of Galway, Roscommon, Westmeath and Offaly, to the project site.

As well as the reference documents listed in **Section 1.2**, various environmental reports have been prepared for the development including:-

- Environmental Impact Assessment Report (Galetech Energy Services);
- Biodiversity Chapter (SLR Consulting);
- Land & Soil Chapter (Hydro Environmental Services);
- Water Chapter (Hydro Environmental Services); and
- Natura Impact Statement (SLR Consulting).

3.0 Description of Baseline Environment

3.1 Site Location

The proposed development site is located in rural Co. Offaly, approximately 4km north of the town of Birr and c. 28km south-west of Tullamore, Co. Offaly. The wind farm will be located in the townlands of Cush, Galros West, Boolinarig Big, and Eglish Co. Offaly. The proposed temporary haul route alteration works to the N52/562 junction at Kennedy's cross are located in the townland of Ballindown, Co. Offaly.

Current land use within the project site is made up predominantly of peat bogs, agricultural pasture/grassland, and forestry, including commercial and woodland planting (of various species) and scrub. Areas to the north and northwest of the project site comprise cutover private bog; areas to the east and west of the N62 exhibit commercial and woodland forestry plantation; and areas to the south and southeast are predominantly agricultural pasture. The wider landscape is characterised by large tracts of industrial cutaway peatlands and agricultural scrub; however, improved agricultural pasture is dominant in areas bordering the east and west of the project site.

The local area is typical of this part of Ireland, with settlement patterns largely comprising dispersed rural dwellings often accompanied by agricultural holdings and buildings.

3.2 Topography

The proposed development site and surrounding topography are typical of the Midlands Region and comprise a generally flat landscape with occasional gentle undulations.

The elevation, across the project site, ranges between approximately 47m and 63m OD (Ordnance Datum). The marginally higher elevations occur in the eastern areas of the site with the overall slope to the west. The most elevated section of the proposed project site is found along the eastern fringes where agricultural grassland rises up to 63m OD (met mast location). The ground slopes in a general westerly direction from this eastern section to the lowest point on the far west of the project site which follows the valley of the Rapemills River.

The underground grid connection route runs in a westerly direction for approximately 5.6km between the electricity substation to the existing 110kV substation at Clondallow, Co. Offaly. The grid connection comprises underground cable to be located predominately within the carriageway of the public road network, with a short section being located within private lands. The ground elevation along the grid connection ranges from approximately 35m OD to 65m OD.

The forestry re-plant lands are almost exclusively agricultural pasture, with fields bounded by hedgerows and treelines. Ground elevations across the re-plant lands range generally between 100m OD and 140m OD.

3.3 Geological Environment

Based on the GSI/Teagasc soils mapping (www.gsi.ie) the project site is overlain by cutover bog, with some basic shallow well-drained mineral soils (BminSW) located in the southeast of the project site at 2 no. proposed turbine locations (T7 and T8).

A small area of basic poorly drained mineral soil (BminPD) is mapped towards the centre of the project site along the N62. The grid connection route from the proposed project site pass through areas mapped predominantly as Cut Peat and BminSW. The mapped soil type at the N62/52 junction works along the haul route is Cut Peat.

GSI subsoils mapping (www.gsi.ie) show that the proposed project site is underlain predominantly by cutover peat (Cut) with Gravels derived from Limestones (GLs) mapped on the southeast and southwest of the project site and also underlying turbine locations T7 and T8. A small pocket of Till derived from Limestones (TLs) is mapped towards the centre of the proposed project site along the N62.

Gravels and eskers are mainly mapped along the grid connection route to the west of the project site. Esker ridges are mapped to coincide with the Gravel deposits at two locations along the proposed route. Area of Fen Peat are mapped in low-lying areas between the Esker ridges.

The proposed 110kV substation, BESS and control building location (grassland) are located where there is a mapped transition from peat (Cut) into Gravels. The subsoil type at the replanting lands is sandstone/shale tills.

3.4 Hydrological Environment

On a regional scale, the proposed project site is located within Hydrometric Area 25 (Lower Shannon Catchment) and mainly situated inside the Shannon[lower]_SC_040 sub-catchment (i.e. Rapemills River). The grid connection route extends into the Shannon[lower]_SC_060 (Little Brosna River) sub-catchment.

On a local scale, the Rapemills River (Rapemills_010) rises approximately 8km to the east of the project site and then flows in westerly direction through the project site itself. The Rapemills River then flows into the River Shannon approximately 10.5km downstream of the project site.

Approximately 2.7km of the grid connection is located in the Rapemills River catchment while the other 2.9km is located in the Little Brosna River catchment. The Little Brosna River flows approximately 1km to the southwest of the existing Dallow substation, at Clondallow, before joining the River Shannon a further 12km downstream.

The proposed haul route alteration works at the N52/N62 junction are also located in the Shannon sub-catchment.

4.0 General Spoil & Peat Management Proposals

The following are a suite of general measures which will be adhered to in the management of excavated material:-

- All excavated peat and spoil will be either temporarily stockpiled locally at turbine hardstands, or transported immediately on excavation to the spoil deposition area(s);
- Excavated material will be re-used on-site for reinstatement and landscaping insofar as possible (Some of the peat, in particular the acrotelm, i.e. the upper layer of the peat, excavated during construction will be used for landscaping purposes);
- Excavated rock, should any arise, shall be utilised in the construction of access tracks and crane hardstandings;
- Excavated sub-soil shall be prioritised for the reinstatement of infrastructure (e.g. turbine foundations);
- Excavated topsoil shall be prioritised for final landscaping measures (e.g. ground profiling/grading, finishing of berms, etc.);
- Road cuttings, or other unsuitable material, shall not be used for reinstatement and shall be removed from site and disposed of at an approved waste management facility;
- Where excavated material is to be re-used (for reinstatement or landscaping), it shall be side-cast and stored temporarily in an appropriate manner. Where excess material arises which will not be re-used at the excavation location, it

shall be used in the construction of berms or transported to the spoil deposition areas for permanent storage;
- Temporary storage locations shall be appropriately sited to avoid any smothering of important habitats or risk of sediment discharge to watercourses;
- Temporary storage locations will be carefully selected to avoid any ground instability risks;
- The temporary storage locations will be regularly inspected by the EM;
- Where an open ditch is present alongside an existing/proposed floating access track, the ditch shall be filled prior to upgrading/constructing the access track. The ditch shall be filled with suitable drainage stone. As applicable, a perforated pipe shall be laid into a ditch to filling so as to maintain water flow within the ditch;
- No excavations (e.g. drainage, peat cuttings) shall be carried out within 5m distance of a completed floating access track edge, or at a distance determined following inspection. The presence of excavations can destabilise the access track. Temporary excavations shall be excavated in short lengths and backfilled as soon as practicable;
- No stockpiling of materials shall take place on or adjacent to floating access tracks so as to avoid bearing failure of the underlying peat;
- End-tipping of stone onto proposed access tracks during the construction/upgrading of the track shall be carefully monitored to ensure that excessive impact loading, which may adversely affect the underlying peat, is limited;
- Due to the nature of floating access track construction it will be necessary to monitor the settlement/movement of the access track. Survey points will be located along the track at 10m intervals in areas of deep peat (greater than 2m). See further measures included at **Section 8.0** below;
- All excavated peat, not being used for backfill, shall be transported immediately on excavation to one of the designated spoil deposition areas (each spoil deposition area will have a depth of no more than 310mm); and
- Reinstatement/landscaping works will commence as soon as practicable following the completion of individual work streams thus allowing for the timely management of material and early commencement of re-vegetation thus reducing the likelihood of soil erosion or release of silt/sediment.

5.0 Estimated Excavation Quantities

On the basis of site investigations undertaken at the project site and the completion of the preliminary project (civil/electrical) design process; estimated volumes of material likely to be excavated during construction have been identified. The project will, should planning permission be granted, be subject to a further detailed design process where the volume of material to be excavated will be further refined. Accordingly, it is important to highlight that the volumes set out below are estimates based on the design process completed to date, the findings of the site investigations, and past experience of similar wind energy developments.

5.1 Site Entrances, Access Tracks. Turbine Foundations & Crane Hardstandings

Project Item	Total Excavated Material (m³)	Peat for Spoil Deposition Areas (m³)	Peat for use in Reinstatement/ Landscaping (m³)	Topsoil & Subsoil for Spoil Deposition Areas (m³)	Topsoil & Subsoil for use in Reinstatement/ Landscaping (m³)	Tar
T1 (Access, hardstand, and foundation)	12,299	7,767	3,475	424	633	n/a
T2 (Access, hardstand, and foundation)	12,019	7,417	3,475	494	633	n/a
T3 (Access, hardstand, and foundation)	13,696	9,559	3,475	71	591	n/a
T4 (Access, hardstand, and foundation)	13,137	8,859	3,475	212	591	n/a
T5 (Access, hardstand, and foundation)	10,622	5,780	3,475	847	520	n/a
T6 (Access, hardstand, and foundation)	12,019	7,459	3,475	494	591	n/a
T7 (Access, hardstand, and foundation)	8,769	2,682	3,475	2,047	565	n/a
T8 (Access, hardstand, and foundation)	8,628	2,682	3,475	1,906	565	n/a
Wind Farm Access Track, including site entrances	2,293	0	0	0	2,293	n/a
Compounds	900	0	0	700	200	n/a
Wind Farm Control Room	160	0	0	160	0	n/a
Met Mast	60	30	0	30	0	n/a
Drainage	8,700	8,700	0	0	0	n/a
Underground Cables	8,678	4,339	0	0	4,339	n/a

Table 1: Estimated Spoil Volumes at Wind Farm Site

5.2 Electrical Substation & Grid Connection

Project Item	Total Excavated Material (m^3)	Peat for Spoil Deposition Areas (m^3)	Peat for use in Reinstatement/ Landscaping (m^3)	Topsoil & Subsoil for Spoil Deposition Areas (m^3)	Topsoil & Subsoil for use in Reinstatement/ Landscaping (m^3)	Tar
Substation Compound	6,708	0	0	4,238	2,471	0
Grid Connection	9,528	0	0	8,835	146	547

Table 2: Estimated Spoil Volumes at Electrical Substation & Grid Connection Route

5.3 Haul Route Upgrade Works

Project Item	Total Excavated Material (m^3)	Peat for Spoil Deposition Areas (m^3)	Peat for use in Reinstatement/ Landscaping (m^3)	Topsoil & Subsoil for Spoil Deposition Areas (m^3)	Topsoil & Subsoil for use in Reinstatement/ Landscaping (m^3)	Tar
Upgrade Works	1,599	0	0	0	1,593	6

Table 3: Estimated Spoil Volumes at Haul Route Upgrade Locations

6.0 Use of Excavated Material

As outlined above, there are a number of possible uses for excavated material which has no further purpose in the construction process. In accordance with the aims of this SPMP, all usable excavated material will be utilised, in the first instance, for site reinstatement and landscaping purposes.

6.1 Reinstatement of Infrastructure

Excavated subsoil and topsoil will, in the first instance, be utilised for the reinstatement of infrastructure including access track edges, crane hardstanding edges, and to provide turbine foundation ballast. Excavated peat from turbine foundation excavations will also be utilised for backfill at turbine foundation locations, where possible. Once again, this will ensure that material is, insofar as is practicable, reinstated at or close to its source location. For site reinstatement works and following the placement of subsoil, a layer of topsoil will be spread across the affected area, graded to match the surrounding ground profile, and re-seeded.

6.2 Landscaping & Permanent Storage

Where subsoil and topsoil is not to be used for reinstatement at its source location, a number of permanent storage options are available, as follows:-

- The creation of track-side and hardstanding-side berms. Berms, constructed predominately of subsoil and topped with topsoil, with an approximate height of 1m could be constructed to permanently store material at appropriate access track and hardstand locations (noting, in line with the general measures included at **Section 4.0**, above, no stockpiling of materials shall take place on or adjacent to floating access tracks). The creation of berms, at appropriate locations, aids in the visual assimilation of infrastructure into the landscape and can assist in screening access tracks and hardstandings from view; and

- Permanent storage of material in the spoil deposition areas. While it is estimated that the above reinstatement and landscaping processes will account for substantial volumes of surplus excavated materials; 3 no. dedicated spoil deposition areas will be developed where excess material which cannot be utilised for reinstatement or is unsuitable for landscaping purposes, e.g. peat and peaty topsoil, will, if such a scenario arises, be stored permanently. The location of the deposition areas has been chosen as they each comprise localised flat/level ground, include a general absence of any particular environmental constraints. The 3 no. spoil deposition areas include one main deposition area, located to the north of proposed turbines T1 and T3, and 2 no. smaller deposition areas located at the base of proposed turbines T5 and T6. Spoil and Peat will be transported to these locations where it will be placed in a thin layer (approximately 310mm in depth) in accordance with best-practice methods. Appropriate drainage management measures will be implemented to ensure that the deposited material does not become waterlogged. Following completion, the deposition areas will be graded to match the surrounding ground profile. Works at the deposition areas will be monitored, on a weekly basis during the construction phase and monthly for a six-month period thereafter, by an appropriately qualified geotechnical engineer.

The layout of the deposition areas, including drainage arrangements, is illustrated at **Annex 2** of the Surface Water Management Plan.

6.3 Permanent Storage of Peat

As set out above, three locations have been identified as designated spoil deposition areas. The larger of the three area is located on the western side of the project site, with the two smaller areas located on the eastern side of the project site. Each area shall have a perimeter buttress which will contain and ensure the placed peat and spoil remains stable. Prior to the placement of any excavated peat and spoil, the permanent buttresses shall be constructed around the perimeter of the deposition area.

The following recommendations/best practice guidelines for the placement of peat within the deposition areas will be considered and taken into account during construction.

- The placement of excavated peat and spoil is to be avoided without first establishing the adequacy of the ground to support the load;
- The height of the buttresses constructed will be greater than the height of the stored peat and spoil to prevent any surface run-off or saturated peat to flow out (see **Annex 1**);
- An interceptor drain will also be installed upslope of the deposition areas. The drain will divert any surface water away from the deposition area and hence prevent water from ponding in the area;
- Where practical, it should be ensured that the surface of the placed peat and spoil is shaped to allow efficient run-off of surface water. Where possible, shaping of the surface of the peat and spoil should be carried out as placement of peat and spoil within the placement area progresses. This will reduce the likelihood of debris run-off and ensure stability of the placed peat and spoil;
- Where possible, the acrotelm shall be placed with the vegetation part of the sod facing the right way up to encourage growth of vegetation at the surface of the placed peat and spoil within the deposition areas;

- Movement monitoring instrumentation may be required adjacent to the access track where peat has been placed. The locations where monitoring is required will be identified by the designer on site;
- Supervision by a geotechnical engineer or appropriately competent person is recommended for the works; and,
- All the above mentioned general guidelines and requirements should be confirmed by the designer prior to construction.

6.4 Disposal Off-Site

Any spoil generated which is unsuitable for reinstatement or landscaping purposes or for storage within berms or the deposition area (e.g. tarmac cuttings from the grid connection installation) shall be removed from site and disposed of at a licensed waste disposal facility.

7.0 General Recommendations for Good Construction Practice

To minimise the risk of construction activity causing potential peat instability it is recommended that the Construction Method Statements (CMS) for the project will also take into account, but not be limited, to the general recommendations below together with the specific recommendations above:-

- Avoidance of uncontrolled concentrated water discharge onto peat slopes identified as being unsuitable for such discharge. All water discharged from excavations during work shall be piped over areas specifically assessed as being unsuitable and hence directly into suitable drainage lines;
- Avoidance of unstable excavations. All excavations shall be suitably supported to prevent collapse and development of tension cracks;
- Installation and regular monitoring of geotechnical instrumentation, as appropriate, during construction in areas of possible poor ground, such as deeper peat deposits;
- Site reporting procedures to ensure that working practices are suitable for the encountered ground conditions. Ground conditions to be assessed by suitably experienced geotechnical engineer;
- Regular briefing of all site staff (e.g. toolbox talks) to provide feedback on construction and ground performance and to promote reporting of any observed change in ground conditions; and,
- Routine inspection of wind farm site by Contractor to include an assessment of ground stability conditions (e.g. cracking, excessive floating access track settlement, disrupted surface, closed-up drains) and drainage conditions (e.g. blocked drains, absence of water in previously flowing drains, springs, etc).

8.0 Instrumentation

To monitor possible peat movements, it is proposed to install sighting posts upslope and downslope of the access track at staggered intervals at locations where the peat depth is greater than 2m. Additional monitoring locations may be required at infrastructure locations with deeper peat deposits. Details of sighting posts are given below:-

- A line of sighting posts shall comprise:-
  (a) line of wooden stakes (typically 1 to 1.5m long) placed vertically into the peat to form a straight line;
  (b) The sighting line shall comprise 6 no. posts at 5m centres that is a line some 25m long; and,

(c) A string line shall be attached to the first and last posts and all intervening posts shall be adjusted so they are just touching the string line;

- Lines of sighting posts shall be placed across the existing slope about 5m away from the area to be worked. It is recommended that the posts are located along the track at 10m intervals in areas of deep peat (say greater than 2m). Where there are relatively steeper slopes or softer ground a sighting line shall be placed down the slope, or at any location where monitoring would be deemed useful;
- Each line of sighting posts shall be uniquely referenced with each post in the line given a reference. The post reference shall be marked on each post (e.g. reference 1-1, 1-2, 1-3, 1-4, 1-5, 1-6 for posts in line 1);
- The sighting lines shall be monitored at the beginning of each working day, and during the day where considered appropriate (e.g. when working activity is concentrated at a specific location);
- Monitoring of the posts shall comprise sighting along the line and recording any relative movement of posts from the string line;
- Where increased movements are recorded the frequency of monitoring shall be increased; and,
- A monitoring record shall be kept of the date, time and relative movement of each post, if any. This record shall be updated and stored as a spreadsheet.

9.0 Contingency Measures

9.1 Excessive Movement

Where there is excessive movement or continuing peat movement recorded at a monitoring location or identified at any location within the site but no apparent signs of distress to the peat (e.g. cracking, surface rippling) then the following shall be carried out:-

- All activities (if any) shall cease within the affected area;
- Increased monitoring at the location shall be carried out. The area will be monitored, as appropriate, until such time as movements have ceased; and,
- Re-commencement of activities shall only start following a cessation of movement and agreement with all parties.

9.2 Onset of Peat Slide

In the unlikely event where there is the onset or actual detachment of peat (e.g. cracking, surface rippling) then the following shall be carried out:-

- On alert of a peat slide incident, all activities (if any) in the area should cease and all available resources will be diverted to assist in the required mitigation procedures;
- Action will be taken to prevent a peat slide reaching any watercourse. This will take the form of the construction of check barrages on land. Due to the terrain and the inability to predict locations it may not be possible to implement any on-land prevention measures, in this case a watercourse check barrage will be implemented;
- All relevant authorities should be notified if a peat slide event occurs on site; and,
- For localised peat slides that do not represent a risk to a watercourse and have essentially come to rest the area will be stabilised initially by rock infill, if required. The failed area and surrounding area will then be assessed by the engineering staff and stabilisation procedures implemented. The area will be monitored, as appropriate, until such time as movements have ceased.

9.3 Check Barrages

Whilst it is not anticipated from the analysis undertaken that a peat slide will occur on site, as a contingency a check barrage procedure is included below.

The check barrage procedure deals with preventing a peat slide from moving downstream within a watercourse. The most effective method of preventing excessive peat slide debris from travelling downstream in a watercourse is the use of a check barrage. A check barrage comprises the placement of rock fill across a watercourse. The check barrage is a highly permeable construction that will allow the passage of water but will prevent peat debris from passing through. Rock fill should comprise well-graded coarse rock pieces from about 300mm up to typically 1000mm.

The size of the barrage will vary depending on the scale of the peat debris to be contained and the geometry of the watercourse at the barrage location. In general, due to the low speed of a peat slide there is generally little impact force and most of the lateral load is due to fluid pressure on the upslope face of the barrage. Typically, the check barrage should fill the entire channel width of the watercourse up to a height of 3 to 4m with a crest width of typically 2m and side slopes of about 45 degrees depending on the geometry of the barrage location.

The check barrage procedure is as follows:-

- Access to the check barrage location shall be along the existing access tracks on the wind farm site and/or along public roads, where possible. When it is necessary to form the barrage then rock fill will be placed across the watercourse to effectively block the passage of peat debris;
- Operatives employed to carry out the construction of the check barrage would need to be inducted by means of a briefing by on-site supervisors as to the proposed location of the check barrage;
- The check barrage provides containment for peat debris in the highly unlikely event of a major peat slide. Further remedial measures, should they be required, will be assessed by the Contractor and the Project Geotechnical Engineer and carried out as soon as physically possible when the location and extent of the failure is established; and,
- Where a barrage was constructed as a precaution and no peat debris reached the watercourse then the barrage should be removed as soon as any measures to prevent further peat sliding is agreed with all parties.

10.0 Conclusion

This SPMP has been prepared to detail the appropriate management of material excavated during the construction of the Cush Wind Farm. Overall, it is assessed that there is sufficient capacity within the project to accommodate all excavated material, through re-use and reinstatement, in the first instance, and deposition, where required, such that no significant volume of material will be transported off-site. Excavated material will be utilised in the reinstatement of infrastructure, landscaping, and permanent storage within the spoil deposition areas.

The range of good practice construction measures, including measures relative to working with peat, will be implemented in full. The peat management measures contained within this SPMP include some drainage guidelines for construction works and for management of peat on site. It should be noted that the control of water quality and drainage measures for site is outlined in detail in the relevant chapter of Environmental Impact Assessment Report (EIAR).

This is a live document and will be updated by the appointed contractor prior to the commencement of development. Prior to the commencement of construction, the updated SPMP will be reviewed by the EM to confirm the appropriateness of the measures set out therein.

Annex 1 –
Spoil Deposition Area Buttress & Drainage Detail

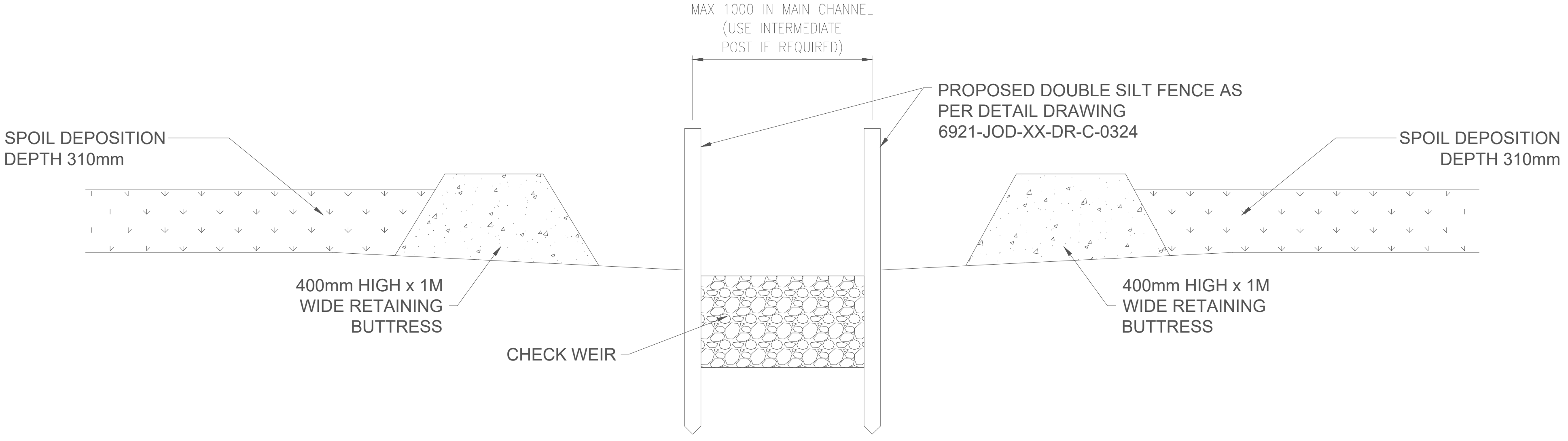

FIGURE 1
SECTION A - A SILT FENCE AT DRAINAGE CHANNEL
SCALE 1:30

Prepared by:

GALETECH ENERGY SERVICES

Legend:

Date:	Rev:	Description:	Drawn By:

Agent Address:

Galetech Energy Services,
Clondargan,
Stradone,
Co. Cavan

Job Title:

Cush Wind Farm

Client:

Cush Wind Ltd

Drawing Title:

Spoil Deposition Area Buttress & Drainage Detail

Drawing No.:	Revision No.:	
CUS_PAS_EIAR_018	0	
Scale: (A3) 1:30	Date: 05/12/2022	
Drawn By: C.M.P	Checked By: D.O	Confirmed By: S.C

Annex 4 –
Surface Water Management Plan

Cush Wind Farm

Planning-Stage Construction & Environmental Management Plan

Surface Water Management Plan

Cush Wind Limited

Galetech Energy Services

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1.0 Introduction

Galetech Energy Services (GES), on behalf of Cush Wind Limited, has prepared this Surface Water Management Plan (SWMP) for the construction and operational phases of the Cush Wind Farm.

1.1 Purpose of this Report

This SWMP provides the framework for water management at the site of the Cush Wind Farm for contractors and incorporates the measures set out in the various environmental assessment documents associated with the development. The purpose of this report is to detail the practical implementation of these measures such that the construction and operational phases do not have an adverse effect on water quality.

This is a live document and will be updated by the appointed contractor prior to the commencement of development. Prior to the commencement of construction, the updated SWMP will be reviewed by the Environmental Manager (EM) and Ecological Clerk of Works (EcoW), as necessary, to confirm the appropriateness of the measures set out therein.

This SWMP aims to:-

- Describe environmental sensitives of the site and any applicable buffer zones;
- Describe how the system will operate to minimise modification and disruption to the existing site hydrology;
- Outline the proposed maintenance regime; and
- Outline the proposed drainage management post-construction.

1.2 Reference Documents

The production of this SWMP has been supported by best practice manuals and will be accounted for in the further development of the appointed contractor's detailed CEMP.

Other documents have been used to develop this SWMP; including a Planning-Stage Construction & Environmental Management Plan, Spoil Management Plan, and Environmental & Emergency Response Plan.

1.2.1 Legislative Background

This report has been prepared in accordance with the following legislation:-

- S.I. 10 of 1972 Dangerous Substances Act, 1972, as amended;
- S.I. No. 293 of 1988 Quality of Salmon Water Regulations;
- S.I. No. 249 of 1989 Quality of Surface Water Intended for Abstraction (Drinking Water);
- S.I. No. 94 of 1997 European Communities (Natural Habitats) Regulations;
- S.I. No. 41 of 1999 Protection of Groundwater Regulations;
- Water Framework Directive (2000/60/EC);
- S. I. No. 600 of 2001 Planning and Development Regulations 2001, as amended;
- S.I. No. 722 of 2003 European Communities (Water Policy) Regulations;
- S.I. 547 of 2008 European Communities (Environmental Liability) Regulations;
- S.I. No. 272 of 2009 European Communities Environmental Objectives (Surface Waters) Regulations;
- S.I. No. 9 of 2010 European Communities Environmental Objectives (Groundwater) Regulations 2010; and
- S.I. No. 350 of 2014 European Union (Water Policy) Regulations 2014.

1.2.2 Construction Industry Research & Information Association (CIRIA) Manuals

- CIRIA (Construction Industry Research & Information Association) Report C502 Environmental Good Practice on Site;
- CIRIA 521 - Sustainable Urban Drainage Systems; Design Manual for Scotland and Northern Ireland;
- CIRIA Report C532 Control of Water Pollution from Construction Sites;
- CIRIA Report C648 Control of Pollution from Linear Construction Project Technical Guidance;
- CIRIA Handbook C650 Environmental good practice on site;
- CIRIA Handbook C651 Environmental good practice on site checklist;
- CIRIA Report C609 - SuDS - hydraulic, structural & water quality advice;
- CIRIA Report C697 - The SuDS Manual; and
- Guidelines on Protection of Fisheries during Construction Work in and Adjacent to Water (Inland Fisheries Ireland, January 2016).

2.0 Description of the Project

Cush Wind Limited intend to construct the Cush Wind Farm which will consist of:-

- 8 no. wind turbines with an overall tip height of 200m, and all associated ancillary infrastructure;
- All associated and ancillary site development, excavation, construction, landscaping and reinstatement works, including provision of site drainage infrastructure and forestry felling.
- Temporary alterations to the turbine component haul route; and,
- Construction of an electricity substation, Battery Electricity Storage System and installation of 5.6km of underground grid connection to facilitate connection of the proposed electricity substation to the existing 110kV substation at Clondallow, County Offaly;

The project site is located in rural Co. Offaly, approximately 4km north of the town of Birr and c. 28km south-west of Tullamore, County Offaly. Off-site and secondary developments; including the forestry replant lands and candidate quarries which may supply construction materials; also form part of the project.

The turbine component haul route, and associated temporary alteration works, are located within counties Galway, Roscommon, Westmeath, and Offaly. It is envisaged that the turbines will be transported from the Port of Galway, through the counties of Galway, Roscommon, Westmeath and Offaly, to the project site.

As well as the reference documents listed in **Section 1.2**, various environmental reports have been prepared for the development including:-

- Environmental Impact Assessment Report (Galetech Energy Services);
- Biodiversity Chapter (SLR Consulting);
- Land & Soil Chapter (Hydro Environmental Services);
- Water Chapter (Hydro Environmental Services); and
- Natura Impact Statement (SLR Consulting).

3.0 Description of Baseline Environment

3.1 Site Location

The proposed development site is located in rural Co. Offaly, approximately 4km north of the town of Birr and c. 28km south-west of Tullamore, Co. Offaly. The wind farm will be located in the townlands of Cush, Galros West, Boolinarig Big, and Eglish Co. Offaly.

The proposed temporary haul route alteration works to the N52/562 junction at Kennedy's cross are located in the townland of Ballindown, Co. Offaly.

Current land use within the project site is made up predominantly of peat bogs, agricultural pasture/grassland, and forestry , including commercial and woodland planting (of various species) and scrub . Areas to the north and northwest of the project site comprise cutover private bog; areas to the east and west of the N62 exhibit commercial and woodland forestry plantation; and areas to the south and southeast are predominantly agricultural pasture. The wider landscape is characterised by large tracts of industrial cutaway peatlands and agricultural scrub; however, improved agricultural pasture is dominant in areas bordering the east and west of the project site.

The local area is typical of this part of Ireland, with settlement patterns largely comprising dispersed rural dwellings often accompanied by agricultural holdings and buildings.

3.2 Topography

The proposed development site and surrounding topography are typical of the Midlands Region and comprise a generally flat landscape with occasional gentle undulations.

The proposed project site is low lying with topography being slightly undulating to flat and with ground elevations ranging between 47 and 63m OD (Ordnance Datum). The overall slope is to the west.

The most elevated section of the proposed project site is found along the eastern fringes where agricultural grassland rises up to 63m OD (met mast location). The ground slopes in a general westerly direction from this eastern section to the lowest point on the far west of the project site which follows the valley of the Rapemills River.

The underground grid connection (5.6km) follows public roads for 4.7km with an off-road section through private lands for 0.65km. Approximately 200m of the route is in the project site itself. The off-road section of the grid connection is through rough grassland. The existing ESB owned Clondallow 110kV substation is located 1.7km to the southwest of the proposed project site. The ground elevation along the grid connection ranges from approximately 35m OD to 65m OD.

The forestry re-plant lands are almost exclusively agricultural pasture, with fields bounded by hedgerows and treelines. Ground elevations across the re-plant lands range generally between 100m OD and 140m OD.

3.3 Hydrological Environment

On a regional scale, the proposed project site is located within Hydrometric Area 25 (Lower Shannon Catchment) and mainly situated inside the Shannon[lower]_SC_040 sub-catchment (i.e. Rapemills River). The grid connection route extends into the Shannon[lower]_SC_060 (Little Brosna River) sub-catchment.

On a local scale, the Rapemills River (Rapemills_010) rises approximately 8km to the east of the project site and then flows in westerly direction through the project site itself. The Rapemills River then flows into the River Shannon approximately 10.5km downstream of the project site.

Approximately 2.7km of the grid connection is located in the Rapemills River catchment while the other 2.9km is located in the Little Brosna River catchment. The Little Brosna River flows approximately 1km to the southwest of the existing Dallow substation, at Clondallow, before joining the River Shannon a further 12km downstream.

The proposed haul route upgrade works at the N52/N62 junction are also located in the Shannon sub-catchment.

3.4 Geological Environment

Based on the GSI/Teagasc soils mapping (www.gsi.ie) the project site is overlain by cutover bog with some basic shallow well-drained mineral soils (BminSW) located in the southeast of the project site at 2 no. proposed turbine locations (T7 and T8).

A small area of basic poorly drained mineral soil (BminPD) is mapped towards the centre of the project site along the N62. The grid connection route from the proposed project site pass through areas mapped predominantly as Cut Peat and BminSW. The mapped soil type at the N62/52 junction works along the haul route is Cut Peat.

GSI subsoils mapping (www.gsi.ie) show that the proposed project site is underlain predominantly by cutover peat (Cut) with Gravels derived from Limestones (GLs) mapped on the southeast and southwest of the project site and also underlying turbine locations T7 and T8. A small pocket of Till derived from Limestones (TLs) is mapped towards the centre of the proposed project site along the N62.

Gravels and eskers are mainly mapped along the grid connection route to the west of the project site. Esker ridges are mapped to coincide with the Gravel deposits at two locations along the proposed route. Area of Fen Peat are mapped in low-lying areas between the Esker ridges.

The proposed 110kV substation, BESS and control building location (grassland) are located where there is a mapped transition from peat (Cut) into Gravels. The subsoil type at the replanting lands is sandstone/shale tills.

3.5 Flood Risk Assessment

OPW's River Flood Extents Mapping, National Indicative Fluvial Mapping, Past Flood Event mapping (https://www.floodinfo.ie/map/floodmaps/) and historical mapping (i.e. 6" & 25" base maps) were consulted to identify those areas of the project site which are at risk of fluvial flooding.

Datasets prepared by the OPW identifying land that might benefit from the implementation of Arterial (Major) Drainage Schemes (under the Arterial Drainage Act 1945) indicate areas of the project site are prone to flooding or poor drainage.

No recurring flood incidents within the proposed project site boundary or along the grid connection were identified from OPW's Past Flood Event Mapping. OPW's Past Flood Event Mapping.

The closest mapped recurring flooding event to the overall proposed project is on the Little Brosna approximately 5km downstream of the proposed grid connection.

The closest mapped recurring flooding event to the proposed project site itself is on the Lower Shannon approximately 10.5km downstream of the project site.

There is no text on local available historical 6" or 25" mapping for the proposed project site or grid connection that identify areas that are "prone to flooding".

OPW's River Flood Extents Mapping is currently the most accurate available flood mapping for the country, however this is currently not available for the area of the proposed project site.

OPW National Indicative Fluvial Mapping is available for the area of the proposed project site which shows the estimated 100-year and 1000-year flood zones. The National Indicative Fluvial Mapping is not as accurate as the Flood Extents Mapping and is also not intended to replace site specific flood risk assessments (discussed below).

According to the National Indicative Fluvial Mapping, 1 no. turbine (T2) is located in a 100-year flood zone along with approximately 350m of its proposed connecting spur road from the south. The southern section of the main construction compound (SC1) is also in a mapped 100-year flood zone.

In addition, approximately 370m of the proposed access road between turbines T2 and T4 is also in a mapped 100-year flood zone along with approximately 120m of the proposed access road leading to turbine T1.

All other proposed project infrastructure is mapped above the mapped 1000-year flood level and therefore all infrastructure is located in Flood Zone C (Low Risk).

It is a key design feature of the project to ensure that all surface water runoff is treated (water quality control) and attenuated (water quantity control) prior to diffuse discharge at pre-existing greenfield rates. As such, the mechanism by which downstream flooding, as a result of the project, is prevented and controlled is through avoidance by design.

A Stage 3 Site Specific Flood Risk Assessment (FRA) including flood modelling was completed by HES for the proposed project site in July 2021(refer to **Annex 7.1** of the EIAR). This was done at the time to assess the accuracy of the Preliminary Flood Risk Assessment (PFRA) mapping which was the only available published flood mapping for the area at the time.

The PFRA mapping, which is no longer used, was a national screening exercise, based on preliminary analysis, to identify areas where there may be a significant risk associated with flooding. The mapping was not site specific and had inherited inaccuracies.

Please note that the Site Specific Flood Risk Assessment also overrides the National Indicative Fluvial Mapping in terms of its flood zone mapping accuracy at the project site.

The Stage 3 Site Specific Flood Risk Assessment involved detailed site topographic surveys, use of Lidar data and flood flow modelling of the Rapemills River and floodplain.

Site specific modelled 100-year and 1000-year flood zones were prepared for the project site. A 20% increase in flows is allowed for climate change.

The site specific flood zone modelling shows that proposed turbine location T2 is just outside the 100-year and 1000-year flood zones. Two sections of access road at watercourse crossing locations between turbine locations T2 and T4 (which amounts to approximately 100m of access road) are located within the 100-year and 1000-year flood zone.

Therefore, with the exception of the 100m of this proposed access road, the project site and grid connection are located in Flood Zone C (Low Risk).

Refer to **Annex 7.1** of the EIAR for Stage 3 Site Specific Flood Risk Assessment report.

3.6 Nature Conservation Sites

Within the Republic of Ireland, designated sites include Natural Heritage Areas (NHAs), proposed Natural Heritage Areas (pNHAs), candidate Special Areas of Conservation (cSAC), Special Areas of Conservation (SAC) and Special Protection Areas (SPAs).

The project is not located within any designated conservation site.

Designated sites in close proximity to the proposed project site and grid connection include Woodville Woods pNHA (Site Code: 000927), Ross and Glens Eskers pNHA and Ridge Road, SW of Rapemills SAC/pNHA (Site Code: 000919). The junction works at the N52/N62 drains into Woodville Woods pNHA.

The proposed grid connection runs adjacent to Ross and Glens Eskers pNHA.

The abovementioned close proximity designated sites are not water dependant.

The closest SPA to the site is Dovegrove Callows SPA (Site Code: 004137) is adjacent to part of the grid connection on the public road to the south of Dallow substation.

The project site drains to the northwest via the Rapemills River, which passes the All Saints Bog and Esker SAC and pNHA (Site Code: 000566) and the All Saints Bog SPA (Site Code:004103) approximately 3.5km from the project site.

However, there is no surface water connection between the project site and All Saints Bog and Esker SAC as All Saints Bog discharges into Rapemills River and not vice versa.

Groundwater flow in the area of the project site is likely to be westerly towards All Saints Bog and Esker SAC. However, groundwater flow below All Saints Bog will be limited to the deeper glacial deposits which are separated from the overlying bog by very low permeability marl and lacustrine clay deposits which underlies the basin peat in this area.

The Rapemills River ultimately drains into the River Shannon and flows through the River Shannon Calllows SAC (Site Code: 00216) and the Middle Shannon Callows SPA (Site Code:004096), which lie approximately 6.8km northwest of the project site.

4.0 Drainage System

4.1 Sustainable Drainage System

Surface water is a valuable resource and this should be reflected in the way it is managed. The appropriate management of surface water should be considered at the early stages of the project design process. It is important, particularly on large developments such as the Cush Wind Farm, that the management of surface water is managed in a fashion will prevents significant alterations to the existing hydrological regime whilst ensuring the appropriate drainage of the proposed site.

The project has been designed to implement a Sustainable Drainage System (SuDS) which seeks to:-

- Minimise any change to the surface water and groundwater conditions within the site;
- Avoid sensitive areas where possible by employing hydrological constraints (i.e. buffer zones);
- Replicate the natural drainage of the site;

- Minimise sediment loads in the runoff, with particular attention being given to the construction phase of the project;
- Maintain runoff rates and volumes at Greenfield rates for a range of storm events (to be incorporated into final detailed design); and,
- Avoid high flow velocities internally within new drain networks and at outfall locations to prevent erosion.

The purpose of a SuDS is:-

- To provide sufficient detail to ensure that water pollution will not occur as a result of construction and operational activities at the site and to minimise the risk of any such occurrence;
- To regulate the rate of surface water run-off downslope to prevent scouring and to encourage settlement of sediment locally; and
- To minimise the quantity of sediment laden stormwater and resulting settlement pond sizes by separating 'clean' water from the 'dirty' development runoff.

4.1.1 SuDS Design

The overarching objective of the SuDS design is to ensure that all surface water runoff is comprehensively attenuated such that no silt or sediment laden waters or deleterious material is discharged into the local drainage system. While the SuDS is, overall, an amalgamation of a suite of drainage infrastructure; the objectives are straightforward. In summary:-

- All surface water runoff will be directed to specially constructed swales surrounding all areas of ground proposed to be disturbed;
- The swales will direct runoff into silt traps/ponds where silt/sediment will be allowed to settle; and
- Following the settlement of silt/sediment, clean water will be discharged indirectly to the local drainage network via buffered outfalls thus ensuring that no scouring/erosion occurs.

The design criteria for the SuDS is as follows:-

- To minimise alterations to the ambient site hydrology and hydrogeology;
- To provide settlement and treatment controls as close to the site footprint as possible and to replicate, where possible, the existing hydrological environment of the site;
- To minimise sediment loads resulting from the development runoff during the construction phase;
- To preserve greenfield runoff rates and volumes;
- To strictly control all surface water runoff such that no silt or other pollutants shall enter watercourses and that no artificially elevated levels of downstream siltation or no plumes of silt arise when substratum is disturbed;
- To provide appropriate retention times such that and no flooding will occur on local roads in the vicinity of the project site which may cause a traffic hazard;
- To provide settlement ponds to encourage sedimentation and storm water runoff settlement;
- To provide lagoon-type sediment traps which follow a design outlined by Altmuller and Dettmer (2006). The tertiary treatment system of the lagoon maturation ponds will absorb the fine particles, which may not settle in the primary and secondary settlement ponds. These ponds are to be vegetated so

as to perform the role of plant filtration best described on Page 7 of the Altmuller and Dettmer document[1] (see **Annex 1**);

- To reduce stormwater runoff velocities throughout the site to prevent scouring and encourage settlement of sediment locally;
- To manage erosion and allow for the effective revegetation of bare surfaces;
- To control water within the site and allow for the discharge of runoff from the site within the limits prescribed in the Freshwater Pearl Mussel and Salmonid Regulations;
- To ensure that oils, fuels and other contaminants are stored appropriately and bunded to prevent any discharge of such materials. The temporary construction compound, where such oils and fuels will be stored, shall incorporate an oil/petrol interceptor within its drainage system. Similarly, an oil/petrol interceptor shall be installed at the proposed electrical substation;
- Additional drainage measures will only be added as necessary. The dimensions of these features will avoid intercepting large volumes of water;
- Storm water runoff from hardstandings and access tracks will be managed via filter drains consisting of open land drains, swales and settlement ponds/lagoon-type sediment traps. Access tracks and hardstandings will crossfall downslope to mimic the natural drainage patterns of the site.
- Swale/settlement pond vegetation used will be appropriate to the local area;
- Temporary erosion protection together with silt fences may be required until the vegetation becomes established (coir matting or similar);
- Access tracks and hardstandings will be constructed from aggregate and will not be surfaced with bitumen materials, thus helping to reduce runoff volumes. Therefore a reduced runoff coefficient of 50% is applicable;
- An additional 20% will be included to take account for global warming;
- A large portion of the hardstanding construction will be of single sized stone therefore the pore spacing in the hardstanding and road will also act to store and attenuate water;
- Swales will be primarily used to attenuate water and to encourage discharge into the ground locally;
- Outflow points will be taken from the swales into the existing onsite drainage channels. Silt fences will be maintained at the interface between the proposed and existing drainage channels for the duration of the construction phase;
- Stormwater runoff within the swale will be treated through the provision of small silt fences or check dams, within a range depending on local slope of swale;
- The stone used for the construction of the check dams will be washed graded stone with a size range between approximately 5mm and 40mm;
- Swales will provide a flow route in extreme events to carry water to the existing surface water channels across site. It will be necessary to increase the cross sectional area of the swales further downstream of the footprint as larger volumes of stormwater are conveyed;
- Discharging directly back into the surrounding area will assist in maintaining the hydrological characteristics of the site;
- Vegetation will be reinstated on slopes as early as possible;
- Under track drainage will be provided with associated sumps and silt fences. The under track drainage will provide a means for flows to pass from a swale on the uphill side of the slope to the downhill side of the slope.

[1] Altmüller R. & Dettmer, R. (2006*) Successful species protection measures for the Freshwate 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*.

- A sump may be required to collect dewaterings from excavations for turbine foundations; water will subsequently be pumped into the settlement pond system and allowed to settle prior to discharging into the swales;
- All swales and ponds will be kept as shallow as possible so that they do not pose any health and safety risk to plant or personnel;
- Field drains/streams will be piped directly under the track through appropriately sized drainage pipes;
- The Office of Public Works (OPW) will be consulted on all stream crossings through the applications for Section 50 consent, prior to works commencing. The design of these crossings follow guidance from Inland Fisheries Ireland;
- Appropriate site management measures will be taken such that runoff from the construction site is not contaminated by fuel or lubricant spillages;
- There will be no discharge of sewage effluent or contaminated drainage into any watercourse system or ditch; and
- The drainage system will be monitored regularly during the construction phase for effectiveness, and cleaned or unblocked if necessary.

4.1.2 SuDS Design Philosophy

The SuDS design principles are as follows:-

Minimise	→	Intercept	→	Treat	→	Disperse	→	Dilute

Minimise

The main principle of this SuDS design is to minimise the volume of 'dirty' water requiring treatment through means of informed, integrated and sustainable drainage design. This is achieved by keeping 'clean' water clean by interception and separation, and by collecting the 'dirty' water and treating it by removing the suspended sediments. The resultant outflow is dispersed across vegetation and will become diluted through contact with the clean water runoff before entering the natural drainage system.

Intercept

The key silt/sediment control measure is the separation of construction runoff from the clean water runoff that arises in the undisturbed areas of the project site and surrounding lands. This significantly reduces the volume, and velocity, of dirty water that the control measures are required to manage. To achieve separation, clean water infiltration interception drains are positioned on the upslope and dirty water swales/drains positioned along the verge, with site surfaces sloped towards dirty water swales/drains. The remainder of this clean water will be regularly piped under both the access tracks and dirty water swales/drains to prevent contamination. This process allow for the mimicking the paths which clean water would have taken in the absence of the project.

Treat, Disperse, & Dilute

'Dirty water' swales/drains collect all incident rainwater that falls on the development infrastructure and drain into the silt traps/ponds. Following a period of attenuation, during which time all suspended solids will have 'fallen', the treated water is dispersed across vegetation (through buffered outfalls) to further filter the discharge. Dispersal in this manner has the effect of allowing the smaller particle sizes to be taken up by the vegetation.

4.2 Design Measures

This SuDS adopts a design for the drainage of the site. The following elements in series are proposed:-

- Areas of ground to be disturbed should be kept to the minimum required;
- Where forestry is to be felled, stumps should be left in the ground (apart from areas for access tracks, site drainage, hardstands and turbine foundations) so as to minimise ground disturbance;
- Open swales for development run-off collection and treatment;
- Infiltration Interception Drains for upslope 'clean' water collection and dispersion;
- Ditches which drain from the area to be felled towards existing surface watercourses will be blocked, and temporary silt traps will be constructed. No direct discharge of such ditches to watercourses will occur. Drains and sediment traps will be installed during ground preparation. Collector drains will be excavated at an acute angle to the contour (~0.3%-3% gradient), to minimise flow velocities. Main drains to take the discharge from collector drains will include water drops and rock armour, as required, where there are steep gradients, and should avoid being placed at right angles to the contour;
- Filtration Check Dams will be installed to reduce velocities along sections of road which run perpendicular to contours;
- Silt/settlement ponds and lagoon-type sediment traps will control and store development runoff to encourage settlement prior to discharge, at greenfield runoff rates, to eliminate any risk to Freshwater Pearl Mussel downstream of the project; and
- Disturbed Sediment Entrainment Mats (SEDIMATS) in all watercourses draining the site (including areas to be clear felled of commercial forestry), to provide further level of protection in relation to silt release.

These measures will provide a comprehensive surface water management train that will avoid any adverse effect on the hydrology of the site and downstream water quality during the construction phase of the project.

4.2.1 Infiltration Interceptor Drains

Drainage management will ensure that natural runoff is not permitted to mix with construction runoff from sources such as excavation dewatering or access track runoff. The SuDS design will ensure that infiltration interceptor drains are installed upslope of infrastructure, to intercept and divert clean surface water runoff, prior to it coming in contact with areas of excavation. The contractor will ensure that natural runoff infiltration interceptor drains are installed ahead of earthworks being undertaken.

The purpose of cut-off drainage is to collect clean run-off water on the upstream side of new infrastructure and transfer it such that it can discharge to the downstream side of infrastructure without having to interact with new infrastructure/excavations where it could potentially pick up fine particles.

This will reduce the flow of natural runoff onto any exposed areas of rock and soil, thereby reducing the volume of silt laden runoff capable of being generated at the project site. Natural runoff water, upslope of infrastructure, will be collected in infiltration interceptor drains and be directed away from the earthworks etc. In certain areas, runoff will be passed through sub-surface clean water culverts (e.g. below access tracks or hardstandings) and will be kept separate to drainage provided for track runoff. The clean water runoff will be discharged downstream of works location and returned to the natural drainage network.

Temporary silt/sediment prevention and erosion protection measures will be provided in all drainage installed in order to mitigate the possibility of erosion and transport of sediment from newly excavated channels which will be formed as part of the construction runoff drainage provisions. All drainage is to be dispersed over vegetated ground as a further filtration method.

The frequency of outflow points will be designed to avoid collection and interception of large catchments creating significant point flows.

4.2.2 Swales

Where swales are utilised, it is proposed that rock filled check dams will be installed at a regular frequency, in order to reduce flow velocities and improve conditions for the settlement of solids in transit. Check dams will be constructed from 5-40mm crushed rock locally won, and will constitute the majority of the check dams.

It is intended that these dams will be relatively simple to construct but will provide treatment of construction runoff at source. There will be outflow points from the swales to the existing drainage network to preserve the hydraulic efficiency of the site and to prevent ponding of water. No outflow will be permitted directly into natural watercourses.

4.2.3 Filtration Check Dams

The project includes areas where infrastructure and accompanying swales run directly downhill. In such situations, appropriate flow attenuation measures will be installed.

Access tracks will be constructed with an appropriate surface cross slope, so that all storm water flow will be directed towards the constructed grass swales located along track verges. The width and depth of constructed swales will be minimised as far as practical in order to reduce ground disturbance, excavation footprint (and hence volume of excavated materials) and also disruption of local hydrology as far as possible.

Check dams (flow barriers or dams constructed across the drainage channel) will be installed at regular intervals within clean water drains and dirty water swales in order to reduce erosion and allow for greater flow control. Check dams allow for a reduction in the velocity of water and therefore allow settlement of coarser sediment particles as well as silt at low flow conditions. Reduction in flow velocity will also prevent erosion of the drainage channel itself.

The number and location of check dams will be dependent on the slope, flow and volume of water, although the following general rules will be applied:

- The maximum spacing between check dams should be such that the toe of the upstream dam is at the same elevation as the top of the downstream dam;
- The centre of the check dam should be at least 0.2m lower than the outside edges;
- Side slopes should be 1:2 or less;
- Check dams should be keyed at least 0.1m into the drainage channel bottom in order to prevent the dam washing out; and
- Check dams will be maintained and monitored on a regular basis. Sediment should be removed before it reaches one half the original dam height.

4.2.4 Silt/Settlement Ponds

Runoff from large areas of hardstanding; including crane hardstandings, temporary construction compound, and electrical substation compound; will be attenuated to mimic natural runoff patterns. To capture runoff generated within the project site, swales (see **Section 4.2.2**) will be utilised to attenuate water and to direct 'dirty' water to silt/settlement ponds, where the flow velocity will reduce to allow sediment and silt to be deposited.

From the silt/settlement ponds, the water will flow through a tertiary treatment system; based on a design from Altmuller and Dettmer (2006); of lagoon-type sediment pond which will absorb the fine particles that may not settle in the primary and secondary settlement ponds.

All swales and ponds will be kept as shallow as possible so that they pose no health and safety risk to plant or personnel. Maximum depth of standing water will be limited to 0.75m within the settlement ponds.

The settlement ponds are utilised to attenuate rain water runoff rates to that of existing green field rates. In addition, the ponds shall aid the removal of suspended solids from runoff water.

4.2.5 Lagoon-type Sediment Ponds

In addition to the silt/settlement ponds, a tertiary treatment system will also be provided to absorb any fine particles that may not settle in the primary and secondary settlement ponds. From the silt/settlement ponds, water will flow through lagoon-type sediment ponds which will be designed with a retention time of 10-days. These ponds; the design of which will be adapted to the characteristics of the project site but based on the principles of Altmuller & Dettmer; will be vegetated so as to perform the role of a 'plant filtration bed' as described at **Annex 1** (pg. 7).

The settlement ponds and lagoon-type sediment traps will assist as part of an overall strategy to remove any risk to FPM downstream of the project site.

Separately, it is also proposed to use Disturbed Sediment Entrainment Mats - SEDIMATS (see http://www.hy-tex.co.uk/ht_bio_sed.html). The use of these mats will provide a further level of protection in relation to silt release.

4.2.6 Planning-Stage Design of Surface Water Management System

A planning-stage drainage/surface water management system has been designed by Jennings O'Donovan & Partners, enclosed at **Annex 2** hereto, and includes preliminary specifications for surface water management infrastructure particularly in relation to the appropriate sizing of silt/settlement ponds. Details of the sizing of each silt/settlement pond, which have been informed by rainfall data for the project site (see **Annex 3**), are provided at **Table 1** below.

Pond Reference (SP)	Development Area (m^2)	Length (m)	Width (m)	Depth (m)	Overall Volume of Silt Pond (m^3)	Settling Velocity m/s <0.0016	Settling Duration Hours >4hrs
1	950	8	2.8	0.75	16.8	0.0004	5.43
2	800	8	2.8	0.75	16.8	0.0003	6.45
3	450	4	2.8	0.75	8.4	0.0002	5.73
4	1750	9	4.5	0.75	30.4	0.0005	5.33

5	650	6	2.8	0.75	12.6	0.0003	5.95
6	3100	14	5.2	0.75	54.6	0.0007	5.41
7	1700	9	4.5	0.75	30.4	0.0005	5.48
8	1700	9	4.5	0.75	30.4	0.0005	5.48
9	500	6	2.8	0.75	12.6	0.0002	7.73
10	1150	8	3.6	0.75	21.6	0.0004	5.77
11	825	8	2.8	0.75	16.8	0.0004	6.25
12	550	6	2.8	0.75	12.6	0.0002	7.03
13	330	4	2.8	0.75	8.4	0.0001	7.81
14	1125	8	3.6	0.75	21.6	0.0004	5.89
15	425	4	2.8	0.75	8.4	0.0002	6.07
16	1050	8	3.6	0.75	21.6	0.0004	6.31
17	2500	12	5.2	0.75	46.8	0.0006	5.75
18	1500	10	3.6	0.75	27.0	0.0005	5.52
19	2000	12	4.5	0.75	40.5	0.0005	6.22
20	1500	10	3.6	0.75	27.0	0.0005	5.52
21	1100	8	3.6	0.75	21.6	0.0004	6.03
22	925	8	2.8	0.75	16.8	0.0004	5.57
23	650	6	2.8	0.75	12.6	0.0003	5.95
24	550	6	2.8	0.75	12.6	0.0002	7.03
25	550	6	2.8	0.75	12.6	0.0002	7.03
26	1500	10	3.6	0.75	27.0	0.0005	5.52
27	1500	10	3.6	0.75	27.0	0.0005	5.52
28	1750	12	3.6	0.75	32.4	0.0006	5.68
29	1750	12	3.6	0.75	32.4	0.0006	5.68
30	700	6	2.8	0.75	12.6	0.0003	5.52
31	700	6	2.8	0.75	12.6	0.0003	5.52
32	1500	10	3.6	0.75	27.0	0.0005	5.52
33	1600	12	3.6	0.75	32.4	0.0005	6.22
34	1600	12	3.6	0.75	32.4	0.0005	6.22
35	500	6	2.8	0.75	12.6	0.0002	7.73
36	1200	10	2.8	0.75	21.0	0.0005	5.37
37	720	6	2.8	0.75	12.6	0.0003	5.37
38	1600	12	3.6	0.75	32.4	0.0005	6.22
39	1450	10	3.6	0.75	27.0	0.0005	5.72
40	650	6	2.8	0.75	12.6	0.0003	5.95
41	500	6	2.8	0.75	12.6	0.0002	7.73
42	200	4	2.8	0.75	8.4	0.0001	12.89
43	500	6	2.8	0.75	12.6	0.0002	7.73
44	600	6	2.8	0.75	12.6	0.0003	6.45
45	650	5	2.8	0.75	10.5	0.0003	4.96
46	1600	12	3.6	0.75	32.4	0.0005	6.22
47	1500	10	3.6	0.75	27.0	0.0005	5.52
48	1650	12	3.6	0.75	32.4	0.0006	6.03
49	400	4	2.8	0.75	8.4	0.0002	6.45

50	600	6	2.8	0.75	12.6	0.0003	6.45
51	1100	10	2.8	0.75	21.0	0.0005	5.86
52	500	6	2.8	0.75	12.6	0.0002	7.73
53	250	4	2.8	0.75	8.4	0.0001	10.31
54	350	4	2.8	0.75	8.4	0.0002	7.37
55	350	4	2.8	0.75	8.4	0.0002	7.37
56	500	6	2.8	0.75	12.6	0.0002	7.73
57	500	6	2.8	0.75	12.6	0.0002	7.73
58	500	6	2.8	0.75	12.6	0.0002	7.73
59	1250	8	3.6	0.75	21.6	0.0004	5.30
60	3300	14	5.6	0.75	58.8	0.0007	5.47
61	550	6	2.8	0.75	12.6	0.0002	7.03
62	500	6	2.8	0.75	12.6	0.0002	7.73
63	500	6	2.8	0.75	12.6	0.0002	7.73
64	400	4	2.8	0.75	8.4	0.0002	6.45
65	1550	10	3.6	0.75	27.0	0.0005	5.35
66	1500	10	3.6	0.75	27.0	0.0005	5.52
67	1500	10	3.6	0.75	27.0	0.0005	5.52
68	750	8	2.8	0.75	16.8	0.0003	6.88
69	1000	10	2.8	0.75	21.0	0.0004	6.45
70	500	6	2.8	0.75	12.6	0.0002	7.73
71	900	8	2.8	0.75	16.8	0.0004	5.73
72	1350	10	3.6	0.75	27.0	0.0005	6.14
73	400	4	2.8	0.75	8.4	0.0002	6.45
74	100	4	2.8	0.75	8.4	0.0000	25.78
75	750	8	2.8	0.75	16.8	0.0003	6.88
76	800	8	2.8	0.75	16.8	0.0003	6.45
77	2400	12	5.2	0.75	46.8	0.0006	5.99
78	2400	12	5.2	0.75	46.8	0.0006	5.99
79	1200	10	2.8	0.75	21.0	0.0005	5.37
80	3100	14	5.6	0.75	58.8	0.0007	5.82
81	2400	12	5.2	0.75	46.8	0.0006	5.99
82	750	8	2.8	0.75	16.8	0.0003	6.88
83	1350	10	3.6	0.75	27.0	0.0005	6.14
84	2300	12	4.5	0.75	40.5	0.0006	5.40
85	2300	12	4.5	0.75	40.5	0.0006	5.40
A	1800	12	3.6	0.75	32.4	0.0006	5.68
B	1800	12	3.6	0.75	32.4	0.0006	5.68
C	1800	12	3.6	0.75	32.4	0.0006	5.68
D	1800	12	3.6	0.75	32.4	0.0006	5.68
E	1100	8	3.6	0.75	21.6	0.0004	6.03
F	1750	12	3.6	0.75	32.4	0.0006	5.68
G	1100	8	3.6	0.75	21.6	0.0004	6.03
H	1750	12	3.6	0.75	32.4	0.0006	5.68

Table 1: Silt/Settlement Pond Specifications

Prior to the commencement of development, the appointed contractor; in conjunction with the project design team, EM, and ECoW; shall prepare a detailed SWMP which shall detail the precise specifications and locations of all surface water management infrastructure to be installed.

5.0 Construction Phase Measures

In the first instance, the project seeks to avoid adverse effects on surface water through avoidance. In particular, the project has sought to avoid direct interactions with watercourses; through minimising the number of watercourse crossings and the implementation of a 50m buffer zone around natural watercourses. The design of the project has, where possible, sought to avoid this buffer area.

Best practice measures are also proposed to minimise impacts to water quality, as follows:-.

- All site personnel will be made aware of their environmental responsibilities at the site;
- Contractors will be required to 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;
- In principle, soil excavation should be undertaken during dry periods, whenever possible;
- Site visits by a Design Engineer will be undertaken at various stages of the construction process to ensure that the SuDS scheme is being constructed and implemented appropriately; and
- In order to verify the efficacy of pollution prevention works during construction, water quality monitoring will be undertaken by a suitably qualified EM, prior to, during and post completion of construction works. This will include all watercourses within the catchment of the construction area. The monitoring will comprise visual and hydrochemistry monitoring, as described in detail in the Water Quality Monitoring Plan.

Finally, all mitigation measures proposed in the Water chapter of the EIAR will be implemented in full, as set out in the following sections.

5.1 Clear Felling & Surface Water Quality Effects

Best practice methods related to water incorporated into the forestry management and mitigation measures have been derived from:-

- Department of Agricultural, Food and the Marine (2019) *Standards for Felling and Reforestation*;
- Forestry Commission (2004) *Forests and Water Guidelines, Fourth Edition*. Publ. Forestry Commission, Edinburgh;
- Coillte (2009) *Forest Operations and Water Protection Guidelines*;
- Forest Services (Draft) Forestry and Freshwater Pearl Mussel Requirements – Site Assessment and Mitigation Measures;
- Coillte (2009) *Methodology for Clear Felling Harvesting Operations*; and,
- Forest Service (2000: *Forestry and Water Quality Guidelines*. Forest Service, DAF, Johnstown Castle Estate, Co. Wexford.

5.1.1 Mitigation by Avoidance

There is a requirement in the *Forest Service Code of Practice* and in the *FSC Certification Standard* for the installation of buffer zones adjacent to aquatic zones at planting stage. Minimum buffer zone widths recommended in the Forest Service (2000) guidance document *Forestry and Water Quality Guidelines* are detailed below.

Average slope leading to the aquatic zone		Buffer zone width on either side of the aquatic zone	Buffer zone width for highly erodible soils
Moderate	(0 – 15%)	10 m	15 m
Steep	(15 – 30%)	15 m	20 m
Very steep	(>30%)	20 m	25 m

During the construction phase, a self-imposed conservative buffer zone of 50m will be maintained for all streams.

The large distance between the majority of the felling areas and sensitive aquatic zones means that any poor quality runoff arising from felling areas can be adequately managed and attenuated prior to even reaching the aquatic buffer zone and primary drainage routes. Where tree felling is required in the vicinity of streams, the additional mitigation measures outlined below will be employed.

5.1.2 Mitigation by Design

Mitigation measures which will reduce the risk of entrainment of suspended solids and nutrient release in surface watercourses comprise best practice methods, as follows:-

- Machine combinations (i.e. handheld or mechanical) will be chosen which are most suitable for ground conditions and which will minimise soils disturbance;
- Checking and maintenance of tracks and culverts will be ongoing through any felling operation. No tracking of vehicles through watercourses will occur. Where possible, existing drains will not be disturbed during felling works;
- Ditches which drain from the areas to be felled towards existing surface watercourses will be blocked, and temporary silt traps will be constructed. No direct discharge of such ditches to watercourses will occur. Drains and sediment traps will be installed during ground preparation. Collector drains will be excavated at an acute angle to the contour (~0.3%-3% gradient), to minimise flow velocities. Main drains to take the discharge from collector drains will include water drops and rock armour, as required, where there are steep gradients, and avoid being placed at right angles to the contour;
- Sediment traps will be sited in drains downstream of felling areas. Machine access will be maintained to enable the accumulated sediment to be excavated. Sediment will be carefully disposed of in the spoil disposal areas. All new silt traps will be constructed on even ground and not on sloping ground;
- In areas particularly sensitive to erosion or where felling inside the 50m buffer is required, it will be necessary to install double or triple sediment traps;
- All drainage channels will taper out before entering the 50m buffer zone, where possible. This ensures that discharged water gently fans out over the buffer zone before entering the aquatic zone, with sediment filtered out from the flow by ground vegetation within the zone. On erodible soils, silt traps will be installed at the end of the drainage channels, to the outside of the buffer zone;

- Drains and silt traps will be maintained throughout all felling works, ensuring that they are clear of sediment build-up and are not severely eroded. Correct drain alignment, spacing and depth will ensure that erosion and sediment build-up are minimized and controlled;
- Brash mats will be used to support vehicles on soft ground, reducing topsoil and mineral soils erosion and avoiding the formation of rutted areas, in which surface water ponding can occur. Brash mat renewal will take place before they become heavily used and worn. Provision will be made for brash mats along all off-road routes, to protect the soil from compaction and rutting. Where there is risk of severe erosion occurring, extraction will be suspended during periods of high rainfall;
- Timber will be stacked in dry areas, and outside the 50m watercourse buffer. Straw bales and check dams will be emplaced on the down gradient side of timber storage/processing sites;
- Works will be carried out during periods of no, or low, rainfall in order to minimise entrainment of exposed sediment in surface water run-off;
- Checking and maintenance of roads/tracks and culverts will be ongoing through the felling operation;
- Refuelling or maintenance of machinery will not occur within 100m of a watercourse. Mobile bowser, drip kits, qualified personnel will be used where refuelling is required;
- A permit to refuel system will be adopted:
- Branches, logs or debris will not be allowed to build up in aquatic zones. All such material will be removed when harvesting operations have been completed, but care will be taken to avoid removing natural debris deflectors;
- Trees will be cut manually from along streams and using machinery to extract whole trees; and
- Travel will only be permitted perpendicular to and away from surface water features.

5.1.2.1 Silt Traps

Silt traps will be strategically placed down-gradient within forestry drains near streams. The main purpose of the silt traps and drain blocking is to slow water flow, increase residence time and allow settling of silt in a controlled manner.

5.1.2.2 Drain Inspection and Maintenance

The following items will be carried out during pre-felling inspections and regularly thereafter:-

- Communication with tree felling operatives in advance to determine whether any areas have been reported where there is unusual waterlogging or bogging of machines;
- Inspection of all areas reported as having unusual ground conditions;
- Inspection of main drainage ditches and outfalls. During pre-felling inspections, the main drainage ditches will be identified. Where possible, the pre-felling inspection will be carried out during rainfall;
- Following tree felling, all main drains will be inspected to ensure that they are functioning;
- Extraction tracks within 10m of drains will be broken up and diversion channels created to ensure that water in the tracks spreads out over the adjoining ground;
- Culverts on drains exiting the site, if impeded by silt or debris, will be unblocked; and

- All accumulated silt will be removed from drains and culverts, and silt traps, and this removed material will be deposited away from watercourses to ensure that it will not be carried back into the trap or stream during subsequent rainfall.

5.1.2.3 Surface Water Quality Monitoring

Sampling will be completed before, during (if the operation is conducted over a protracted time) and after the felling activity. The 'before' sampling will be conducted within 4-weeks of the felling activity commencing, preferably in medium-to-high water flow conditions. The 'during' sampling will be undertaken once a week or after rainfall events. The 'after' sampling will comprise as many samplings as necessary to demonstrate that water quality has returned to pre-activity status (i.e. where an impact has been shown).

Details of the proposed surface water quality monitoring programme are outlined in the Water Quality Monitoring Plan.

The surface water sampling locations used in this EIAR for the wind farm site (i.e. SW1 – SW2) will also be used as sampling locations during felling activities.

Also, daily surface water monitoring forms (for visual inspections and field chemistry measurements) will also be utilised at every works site near any watercourse. These will be taken daily and kept on site for record and inspection.

5.2 Earthworks (Removal of Vegetation Cover, Excavations and Stock Piling) Resulting in Suspended Solids Entrainment in Surface Water

5.2.1 Mitigation by Avoidance

The key mitigation measure during the construction phase is the avoidance of sensitive aquatic areas by using a 50m buffer. From the constraints map (**Chapter 7** of the EIAR) it is evident that; other than some sections of access tracks, watercourse crossings (4 no.), part of the crane hardstanding of turbine T7, the southern end of the main construction compound and the northern end of the spoil deposition area at turbine T5; the majority of the proposed wind farm infrastructure (including all turbine locations and the spoil deposition areas) is located outside of areas that have been assessed to be hydrologically sensitive. Additional mitigation in the form of double silt fencing will be placed around all infrastructure that encroaches the 50m buffer zone.

As described above and at **Chapter 3**, specific mitigation measures, incorporated into the design of the project (embedded mitigation) and through implementation of best practice methodologies will be employed where work inside buffer zones is proposed.

The generally large setback distance from sensitive hydrological features ensures that sufficient space is provided for the installation of drainage mitigation measures (discussed below) and to ensure their effective operation. The proposed buffer zone will ensure:-

- Avoidance of physical damage to watercourses, and associated release of sediment;
- Avoidance of excavations within close proximity to surface water courses;
- Avoidance of the entry of suspended sediment from earthworks into watercourses; and,
- Avoidance of the entry of suspended sediment from the construction phase drainage system into watercourses, achieved in part by ending drain discharge outside the buffer zone and allowing percolation across the vegetation of the buffer zone.

5.2.2 Mitigation by Prevention

The following section details the measures which will be put in place during the construction phase to ensure that surface water features are protected from the release of silt or sediment and to ensure that all surface water runoff is fully treated and attenuated to avoid the discharge of dirty water.

Source controls to limit the likelihood for 'dirty water' to occur:-

- Interceptor drains, vee-drains, diversion drains, flume pipes, erosion and velocity control measures such as use of sand bags, oyster bags filled with clean washed gravel, filter fabrics, and other similar/equivalent or appropriate systems;
- Small working areas, covering stockpiles, weathering off stockpiles, cessation of works in certain areas or other similar/equivalent or appropriate measures.

In-Line controls to ensure appropriate management of silt laden water:-

- Interceptor drains, vee-drains, oversized swales, erosion and velocity control measures such as check dams, sandbags, oyster bags, straw bales, flow limiters, weirs, baffles, silt bags, silt fences, sedimats, filter fabrics, and collection sumps, temporary sumps/attenuation lagoons, sediment traps, pumping systems, settlement ponds, temporary pumping chambers, or other similar/equivalent or appropriate systems.

Treatment systems to fully attenuate silt laden waters prior to discharge:-

Temporary sumps and attenuation ponds, temporary storage lagoons, sediment traps, and settlement ponds, and proprietary settlement systems such as Siltbuster, and/or other similar/equivalent or appropriate systems.It should be noted for this site that an extensive network of bog and forestry drains already exists, and these will be integrated and enhanced as required and used within the wind farm drainage system. The integration of the existing land drainage network and the proposed wind farm network is common practice in wind energy developments and will also result in benefits to surrounding agricultural lands.

The main elements of interaction with existing drains will be as follows:-

- Apart from interceptor drains, which will convey clean runoff water to the downstream drainage system, there will be no direct discharge (without treatment for sediment reduction and attenuation for flow management) of runoff from the wind farm drainage into the existing site drainage network. This will reduce the likelihood of any increased risk of downstream flooding or sediment transport/erosion;
- Silt traps will be placed in the existing drains upstream of any streams where construction works is taking place, and these will be diverted into proposed interceptor drains, or culverted under/across the works area; and
- Buffered outfalls, which will be numerous over the site, will promote percolation of drainage waters across vegetation and close to the point at which the additional runoff is generated, rather than direct discharge to the existing drains of the site.

5.2.2.1 Water Treatment Train

While the silt/sediment ponds and lagoons are assessed as providing a sufficient level of protection to avoid any deterioration in downstream water quality; a final line of defence can be provided by a water treatment train such as a 'Siltbuster', if required. If the discharge water from construction areas fails to be of a high quality, then a filtration treatment system (such as a 'Siltbuster' or similar equivalent treatment train [sequence of water treatment processes]) will be used to filter and treat all surface discharge water collected in the dirty water drainage system. This water treatment train will apply for the entirety of the construction phase.

5.2.2.2 Silt Fences

Silt fences will be emplaced within drains down-gradient of all construction areas. Silt fences are effective at removing heavy settleable solids. This will act to prevent entry to watercourses of sand and gravel sized sediment, released from excavation of mineral sub-soils of glacial and glacio-fluvial origin, and entrained in surface water runoff. Inspection and maintenance of these structures during construction phase is critical to their functioning to stated purpose. They will remain in place throughout the entire construction phase. Double silt fences will be emplaced within drains down-gradient of all construction areas inside the 50m hydrological buffer zones to provide an additional layer of protection in these areas.

5.2.2.3 Silt Bags

Silt bags will be used where small to medium volumes of water need to be pumped from excavations. As water is pumped through the bag, most of the sediment is retained by the geotextile fabric allowing filtered water to pass through. Silt bags will be used with natural vegetation filters or sedimats (sediment entrapment mats, consisting of coir or jute matting) placed at the silt bag location to provide further treatment of the water outfall from the silt bag. Sedimats will be secured to the ground surface using stakes/pegs. The sedimat will extend to the full width of the outfall to ensure all water passes through this additional treatment measure.

5.2.2.4 Management of Runoff from Spoil Deposition Areas

It is proposed that excavated overburden/spoil will be utilised for reinstatement of excavated areas etc. and for landscaping purposes. Excess material, or material which is unsuitable for this purpose, will be stored, permanently, at the dedicated spoil deposition areas.

The main spoil deposition area is located outside the 50m stream buffer zone. A small section of the spoil deposition area at turbine T5 encroaches the 50m buffer zone. Additional mitigation in the form of double silt fencing will be placed around all infrastructure that encroaches the 50m buffer zone.

During the initial placement of spoil in the deposition areas, silt fences, straw bales and biodegradable matting will be used to control surface water runoff. Double silt fencing will be placed along the edge of the bog drain that intercepts the deposition areas.

Drainage from the overburden deposition areas will ultimately be into to the existing bog drain network where it is proposed that check dams will be installed every 20m or so to create a series of settlement ponds, before being discharged.

Spoil deposition areas will be sealed with a digger bucket and allowed to revegetate as soon possible to reduce sediment entrainment in runoff. Once re-vegetated and stabilised, spoil deposition areas will no longer be a likely source of silt laden runoff. Surface water protection infrastructure will be left in place until the areas have stabilised.

5.2.2.5 Grid Connection Installation Works

Temporary silt fencing/silt trap arrangements will be placed within existing roadside/field drainage features along the grid connection route to remove any suspended sediments from the works area. The trapped sediment will be removed and disposed of at an appropriate licenced facility. Any bare-ground will be re-seeded/reinstated immediately and silt fencing temporally left in place if necessary.

5.2.2.6 Pre-emptive Site Drainage Management

The works programme for the initial construction stage of the development will also take account of weather forecasts, and predicted rainfall in particular. Large excavations and movements of soil/subsoil or vegetation stripping will be suspended or scaled back if prolonged or intense rain is forecast. The extent to which works will be scaled back or suspended will relate directly to the amount of rainfall forecast.

The following forecasting systems are available and will be used on a daily basis at the site to direct proposed construction activities:-

- General Forecasts: Available on a national, regional and county level from the Met Eireann website (www.met.ie/forecasts). These provide general information on weather patterns including rainfall, wind speed and direction but do not provide any quantitative rainfall estimates;
- Meteo Alarm: Alerts to the possible occurrence of severe weather for the next 2 days. Less useful than general forecasts as only available on a provincial scale;
- 3 hour Rainfall Maps: Forecast quantitative rainfall amounts for the next 3 hours but does not account for possible heavy localised events;
- Rainfall Radar Images: Images covering the entire country are freely available from the Met Eireann website (www.met.ie/latest/rainfall_radar.asp). The images are a composite of radar data from Shannon and Dublin airports and give a picture of current rainfall extent and intensity. Images show a quantitative measure of recent rainfall. A 3 hour record is given and is updated every 15 minutes. Radar images are not predictive; and,
- Consultancy Service: Met Eireann provide a 24 hour telephone consultancy service. The forecaster will provide interpretation of weather data and give the best available forecast for the area of interest.

Using the safe threshold rainfall values will allow work to be safely controlled (from a water quality perspective) in the event of an impending high rainfall intensity event.

Works will be suspended if forecasting suggests either of the following is likely to occur:-

- >10 mm/hr (i.e. high intensity local rainfall events);
- >25 mm in a 24-hour period (heavy frontal rainfall lasting most of the day); or,
- >half monthly average rainfall in any 7 days.

Prior to works being suspended the following control measures will be completed:-

- Secure all open excavations;
- Provide temporary or emergency drainage to prevent back-up of surface runoff; and,
- Avoid working during heavy rainfall and for up to 24-hours after heavy events to ensure drainage systems are not overloaded.

5.2.2.7 Timing of Site Construction Works

The construction of the site drainage system will be carried out, at the respective locations, prior to other activities being commenced. The construction of the drainage system will only be carried out during periods of, where possible, no rainfall, therefore avoiding runoff. This will avoid the risk of entrainment of suspended sediment in surface water runoff, and transport via this pathway to surface watercourses.

Construction of the drainage system during this period will also ensure that attenuation features associated with the drainage system will be in place and functional for all subsequent construction works.

5.2.3 Monitoring

Prior to the commencement of development, a detailed Site Drainage Plan and SWMP will be prepared to detail the siting and composition of the surface water management measures. The respective plans, which will form part of a detailed Construction Environmental Management Plan (CEMP), will be prepared prior to the commencement of development.

The CEMP will also include a detailed Water Quality Monitoring Plan for the monitoring of surface waters in the vicinity of the construction site by a designated Environmental Manager. The monitoring programme will comprise field testing and laboratory analysis of a range of agreed parameters. The civil works contractor, who will be responsible for the construction of the site drainage system, and Environmental Manager will undertake regular inspections of the drainage system to ensure that all measures are functioning effectively. The surface water sampling locations used in this EIAR (i.e. SW1 – SW4) will be used during construction activities. Regular inspections of all installed drainage systems will be undertaken, especially after heavy rainfall, to check for blockages, and ensure there is no build-up of standing water in parts of the systems where it is not intended.

Any excess build-up of silt levels that may decrease the effectiveness of the drainage feature, will be removed and disposed of in an appropriate manner.

5.3 Excavation Dewatering and Effects on Surface Water Quality

The management of excavation dewatering (pumping), particularly in relation to any accumulation of water in foundations or electricity line trenches, and subsequent treatment prior to discharge into the drainage network will be undertaken as follows:-

- Appropriate interceptor drainage, to prevent upslope surface runoff from entering excavations, will be put in place;
- The interceptor drainage will be discharged to the site constructed drainage system or onto natural vegetated surfaces and not directly to surface waters to ensure that Greenfield runoff rates are mimicked;
- If required, pumping of excavation inflows will prevent build-up of water in the excavation;
- The pumped water volumes will be discharged via volume and silt/sediment ponds and settlement lagoons adjacent to excavation areas, or via specialist treatment systems such as a Siltbuster unit;
- There will be no direct discharge to surface watercourses, and therefore no risk of hydraulic loading or contamination will occur;
- Daily monitoring of wind farm excavations by the Environmental Manager will occur during the construction phase. If high levels of seepage inflow occur, excavation work at this location will cease immediately and a geotechnical assessment undertaken; and,
- A mobile 'Siltbuster' or similar equivalent specialist treatment system will be available on-site for emergencies. Siltbusters are mobile silt traps that can remove fine particles from water using a proven technology and hydraulic design in a rugged unit. The mobile units are specifically designed for use on construction-sites. They will be used as final line of defence if needed.

5.4 Release of Hydrocarbons during Construction and Storage

- The volume of fuels or oils stored on site will be minimised. All fuel and oil will be stored in an appropriately bunded area within the temporary construction compound. Only an appropriate volume of fuel will be stored at any given time. The bunded area will be roofed to avoid the ingress of rainfall and will be fitted with a storm drainage system and an appropriate oil interceptor;
- All bunded areas will have 110% capacity of the volume to be stored;
- On site refuelling of machinery will be carried out using a mobile double skinned fuel bowser. The fuel bowser, a double-axel custom-built refuelling trailer will be re-filled at the temporary compound and will be towed around the site by a 4x4 jeep to where plant and machinery is located. No refuelling will be permitted at works locations within the 50m hydrological buffer. The 4x4 jeep will also be fully stocked with fuel absorbent material and pads in the event of any accidental spillages. The fuel bowser will be parked on a level area in the construction compound when not in use and only designated trained and competent operatives will be authorised to refuel plant on site. Mobile measures such as drip trays and fuel absorbent mats will be used during all refuelling operations to avoid any accidental leakages;
- All plant and machinery used during construction will be regularly inspected for leaks and fitness for purpose;
- Spill kits will be readily available to deal with and accidental spillages;
- All waste tar material arising from road cuttings (from trenching or other works in public roads) will be removed off-site and taken to a licensed waste facility. Due to the potential for contamination of soils and subsoils, it is not proposed to utilise this material for any reinstatement works; and
- An outline emergency plan for the construction phase to deal with accidental spillages is contained within the Planning-Stage CEMP (**Annex 3.4**). This emergency plan will be further developed prior to the commencement of development, and will be agreed with the Planning Authority as part of the detailed CEMP.

5.4.1 Mitigation by Best Practice

Environmental management guidelines from the EPA guidance document *Environmental Management in the Extractive Industry* in relation to groundwater protection will be implemented during the construction phase, particularly the best practice measures relating to oil and fuels.

5.5 Groundwater and Surface Water Contamination from Wastewater Disposal

Measures to avoid contamination of ground and surface waters by wastewaters will comprise:-

- Self-contained port-a-loos (chemical toilets) with an integrated waste holding tank will be installed at the site compound, maintained by the providing contractor, and removed from site on completion of the construction works;
- Water supply for the site office and other sanitation will be brought to site and removed after use to be discharged at a suitable off-site treatment location; and,
- No water will be sourced on the site, nor will any wastewater be discharged to the site.

5.6 Release of Cement-Based Products

The following mitigation measures are proposed to ensure that the release of cement-based products is avoided:-

- No batching of wet-cement products will occur on site. Ready-mixed concrete will be brought to site as required and, where possible, emplacement of pre-cast products, will take utilised;
- All watercourse crossings will utilise pre-cast products and the use of wet-cement products within the hydrological buffer will be avoided
- Where concrete is delivered on site, only the chute will be cleaned, using the smallest volume of water practicable. Chute cleaning will be undertaken at lined cement washout ponds with waters being stored in the temporary construction compound, removed off site and disposed of at an approved licensed facility. No discharge of cement contaminated waters to the construction phase drainage system or directly to any artificial drain or watercourse will be allowed;
- Weather forecasting will be used to ensure that prolonged or intense rainfall is not predicted during concrete pouring activities; and
- The concrete pour site will be kept free of standing water and plastic covers will be ready in case of sudden rainfall event.

5.7 Morphological Changes to Surface Water Courses & Drainage Patterns

The following mitigation measures are proposed:-

- All proposed new stream crossings will be clear span bridges (bottomless culverts) and the stream beds will remain undisturbed. No in-stream excavation works at the crossing locations are proposed and therefore there will be no impact on the stream at the proposed crossing location;
- All internal wind farm electrical cabling or grid connection cabling will pass above or below the existing culvert and will not directly interfere with the culvert;
- At the time of construction, all guidance/best practice requirements of the OPW or Inland Fisheries Ireland will be incorporated into the design/construction of the proposed watercourse/culvert crossings;
- As a further precaution, in-stream construction work (if/where required) will only be carried out during the period permitted by Inland Fisheries Ireland for in-stream works according to *Guidelines on Protection of Fisheries During Construction Works in and Adjacent to Waters* (2016) (i.e., July to September inclusive). This time period coincides with the period of lowest expected rainfall, and therefore minimum runoff rates. This will minimise the risk of entrainment of suspended sediment in surface water runoff, and transport via this pathway to surface watercourses (any deviation from this will be done in discussion with the IFI);
- During the near stream construction works (i.e. within the 50m buffer zone), double row silt fences will be emplaced immediately down-gradient of the construction area for the duration of the construction phase;
- The new watercourse crossings at the wind farm site will require a Section 50 license application to the OPW in accordance with the Arterial Drainage Act 1945. The river/stream crossings will be designed in accordance with OPW guidelines/requirements on applying for a Section 50 consent; and,
- No instream works are proposed at the grid connection watercourse crossings.

6.0 Operational Phase Measures

Following the completion of construction and the re-vegetation of disturbed ground, the generation of 'dirty' water runoff will be significantly diminished. It is important to reiterate that areas of hardstanding will be impermeable and the majority of incident rainfall will percolate naturally to ground.

Infiltration interceptor drains will be retained for the duration of the project to ensure that up-slope ('clean') runoff is directed away from site infrastructure and managed in an appropriate manner.

Swales and check dams (i.e. for the management of 'dirty' water) shall be retained for the duration of the project. The swales, having become vegetated, and check dams will act as a filtration feature for the low volume of surface water runoff arising and will be sufficient to ensure the avoidance of any deleterious matter being discharged to downstream watercourses. Accordingly, it is proposed that the silt/settlement ponds and lagoon-type sediment ponds will be decommissioned 1-year following the completion of construction. This period will ensure that the swales have become sufficiently vegetated to filter any silt/sediment which may arise.

The following measures will also be implemented.

6.1 Progressive Replacement of Natural Surface with Lower Permeability Surfaces

The operational phase drainage system of the project is described below:-

- Interceptor drains will be installed up-gradient of all infrastructure to collect clean surface runoff, in order to minimise the amount of runoff reaching areas where suspended sediment could become entrained. It will then be directed to areas where it can be re-distributed over the ground by means of a level spreader;
- Swales/road side drains will be used to collect runoff from access tracks, turbine hardstanding areas and substation compound areas which may contain entrained suspended sediment, and channel it to settlement ponds for sediment settling;
- Transverse drains ('grips') will be constructed, where appropriate, in the surface layer of access tracks to divert any runoff into swales/track side drains;
- Check dams will be used along sections of access tracks drains to intercept silts at source. Check dams will be constructed from a 40mm non-friable crushed rock or similar;
- Swales and check dams will buffer volumes of runoff discharging from the drainage system during periods of high rainfall, by retaining water until the storm hydrograph has receded, thus reducing the hydraulic loading to watercourses; and,
- Settlement ponds will be designed in accordance the greenfield runoff rate requirements; and,
- Imported rock for construction purposes and road surfacing will be strong, well-graded limestone which will be resistant to erosion and have a low likelihood to generate fines in hardstand runoff.

The operation of the underground grid connection will not result in any likely hydrological or water quality effects and therefore do not require mitigation measures.

6.2 Hydrocarbons Spillages/Leakages

Mitigation measures relating to oils and fuels are as follows:-

- Fuels stored on site will be minimised. Any storage areas will be bunded appropriately for the fuel storage volume for the time period of the construction;
- The substation transformer and oil storage tanks will be located in a concrete bund, impervious to rainwater ingress, capable of holding 110% of the stored oil volume.
- Turbine transformers will be located within the turbines, and any leaks will be fully contained within the turbine thus eliminating any pathway for leakages to affect land and soil.
- Maintenance vehicles will be regularly inspected for leaks and fitness for purpose; and
- An emergency plan for the operational phase to deal with accidental spillages will be contained within an Operational-Phase Environmental Management Plan. Spill kits will be available to deal with accidental spillages.

6.3 Increased Flood Risk due to Development in Fluvial Flood Zones

The design criteria implemented as part of the SuDS are as follows:-

- To minimise alterations to the ambient site hydrology and hydrogeology;
- To provide settlement and treatment controls as close to the site footprint as possible and to replicate, where possible, the existing hydrological environment of the site;
- To minimise sediment loads resulting from the development run-off during the construction phase;
- To preserve greenfield runoff rates and volumes;
- To strictly control all surface water runoff such that no silt or other pollutants shall enter watercourses and that no artificially elevated levels of downstream siltation or no plumes of silt arise when substratum is disturbed;
- To provide settlement ponds to encourage sedimentation and storm water runoff settlement;
- To reduce stormwater runoff velocities throughout the site to prevent scouring and encourage settlement of sediment locally;
- To manage erosion and allow for the effective revegetation of bare surfaces;
- To manage and control water within the site and allow for the discharge of runoff from the site below the MAC of the relevant surface water regulation value; and,
- The high sensitivity of downstream receptors along with WFD status.

Flood Resilience Measures

The site-specific flood zone modelling shows that only short sections of proposed access road at 2 no. watercourse crossing locations will potentially be affect by fluvial flooding. One crossing is on the Rapemills River itself and the second is a large land drain on the south of the site which drains into the Rapemills River.

For these new crossing works a consent will be sought under Section 50 of the Arterial Drainage Act, 1945 to install a new culvert/bridge with the hydraulic capacity to accommodate a 100-year flood flows while maintaining at least a 300mm freeboard above the flood level.

The proposed access road surface level will be close or at the existing ground level to prevent obstruction of surface water flow paths.

6.4 Turbine Foundation Piling and Hydrogeological Effects

The proposed mitigation measures designed for the protection of downstream surface water quality and groundwater quality within the peat bog will be implemented at all construction work areas. Mitigation measures for sediment control, control of hydrocarbons during construction works, and control of cement-based products, as set out above, will be implemented in full.

Proposed mitigation measures relative to piling works will comprise:

- Strict QA/QC procedures for piling works will be followed;
- Piles will be kept vertical during piling works;
- Good workmanship will be employed during all piling works; and,
- Where required use bentonite seal to prevent upward/downward movement of surface water/groundwater.

7.0 Decommissioning Phase Measures

Prior to decommissioning works, a detailed Decommissioning Plan will be developed to detail the methods and measures to be adopted during that phase of works. The Decommissioning Plan will avail of, and implement, prevailing best practice measures including surface water protection methods.

It is likely that the methods adopted will be similar to those presented above in respect of the construction phase but of a reduced scale. Regardless of the specific practices and methods to be adopted; the overall objective will be the prevention of any silt, sediment or deleterious matter being discharged from the site such that could cause a deterioration in downstream water quality.

8.0 Conclusion

This SWMP has been prepared to detail the practical implementation of surface water management infrastructure to address the requirements of measures set out in the EIAR. This is a live document and will be updated by the appointed contractor prior to the commencement of development. Prior to the commencement of construction, the updated SWMP will be reviewed by the Environmental Manager (EM) and Ecological Clerk of Works (EcoW), as necessary, to confirm the appropriateness of the measures set out therein.

The SWMP incorporates the principles of SuDS; with the overall objective of ensuring that no silt, sediment or other material is discharged from the site to surrounding drainage features; to ensure that the project does not adversely affect the drainage regime within the project site and in its vicinity.

The proposed SuDS comprises drainage infrastructure to intercept and direct ‘clean’ incidental runoff away from works locations; and a separate surface water management train to effectively control manage and treat ‘dirty’ water runoff from the works areas. Given the connectivity of the project site to a designated conservation site for Freshwater Peal Mussel, the surface water management train is supplemented by a further lagoon-type sediment ponds with a retention period of 10-days thus encouraging settlement of any silt/sediment prior to discharge.

The efficacy of the measures set out in this SWMP will be regularly monitored and will be supported by water quality monitoring as set out in the Water Quality Monitoring Plan.

Annex 1 –

Altmuller & Dettmer Research Paper

Foreword and acknowledgment
This pdf-file is the English version of an article which is published with three other articles dealing with species and biotope protection for the freshwater pearl mussel *Margaritifera margaritifera* in Lower Saxony, North Germany
(see: http://www.nlwkn.niedersachsen.de/master/C35794242_N14750639_L20_D0_I5231158.html).
With this pdf-file we want to give our non-German speaking colleagues an opportunity to read about the chance to do something for this endangered mussel species in Europe.

To get a good readable English text we are very glad to have our Irish friends and colleagues EVELYN MOORKENS and IAN KILLEEN on our side in our efforts to help *Margaritifera*, and we are very thankful to them for helping us in bringing our "Denglish" to a readable English version.

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 -

by Reinhard Altmüller and Rainer Dettmer

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1 Introduction and Objectives

The conservation of freshwater pearl mussels [FPM] (*Margaritifera margaritifera*) and thick-shelled river mussels (*Unio crassus*) is a task of european importance (Habitats Directive, Water Framework Directive). This task can only be solved by cooperative efforts of all groups and institutions that are involved with running waters.

All conservation efforts in the past for these two mussel species were focused on maintaining high water quality. For the FPM it is a requirement as all known populations of FPM live only in running waters with the highest water quality. For the thick-shelled river mussel this requirement is as well documented by the fundamental investigations from HOCHWALD (1997). But the question does arise as to whether there are more important factors for the survival of the thick-shelled river mussel than water quality alone. This species was widely distributed in Lower Saxony, for example the river Weser from the city Hannoversch-Münden (in the south of Lower Saxony) to the city of Bremen (367 km to the north) in very different ecological conditions.

For the FPM, we have been able to clearly demonstrate that in addition to the best water quality, a naturally very low level of fine sediments is characteristic to an intact, recruiting FPM environment After leaving their host fish the young Freshwater Pearl mussels (only 0.5 mm long) live in the hollow system (=Interstitium) between gravel and stones, well protected against water current. The present day high amounts of input and load of fine materials in running waters resulting from current landuse clog up the interstitium and suffocate the typical freshwater organisms living there, including, the young FPM. Because of the failure of young mussels to survive, the FPM was threatened with extinction in the Lutter river and is threatened with extinction all over Europe in human populated regions. If the load of fine material is reduced to naturally occurring amounts, even brooks with overaged FPM populations can recover and numerous young mussels can survive and grow. This has been successfully demonstrated within the lutterproject (ABENDROTH 1993, ALTMÜLLER & DETTMER 2000, ALTMÜLLER 2005). The lutterproject is situated at the south edge of the Lüneburg Heath (Germany, Lower Saxony). It is a nature conservation project led by the counties of Celle and Gifhorn to restore the heather brook Lutter. The reason and main target organism is the freshwater pearl mussel. This very successful nature conservation project was made possible through the financial support of the German Federal Agency for Nature Conservation within the scope of its programme concerning riparian land (SCHERFOSE *et al*. 1996) by the Ministry for Environment of Lower Saxony and of the financial and manpower support of the counties of Celle and Gifhorn.

For successful measures to be taken to reduce unnaturally high sediment load it is necessary to know the origin of the sediment. Apart from the necessity to analyse the specific sediment origin throughout the catchment there are some general experiances and information knowledge. The experiences of unnaturally high loading in the Lutter catchment was reported by ALTMÜLLER & DETTMER (1996). The experiences of unnaturally high loading in the Lutter catchment was reported by ALTMÜLLER & DETTMER (1996). This paper showed that soil erosion and fish pond waste were important contributers to the high loading of fine sediments in running waters.

Since 1996 more knowledge and experience has been gained about the reasons for the unnaturally high load of fine material, which are described herein. All observations and measurements have been carried out to determine the reasons of the extreme sediment input to running waters and to find workable countermeasures.

2 Study of sediment levels entering the Lutter - an example from the Endeholz Ditch

Within the scope of the measurement program „quantifying load of sand and mud in heather creeks“ a sediment trap was installed in the Endeholz Ditch. The Endeholz Ditch is a small tributary of the Lutter river which has a catchment size of about 2.38 km^2 (HEUER-JUNGEMANN i. lit). Originally it was a small creek which has been extended to form a drainage ditch. About 10 m above it’s confluence with the Lutter river a wooden box was installed in the river bottom (Fig. 1).

Fig. 1: Sediment trap in the Endeholz Ditch to quantify the load of fine sediments. The wooden box (Size: 2 m long, 1 m wide, 0.5 m deep) is open on the top. The sandy material which is mostly transported by rolling over the substrate, along with organic material is deposited in and caught by the box. The sand ripples which are seen in Fig. 1 on the left are typical of an unnaturally high sandy load and are more characteristic of a beach than the bottom of a natural heather creek.

From the end of 1991 to mid 2002 the sediment trap was emptied every week by young men who were doing their civilian service[1] (Zivildienstleistende = ZDL) in the nature conservation specialist agency of Lower Saxony. The amount of deposited material was measured as exactly as possible (Fig. 2).

Fig. 2: Sediment trap in the Endeholz Ditch just before the confluence with the Lutter river (background) with the mound of sandy and organic material which was taken out of the trap from 1991 to 03. April 1998. The size of the mound shows the large amount of material carried by this small ditch.

[1] The sample collection within the measurement program „quantifying load of sand and mud in heather creeks" has been done by the ZDL of the nature conservation agency. The following ZDL beared the main responsibility: Carsten Brauns (1991), Gundolf Reichert (1991/92), Gerrit Grannas (1992/93), Dierk Rischbieter (1993/94), Moritz Haupt (1994/95), Niels Ubbelohde (1995/96), Tobias Polch (1996/97), Michael Koslowski (1997/98), Gunther May (1998/99), Bernhard Schwarz (1999/2000) Arnold Ziesche (2000/01) und Michael. Herbst (2001/02).

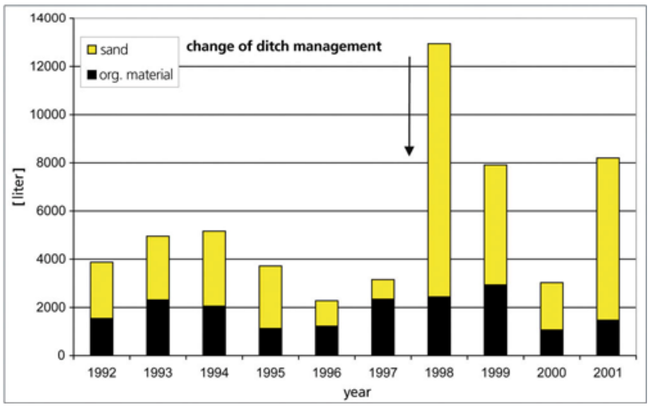

Fig 3: Annual sum of sediment load in the Endeholz Ditch. The change in the method of ditch management from hand clearance to machine clearance from the end of 1997 had a damaging effect on the ditch bottom and its banks, and the sediment load increased significantly. The amount of load after the maintenance of the ditch by machines was much higher than is shown in the figure as the sediment trap overflowed in the first weeks after that occasion.

In Fig 3 the result of weekly emptying the sediment trap is shown as annual sums. The change of load amount from about 3.2 m^3 in the year 1997 to about 12.9 m^3 in the year 1998. Up to 1997 management of the Endeholz Ditch was carried out by hand but from autumn 1997 it was was done using an excavator. The effect of the excavator was to loosen the sand from the banks and bed of the ditch and to transport it downstream. The authors only heard of this change from the young men who were doing their civilian service, who suddenly every week had to remove more than one m^3 out of the sediment trap. The figures 4 to 6 show the effect of this change.

Fig. 4: The Endeholz Ditch in spring of 1998 after management by machines. On the right side the excavated material can be seen. The river bottom is exclusively sand. The ripples are characteristic of the moving sand.

Fig. 5: Mouth of the Endeholz Ditch to the Lutter river in April 1994. At this time very little sand was transported into the Lutter river.

Fig. 6: Mouth of the Endeholz Ditch to the Lutter river on 03.04.1998. The large mass of sand which has been transported into the Lutter river after management of the ditch by machines is clearly seen. The sand which is seen here wasn't caught in the sediment trap 10 m upstream, because the trap was full. Therefore, the amount of load shown in Figure 3 for 1998 is an underestimate.

3 Reduction of unnaturally high sand load through installation of sediment traps and monitoring by photo documentation

The input of unnaturally high load of fine sediments in running waters can arise from several different sources depending on the type of land use. Therefore different measures are required to reduce the input. Erosion from farmland results in a considerable loss of valuable soil, therefore it makes sense for farmers to increase their efforts to minimize this loss. In spite of the efforts of the farmers, there will be soil conditions (for example directly after ploughing) when heavy rainfall will bring high amounts of erosion. There needs to be methods utilised that will reliably prevent harmful input of fine sediments in all situations.

Once it was recognised that the unnaturally high sand load from drainage ditches which flow into the Lutter and its tributaries was the essential reason for the absence of FPM reproduction, sediment traps and plant beds were designed to stop the problem. Sediment traps are created by widening and deepening the drainage ditches. This causes the flow velocity in the area to be reduced so that the sand, silt and coarse organic material is deposited and can be excavated with ease. The function can be demonstrated by taking the sediment trap near the village of Bargfeld as an example. A photo series shows the origin of the sandy load and the successful disposal of these pollutants by the use of the sediment trap.

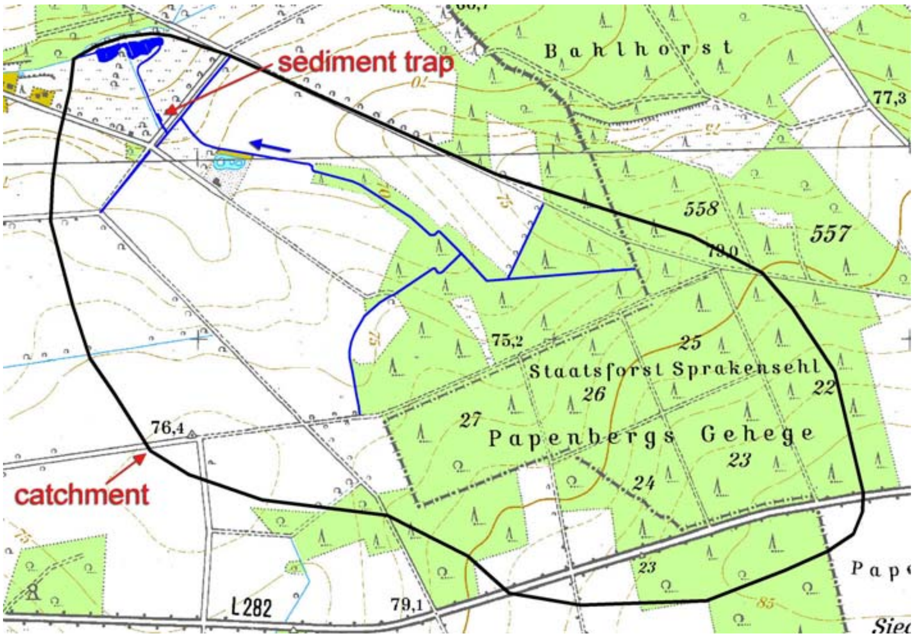

Fig.7: The sediment trap of Bargfeld (in the picture top on the left side) . The sediment trap is situated near a road and, therefore it is within easy and cost-effective reach by machines to empty it.

The sediment trap of Bargfeld (Fig. 7) (WIDRINKA in litt.) receives material from a catchment of about 2 km², of which about 50 % is farmland. This area is almost completely drained and the drainage ditches are cleaned out by machines every year as part of the obligations of water maintenance. The sandy soils are very thin and lay on impervious glacial till. Because of this they can hold and store only small amounts of water. So the drainage ditches are constantly water-bearing only in wet years. In „normal“ years they dry out in summertime.

As with all other cases within the Lutterproject, this sediment trap is situated for ecological reasons directly downstream of the part of the drainage ditch that is under periodic maintenance. So the total sand load of the entire stretch upstream can be caught. The riverbed downstream is not under water maintenance - only the vegetation above water level is cut, in exceptional circumstances. Being permanently water-bearing, the strech downstream of the sediment trap is free of unnatural sediment loads and can develop in a near-natural way.

For economic reasons the sediment trap is built near a road in order to reach it easily with machines for excavation. The system of water management is shown in Fig. 7 and 8. The water which comes from the farmland flows into ditches near the road, crosses the road (red arrow) and flows to the north north-west (nnw) into the little creek called “Köttelbeck” in the region of “Langenfeld”. In this ditch a sediment trap was built near the road in the winter of 1998/99.

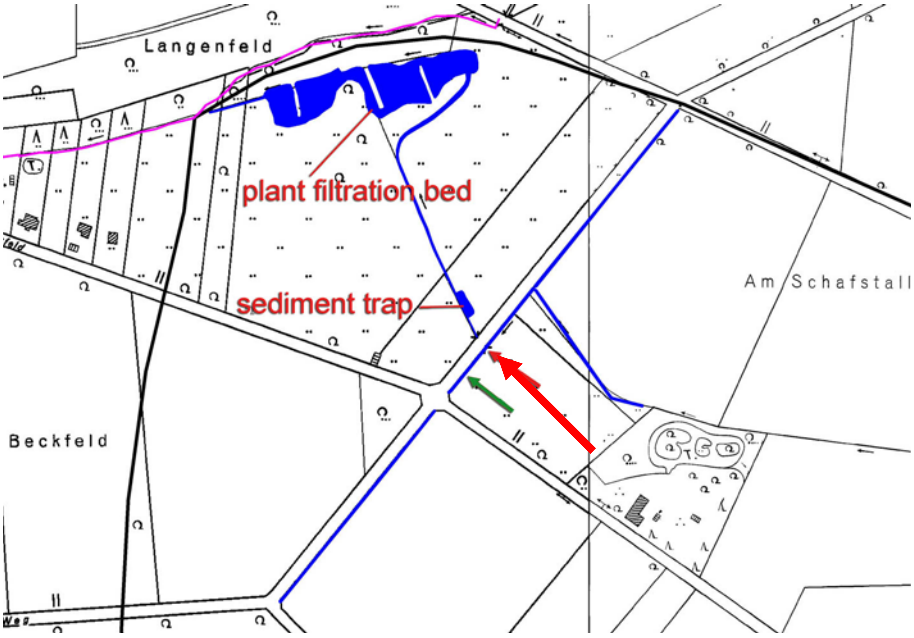

Fig. 8: The complete system, comprising the sediment trap and the plant-bed situated at the lower end of the catchment. The water from the drainage ditches first enters the the sediment trap and then flows through the plant filtration bed. This is a secondary system to absorb the fine particles, which are so small that they do not settle in the sediment trap.

Fig. 9: View in flow direction of the „Sediment trap Bargfeld“ in summer of 1999 about one year after completion and after the first time of excavation. In front of the left side the mouth of the drainage ditch can be seen. At the far end on the left of the sediment trap the drainage ditch continues its flow through dense vegetation.

In winter 2004/2005 the function of this sediment trap was documented photographically. It should be pointed out that there is a time difference between “cause of the unnaturally high load” (this means: ditch management) and “occurrence of the sand downstream” (this means: in the sediment trap).

The following photo series clearly show the effect of ditch management by machines, the successive transport of sand and the function of the sediment trap.

Photo series 1 (Fig. 10a-d)
The position of the photographer is about at the top of the red arrow in Fig. 8. For an illustration of the situation in autumn, a picture was taken in autumn of 2005. (Fig. 10a).

Fig. 10: Drainage ditch running parallel to the farm road. For position of the photographer see Fig. 8, top of the red arrow, view direction: sw.
Fig. 10a: Situation before the annual ditch maintenance (12.11.2005).
Fig. 10b: directly after maintenance by machines (21.11.2004).
Fig 10c: More than one month after maintenance at 30.12.2004 . Additional sand is transported in this stretch.
Fig. 10d: At 16. 03. 2005, most of the sand which was loosened during clearance is washed away. It remains a stony and gravely river bed as is typical for natural creeks in this region.

Photo series 2, Fig. 11a – 11 d: Position of the photographer the same as in fig. 9, south of the sediment trap. View direction: north in flow direction of the drainage ditch.

Fig. 11: Sediment trap "Bargfeld".
Fig. 11a: the sediment trap on 30 12. 2004. No sand has reached the sediment trap, more than five weeks after the ditch clearance and only 30 m downstream of position fig. 9 and 10. Only after two months (fig.: 11b, 22.01.2005), the amount of transported sand becomes more visible and then more evident two weeks later (fig. 11c, 06.02.2005). One month later (fig. 11d, at 16. 03. 2005) the sand transportation in the drainage ditch has been completed and the sand has reached the sediment trap. The plant has done its job. The sediment trap is approximately one third full, equivalent to about 50 m³. At this time the drainage ditch is already washed free of sandy material (see fig. 10d). Without the sediment trap the mass of sand would have been transported downstream to the Lutter River where it would have infiltrated and overlayed the naturally stony and gravely river bed similar to the situation visible in fig. 10b and 10c. Also, without the sediment trap there would be no evidence of the quantity of sand that was mobilised by only one episode of ditch management by machine.

Both photo series demonstrate and explain one origin of unnaturally high sand load in a small drainage ditch in a low gradient area. It is a stark demonstration of the ecological problem present for the FPM. They also show that the chances to minimize this source of threat for the biocoenosis of running waters is relatively easy when located at the right place. Additionally they show that one needs a sediment trap to demonstrate the huge amounts of sand which can be contributed to a natural creek by one small drainage ditch. At the same point on the drainage ditch the situation can look stable for a long time (Fig. 10b and 10c). However, the sand passes over this area and, therefore one is unable to formulate an impression of the quantity of the sand that has passed through.

The sediment trap Bargfeld is an example of how unnatural sand input is prevented from entering natural running waters within the Lutterproject. Installation of sediment traps in each of the numerous drainage ditches within the catchment of the Lutter River was reliant on the fact that the areas were purchased by the project management. Then a procedure was developed to get permission to install the sediment traps. The realization of all the necessary projects took a very long time - from 1989 up to the present (2006). Therefore the input of sand could only be reduced in successive stages. The effect to the biocoenoses of all these measures therefore could only arise after the gradual improvement of the ecological conditions.

4 Accelerated reduction of fine sediment load by the use of a mill pond as a sediment trap

The reduction of fine sediment load in the lower reaches of the Lutter River got an important boost through purchasing the rights to an old Mill in the village of Eldingen by the lutterproject management. The remaining semi natural streches of the river Lutter lie downstream of this mill. In the summer of 1989 the owner of the mill was informed about the problems the pearlmussels had with mobilized sediments coming from the mill pond. After this he kindly agreed not to drain off the mill pond. Previously, the mill weir had been raised during flood events to preserve the buildings. The effect or success of not raising the weir is shown in figure 12. After purchasing the watermill in 1992, the water level of the mill pond has been permanently lowered as far as it was possible, so that the water could pass the mill even in flood without damaging the buildings (See 12b). Since then the mill pond has never been emptied and it acts as a very large sediment trap. The accumulated sand and mud has been taken out by the use of a suction dredge. To date, about 6,800 m^3 of sand and mud have been pumped out (personal communication: government of the county of Celle and engineering office HEIDT & PETERS, Celle).

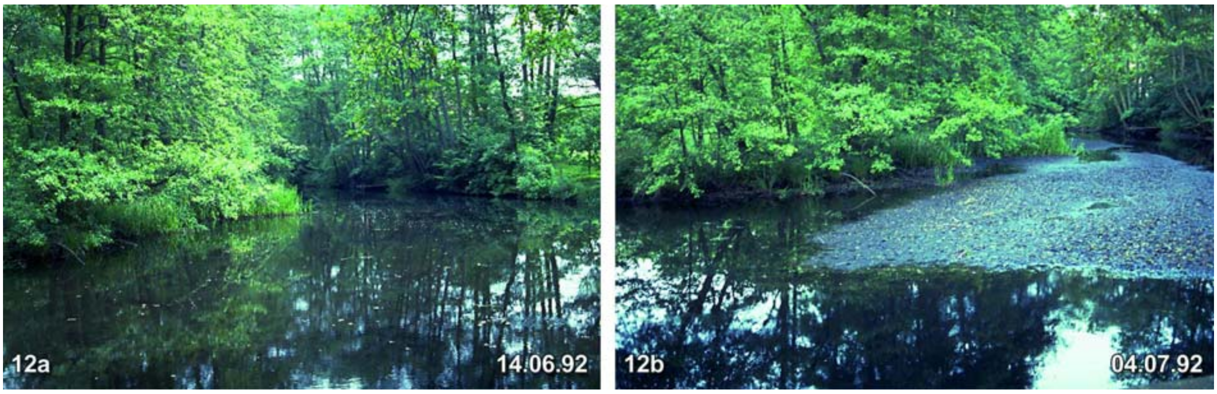

Fig. 12: Back water of the mill of Eldingen just before (left) and just after (right) the notary certification of the contract of sale. Prior to 1992, large quantities of sediments had already accumulated in the backwater of the mill (right picture).

As these pumped out masses of sediments are not washed downstream, they have not covered the natural river bottom and killed the typical biocoenosis. On the contrary, the sand masses which covered the stony and gravely river bottom up to this time were successively washed away so that gravel and stones appeared again at the surface. Fig. 13 shows how much the quantity of sediment drift has been reduced by this action. In the year 1968 under leadership of BISCHOFF a small bypass was built in a narrow curve of the Lutter about seven kilometres downstream of the mill of Eldingen. About 5 - 10 % of the Lutter water runs through this bypass. In January of 1991 a sediment trap like the one shown in fig. 1 was built in this bypass. This sediment trap has been emptied weekly since then. Fig. 13 shows the annual sum of the sediment drift from 1991 to 2006. The sum of rainfall has been measured in the private „weather station“ of the first author, which is located about 5 km from the sediment trap. The high rainfall in winter 1993/94 gave rise to a corresponding high flow in the Lutter, and produced very high sediment drift. In 1994 up to 19 m^3 sand was removed from the sediment trap. This equates to about 190 - 380 m^3 sand transport in the Lutter. As with the trap in the Endeholz ditch, this sediment trap also overflows in the weeks with the highest sand transport. As the fine sand fraction doesn't deposit, the real amount of transported material is even higher than has been measured.

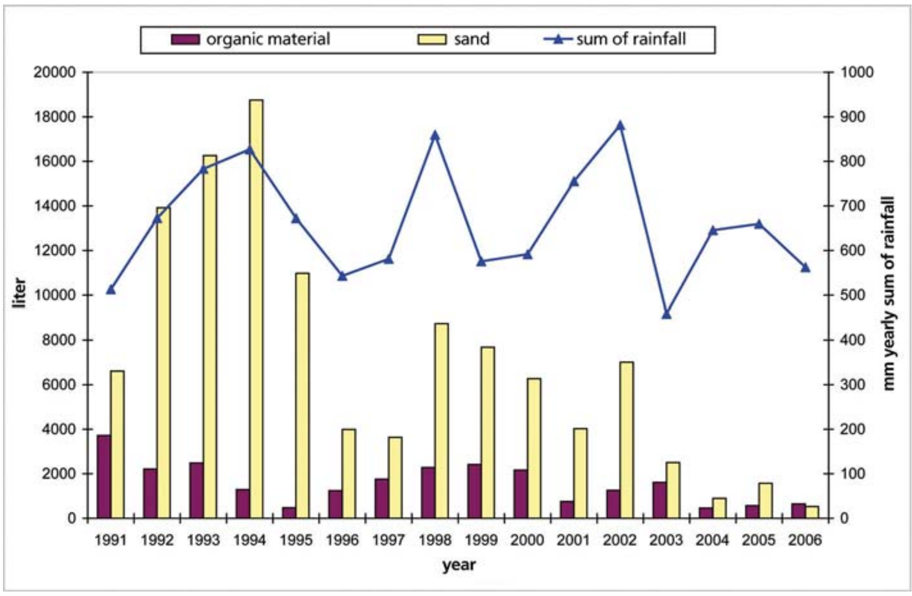

Fig. 13: Trend of sediment transportation in the Lutter. The amount has been measured in a sediment trap as shown in fig. 1. The success of the sediment trap "mill pond" and of the sediment traps in the drainage ditches is clearly seen.

Initially the upper reaches of the c. seven kilometre long stretch downstream of the mill were washed free from overlaying sand. The stony and gravely substrate emerged again and could be colonized by the typical Flora and Fauna. The typical inhabitants of a natural brook reacted immediately to this naturally recovered structure of the river bottom. An example of this phenomenon was the new high reproduction of minnows (*Phoxinus phoxinus*).

5 Successes for the biocoenosis of the brook

5.1 Example minnows (*Phoxinus phoxinus*)

Minnows are typical and numerous inhabitants of waters with stony gravely bottom and / or shores. In the lower reaches of the river Lutter downstream of the mill of Eldingen they had only seldom been caught by annual electro fishing, which had been carried out since 1985. This changed after the transport of fine sediments was stopped in summer 1992. The winter flood in 1993/94 then washed out the sand, which had previously covered the stony gravely river bottom (ALTMÜLLER & DETTMER 1996). The minnows reacted immediately to this and reproduced very successfully. Given their former rareness the sudden appearance of breeding minnows was very surprising. It was also confirmation that the large amounts of sand were the greatest remaining problem for the river ecosystem.
Minnows spawn in gravel material and prefer a grain size of 2 cm in diameter (BLESS 1992), and they spawn in sections with high current. While spawning the Minnow -♀ inject their eggs between the gravel (Fig. 14). The eggs cling on to the gravel because of their adhesive surface. Here they are protected against voracious individuals of the same species and are supplied by a circulation of oxygen rich water. After about a one week's embryonic development the hatched out fish larvae migrate as deep as possible into the substrate, most likely to escape the suction from the turbulent water above them. They are supported by a yolk sac and are not able to swim (benthic phase). They hide in narrow niches between stones where the current is at its lowest (Fig. 15). Here they are most protected. However,

these are also the parts of the river bed that are first clogged if sediments are brought into the river - which is fatal for the inhabitants. After development within the substrate the minnow larvae migrate upwards through the interstitium into the open water (pelagic phase, free swimming larvae).

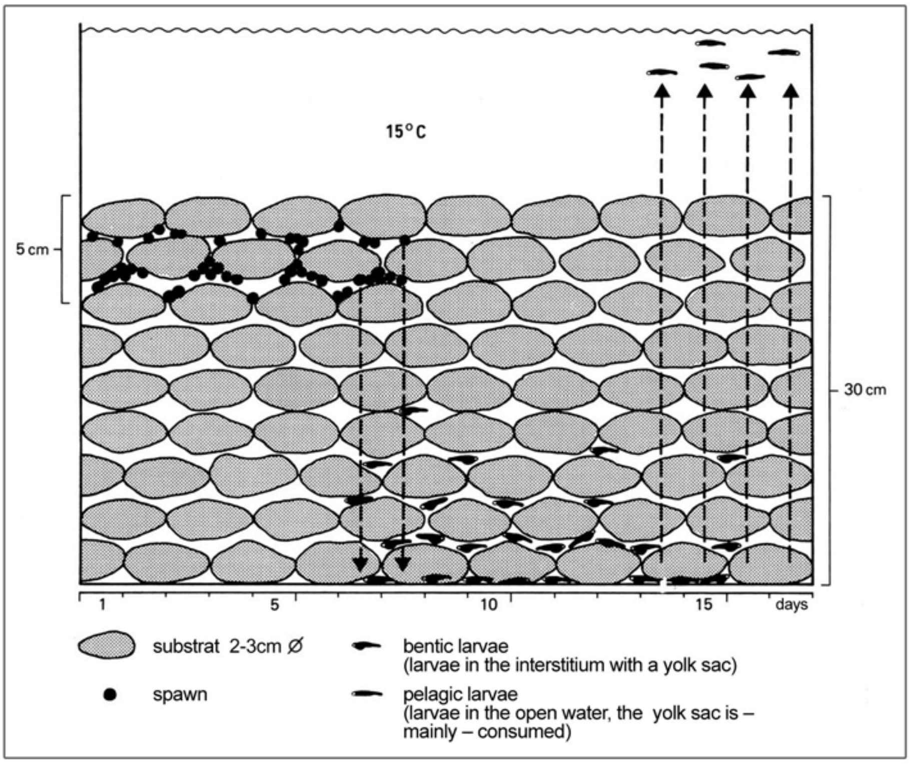

Fig. 14: Time table (Tage = days) of the space used by juvenile stages of minnows at 15 °C water temperature (after experiments in an aquarium). The aquarium is filled with a 30 cm thick gravel layer in a size which minnow-♀ prefer. For explanation see text (Figure adapted slightly from BLESS 1992).

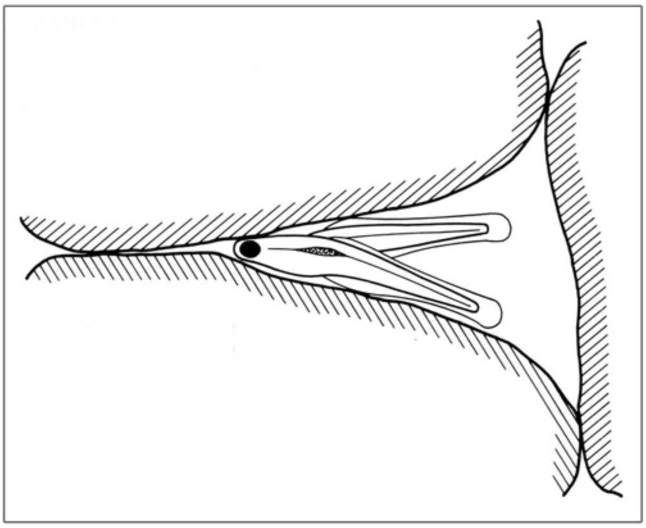

Fig. 15: Minnow larvae hide into narrow niches made by the gravel, probably to protect themselves against upward suction by the current. Here (as deep as possible in the bottom in the narrow niches formed by the gravel) the suction power is lowest and so is the danger of washout (after BLESS 1992).

The following graphs (Fig. 16a-e) show the minnow population in the lower reaches of the river Lutter downstream the mill of Eldingen. In the graphs the number of minnows per 100 metres is shown within each of the randomly selected fishing sectors. The sectors which have not been fished are marked. It can be clearly seen that the minnows - starting in the upper reaches - successively colonized (or re colonized) the river Lutter. Minnows are now (in 2006) again the typical and most numerous inhabitants of the river, and always accompany the author during the snorkelling surveys to investigate the pearl mussel population.

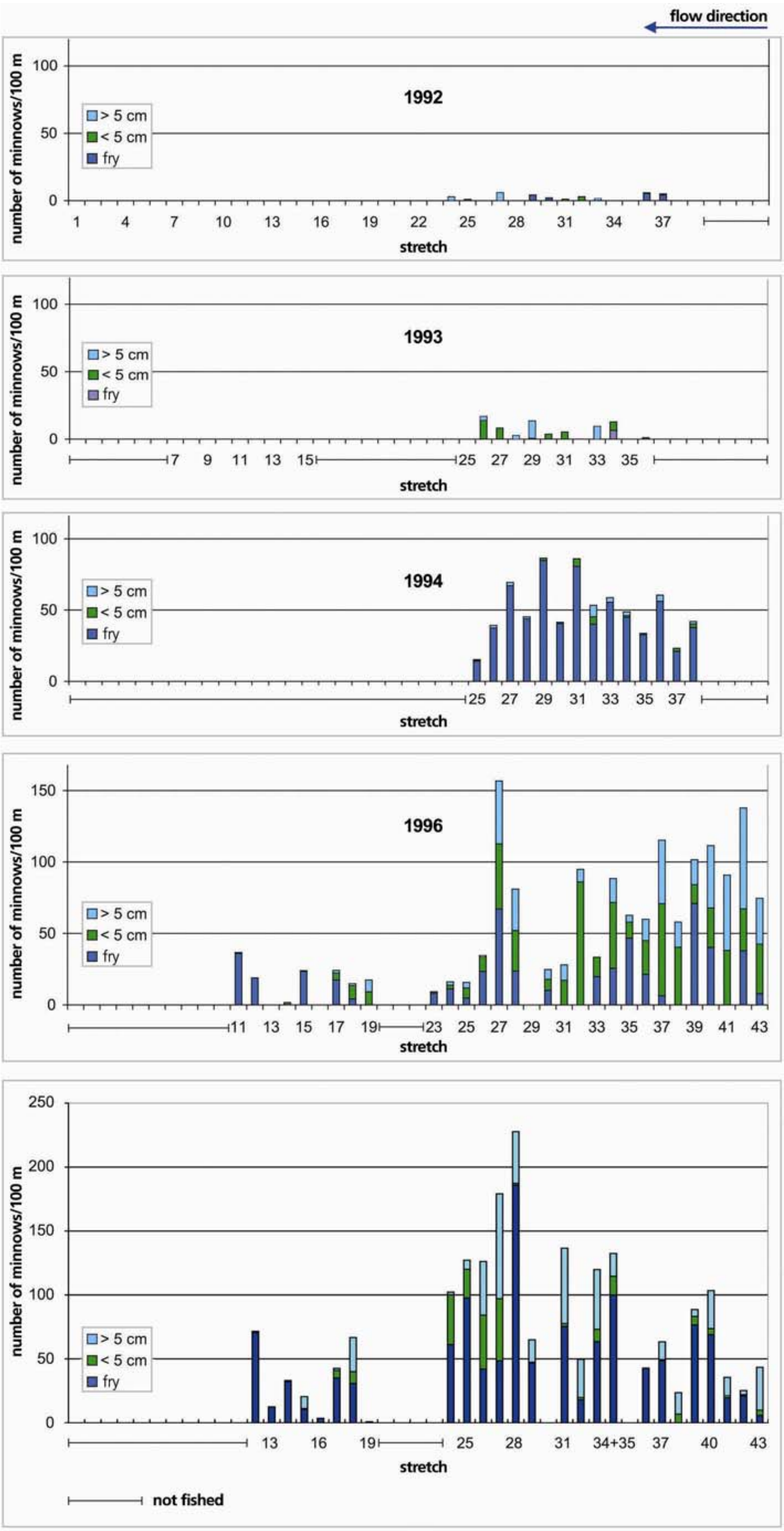

Fig. 16a-e: Development of the minnow population in the natural lower reaches of the river Lutter in the years 1992 - 1998. Sectors which were not investigated by electro fishing are shown by a line. Abschnitt = stretch; nicht befischte = not fished.

5.2 Example of the Freshwater Pearl Mussel

As the rate of growth of the FPM is very slow and the young mussels spend at least the first 5 years of their life hidden in the river bed substrate, the success of the measures for the species and biotope protection for the FPM (the target species), could only be shown after several years.

In the river Lutter the young FPM need to reach the age of about seven years before they are big enough to emerge from the gravel into the flowing water to get more water through their gills for better oxygen and food supply. It is only then that they can be seen by the investigator without destroying their habitat by dredging.

Fig. 17: River bottom of the Lutter with an adult FPM and three young mussels which are not easily seen between the gravel.

The first shells of young mussels were found in 1997, and the mussel population has been investigated by snorkelling annually since 2000.

The results of these investigations are shown in figure 18. In 2006 more than 83 % of the total of about 7,400 FPM in the river Lutter are younger than 20 years. This success is in great contrast to the fact that all other european freshwater pearl mussel populations in human settled regions are without successful reproduction and therefore they are threatened with extinction (GEIST 2005).

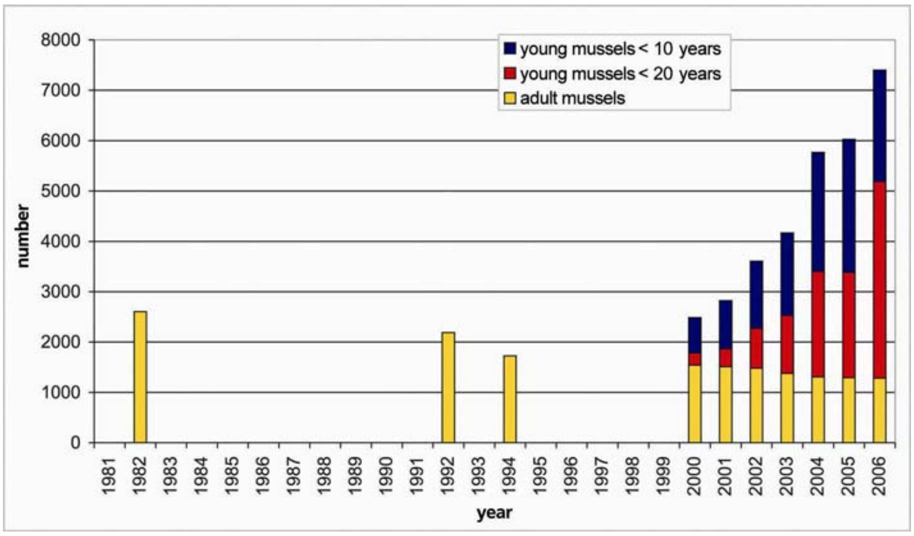

Fig. 18: Population development of the Freshwater Pearlmussels in the river Lutter. This positive trend is due to the reduction of the anthropogenic sand load since the upstream mill pond has not been drained off and therefore the sediments are no longer washed out of the mill pond.

The long term survival of the FPM population in the river Lutter was given additional hope with the verification of the presence of young brown trout (*Salmo trutta f. fario*) in 2005 and 2006, which were naturally infected with FPM glochidia. (Fig. 19). Since the year 2003 no brown trout have been artificially infected with larva (glochidia) of the FPM in the natural lower reaches of the river Lutter. Furthermore, given that the oldest of the young FPM came to mature age and in view of such a large number of young mussels, natural infection of brown trout should be possible. However, to be certain of this, the artificial infection of brown trout with FPM glochidia must be stopped. The young infected brown trout which were found in 2005 and 2006 live in reaches of the river Lutter where only a few old FPM can be found. These few individuals produce too few glochida to successfully infect brown trout. The high number of glochida necessary for an intensive infection can only come from the high number of young mussels which are maturing at present.

The age composition of the infected brown trout is very interesting. Most of the infected fish examined in May of 2006 were born the previous year. They had been infected at an age of only a few months old. During the periods of artificial infection, fish this young were not utilised as they are very sensitive and easily damaged.

Fig. 19: Young brown trout of 2005 with nearly ripe young freshwater pearl mussels in the gills (light points) (result of electro fishing for monitoring - 07.05.2006). The glochidia are derived from young mussels which have matured after successful species and biotope protection measures. They will build up the F2 generation, but any success cannot be proven for another 5 – 7 years.

6 Conclusion and outlook on the future

Unnaturally high sediment load, produced by human land use and other activities, considerably affects running waters and their biocoenosis. Most of the running waters of the northern german lowland are in this damaged condition.

Taking the example of the river Lutter and its ecologically very demanding resident population of freshwater pearl mussel, it has been shown that there are indeed opportunities for restoration and, within this, chances of survival even for very demanding species which once were typical and abundant. This is dependent upon water quality not being reduced by waste water or unnaturally high input of nutrients, that there is still the original or a near-natural river bottom, and no unnatural sediment input.

The nature conservation measures for the freshwater pearl mussel in the catchment of the river Lutter were only made possible by the considerable funds made available for the Lutter Project, and by the goodwill, trust and cooperation of everyone involved in the project (ALTMÜLLER 2005).

The experiences and knowledge from the Lutter Project should be used not only for freshwater pearl mussel conservation measures in other catchments, they should be used in general for river conservation, development and restoration measures.

Anthropogenically derived high sediment load clogs the lattice system (Interstitium) between sand, gravel and stones so that the typical animals living there die. Furthermore, sediment covers continously, in a rolling movement – like shifting sand dunes – even in a river bottom that was originally stable.

Each river bottom that is mainly stable is colonized by organisms almost on the surface. Where there is light and nutrient, algae may grow, but even small animals colonise a stable bottom in huge numbers or they live burrowed by themselves in the upper film. Even these less demanding surface organisms are suffocated by shifting sediment dunes, as well as those that live in the deeper interstitium.

As with the reduction of nutrient load, the reduction of fine sediment load must become a general requirement within running water restoration and protection work and a common goal of water and nature conservation.

In every case the place for reducing the unnaturally high load should be located as close as possible to the source of the problem. Erosion is harmful to a farmer’s business and, therefore, it is in every farmer’s interest to take all known and possible steps to reduce erosion and preserve economic viability. The most important measure is to have as complete a soil cover as possible. However in the course of a year their may be a phase without soil cover for arable farmland. For this period of time it is necessary to take precautionary measures on all sites which are at risk from erosion. For some farmers this precaution may seem to be excessive, because incidents of erosion are relatively few in number and with long periods between, and may even discourage some farmers from taking precautionary measures because of economic impact. However, even a single high erosion incident can bring major sediment input which can severely damage running waters and their very long lived biocoenosis.

Within the sphere of the Lutter project with maintenance of waters, especially management of drainage ditches, and the resultant sediment load, from an economic point of view it is indispensable to install sediment catchers in all drain ditches. In time it is possible to take out of the waters both the sediments which are mobilized by ditch management and those which are coming from erosion and/or other origins.

The excavation of the sediment traps can be done within the yearly maintenance of waters without any significant increase in cost, provided that the sediment trap is located where it will have maximum effect and its dimensions are big enough. However, the emptying of the sediment traps has to be done with care or else they will refill very quickly and then overflow. Special responsibility for the correct management of the sediment traps has to be taken by the association that also maintains the waters and manages the ditches.

The measures of nature and water protection that are described in this article especially apply to the preservation and recovery of the freshwater pearl mussel. But all measures together already contribute towards fulfilling targets set within several Directives of the European Parliament. So the restoration work on the lower reaches of the river Lutter are very successfull species and habitat conservation projects within the European Habitats Directive but also within the European Water Framework Directive to achieve good ecological conditions:

- Within the European Habitats Directive the habitat 3260 „Water courses of plain to montane levels with the *Ranunculion fluitantis* and *Callitricho-Batrachion* vegetation " have been brought into favourable conservation status (Annex I, Directive 92/43/EWG)
- the populations of the freshwater pearl mussel, the Green Club-tailed Dragonfly (*Ophiogomphus cecilia*) and the Bullhead (*Cottus gobio*) has been brought into favourable conservation status (Annex II, Directive 92/43/EWG).

Within the European Water Framework Directive (Directive 2000/60/EC) the recovered stretch of the river Lutter, or rather the condition of it, was brought into a good status, i.e. the hydromorphological characteristics and the physico-chemical quality elements.

In addition to the above, the special feature of this water protection, water conservation and nature conservation project is that there are only small follow-up costs and also no costs to manage a specific state of cultural landscape.

7 Table of the colleagues involved in the species protection measures for the freshwater pearl mussel

The results of electrofishing and the success of the species protection measures that are described here has been achieved by enthusiastic friends of nature, generally in their free time. The spawning time of the FWP-♀ is not predictable. Therefore in summer from mid-July all private appointments had to be subordinate to the life history of the mussels. In the following all attendees of the species protection measures for the freshwater pearl mussel in Lower Saxony (also in the rivers Lachte and Bornbach) are listed in alphabetic order.

Reinhard Altmüller, Wolf-Dietrich Bischoff, Dietrich Blanke, Ulli Brandt, Rainer Dettmer, Frauke und Heiner Drögemüller, Christian Gietz, Otto Golze, Günter Grein, Roger Günsel, Stefan Heitz, Iris Herrmann, Thomas Herrmann, Matthias Holsten, Renate und Stefan Hölter, Lennart, Manuel und Norbert Horny, Gerd Hübner, Thomas Kaiser, Heinrich Klaholt, Andreas Knoop, Ernst und Ole Kohls, Henning Köneke, Gabi Kremming, Jens Kubitzki, Peter Lorz, Hans-Jürgen Löther, Sonja Lüßmann, Christian Makala, Anna, Hans und Moritz Menneking, Lars und Wolfgang Mosel, Annette Most, Dirk Mundt, Matthias Olthoff, Sören Ostermann, Ulrich Pittius, Gabriele Potabgy, Anke Preiß, Manfred Rasper, Günter, Ronja und Vigdis Ratzbor, Dierk Rischbieter, Thomas Schick, Gudrun Schmal, Daniel Schneider, Burkhard und Ulrich Schnepper, Peter Sellheim, Brigitte Steinhardt, Egon Steinkraus, Agnes Steinmann, Andreas Thiess, Frank, Hans-Hermann und Holger Trumann, Wieland Utermark, Günther Wilkens.

In addition to the young men listed an page 3 who made their civilian service (ZDL) were the following ZDL involved in the species protection measures and the surveys:

Thomas Clavier, Carsten Dettmann, Michael Friese, Thorben Fründt, Michael Geilke, Manfred Grenz, Günther Hansen, Horst Hildebrandt, Markus Kietz, Thomas Klug, Andreas Nitschke, Ulrich Söffker und Alexander Wiebe.

8 Summary

The freshwater pearl mussel was formerly abundant in running waters of the „Lüneburg Heath", a north eastern landscape in Lower Saxony in the North of Germany. Using the example of the remaining freshwater pearl mussel population in the river Lutter it has been shown that good water quality alone is not enough for its survival. The unnaturally high amounts of load (sand and silt) are harmful substances for the river biocoenosis. Only after the reduction of these high amounts of load could typical fish such as minnows (*Phoxinus phoxinus*) naturally reproduce. Also, it is only after the reduction of the huge load that the relief measures which focused on artificially infecting wild living brown trout (*Salmo trutta* f. *fario*) with glochidia became successful with young mussels surviving and growing. Currently the next mussel generation has started to grow up without any artificial help.

With the installation of sediment traps in all drainage ditches a method has been developed and used, which can help to reduce the problems with unnaturally high load of fine sediment and which may be applied across Europe.

Some targets of the European Habitats Directive and of the European Water Framework Directive are shown to be achievable.

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The authors

Dr. Reinhard Altmüller, born 1948, studied biology and read for his doctorate at the Georg-August-Universität at Göttingen. Since 1976 he has been responsible for Invertebrates at the Lower Saxony Specialist Agency for Nature Conservancy. One focus of his job has been to investigate the organisms of running waters, especially the freshwater pearl mussel, and the development of ways to improve their habitats.

Rainer Dettmer, born 1955, studied biology at Hanover. In his dissertation he investigated the biology of the freshwater pearl mussel (1982). Since then he has worked on the biology and conservation of naiads and other limnological questions, especially electro fishing, funded by different institutions (TiHo Hannover, Lower Saxony State Agency for Ecology, NLWKN, Nature Conservation Organisations, Nature Conservation Council).

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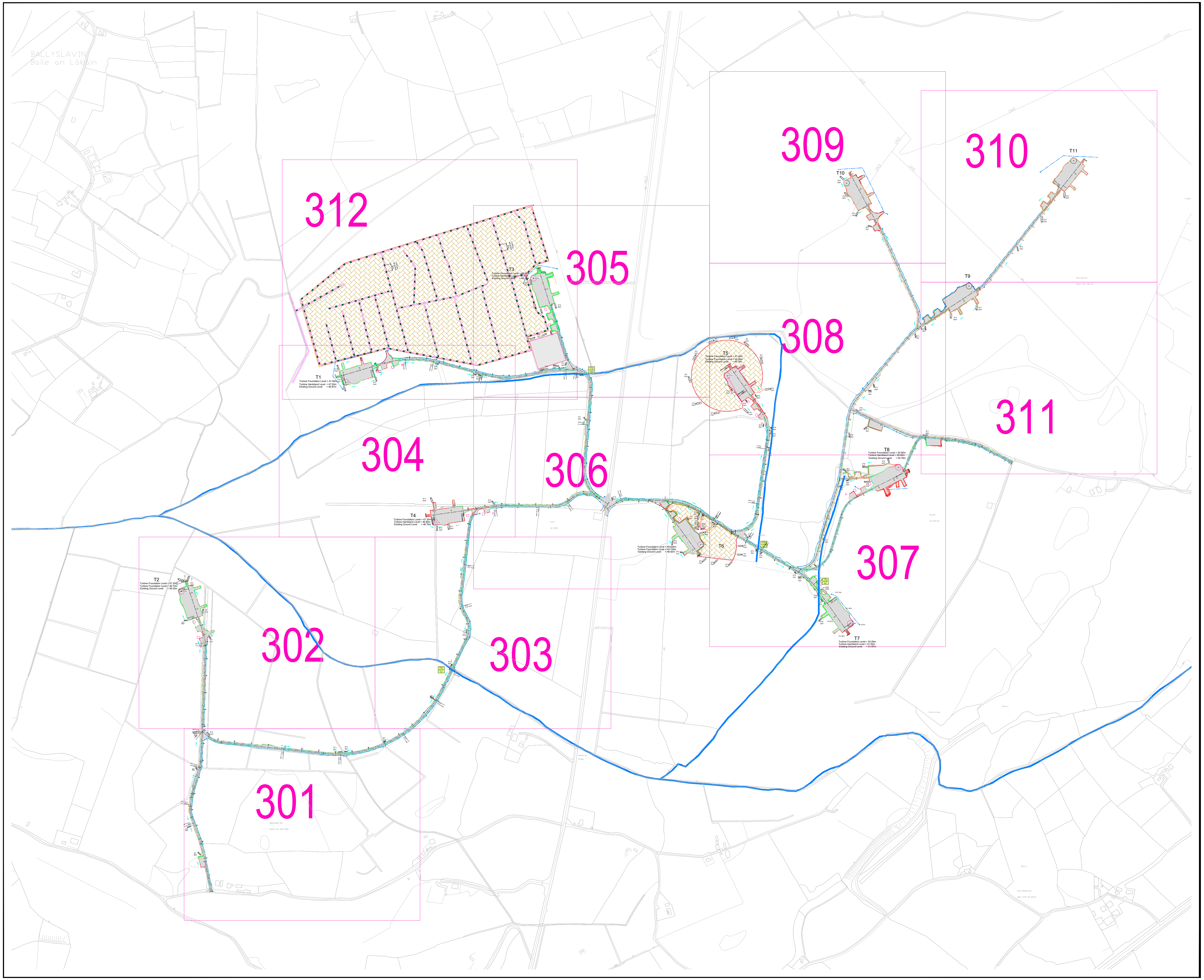
Annex 2 –

Planning-stage Drainage/Surface Water Management System



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- Proposed Hardstand
- Proposed Clean Water Drainage
- Proposed Dirty Water Drainage
- SP 12 550m² — Stilling Pond Number, Catchment Area & Flow Direction
- Proposed Culvert to Existing Open Drain
- Spoil Deposition Area

N

rev.	modifications	by	date
P01.3	Silt Ponds added to Spoil Deposition Areas, Drainage Table Updated	AMcC	23.11.23
P01.2	Spoil Deposition Areas Updated	AMcC	13.11.23
P01.1	Issued For Comment	AMcC	13.04.23

Client
Cush Wind Farm

Project
Cush Wind Farm, Co Offlay.

Stage
Planning

Title
Drainage Layout Keyplan

Scales
1:10,000 (A3)

Surveyed	Prepared By	Checked	Date
	AMcC	JMcE	16.04.2023

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Job No.	Drawing no.	Revision
6921	6921-JOD-XX-DR-C-0300	P01.3

Pond Ref. SP	Development Area (m^2)	Dim. length (m)	Dim. Width (m)	Dim. Depth (m)
1	950	8	2.8	0.75
2	800	8	2.8	0.75
3	450	4	2.8	0.75
4	1750	9	4.5	0.75
5	650	6	2.8	0.75
6	3100	14	5.2	0.75
7	1700	9	4.5	0.75
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10	1150	8	3.6	0.75
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12	550	6	2.8	0.75
13	330	4	2.8	0.75
14	1125	8	3.6	0.75
15	425	4	2.8	0.75
16	1050	8	3.6	0.75
17	2500	12	5.2	0.75
18	1500	10	3.6	0.75
19	2000	12	4.5	0.75
20	1500	10	3.6	0.75
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22	925	8	2.8	0.75
23	650	6	2.8	0.75
24	550	6	2.8	0.75
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26	1500	10	3.6	0.75
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36	1200	10	2.8	0.75
37	720	6	2.8	0.75
38	1600	12	3.6	0.75
39	1450	10	3.6	0.75
40	650	6	2.8	0.75
41	500	6	2.8	0.75
42	200	4	2.8	0.75
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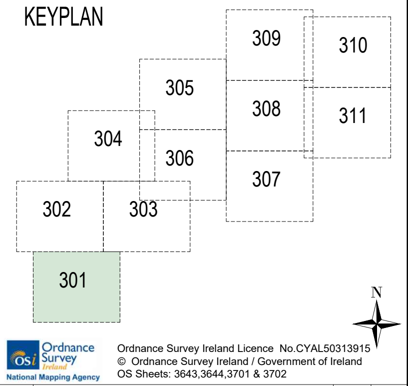
KEYPLAN



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P01.2	Silt Ponds added to Spoil Deposition Areas, Drainage Table Updated	AMcC	23.11.23
P01.1	Issued For Comment	AMcC	13.04.23

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Stage
Planning

Title
Drainage Layout Plan
Sheet 1 of 11

Scales
1:2000 (A3)

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Job No.	Drawing no.	Revision
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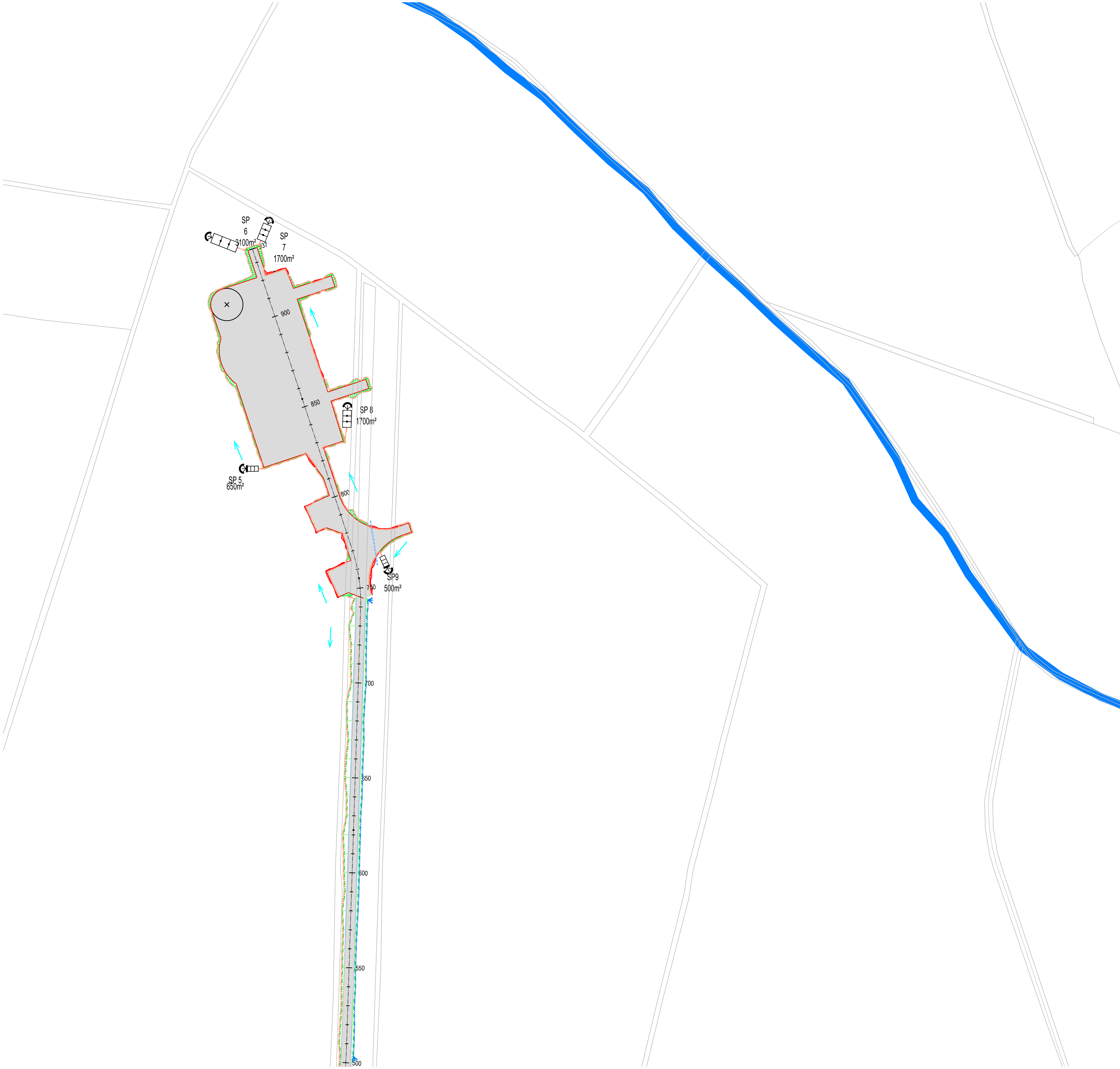

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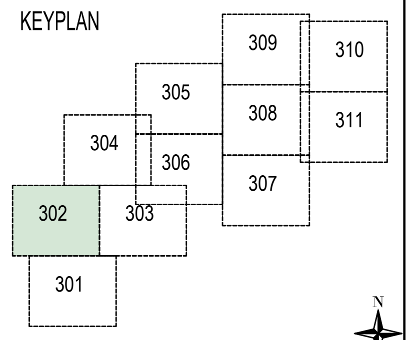

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Client
Cush Wind Farm

Project
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Stage
Planning

Title
Drainage Layout Plan
Sheet 2 of 11

Scales
1:2000 (A3)

Surveyed	Prepared By	Checked	Date
	AMcC	JMcE	16.04.2023

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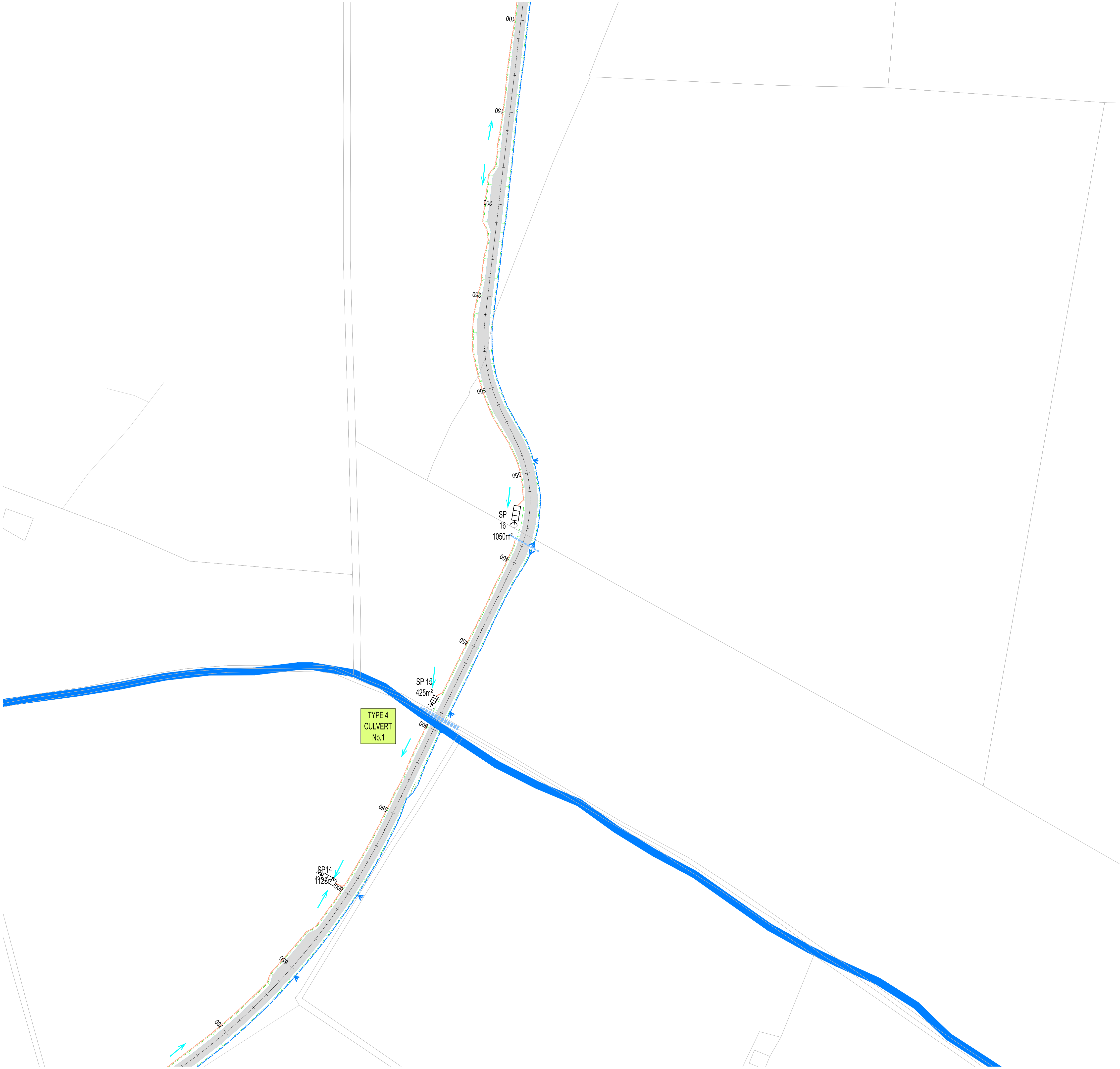
Job No.	Drawing no.	Revision
6921	6921-JOD-XX-DR-C-0302	P01.3



Pond Ref. SP	Development Area (m^2)	Dim. length (m)	Dim. Width (m)	Dim. Depth (m)
1	950	8	2.8	0.75
2	800	8	2.8	0.75
3	450	4	2.8	0.75
4	1750	9	4.5	0.75
5	650	6	2.8	0.75
6	3100	14	5.2	0.75
7	1700	9	4.5	0.75
8	1700	9	4.5	0.75
9	500	6	2.8	0.75
10	1150	8	3.6	0.75
11	825	8	2.8	0.75
12	550	6	2.8	0.75
13	330	4	2.8	0.75
14	1125	8	3.6	0.75
15	425	4	2.8	0.75
16	1050	8	3.6	0.75
17	2500	12	5.2	0.75
18	1500	10	3.6	0.75
19	2000	12	4.5	0.75
20	1500	10	3.6	0.75
21	1100	8	3.6	0.75
22	925	8	2.8	0.75
23	650	6	2.8	0.75
24	550	6	2.8	0.75
25	550	6	2.8	0.75
26	1500	10	3.6	0.75
27	1500	10	3.6	0.75
28	1750	12	3.6	0.75
29	1750	12	3.6	0.75
30	700	6	2.8	0.75
31	700	6	2.8	0.75
32	1500	10	3.6	0.75
33	1600	12	3.6	0.75
34	1600	12	3.6	0.75
35	500	6	2.8	0.75
36	1200	10	2.8	0.75
37	720	6	2.8	0.75
38	1600	12	3.6	0.75
39	1450	10	3.6	0.75
40	650	6	2.8	0.75
41	500	6	2.8	0.75
42	200	4	2.8	0.75
43	500	6	2.8	0.75
44	600	6	2.8	0.75
45	650	5	2.8	0.75
46	1600	12	3.6	0.75
47	1500	10	3.6	0.75
48	1650	12	3.6	0.75
49	400	4	2.8	0.75
50	600	6	2.8	0.75
51	1100	10	2.8	0.75
52	500	6	2.8	0.75
53	250	4	2.8	0.75
54	350	4	2.8	0.75
55	350	4	2.8	0.75
56	500	6	2.8	0.75
57	500	6	2.8	0.75
58	500	6	2.8	0.75
59	1250	8	3.6	0.75
60	3300	14	5.6	0.75
61	550	6	2.8	0.75
62	500	6	2.8	0.75
63	500	6	2.8	0.75
64	400	4	2.8	0.75
65	1550	10	3.6	0.75
66	1500	10	3.6	0.75
67	1500	10	3.6	0.75
68	750	8	2.8	0.75
69	1000	10	2.8	0.75
70	500	6	2.8	0.75
71	900	8	2.8	0.75
72	1350	10	3.6	0.75
73	400	4	2.8	0.75
74	100	4	2.8	0.75
75	750	8	2.8	0.75
76	800	8	2.8	0.75
77	2400	12	5.2	0.75
78	2400	12	5.2	0.75
79	1200	10	2.8	0.75
80	3100	14	5.6	0.75
81	2400	12	5.2	0.75
82	750	8	2.8	0.75
83	1350	10	3.6	0.75
84	2300	12	4.5	0.75
85	2300	12	4.5	0.75
A	1800	12	3.6	0.75
B	1800	12	3.6	0.75
C	1800	12	3.6	0.75
D	1800	12	3.6	0.75
E	1100	8	3.6	0.75
F	1750	12	3.6	0.75
G	1100	8	3.6	0.75
H	1750	12	3.6	0.75

NOTES:

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Legend

Proposed Access Road in Cut

Proposed Access Road in Fill

Proposed Hardstand

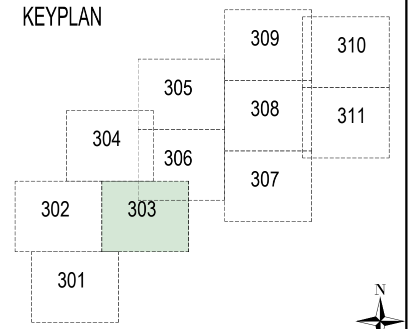
Proposed Clean Water Drainage

Proposed Dirty Water Drainage

SP 12 550m² Stilling Pond Number, Catchment Area & Flow Direction

Proposed Culvert to Existing Open Drain

KEYPLAN



rev.	modifications	by	date
P01.2	Silt Ponds added to Spoil Deposition Areas, Drainage Table Updated	AMcC	23.11.23
P01.1	Issued For Comment	AMcC	13.04.23

Client

Cush Wind Farm

Project

Cush Wind Farm, Co Offlay.

Stage

Planning

Title

Drainage Layout Plan
Sheet 3 of 11

Scales

1:2000 (A3)

Surveyed	Prepared By	Checked	Date
	AMcC	JMcE	16.04.2023

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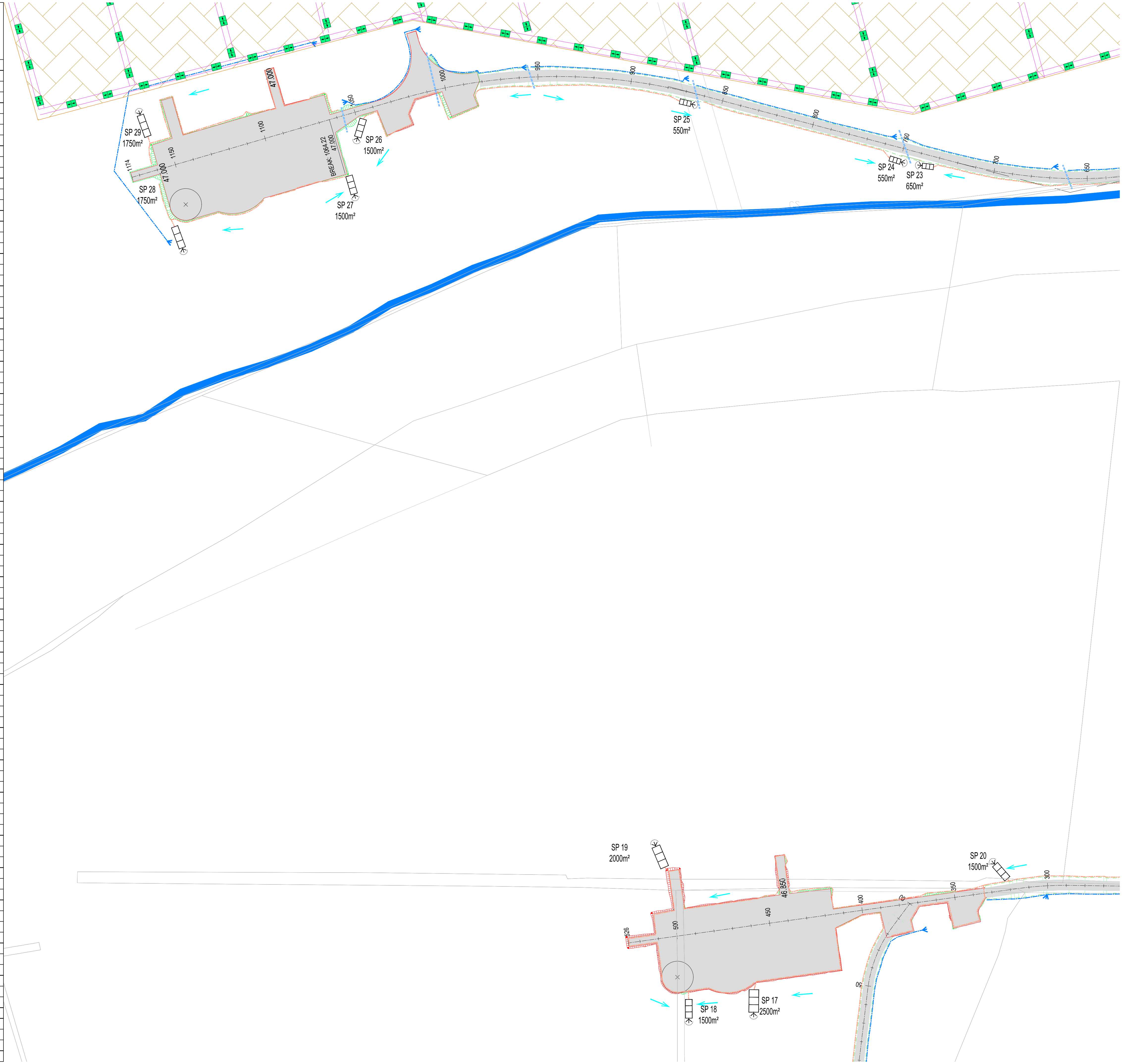
Job No.	Drawing no.	Revision
6921	6921-JOD-XX-DR-C-0303	P01.2

Pond Ref. SP	Development Area (m^2)	Dim. length (m)	Dim. Width (m)	Dim. Depth (m)
1	950	8	2.8	0.75
2	800	8	2.8	0.75
3	450	4	2.8	0.75
4	1750	9	4.5	0.75
5	650	6	2.8	0.75
6	3100	14	5.2	0.75
7	1700	9	4.5	0.75
8	1700	9	4.5	0.75
9	500	6	2.8	0.75
10	1150	8	3.6	0.75
11	825	8	2.8	0.75
12	550	6	2.8	0.75
13	330	4	2.8	0.75
14	1125	8	3.6	0.75
15	425	4	2.8	0.75
16	1050	8	3.6	0.75
17	2500	12	5.2	0.75
18	1500	10	3.6	0.75
19	2000	12	4.5	0.75
20	1500	10	3.6	0.75
21	1100	8	3.6	0.75
22	925	8	2.8	0.75
23	650	6	2.8	0.75
24	550	6	2.8	0.75
25	550	6	2.8	0.75
26	1500	10	3.6	0.75
27	1500	10	3.6	0.75
28	1750	12	3.6	0.75
29	1750	12	3.6	0.75
30	700	6	2.8	0.75
31	700	6	2.8	0.75
32	1500	10	3.6	0.75
33	1600	12	3.6	0.75
34	1600	12	3.6	0.75
35	500	6	2.8	0.75
36	1200	10	2.8	0.75
37	720	6	2.8	0.75
38	1600	12	3.6	0.75
39	1450	10	3.6	0.75
40	650	6	2.8	0.75
41	500	6	2.8	0.75
42	200	4	2.8	0.75
43	500	6	2.8	0.75
44	600	6	2.8	0.75
45	650	5	2.8	0.75
46	1600	12	3.6	0.75
47	1500	10	3.6	0.75
48	1650	12	3.6	0.75
49	400	4	2.8	0.75
50	600	6	2.8	0.75
51	1100	10	2.8	0.75
52	500	6	2.8	0.75
53	250	4	2.8	0.75
54	350	4	2.8	0.75
55	350	4	2.8	0.75
56	500	6	2.8	0.75
57	500	6	2.8	0.75
58	500	6	2.8	0.75
59	1250	8	3.6	0.75
60	3300	14	5.6	0.75
61	550	6	2.8	0.75
62	500	6	2.8	0.75
63	500	6	2.8	0.75
64	400	4	2.8	0.75
65	1550	10	3.6	0.75
66	1500	10	3.6	0.75
67	1500	10	3.6	0.75
68	750	8	2.8	0.75
69	1000	10	2.8	0.75
70	500	6	2.8	0.75
71	900	8	2.8	0.75
72	1350	10	3.6	0.75
73	400	4	2.8	0.75
74	100	4	2.8	0.75
75	750	8	2.8	0.75
76	800	8	2.8	0.75
77	2400	12	5.2	0.75
78	2400	12	5.2	0.75
79	1200	10	2.8	0.75
80	3100	14	5.6	0.75
81	2400	12	5.2	0.75
82	750	8	2.8	0.75
83	1350	10	3.6	0.75
84	2300	12	4.5	0.75
85	2300	12	4.5	0.75
A	1800	12	3.6	0.75
B	1800	12	3.6	0.75
C	1800	12	3.6	0.75
D	1800	12	3.6	0.75
E	1100	8	3.6	0.75
F	1750	12	3.6	0.75
G	1100	8	3.6	0.75
H	1750	12	3.6	0.75



NOTES:
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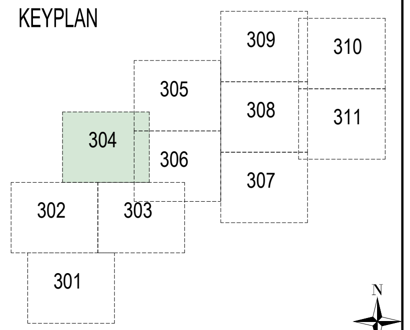
3 ENGINEER TO BE INFORMED OF ANY DISCREPANCIES BEFORE ANY WORK COMMENCES.
4 THIS DRAWING TO BE READ IN CONJUNCTION WITH ALL OTHER RELEVANT DRAWINGS AND SPECIFICATIONS.

Legend
- Proposed Access Road in Cut
- Proposed Access Road in Fill
- Proposed Hardstand
- Proposed Clean Water Drainage
- Proposed Dirty Water Drainage
- SP 12 550m² — Stilling Pond Number, Catchment Area & Flow Direction
- Proposed Culvert to Existing Open Drain
- Spoil Deposition Area

KEYPLAN



rev.	modifications	by	date
P01.3	Silt Ponds added to Spoil Deposition Areas, Drainage Table Updated	AMcC	23.11.23
P01.2	Spoil Deposition Areas Updated	AMcC	13.11.23
P01.1	Issued For Comment	AMcC	13.04.23

Client
Cush Wind Farm

Project
Cush Wind Farm, Co Offlay.

Stage
Planning

Title
Drainage Layout Plan
Sheet 4 of 11

Scales
1:2000 (A3)

Surveyed	Prepared By	Checked	Date
	AMcC	JMcE	16.04.2023

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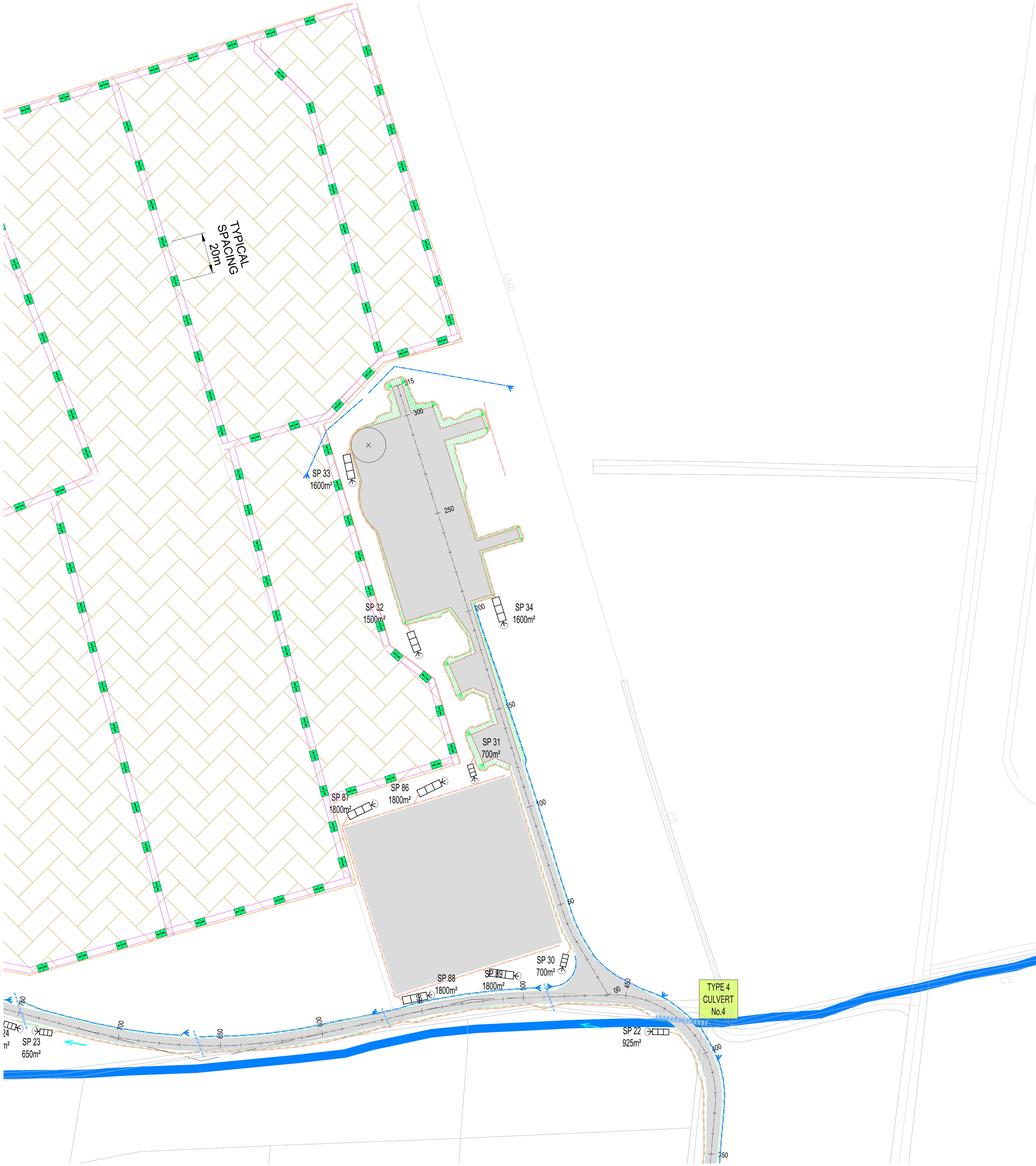
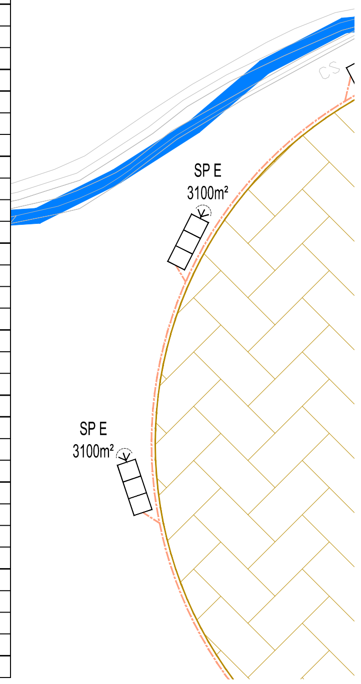
Job No.	Drawing no.	Revision
6921	6921-JOD-XX-DR-C-0304	P01.3



Pond Ref. SP	Development Area (m^2)	Dim. length (m)	Dim. Width (m)	Dim. Depth (m)
1	950	8	2.8	0.75
2	800	8	2.8	0.75
3	450	4	2.8	0.75
4	1750	9	4.5	0.75
5	650	6	2.8	0.75
6	3100	14	5.2	0.75
7	1700	9	4.5	0.75
8	1700	9	4.5	0.75
9	500	6	2.8	0.75
10	1150	8	3.6	0.75
11	825	8	2.8	0.75
12	550	6	2.8	0.75
13	330	4	2.8	0.75
14	1125	8	3.6	0.75
15	425	4	2.8	0.75
16	1050	8	3.6	0.75
17	2500	12	5.2	0.75
18	1500	10	3.6	0.75
19	2000	12	4.5	0.75
20	1500	10	3.6	0.75
21	1100	8	3.6	0.75
22	925	8	2.8	0.75
23	650	6	2.8	0.75
24	550	6	2.8	0.75
25	550	6	2.8	0.75
26	1500	10	3.6	0.75
27	1500	10	3.6	0.75
28	1750	12	3.6	0.75
29	1750	12	3.6	0.75
30	700	6	2.8	0.75
31	700	6	2.8	0.75
32	1500	10	3.6	0.75
33	1600	12	3.6	0.75
34	1600	12	3.6	0.75
35	500	6	2.8	0.75
36	1200	10	2.8	0.75
37	720	6	2.8	0.75
38	1600	12	3.6	0.75
39	1450	10	3.6	0.75
40	650	6	2.8	0.75
41	500	6	2.8	0.75
42	200	4	2.8	0.75
43	500	6	2.8	0.75
44	600	6	2.8	0.75
45	650	5	2.8	0.75
46	1600	12	3.6	0.75
47	1500	10	3.6	0.75
48	1650	12	3.6	0.75
49	400	4	2.8	0.75
50	600	6	2.8	0.75
51	1100	10	2.8	0.75
52	500	6	2.8	0.75
53	250	4	2.8	0.75
54	350	4	2.8	0.75
55	350	4	2.8	0.75
56	500	6	2.8	0.75
57	500	6	2.8	0.75
58	500	6	2.8	0.75
59	1250	8	3.6	0.75
60	3300	14	5.6	0.75
61	550	6	2.8	0.75
62	500	6	2.8	0.75
63	500	6	2.8	0.75
64	400	4	2.8	0.75
65	1550	10	3.6	0.75
66	1500	10	3.6	0.75
67	1500	10	3.6	0.75
68	750	8	2.8	0.75
69	1000	10	2.8	0.75
70	500	6	2.8	0.75
71	900	8	2.8	0.75
72	1350	10	3.6	0.75
73	400	4	2.8	0.75
74	100	4	2.8	0.75
75	750	8	2.8	0.75
76	800	8	2.8	0.75
77	2400	12	5.2	0.75
78	2400	12	5.2	0.75
79	1200	10	2.8	0.75
80	3100	14	5.6	0.75
81	2400	12	5.2	0.75
82	750	8	2.8	0.75
83	1350	10	3.6	0.75
84	2300	12	4.5	0.75
85	2300	12	4.5	0.75
A	1800	12	3.6	0.75
B	1800	12	3.6	0.75
C	1800	12	3.6	0.75
D	1800	12	3.6	0.75
E	1100	8	3.6	0.75
F	1750	12	3.6	0.75
G	1100	8	3.6	0.75
H	1750	12	3.6	0.75



NOTES:
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Legend

- Proposed Access Road in Cut
- Proposed Access Road in Fill
- Proposed Hardstand
- Proposed Clean Water Drainage
- Proposed Dirty Water Drainage
- SP 12 550m² Stilling Pond Number, Catchment Area & Flow Direction
- Proposed Culvert to Existing Open Drain
- Proposed Double Silt Fence As Detail Drawing 6921-JOD-XX-DR-C-0324
- Proposed Drainage Check Weir (20m Intervals) As Detail Drawing 6921-JOD-XX-DR-C-0321
- Proposed Spoil Deposition Area

KEYPLAN

309 310 305 308 311 304 306 307 302 303 301

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OS Sheets: 3643,3644,3701 & 3702

rev.	modifications	by	date
P01.3	Silt Ponds added to Spoil Deposition Areas, Drainage Table Updated	AMcC	23.11.23
P01.2	Spoil Deposition Areas Updated	AMcC	13.11.23
P01.1	Issued For Comment	AMcC	13.04.23

Client
Cush Wind Farm

Project
Cush Wind Farm, Co Offlay.

Stage
Planning

Title
Soil Deposition Area
Silt Fencing Layout Plan

Scales
1:2500 (A3)

Surveyed	Prepared By	Checked	Date
	AMcC	JMcE	24.04.2023

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Job No.	Drawing no.	Revision
6921	6921-JOD-XX-DR-C-0305	P01.3

Pond Ref. SP	Development Area (m^2)	Dim. length (m)	Dim. Width (m)	Dim. Depth (m)
1	950	8	2.8	0.75
2	800	8	2.8	0.75
3	450	4	2.8	0.75
4	1750	9	4.5	0.75
5	650	6	2.8	0.75
6	3100	14	5.2	0.75
7	1700	9	4.5	0.75
8	1700	9	4.5	0.75
9	500	6	2.8	0.75
10	1150	8	3.6	0.75
11	825	8	2.8	0.75
12	550	6	2.8	0.75
13	330	4	2.8	0.75
14	1125	8	3.6	0.75
15	425	4	2.8	0.75
16	1050	8	3.6	0.75
17	2500	12	5.2	0.75
18	1500	10	3.6	0.75
19	2000	12	4.5	0.75
20	1500	10	3.6	0.75
21	1100	8	3.6	0.75
22	925	8	2.8	0.75
23	650	6	2.8	0.75
24	550	6	2.8	0.75
25	550	6	2.8	0.75
26	1500	10	3.6	0.75
27	1500	10	3.6	0.75
28	1750	12	3.6	0.75
29	1750	12	3.6	0.75
30	700	6	2.8	0.75
31	700	6	2.8	0.75
32	1500	10	3.6	0.75
33	1600	12	3.6	0.75
34	1600	12	3.6	0.75
35	500	6	2.8	0.75
36	1200	10	2.8	0.75
37	720	6	2.8	0.75
38	1600	12	3.6	0.75
39	1450	10	3.6	0.75
40	650	6	2.8	0.75
41	500	6	2.8	0.75
42	200	4	2.8	0.75
43	500	6	2.8	0.75
44	600	6	2.8	0.75
45	650	5	2.8	0.75
46	1600	12	3.6	0.75

Pond Ref. SP	Development Area (m^2)	Dim. length (m)	Dim. Width (m)	Dim. Depth (m)
47	1500	10	3.6	0.75
48	1650	12	3.6	0.75
49	400	4	2.8	0.75
50	600	6	2.8	0.75
51	1100	10	2.8	0.75
52	500	6	2.8	0.75
53	250	4	2.8	0.75
54	350	4	2.8	0.75
55	350	4	2.8	0.75
56	500	6	2.8	0.75
57	500	6	2.8	0.75
58	500	6	2.8	0.75
59	1250	8	3.6	0.75
60	3300	14	5.6	0.75
61	550	6	2.8	0.75
62	500	6	2.8	0.75
63	500	6	2.8	0.75
64	400	4	2.8	0.75
65	1550	10	3.6	0.75
66	1500	10	3.6	0.75
67	1500	10	3.6	0.75
68	750	8	2.8	0.75
69	1000	10	2.8	0.75
70	500	6	2.8	0.75
71	900	8	2.8	0.75
72	1350	10	3.6	0.75
73	400	4	2.8	0.75
74	100	4	2.8	0.75
75	750	8	2.8	0.75
76	800	8	2.8	0.75
77	2400	12	5.2	0.75
78	2400	12	5.2	0.75
79	1200	10	2.8	0.75
80	3100	14	5.6	0.75
81	2400	12	5.2	0.75
82	750	8	2.8	0.75
83	1350	10	3.6	0.75
84	2300	12	4.5	0.75
85	2300	12	4.5	0.75
A	1800	12	3.6	0.75
B	1800	12	3.6	0.75
C	1800	12	3.6	0.75
D	1800	12	3.6	0.75
E	1100	8	3.6	0.75
F	1750	12	3.6	0.75
G	1100	8	3.6	0.75
H	1750	12	3.6	0.75

NOTES:

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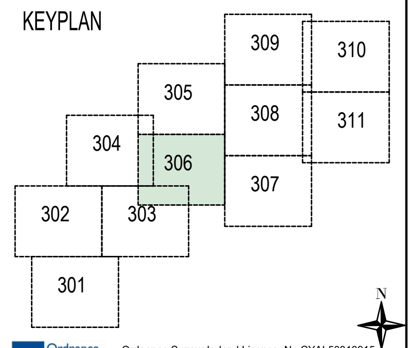
Legend

- Proposed Access Road in Cut
- Proposed Access Road in Fill
- Proposed Hardstand
- Proposed Clean Water Drainage
- Proposed Dirty Water Drainage
- SP 12 550m² Stilling Pond Number, Catchment Area & Flow Direction
- Proposed Culvert to Existing Open Drain
- Spoil Deposition Area

KEYPLAN



rev.	modifications	by	date
P01.3	Silt Ponds added to Spoil Deposition Areas, Drainage Table Updated	AMcC	23.11.23
P01.2	Spoil Deposition Areas Updated	AMcC	13.11.23
P01.1	Issued For Comment	AMcC	13.04.23

Client
Cush Wind Farm

Project
Cush Wind Farm, Co Offlay.

Stage
Planning

Title
Drainage Layout Plan
Sheet 6 of 11

Scales
1:2000 (A3)

Surveyed	Prepared By	Checked	Date
	AMcC	JMcE	16.04.2023

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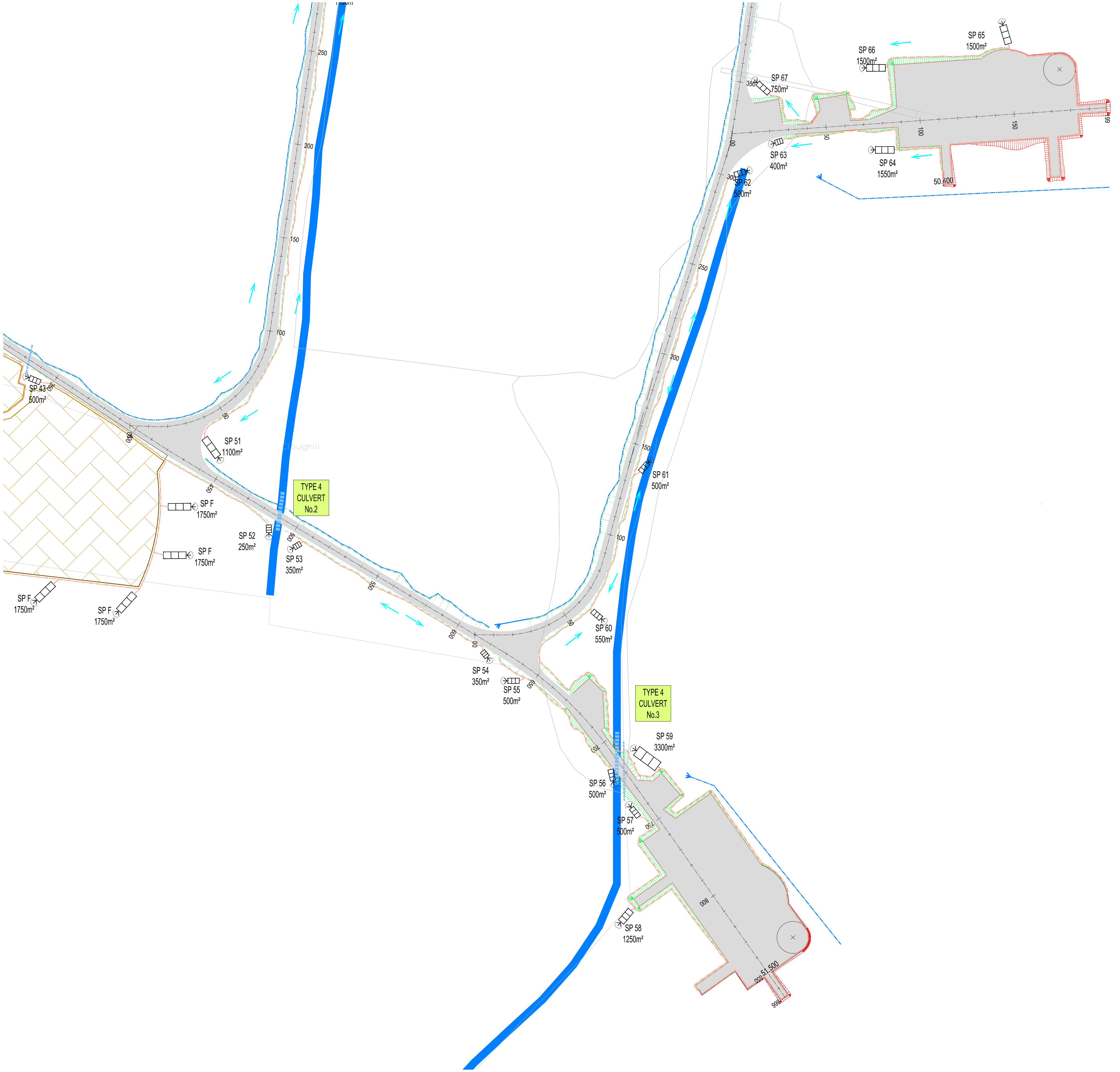
Job No.	Drawing no.	Revision
6921	6921-JOD-XX-DR-C-0306	P01.3



Pond Ref. SP	Development Area (m^2)	Dim. length (m)	Dim. Width (m)	Dim. Depth (m)
1	950	8	2.8	0.75
2	800	8	2.8	0.75
3	450	4	2.8	0.75
4	1750	9	4.5	0.75
5	650	6	2.8	0.75
6	3100	14	5.2	0.75
7	1700	9	4.5	0.75
8	1700	9	4.5	0.75
9	500	6	2.8	0.75
10	1150	8	3.6	0.75
11	825	8	2.8	0.75
12	550	6	2.8	0.75
13	330	4	2.8	0.75
14	1125	8	3.6	0.75
15	425	4	2.8	0.75
16	1050	8	3.6	0.75
17	2500	12	5.2	0.75
18	1500	10	3.6	0.75
19	2000	12	4.5	0.75
20	1500	10	3.6	0.75
21	1100	8	3.6	0.75
22	925	8	2.8	0.75
23	650	6	2.8	0.75
24	550	6	2.8	0.75
25	550	6	2.8	0.75
26	1500	10	3.6	0.75
27	1500	10	3.6	0.75
28	1750	12	3.6	0.75
29	1750	12	3.6	0.75
30	700	6	2.8	0.75
31	700	6	2.8	0.75
32	1500	10	3.6	0.75
33	1600	12	3.6	0.75
34	1600	12	3.6	0.75
35	500	6	2.8	0.75
36	1200	10	2.8	0.75
37	720	6	2.8	0.75
38	1600	12	3.6	0.75
39	1450	10	3.6	0.75
40	650	6	2.8	0.75
41	500	6	2.8	0.75
42	200	4	2.8	0.75
43	500	6	2.8	0.75
44	600	6	2.8	0.75
45	650	5	2.8	0.75
46	1600	12	3.6	0.75
47	1500	10	3.6	0.75
48	1650	12	3.6	0.75
49	400	4	2.8	0.75
50	600	6	2.8	0.75
51	1100	10	2.8	0.75
52	500	6	2.8	0.75
53	250	4	2.8	0.75
54	350	4	2.8	0.75
55	350	4	2.8	0.75
56	500	6	2.8	0.75
57	500	6	2.8	0.75
58	500	6	2.8	0.75
59	1250	8	3.6	0.75
60	3300	14	5.6	0.75
61	550	6	2.8	0.75
62	500	6	2.8	0.75
63	500	6	2.8	0.75
64	400	4	2.8	0.75
65	1550	10	3.6	0.75
66	1500	10	3.6	0.75
67	1500	10	3.6	0.75
68	750	8	2.8	0.75
69	1000	10	2.8	0.75
70	500	6	2.8	0.75
71	900	8	2.8	0.75
72	1350	10	3.6	0.75
73	400	4	2.8	0.75
74	100	4	2.8	0.75
75	750	8	2.8	0.75
76	800	8	2.8	0.75
77	2400	12	5.2	0.75
78	2400	12	5.2	0.75
79	1200	10	2.8	0.75
80	3100	14	5.6	0.75
81	2400	12	5.2	0.75
82	750	8	2.8	0.75
83	1350	10	3.6	0.75
84	2300	12	4.5	0.75
85	2300	12	4.5	0.75
A	1800	12	3.6	0.75
B	1800	12	3.6	0.75
C	1800	12	3.6	0.75
D	1800	12	3.6	0.75
E	1100	8	3.6	0.75
F	1750	12	3.6	0.75
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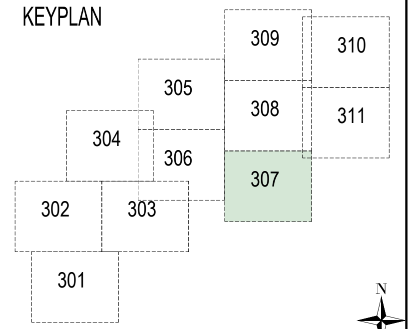
Legend

- Proposed Access Road in Cut
- Proposed Access Road in Fill
- Proposed Hardstand
- Proposed Clean Water Drainage
- Proposed Dirty Water Drainage
- SP 12 550m² Stilling Pond Number, Catchment Area & Flow Direction
- Proposed Culvert to Existing Open Drain
- Spoil Deposition Area

KEYPLAN



rev.	modifications	by	date
P01.3	Silt Ponds added to Spoil Deposition Areas, Drainage Table Updated	AMcC	23.11.23
P01.2	Spoil Deposition Areas Updated	AMcC	13.11.23
P01.1	Issued For Comment	AMcC	13.04.23

Client
Cush Wind Farm

Project
Cush Wind Farm, Co Offlay.

Stage
Planning

Title
Drainage Layout Plan
Sheet 7 of 11

Scales
1:2000 (A3)

Surveyed	Prepared By	Checked	Date
	AMcC	JMcE	16.04.2023

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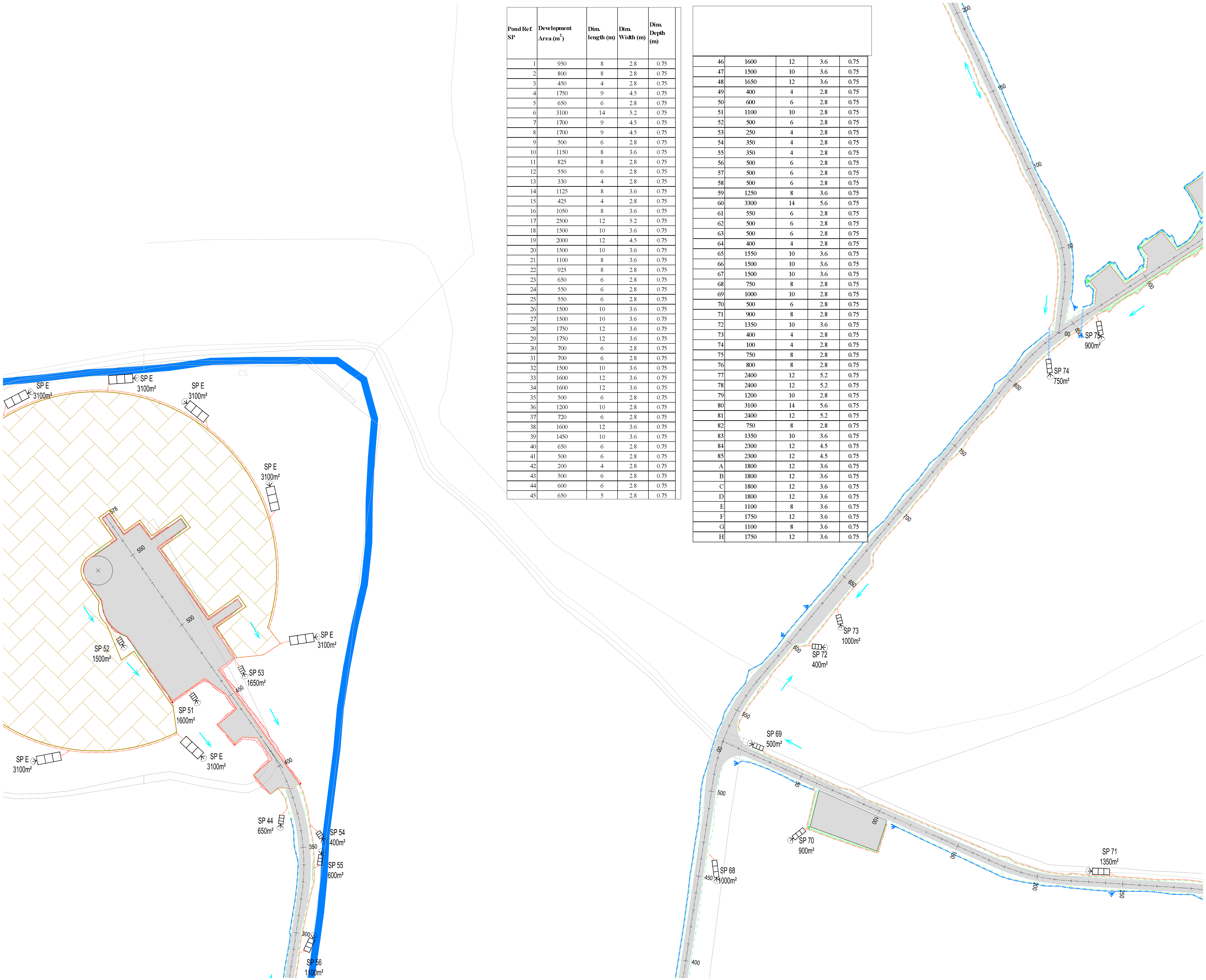
Job No.	Drawing no.	Revision
6921	6921-JOD-XX-DR-C-0307	P01.3



Pond Ref. SP	Development Area (m^2)	Dim. length (m)	Dim. Width (m)	Dim. Depth (m)
1	950	8	2.8	0.75
2	800	8	2.8	0.75
3	450	4	2.8	0.75
4	1750	9	4.5	0.75
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9	500	6	2.8	0.75
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11	825	8	2.8	0.75
12	550	6	2.8	0.75
13	330	4	2.8	0.75
14	1125	8	3.6	0.75
15	425	4	2.8	0.75
16	1050	8	3.6	0.75
17	2500	12	5.2	0.75
18	1500	10	3.6	0.75
19	2000	12	4.5	0.75
20	1500	10	3.6	0.75
21	1100	8	3.6	0.75
22	925	8	2.8	0.75
23	650	6	2.8	0.75
24	550	6	2.8	0.75
25	550	6	2.8	0.75
26	1500	10	3.6	0.75
27	1500	10	3.6	0.75
28	1750	12	3.6	0.75
29	1750	12	3.6	0.75
30	700	6	2.8	0.75
31	700	6	2.8	0.75
32	1500	10	3.6	0.75
33	1600	12	3.6	0.75
34	1600	12	3.6	0.75
35	500	6	2.8	0.75
36	1200	10	2.8	0.75
37	720	6	2.8	0.75
38	1600	12	3.6	0.75
39	1450	10	3.6	0.75
40	650	6	2.8	0.75
41	500	6	2.8	0.75
42	200	4	2.8	0.75
43	500	6	2.8	0.75
44	600	6	2.8	0.75
45	650	5	2.8	0.75
46	1600	12	3.6	0.75
47	1500	10	3.6	0.75
48	1650	12	3.6	0.75
49	400	4	2.8	0.75
50	600	6	2.8	0.75
51	1100	10	2.8	0.75
52	500	6	2.8	0.75
53	250	4	2.8	0.75
54	350	4	2.8	0.75
55	350	4	2.8	0.75
56	500	6	2.8	0.75
57	500	6	2.8	0.75
58	500	6	2.8	0.75
59	1250	8	3.6	0.75
60	3300	14	5.6	0.75
61	550	6	2.8	0.75
62	500	6	2.8	0.75
63	500	6	2.8	0.75
64	400	4	2.8	0.75
65	1550	10	3.6	0.75
66	1500	10	3.6	0.75
67	1500	10	3.6	0.75
68	750	8	2.8	0.75
69	1000	10	2.8	0.75
70	500	6	2.8	0.75
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74	100	4	2.8	0.75
75	750	8	2.8	0.75
76	800	8	2.8	0.75
77	2400	12	5.2	0.75
78	2400	12	5.2	0.75
79	1200	10	2.8	0.75
80	3100	14	5.6	0.75
81	2400	12	5.2	0.75
82	750	8	2.8	0.75
83	1350	10	3.6	0.75
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85	2300	12	4.5	0.75
A	1800	12	3.6	0.75
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D	1800	12	3.6	0.75
E	1100	8	3.6	0.75
F	1750	12	3.6	0.75
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KEYPLAN

309 310 305 308 311 304 306 307 302 303 301

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OS Sheets: 3643,3644,3701 & 3702

rev.	modifications	by	date
P01.3	Silt Ponds added to Spoil Deposition Areas, Drainage Table Updated	AMcC	23.11.23
P01.2	Spoil Deposition Areas Updated	AMcC	13.11.23
P01.1	Issued For Comment	AMcC	13.04.23

Client

Cush Wind Farm

Project

Cush Wind Farm, Co Offlay.

Stage

Planning

Title

Drainage Layout Plan
Sheet 8 of 11

Scales

1:2000 (A3)

Surveyed	Prepared By	Checked	Date
	AMcC	JMcE	16.04.2023

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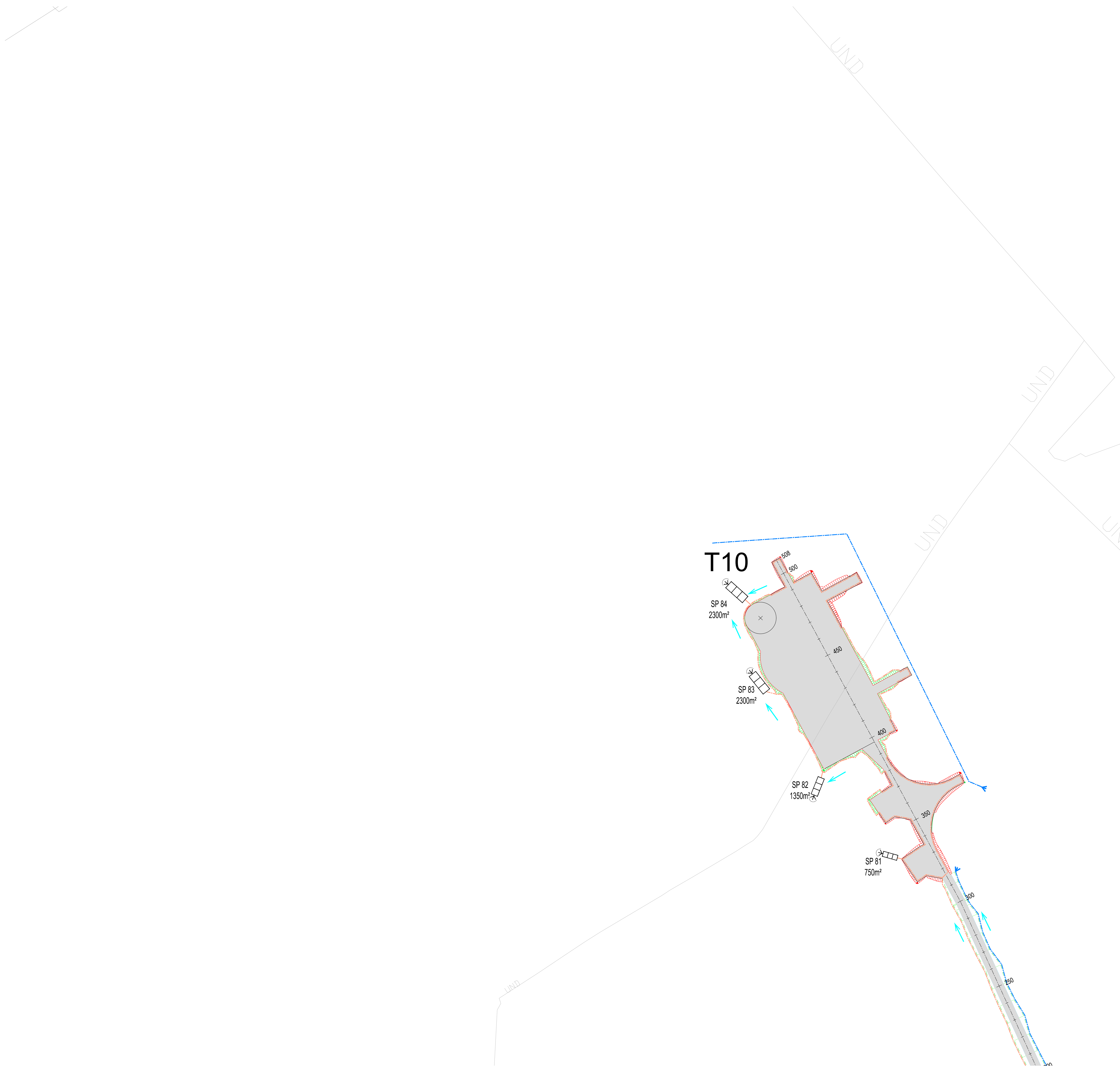
Job No.	Drawing no.	Revision
6921	6921-JOD-XX-DR-C-0308	P01.3



Pond Ref. SP	Development Area (m^2)	Dim. length (m)	Dim. Width (m)	Dim. Depth (m)
1	950	8	2.8	0.75
2	800	8	2.8	0.75
3	450	4	2.8	0.75
4	1750	9	4.5	0.75
5	650	6	2.8	0.75
6	3100	14	5.2	0.75
7	1700	9	4.5	0.75
8	1700	9	4.5	0.75
9	500	6	2.8	0.75
10	1150	8	3.6	0.75
11	825	8	2.8	0.75
12	550	6	2.8	0.75
13	330	4	2.8	0.75
14	1125	8	3.6	0.75
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16	1050	8	3.6	0.75
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22	925	8	2.8	0.75
23	650	6	2.8	0.75
24	550	6	2.8	0.75
25	550	6	2.8	0.75
26	1500	10	3.6	0.75
27	1500	10	3.6	0.75
28	1750	12	3.6	0.75
29	1750	12	3.6	0.75
30	700	6	2.8	0.75
31	700	6	2.8	0.75
32	1500	10	3.6	0.75
33	1600	12	3.6	0.75
34	1600	12	3.6	0.75
35	500	6	2.8	0.75
36	1200	10	2.8	0.75
37	720	6	2.8	0.75
38	1600	12	3.6	0.75
39	1450	10	3.6	0.75
40	650	6	2.8	0.75
41	500	6	2.8	0.75
42	200	4	2.8	0.75
43	500	6	2.8	0.75
44	600	6	2.8	0.75
45	650	5	2.8	0.75
46	1600	12	3.6	0.75
47	1500	10	3.6	0.75
48	1650	12	3.6	0.75
49	400	4	2.8	0.75
50	600	6	2.8	0.75
51	1100	10	2.8	0.75
52	500	6	2.8	0.75
53	250	4	2.8	0.75
54	350	4	2.8	0.75
55	350	4	2.8	0.75
56	500	6	2.8	0.75
57	500	6	2.8	0.75
58	500	6	2.8	0.75
59	1250	8	3.6	0.75
60	3300	14	5.6	0.75
61	550	6	2.8	0.75
62	500	6	2.8	0.75
63	500	6	2.8	0.75
64	400	4	2.8	0.75
65	1550	10	3.6	0.75
66	1500	10	3.6	0.75
67	1500	10	3.6	0.75
68	750	8	2.8	0.75
69	1000	10	2.8	0.75
70	500	6	2.8	0.75
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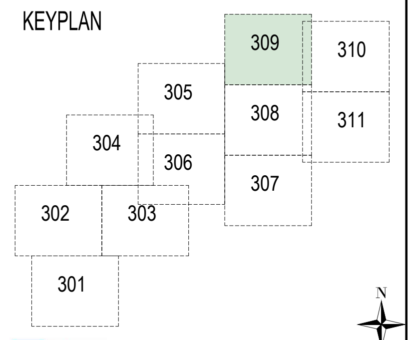
SP 12
550m² Stilling Pond Number, Catchment Area & Flow Direction
Proposed Culvert to Existing Open Drain

KEYPLAN



rev.	modifications	by	date
P01.2	Silt Ponds added to Spoil Deposition Areas, Drainage Table Updated	AMcC	23.11.23
P01.1	Issued For Comment	AMcC	13.04.23

Client
Cush Wind Farm

Project
Cush Wind Farm, Co Offlay.

Stage
Planning

Title
Drainage Layout Plan
Sheet 9 of 11

Scales
1:2000 (A3)

Surveyed	Prepared By	Checked	Date
	AMcC	JMcE	16.04.2023

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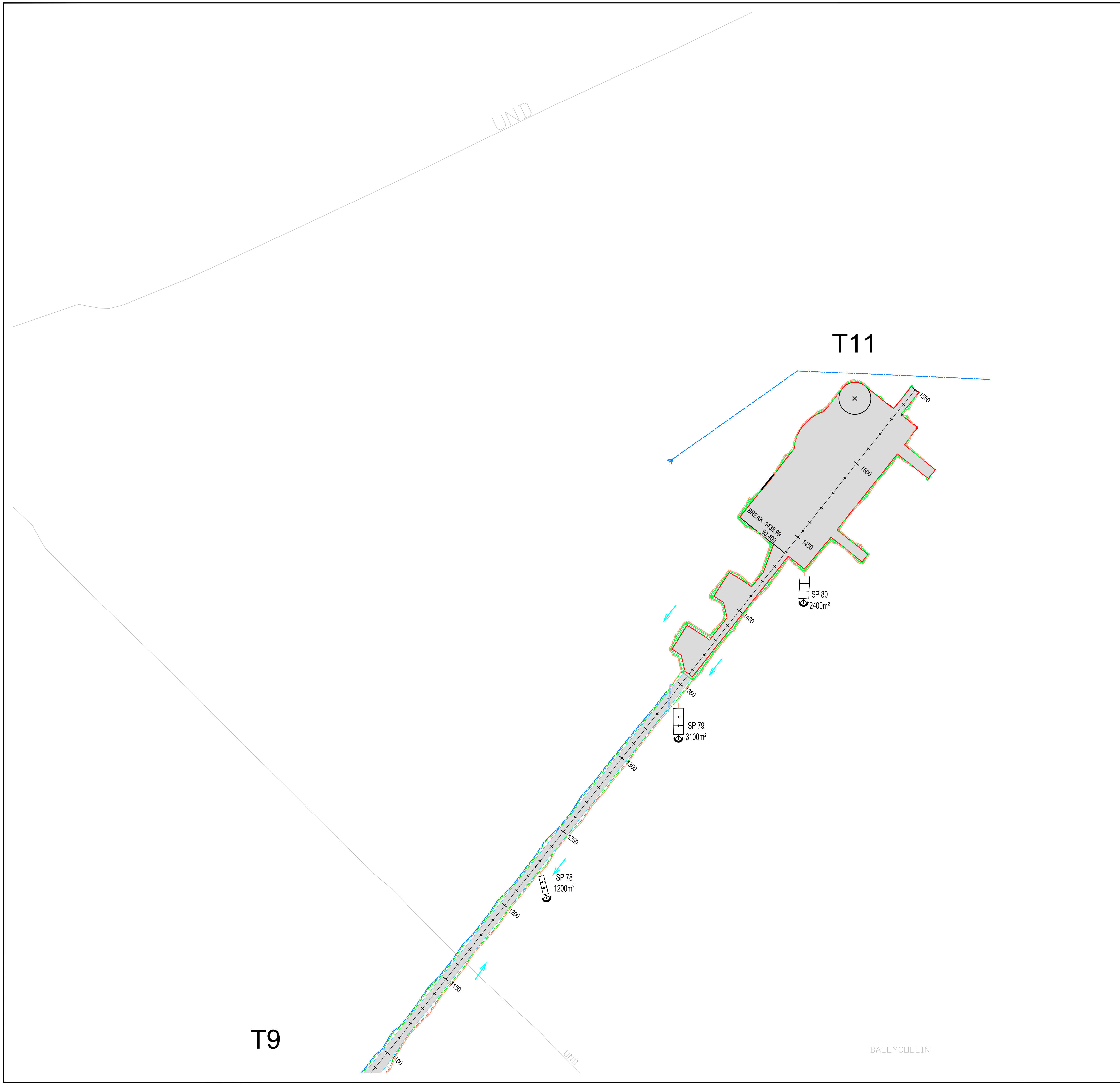
Job No.	Drawing no.	Revision
6921	6921-JOD-XX-DR-C-0309	P01.2



Pond Ref. SP	Development Area (m²)	Dim. length (m)	Dim. Width (m)	Dim. Depth (m)
1	950	8	2.8	0.75
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26	1500	10	3.6	0.75
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29	1750	12	3.6	0.75
30	700	6	2.8	0.75
31	700	6	2.8	0.75
32	1500	10	3.6	0.75
33	1600	12	3.6	0.75
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62	500	6	2.8	0.75
63	500	6	2.8	0.75
64	400	4	2.8	0.75
65	1550	10	3.6	0.75
66	1500	10	3.6	0.75
67	1500	10	3.6	0.75
68	750	8	2.8	0.75
69	1000	10	2.8	0.75
70	500	6	2.8	0.75
71	900	8	2.8	0.75
72	1350	10	3.6	0.75
73	400	4	2.8	0.75
74	100	4	2.8	0.75
75	750	8	2.8	0.75
76	800	8	2.8	0.75
77	2400	12	5.2	0.75
78	2400	12	5.2	0.75
79	1200	10	2.8	0.75
80	3100	14	5.6	0.75
81	2400	12	5.2	0.75
82	750	8	2.8	0.75
83	1350	10	3.6	0.75
84	2300	12	4.5	0.75
85	2300	12	4.5	0.75
A	1800	12	3.6	0.75
B	1800	12	3.6	0.75
C	1800	12	3.6	0.75
D	1800	12	3.6	0.75
E	1100	8	3.6	0.75
F	1750	12	3.6	0.75
G	1100	8	3.6	0.75
H	1750	12	3.6	0.75

NOTES:

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Legend

Proposed Access Road in Cut

Proposed Access Road in Fill

Proposed Hardstand

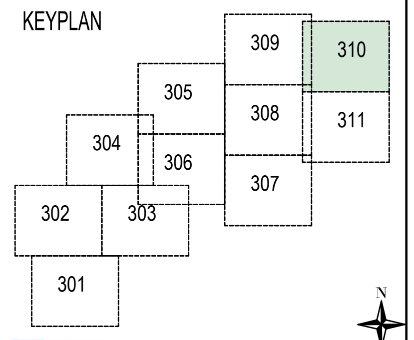
Proposed Clean Water Drainage

Proposed Dirty Water Drainage

SP 12
550m²
Stilling Pond Number, Catchment Area & Flow Direction

Proposed Culvert to Existing Open Drain

KEYPLAN



Ordnance Survey Ireland
National Mapping Agency

rev.	modifications	by	date
P01.2	Silt Ponds added to Spoil Deposition Areas, Drainage Table Updated	AMcC	23.11.23
P01.1	Issued For Comment	AMcC	13.04.23

Client
Cush Wind Farm

Project
Cush Wind Farm, Co Offlay.

Stage
Planning

Title
Drainage Layout Plan
Sheet 10 of 11

Scales
1:2000 (A3)

Surveyed	Prepared By	Checked	Date
	AMcC	JMcE	16.04.2023

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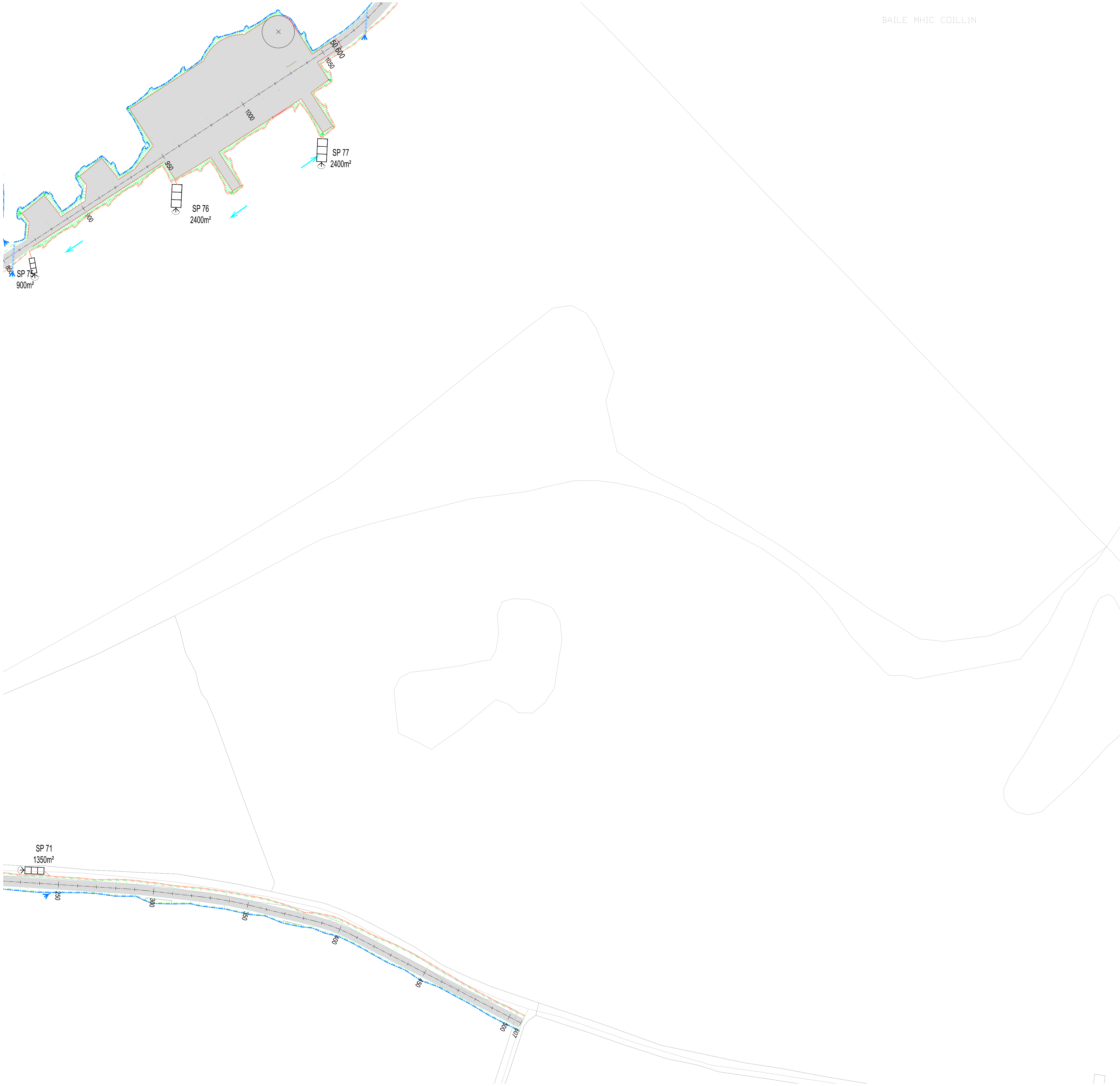
Job No.	Drawing no.	Revision
6921	6921-JOD-XX-DR-C-0310	P01.2



Pond Ref. SP	Development Area (m^2)	Dim. length (m)	Dim. Width (m)	Dim. Depth (m)
1	950	8	2.8	0.75
2	800	8	2.8	0.75
3	450	4	2.8	0.75
4	1750	9	4.5	0.75
5	650	6	2.8	0.75
6	3100	14	5.2	0.75
7	1700	9	4.5	0.75
8	1700	9	4.5	0.75
9	500	6	2.8	0.75
10	1150	8	3.6	0.75
11	825	8	2.8	0.75
12	550	6	2.8	0.75
13	330	4	2.8	0.75
14	1125	8	3.6	0.75
15	425	4	2.8	0.75
16	1050	8	3.6	0.75
17	2500	12	5.2	0.75
18	1500	10	3.6	0.75
19	2000	12	4.5	0.75
20	1500	10	3.6	0.75
21	1100	8	3.6	0.75
22	925	8	2.8	0.75
23	650	6	2.8	0.75
24	550	6	2.8	0.75
25	550	6	2.8	0.75
26	1500	10	3.6	0.75
27	1500	10	3.6	0.75
28	1750	12	3.6	0.75
29	1750	12	3.6	0.75
30	700	6	2.8	0.75
31	700	6	2.8	0.75
32	1500	10	3.6	0.75
33	1600	12	3.6	0.75
34	1600	12	3.6	0.75
35	500	6	2.8	0.75
36	1200	10	2.8	0.75
37	720	6	2.8	0.75
38	1600	12	3.6	0.75
39	1450	10	3.6	0.75
40	650	6	2.8	0.75
41	500	6	2.8	0.75
42	200	4	2.8	0.75
43	500	6	2.8	0.75
44	600	6	2.8	0.75
45	650	5	2.8	0.75
46	1600	12	3.6	0.75
47	1500	10	3.6	0.75
48	1650	12	3.6	0.75
49	400	4	2.8	0.75
50	600	6	2.8	0.75
51	1100	10	2.8	0.75
52	500	6	2.8	0.75
53	250	4	2.8	0.75
54	350	4	2.8	0.75
55	350	4	2.8	0.75
56	500	6	2.8	0.75
57	500	6	2.8	0.75
58	500	6	2.8	0.75
59	1250	8	3.6	0.75
60	3300	14	5.6	0.75
61	550	6	2.8	0.75
62	500	6	2.8	0.75
63	500	6	2.8	0.75
64	400	4	2.8	0.75
65	1550	10	3.6	0.75
66	1500	10	3.6	0.75
67	1500	10	3.6	0.75
68	750	8	2.8	0.75
69	1000	10	2.8	0.75
70	500	6	2.8	0.75
71	900	8	2.8	0.75
72	1350	10	3.6	0.75
73	400	4	2.8	0.75
74	100	4	2.8	0.75
75	750	8	2.8	0.75
76	800	8	2.8	0.75
77	2400	12	5.2	0.75
78	2400	12	5.2	0.75
79	1200	10	2.8	0.75
80	3100	14	5.6	0.75
81	2400	12	5.2	0.75
82	750	8	2.8	0.75
83	1350	10	3.6	0.75
84	2300	12	4.5	0.75
85	2300	12	4.5	0.75
A	1800	12	3.6	0.75
B	1800	12	3.6	0.75
C	1800	12	3.6	0.75
D	1800	12	3.6	0.75
E	1100	8	3.6	0.75
F	1750	12	3.6	0.75
G	1100	8	3.6	0.75
H	1750	12	3.6	0.75

NOTES:

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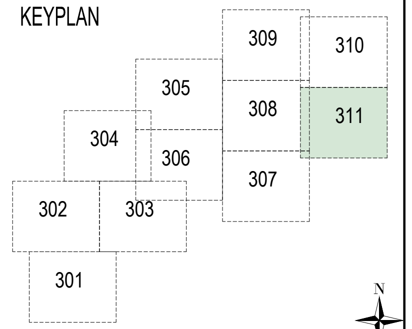
Legend

- Proposed Access Road in Cut
- Proposed Access Road in Fill
- Proposed Hardstand
- Proposed Clean Water Drainage
- Proposed Dirty Water Drainage
- SP 12 550m² Stilling Pond Number, Catchment Area & Flow Direction
- Proposed Culvert to Existing Open Drain

KEYPLAN



rev.	modifications	by	date
P01.2	Silt Ponds added to Spoil Deposition Areas, Drainage Table Updated	AMcC	23.11.23
P01.1	Issued For Comment	AMcC	13.04.23

Client
Cush Wind Farm

Project
Cush Wind Farm, Co Offlay.

Stage
Planning

Title
Drainage Layout Plan
Sheet 11 of 11

Scales
1:2000 (A3)

Surveyed	Prepared By	Checked	Date
	AMcC	JMcE	16.04.2023

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Web. www.jodireland.com

Job No.	Drawing no.	Revision
6921	6921-JOD-XX-DR-C-0311	P01.2

NOTES:
1 FIGURED DIMENSIONS ONLY TO BE TAKEN FROM THIS DRAWING.
2 ALL DRAWINGS TO BE CHECKED BY THE CONTRACTOR ON SITE.
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4 THIS DRAWING TO BE READ IN CONJUNCTION WITH ALL OTHER RELEVANT DRAWINGS AND SPECIFICATIONS.

Legend

- Proposed Access Road in Cut
- Proposed Access Road in Fill
- Proposed Hardstand
- Proposed Clean Water Drainage
- Proposed Dirty Water Drainage
- SP 12 550m² — Stilling Pond Number, Catchment Area & Flow Direction
- Proposed Culvert to Existing Open Drain
- Proposed Double Silt Fence As Detail Drawing 6921-JOD-XX-DR-C-0324
- Proposed Drainage Check Weir (20m Intervals) As Detail Drawing 6921-JOD-XX-DR-C-0321
- Proposed Spoil Deposition Area

KEYPLAN

312

rev.	modifications	by	date
P01.3	Spoil Deposition Area Updated	AMcC	13.11.23
P01.2	Issued For Comment, Site layout revised and drainage revised accordingly	AMcC	04.09.23
P01.1	Issued For Comment	AMcC	13.04.23
P01.1	Issued For Comment	AMcC	13.04.23

Client
Cush Wind Farm

Project
Cush Wind Farm, Co Offlay.

Stage
Planning

Title
Soil Deposition Area Silt Fencing Layout Plan

Scales
1:2500 (A3)

Surveyed	Prepared By	Checked	Date
	AMcC	JMcE	24.04.2023

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Job No.	Drawing no.	Revision
6921	6921-JOD-XX-DR-C-0312	P01.3

Annex 3 –
Rainfall Data

Met Eireann
Return Period Rainfall Depths for sliding Durations
Irish Grid: Easting: 207791, Northing: 210074,

	Interval		Years													
DURATION	6months,	1year,	2,	3,	4,	5,	10,	20,	30,	50,	75,	100,	150,	200,	250,	500,
5 mins	2.6,	3.7,	4.4,	5.4,	6.1,	6.6,	8.4,	10.5,	11.9,	13.9,	15.7,	17.1,	19.3,	21.0,	22.5,	N/A ,
10 mins	3.6,	5.2,	6.1,	7.5,	8.5,	9.2,	11.7,	14.6,	16.6,	19.4,	21.9,	23.8,	26.9,	29.3,	31.3,	N/A ,
15 mins	4.2,	6.1,	7.2,	8.8,	10.0,	10.8,	13.8,	17.2,	19.5,	22.8,	25.7,	28.0,	31.6,	34.5,	36.8,	N/A ,
30 mins	5.5,	7.8,	9.0,	11.0,	12.2,	13.3,	16.6,	20.3,	22.8,	26.4,	29.6,	32.0,	35.8,	38.8,	41.3,	N/A ,
1 hours	7.1,	9.9,	11.4,	13.6,	15.0,	16.2,	19.9,	24.0,	26.8,	30.6,	34.0,	36.6,	40.6,	43.7,	46.3,	N/A ,
2 hours	9.3,	12.6,	14.3,	16.8,	18.5,	19.8,	23.9,	28.4,	31.4,	35.5,	39.1,	41.8,	46.0,	49.2,	51.8,	N/A ,
3 hours	10.9,	14.5,	16.3,	19.1,	20.8,	22.2,	26.6,	31.4,	34.4,	38.7,	42.4,	45.2,	49.5,	52.7,	55.4,	N/A ,
4 hours	12.2,	16.0,	18.0,	20.8,	22.7,	24.1,	28.7,	33.6,	36.8,	41.1,	44.9,	47.8,	52.1,	55.4,	58.1,	N/A ,
6 hours	14.2,	18.4,	20.5,	23.6,	25.6,	27.1,	31.9,	37.1,	40.4,	44.8,	48.7,	51.6,	56.0,	59.4,	62.1,	N/A ,
9 hours	16.6,	21.2,	23.5,	26.8,	28.9,	30.5,	35.5,	40.9,	44.3,	48.9,	52.8,	55.8,	60.3,	63.7,	66.4,	N/A ,
12 hours	18.6,	23.4,	25.8,	29.3,	31.5,	33.1,	38.3,	43.8,	47.3,	52.0,	56.0,	59.0,	63.5,	66.9,	69.6,	N/A ,
18 hours	21.7,	27.0,	29.5,	33.2,	35.5,	37.2,	42.7,	48.4,	51.9,	56.7,	60.7,	63.8,	68.3,	71.7,	74.4,	N/A ,
24 hours	24.3,	29.8,	32.5,	36.2,	38.7,	40.5,	46.0,	51.8,	55.4,	60.3,	64.3,	67.4,	71.9,	75.3,	78.0,	87.1,
2 days	30.8,	36.9,	39.9,	43.9,	46.5,	48.4,	54.2,	60.2,	63.9,	68.8,	72.9,	75.9,	80.4,	83.7,	86.4,	95.2,
3 days	36.4,	43.0,	46.1,	50.5,	53.2,	55.2,	61.3,	67.5,	71.3,	76.3,	80.5,	83.6,	88.1,	91.5,	94.1,	103.0,
4 days	41.4,	48.5,	51.8,	56.3,	59.2,	61.3,	67.6,	74.1,	78.0,	83.1,	87.4,	90.5,	95.1,	98.5,	101.2,	110.2,
6 days	50.6,	58.3,	61.9,	66.9,	69.9,	72.2,	79.0,	85.8,	89.9,	95.3,	99.7,	103.0,	107.7,	111.2,	114.0,	123.2,
8 days	59.0,	67.3,	71.2,	76.4,	79.7,	82.1,	89.2,	96.4,	100.6,	106.2,	110.8,	114.2,	119.1,	122.7,	125.6,	134.9,
10 days	66.8,	75.7,	79.8,	85.4,	88.8,	91.3,	98.7,	106.2,	110.6,	116.4,	121.1,	124.6,	129.6,	133.3,	136.2,	145.7,
12 days	74.4,	83.7,	88.0,	93.8,	97.4,	100.0,	107.7,	115.4,	120.0,	125.9,	130.8,	134.3,	139.5,	143.2,	146.2,	155.8,
16 days	88.8,	98.9,	103.6,	109.8,	113.6,	116.4,	124.6,	132.7,	137.5,	143.7,	148.8,	152.5,	157.8,	161.7,	164.8,	174.7,
20 days	102.5,	113.3,	118.3,	124.9,	128.9,	131.8,	140.4,	148.9,	153.9,	160.3,	165.6,	169.4,	174.9,	178.9,	182.0,	192.2,
25 days	119.0,	130.6,	135.9,	142.8,	147.1,	150.2,	159.2,	168.0,	173.2,	179.9,	185.3,	189.3,	194.9,	199.1,	202.3,	212.7,

NOTES:
N/A Data not available
These values are derived from a Depth Duration Frequency (DDF) Model
For details refer to:
'Fitzgerald D. L. (2007), Estimates of Point Rainfall Frequencies, Technical Note No. 61, Met Eireann, Dublin',
Available for download at www.met.ie/climate/dataproducts/Estimation-of-Point-Rainfall-Frequencies_TN61.pdf

Annex 5 –
Water Quality Monitoring Plan

Cush Wind Farm

Planning-Stage Construction & Environmental Management Plan

Water Quality Monitoring Plan

Cush Wind Limited

Galetech Energy Services

Clondargan, Stradone, Co. Cavan Ireland

Telephone +353 49 555 5050

www.galetechenergy.com

Contents

1.0 Introduction **1**
- 1.1 Purpose of this Report 1
- 1.2 Requirement for Water Quality Monitoring 1
- 1.3 Reference Documents 1

2.0 Description of the Project **1**

3.0 Responsibilities **1**
- 3.1 Contractor 2
- 3.2 Environmental Manager 2

4.0 Water Sampling Methodology **3**
- 4.1 Hydrochemistry 4

5.0 Reporting **4**

6.0 Emergency Response **4**

1.0 Introduction

Galetech Energy Services (GES), on behalf of Cush Wind Limited, has prepared this Water Quality Monitoring Plan (WQMP) to outline the procedures to be followed during the monitoring of surface waters prior to, during and post-construction of the Cush Wind Farm.

1.1 Purpose of this Report

Many construction and industrial sites have the potential to cause a deterioration in downstream water quality through pollution events from hydrocarbons and siltation/sedimentation. The purpose of this report is to verify the efficacy of pollution prevention and mitigation measures implemented at the Cush Wind Farm during construction.

This is a live document and will be updated by the appointed contractor prior to the commencement of development. Prior to the commencement of construction, the updated WQMP will be reviewed by the Environmental Manager (EM) and Ecological Clerk of Works (EcoW), as necessary, to confirm the appropriateness of the measures set out therein.

1.2 Requirement for Water Quality Monitoring

As described above, construction activities associated with the development of a wind farm can give rise to a risk of pollution. A deterioration in downstream water quality could arise from:-

- Land Slide;
- Fire;
- Leaking plant or equipment;
- Containment Failure;
- Overfilling of containment vessels;
- Wind-blown waste, litter or dust;
- Flooding on site;
- Leaking Portaloo;
- Fuel drips or spills during re-fuelling;
- Leak from fuel or chemical containers; and
- Failure of pumps and pipelines.

Any of these incidents could affect downstream surface waters which, in turn, could result in adverse effects on aquatic species and habitats.

1.3 Reference Documents

The production of this WQMP has been supported by best practice manuals and will be accounted for in the further development of the appointed contractor's detailed CEMP.

Other guidance documents have been used to develop this WQMP; including a Planning-Stage Construction & Environmental Management Plan, Spoil Management Plan, Surface Water Management Plan, and Environmental & Emergency Response Plan.

2.0 Description of the Project

Cush Wind Limited intend to construct the Cush Wind Farm which will consist of:-

- 8 no. wind turbines with an overall tip height of 200m, and all associated ancillary infrastructure;

- All associated and ancillary site development, excavation, construction, landscaping and reinstatement works, including provision of site drainage infrastructure and forestry felling.
- Temporary alterations to the turbine component haul route; and,
- Construction of an electricity substation, Battery Electricity Storage System and installation of 5.6km of underground grid connection to facilitate connection of the proposed electricity substation to the existing 110kV substation at Clondallow, County Offaly;

The project site is located in rural Co. Offaly, approximately 4km north of the town of Birr and c. 28km south-west of Tullamore, County Offaly. Off-site and secondary developments; including the forestry replant lands and candidate quarries which may supply construction materials; also form part of the project.

The turbine component haul route, and associated temporary alteration works, are located within counties Galway, Roscommon, Westmeath, and Offaly. It is envisaged that the turbines will be transported from the Port of Galway, through the counties of Galway, Roscommon, Westmeath and Offaly, to the project site.

As well as the reference documents listed in **Section 1.3**, various environmental reports have been prepared for the development including:-

- Environmental Impact Assessment Report (Galetech Energy Services);
- Biodiversity Chapter (SLR Consulting);
- Land & Soil Chapter (Hydro Environmental Services);
- Water Chapter (Hydro Environmental Services); and
- Natura Impact Statement (SLR Consulting).

3.0 Responsibilities

3.1 Contractor

The appointed Contractor will be responsible for employing an independent Environmental Manager (EM) to undertake all water quality monitoring and sampling prior to, during, and post-construction.

3.2 Environmental Manager

The independent EM, appointed prior to construction, will be responsible for the implementation and coordination of the methods set out in this WQMP. Prior to construction, the Contractor will be instructed to provide a 'schedule of work' to the EM at the beginning of each week to determine the intensity of monitoring required.

The EM will prepare and deliver site induction and training to all construction personnel, in liaison with the Project Manager and Contractor.

The EM will:-

- Undertake specific monitoring activities and reporting in accordance with best practice;
- Undertake weekly visual inspections for signs of ground damage or solids escaping to nearby drainage features watercourses in vicinity of construction works;
- Undertake weekly visual inspections of the installed surface water management system (e.g. silt traps, silt ponds, settlement lagoons, check dams, and buffered outfalls) and other drainage features for evidence of contaminated run-off or drainage system failure;

- Collection and analysis of water samples at monitoring locations (upstream & downstream of the project site). The selection of water monitoring locations will be agreed with the local authority prior to the commencement of construction;
- Attend critical work phases including installation/construction of watercourse crossings, turbine foundation concrete pours, and grid connection Horizontal Direction Drilling (HDD) works.

4.0 Water Sampling Methodology

The collection and analysis of water samples at the monitoring locations (i.e. upstream & downstream of project site) will be completed prior to, during and post-construction. The precise scope of monitoring will agreed with the local authority prior to commencement of construction works.

With respect to the proposed felling works, it is proposed that 1 no. round of sampling will be undertaken within 4-weeks of the commencement of felling which will provide a set of baseline results against which all subsequent samples can be assessed. Weekly-sampling will then be completed for the duration of the felling activities; while a minimum of 1 no. round of sampling will be completed following the felling operations. Sampling locations SW1 and SW2, as outlined in **Chapter 7** of the EIAR, will be selected as sampling locations for felling operations.

Additionally, daily surface water monitoring forms (for visual inspections and field chemistry measurements) will also be utilised at every works site near any watercourse. These will be taken daily and kept on site for record and inspection

With regards general construction activity, it is proposed that 1 no. round of sampling will be undertaken prior to the commencement of development which will provide a set of baseline results against which all subsequent samples can be assessed. Monthly-sampling will then be completed for the duration of the construction phase; while a further 1 no. round of sampling will be completed following the completion of construction and reinstatement activities. Sampling locations SW1-SW4, as outlined in **Chapter 7** of the EIAR, will be selected as sampling locations for the duration of the construction phase.

As a minimum, the general monitoring programme will include:-

- 1 no. baseline sample (by the EM);
- Daily visual observation in areas of high construction activity (by a suitably trained staff-member) or during high rainfall periods to identify any evidence of siltation, oil or silt. Visual inspections will include details of the colour of the water at the time of inspection;
- Weekly visual inspections and monthly field hydrochemistry (by the EM); and
- One round of post construction monitoring (by the EM).

Monitoring locations will be identified through grid reference, photographic record and indicated on a drawing. Each location will be marked on the ground (stake/post) to ensure that the correct location is sampled each time during repeat sampling locations.

For the duration of the monitoring period, sample locations shall be consistently identified and any additional locations will be recorded and a photograph taken at the time of sampling.

'Control' sample locations may also be included in the scope of any monitoring.

4.1 Hydrochemistry

In addition to the visual inspections described above, all water samples will be subject to hydrochemistry analysis. The parameters to be analysed will be agreed with the local authority prior to the commencement of construction, and may include:-

- pH;
- Temperature;
- Total Suspended Solids (TSS);
- Dissolved Organic Carbon (DOC);
- Conductivity;
- Dissolved Oxygen (DO);
- Total Oxidized Nitrogen (TON);
- Ammoniacal Nitrogen;
- Ammonia;
- Potassium;
- Phosphate;
- Biological Oxygen Demand (BOD);
- Chemical Oxygen Demand (COD); and
- Total Petroleum Hydrocarbons (TPH) (Construction Phase only).

5.0 Reporting

Each month, the EM will prepare a report on the results of the water quality monitoring. The results will assist in determining the requirements for improvements in drainage, surface water management, and pollution prevention measures.

The EM will also present the results to staff and construction personnel to ensure full awareness of any necessary improvements. This shall be done at monthly-meetings and reported within the overall Monthly Environmental Report to be prepared by the EM. The monthly reports on water quality will be provided to Cush Wind Limited and will be made available to the local authority, as may be necessary.

The monthly reports on water quality will consider all visual, field monitoring and results of laboratory analysis undertaken that month. Reports will describe how the results compare with baseline data as well as previous monthly reports on water quality. The reports will describe whether any deterioration or improvement in water quality has been observed and whether any effects are attributable to construction activities and what remedial measures or corrective actions have been, or are required to be, implemented.

Upon completion of all post-construction monitoring, the EM will prepare a final report on water quality. This will detail the overall performance against baseline data, details on any impacts attributed to construction works and recommendations for remedial works if required. The final report will be provided to the local authority.

6.0 Emergency Response

In the event that a pollution incident arises from construction works; such as that resulting from a spill or accidental release of chemicals, oils and fuels or concrete effluent; which threatens to enter, or has entered, a watercourse, additional sampling and analysis of surface water samples will be undertaken to determine the level of impact and whether remedial measures are required.

Where a pollution incident has occurred as a result of construction works, the EM will consult with the local authority to determine sampling requirements and any additional survey requirements. Where it is demonstrated that the pollution occurred as a result of non-compliance with measures set out in project documentation (including the Environmental Impact Assessment Report, Natura Impact Statement, Construction Environmental Management Plan, and Surface Water Management Plan), the costs of any additional sampling or remedial measures shall be borne, in full, by the Contractor.

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