Appendix 12.2

Natural Power Bat Report (2018)

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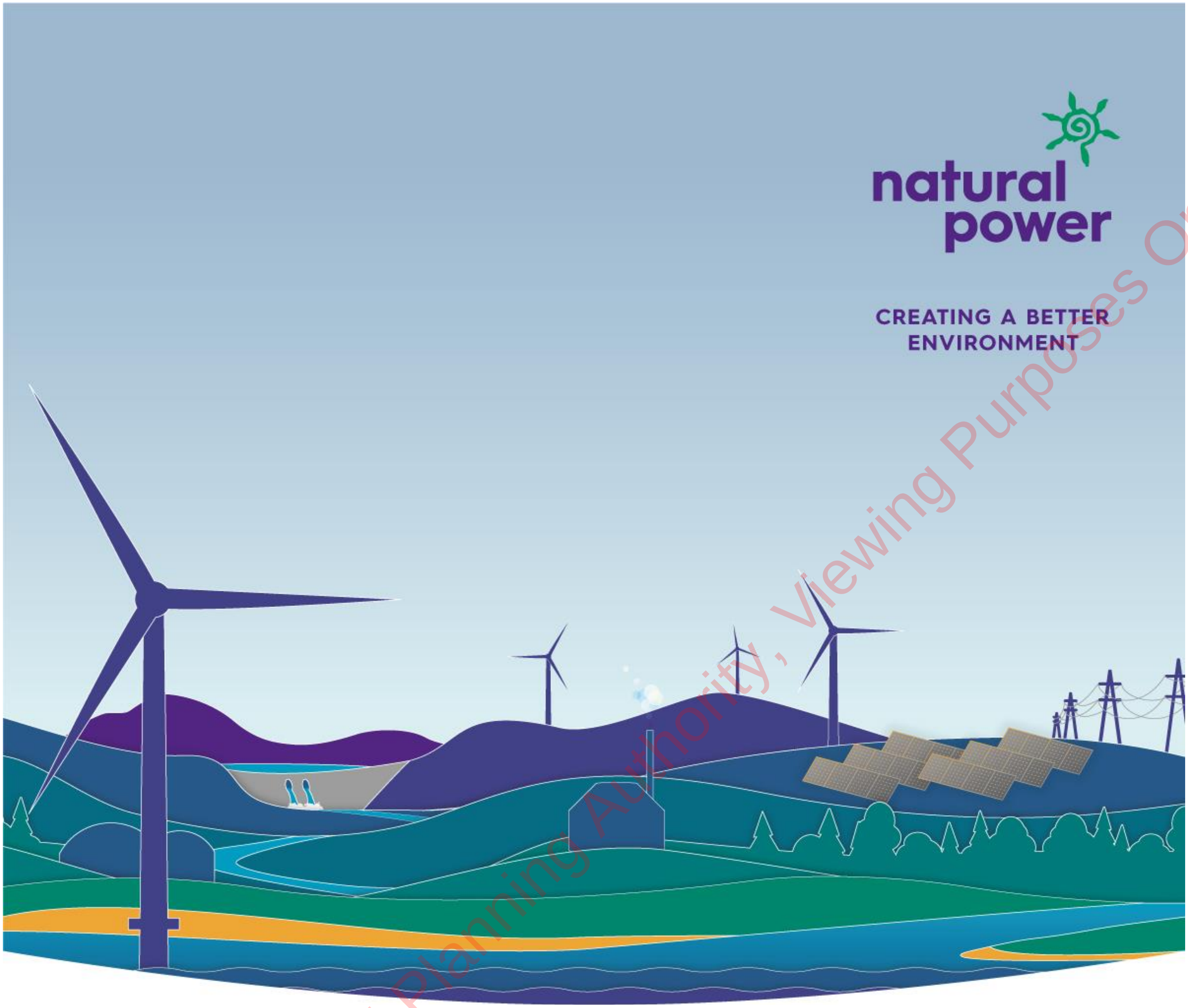

Baybridge Bat Survey 2018

13 November 2018

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Contents

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1. Executive Summary

This report presents the results of bat surveys undertaken by Natural Power in 2018, at lands for the proposed Baybridge Wind Farm, Co. Laois. Surveys were carried out in accordance with current industry guidance for a site assessed as having moderate suitability for bats.

In total, a minimum of four bat species were recorded within the site: common pipistrelle, soprano pipistrelle and Leisler's bat. Some *Pipistrellus* sp. and *Myotis* sp. were also recorded but not confirmed to species level.

Bat activity levels when combining the results of the static detector and transect surveys are considered to be low for species at high risk of collision (Leisler's bat); moderate for species at medium risk (common pipistrelle and soprano pipistrelle - most common species) and low for species at low risk (*Myotis* sp.). Of the high collision-risk species Leisler's bat was recorded in low numbers at all 6 static recording locations. Overall, bat activity (all species) was considered to be moderate for the site.

Bat roost surveys were conducted of potential roost features including old buildings and mature trees within 500m of proposed turbines. One small confirmed (1 individual bat observed) bat roost was recorded in a derelict two-storey house approximately 400 m from the nearest proposed turbine location. No other potential roosts were determined.

Preliminary impacts from a windfarm at this location and recommendations for reducing/avoiding adverse impacts on bats and monitoring are provided in this report.

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2. Introduction

2.1. Site Description

The proposed Baybridge wind farm site is located in Co. Laois, approximately 2 km north of the town of Mountmellick. The site comprises a mosaic of improved grassland for grazing, parcels of coniferous plantation and pockets of broadleaved woodland. An area of approximately 172 ha of cutover bog, which is presently subject to commercial peat harvesting, is situated immediately north of the site. There are a number of watercourses surrounding the site, including Cottoners Brook which abuts the eastern boundary and the River Barrow which lies just along the southern site boundary. The N80 road also lies to the west of the site.

The proposed development will encompass 8 wind turbines and all associated ancillary works. In accordance with best practice guidelines, the focus of the study (static fixed meter detectors) was the proposed turbine locations and a 200 m buffer (Collins, 2016); refer to Figure 1 (Appendix 3). Lands outside this buffer but within survey lands identified in Figure 1 were additionally included in transect and roost assessment surveys.

2.2. Statement of Authority

The bat surveys and reporting were carried out by professional experienced ecologists as follows;

- Roger Macnaughton is a professional ecologist from Natural Power, who is a full member of the Chartered Institute of Ecology and Environmental Management (CIEEM) (MCIEEM). He has over 16 year's professional ecology experience including bat surveys throughout Ireland and Scotland.
- Kathryn Oliver is a professional ecologist from Natural Power, who is a graduate member CIEEM (Grad CIEEM). She has over two year's full time professional bat survey experience throughout Ireland and England.
- Nick Veale is a professional ecologist from Veale Ecology. He has over 16 years professional experience as a consultant ecologist and is a full member of CIEEM (MCIEEM).

2.3. Irish Bats: Legislation

All Irish bat species are protected under the European Habitats Directive (92/43/EEC), listed on Annex IV of the Directive which requires the strict protection of individuals, their breeding sites and resting places. In addition to this, the lesser horseshoe bat (*Rhinolophus hipposideros*) is also listed on Annex II of the same Directive which requires the designation of special areas of conservation for these species. The Directive is transposed into Irish law through the European Communities (Birds and Natural Habitats) Regulations 2011. Bat species in Ireland are also afforded protection under the Wildlife (Amendment) Act, 2000 under which it is an offence to intentionally disturb, injure or kill a bat or disturb a bat roost.

2.4. Potential Impacts

Based on current knowledge, typical flight behaviour of many bat species in Ireland would not be expected to bring them into contact with turbine blades at operational wind farms. This is because the bat species typically found in Ireland are not known to migrate at high altitude and many species, such as *Myotis* bats, rarely fly at heights with potential to intersect with turbine blades. However, this is based on relatively few studies in a UK context, and therefore actual collision rates are still largely unknown (DEFRA, 2016). Based on available information of example flight heights, speeds, hunting techniques, habitat preference and migration (although not specifically in relation to behaviour near wind turbines); Natural England has produced guidance (Natural

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England, 2014) which puts UK bats into different risk categories (high, medium and low) at both an individual and population level. Table 1 summarises the risk of wind turbines to individual bats of species that occur in Ireland.

Table 1: Risk of wind turbines to individual bats of species that occur in Ireland

Low Risk	Medium Risk	High Risk
Myotis species	Common pipistrelle	Leisler's bat
Brown long-eared bats	Soprano pipistrelle	Nathusius' pipistrelle
Lesser Horseshoe bats		

Potential effects on bat species from the operational phase of the proposed development are from accidental injury or deaths through turbine collision or barotrauma. Barotrauma injuries may occur when bats fly near to a moving turbine blade and suffer internal haemorrhaging as a result of the rapidly decreasing air pressure in the lee of the turning blade (Baerwald *et al.*, 2008). Other possible impacts include loss of foraging habitat (due to wind farm construction or because bats actively avoid the wind farm area) and fragmentation of habitat (wind farms may form barriers to commuting or seasonal movements).

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3. Methodology

3.1. Desk Study

A desk-based study was undertaken to collate relevant existing bat records for within the site and a 10 km radius within the last 10 years. The following online sources were accessed:

- Bat Conservation Ireland (https://www.batconservationireland.org/)
- Biodiversity Ireland (https://maps.biodiversityireland.ie/Map)

The Bat Landscape Map on the Biodiversity Ireland website was also accessed to view the suitability of habitat within the site and immediate surrounding area for bat species.

3.2. Habitat Assessment

Bat walkover habitat surveys were conducted throughout the survey period, with a more focussed habitat assessment survey carried out on the 12th July 2018. During this survey habitat types within the site were recorded and assessed for their suitability to support bats. Suitability was assessed according to Collins (2016) which provides a grading protocol for roosting habitats and for commuting and foraging areas. Suitability categories, divided into 'high', 'moderate' and 'negligible', are described in Appendix 1.

3.3. Preliminary Roost Assessment

A preliminary roost assessment was undertaken on 12th July 2018 to establish the presence of potential bat roosts within 200m of the developable area. All potential roost structures and trees identified were examined in more detail to assess their potential to support roosting bats, see Appendix 1 for criteria in assessing roosting habitats.

A detailed internal and external inspection of all structures was carried out from ground-level to identify potential roosting locations and field signs including bat droppings, bat carcasses, feeding remains (particularly butterfly and moth wings), urine staining and the presence of areas of cleared cobwebs. Structures were assessed as having either 'high', 'medium', 'low' or 'negligible' potential to support roosting bats and categorized using definitions in Collins (2016), see Appendix 1.

Trees were inspected from ground-level during daylight for signs of potential bat roost features including rot holes, cracks and splits, trunk cavities and dense ivy growth. Survey methods followed the guidelines and techniques recommended in Andrew (2013) and Collins (2016). Binoculars were used as required to obtain a better view of potential roost features. Trees were assessed as having either 'high', 'medium', 'low' or 'negligible' potential to support roosting bats and categorized using definitions in Collins (2016).

Any potential roost sites identified during the preliminary roost assessment were subject to further survey work, refer to section 3.4 below.

3.4. Dusk Emergence Survey

A dusk emergence survey was undertaken on 11th September 2018 of a potential roost site identified namely Building 3, refer to Appendix 2. Equipped with a Peersonic full spectrum bat detector, the surveyor was situated at a strategic point outside the building. The survey was conducted in suitable weather conditions; dry, 20°C and light wind. All bats seen and heard between 19:38 and 21:08 (sunset 19:53) were recorded. Species

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identification was made in the field. Other information recorded includes time of bat contact, location and behavior.

3.5. Static Detector Surveys

Anabat Express bat detectors (automated static recording detectors) were deployed at 6 locations within the site, for a minimum of 10 nights each per month between June and September 2018 (inclusive) following methods described in Collins (2016). Locations covered the proposed turbine layout and encompassed a variety of habitat features within the site including coniferous plantation, coniferous plantation edge, open grassland, edge of cutover bog and edge of broadleaved woodland, refer to Figure 1. Detectors were programmed to commence recording from at least 60 minutes before sunset until at least 60 minutes after sunrise. A summary of the survey methodology is provided in Tables 2 and 3 below.

Table 2: Location information for the Anabat express detectors deployed in 2018

Location	Irish grid ref.	Habitat
1	N 44364 09575	Deciduous tree-line within improved grassland
2	N 44318 10552	Edge of conifer plantation bordering improved grassland
3	N 43652 11338	Edge of cutover bog bordering a drainage ditch and 50m from the edge of coniferous plantation
4	N 44150 11403	Edge of cutover bog, next to scrub
5	N 45370 11494	Within conifer plantation
6	N 43786 10589	Edge of conifer plantation facing a tree-lined lane

Table 3: Detector deployment summary

Month	Location	Dates	Total no. nights	Total time (hhh.mm)
June	1, 2 and 3	26th June – 6th July 2018	46	421.08
	4	26th – 5th July 2018*		
	5	26th – 28th July 2018*		
July	1, 3 and 5	11th June – 19th July 2018*	49	471.17
	2 and 4	11th June – 21st July 2018		
August	1, 2, 3 and 4	30th July – 9th August 2018	53	561.27
	5	30th July – 7th August 2018*		
September	1, 2, 3, 5 and 6	10th September – 17th September	40	608.15

* recorded less than 10 nights

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Table 4: Total recording time per detector location

Location	Total time (hh.mm)
1	363.45
2	368.18
3	408.57
4	408.57
5	268.30
6	137.30

3.6. Transect Surveys

Two transect routes (Figure 1) were surveyed alternatively once per month between May and September 2018 (inclusive) in accordance with the best practice guidelines (Collins, 2016). The transects covered the proposed turbine areas and encompassed all the main habitats present within the site including coniferous plantation, coniferous plantation edge, improved grassland, edge of cutover bog and edge of broadleaved woodland. All transect surveys were conducted at dusk. They commenced 30 minutes before sunset and were completed within 2 hours after sunset.

Transects were undertaken on foot and bats were recorded in real time by a minimum of two surveyors. Surveyors were equipped with a Peersonic full spectrum bat detector and Batbox Duet detector. Surveyors stopped regularly in areas of particularly suitable bat foraging and commuting habitat. Species identification was made in the field. Other information recorded includes time of bat contact, location and behaviour.

Table 5: Summary of transect survey effort in 2018

Date	Surveyors	Type	Sunset/Sunrise (hh:mm)	Start – Finish (hh:mm)	Total time (hh:mm)
31st May 2018	Roger Macnaughton and Kathryn Oliver	Dusk	21:43	21:15 – 23:15	02:00
26th June 2018	Kathryn Oliver and Nick Veale	Dusk	22:00	21:30 – 23:15	01:45
24th July 2018	Kathryn Oliver and Nick Veale	Dusk	21:35	21:05 – 23:30	02:25
21st August 2018	Kathryn Oliver and Nick Veale	Dusk	20:46	20:30 – 22:45	02:15
25th September 2018	Kathryn Oliver and Nick Veale	Dusk	19:32	19:15 – 21:00	01:45
Total Survey Time					**10:10**

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Table 6: Weather conditions during transect surveys within the site during 2018

Date	Temperature (°C)	Precipitation	Wind speed (Beaufort scale)	Cloud cover
31st May 2018	16	none	1	2/8
26th June 2018	24	none	0	0/8
24th July 2018	18	none	2	4/8
20th August 2018	20	none	1	3/8
25th September 2018	16	none	2	4/8

Weather conditions were excellent on all dates for conducting the transect surveys.

3.7. Bat Survey Analysis

All recordings during static and transect surveys were made in full spectrum, retaining all amplitude and harmonic information from the original bat call for subsequent analysis. Recordings were analysed using bat call analysis software (Analook, Titley Scientific). All files were split to a maximum duration of 15 seconds and were reviewed manually, using established call parameters, to identify individual bat species. However, accurate identification to species level within the genus Myotis from echolocation alone is imprecise, therefore, all records were identified as '*Myotis* sp.'. In addition, calls with peak frequencies between 50 – 52 kHz were not identified to species level and were recorded as '*Pipistrellus* sp.'

A bat pass was defined as a sequence of bat pulses captured on a 15 second Anabat sound file. One sound file was counted as one bat record. Different species within the same 15 second sound file were counted as different bat records.

An individual bat can pass a particular feature on several occasions while foraging. It is therefore not possible to estimate the number of individual bats. In accordance with best practice guidance (Collins, 2016) an activity index is used; calculated from bat records per hour or per night which allows analysis of bat activity to estimate abundance and/or activity. The calculation is as follows;

BAI (Bat Activity Index) = Total number of bat records / number of hours of recording

This calculation cannot be used to compare different sites, but is a means of identifying the most active bat areas within habitats in one site boundary to identify where activity is concentrated.

3.8. Survey Limitations

The following potential limitations when undertaking surveys are discussed below;

- The Anabat automated static detectors are powered by 12 volt batteries and on four occasions the battery charge was not sufficient to complete a full survey period, or the equipment malfunctioned. Overall recommended recording times were adhered to or exceeded. The small loss of data is not considered to be a significant limitation.
- The bat emergence survey was conducted in September. This is outside the recommended survey period for detecting maternity colonies and males/non-breeding females in summer roost according to best practice guidance (Collins, 2016). However, due to the favourable weather conditions experienced during the summer, including September, this is not considered to be a significant limitation as the site was nevertheless confirmed as a bat roost.

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- It is not always possible to identify all bat calls to species level, especially for Myotis species. Recorded files from automated detectors may contain only fragments of a call, or the bat may be calling from a distance (from the detector) in which case it may not be clear enough to assign the call to a specific species;
- Some caution must be taken when comparing activity levels between species, as bias can be shown towards those species with 'louder' or 'lower frequency' echolocation calls. For example *Nyctalus* species have louder and low frequency echolocation calls which carry further than the quieter and more broadband brown long-eared bat (*Plecotus auritus*) echolocation calls; and
- In the absence of any recognised criteria to define levels of bat activity (e.g. what constitutes low, medium or high activity) professional judgement has been used, taking into consideration geographical location and experience gained through conducting similar surveys at other sites throughout Ireland and UK.

It is considered that limitations detailed above are minor and the survey findings detailed in this report provide an accurate reflection of bat usage on the Baybridge site during 2018.

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4. Results

4.1. Desk Study

Consultation with the BCT and Biodiversity Ireland returned records of 5 bat species from within the 10 km radius of the site, refer to Table 7. No bat records were returned from within the site boundary. However, it should be noted that records are biased based on the distribution of observers and thus these records may not be fully representative of current species distributions in this area.

Table 7: Records of bat species within 10 km of the proposed site

Species	Latin name	Year of record	No. of individuals	Dataset
Soprano pipistrelle	*Pipistrellus pygmaeus*	2009	5	National Bat Database of Ireland
		2009	2	National Bat Database of Ireland
Pipistrellus sp.	*Pipistrellus* sp.	2009	2	National Bat Database of Ireland
Brown long-eared bat	*Plecotus auritus*	2014	5	National Bat Database of Ireland
		2014	6	National Bat Database of Ireland
Daubenton's bat	*Myotis daubentonii*	2009	3	National Bat Database of Ireland
		2013	27	National Bat Database of Ireland
Natterer's bat	*Myotis nattereri*	2007	1	National Bat Database of Ireland
Leisler's bat	*Nyctalus leisleri*	2009	1	National Bat Database of Ireland
		2011	3	National Bat Database of Ireland

In addition, consultation with the Biodiversity Ireland Bat Landscape Map showed that the overall habitat suitability within the site for bat species present in Ireland is low – moderate, refer to Figure 2 below. The map is a visualisation of a 'habitat suitability' index conducted by Lundy *et al*. (2011). The index ranges from 0 – 100 with 0 being least favourable habitat and 100 most favourable habitat for bats.

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Figure 2: Biodiversity Ireland Bat Landscape Map for 'all bats' for the survey lands

4.2. Forage Habitat Assessment

The site comprises a mosaic of improved grassland with associated mature hedgerows and deciduous treelines, parcels of coniferous plantation, and pockets of broadleaved woodland. A *c*.172ha area of cutover bog, which is presently subject to commercial peat harvesting, is situated immediately north of the site. There are a number of watercourses surrounding the site, including Cottoners Brook with abuts the eastern boundary and the River Barrow which lies just beyond the western site boundary.

The predominantly open nature of the improved grassland and cutover bog, and closed nature of the coniferous plantation and broadleaved woodland provides suboptimal bat habitat. However, continuous, high-quality habitat that is well connected to the wider landscape and likely to be used regularly by foraging and commuting bats is present in the form of plantation edges, hedgerows, treelines and the watercourses that adjoin the site.

Overall, the proposed development was assessed as having moderate suitability for bats.

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4.3. Preliminary Roost Assessment and Dusk Emergence Surveys

Four mature trees (Tree 1, Tree 2 and Tree 3) and three buildings ((a barn (Building 1), an abandoned house (Building 2) and derelict ivy clad house (Building 3)) were identified during habitat assessment surveys as possible bat roosts, refer to Appendix 2: Photos 1 - 8.

Tree 1 is a mature horse chestnut tree with no obvious roosting features were recorded.

Trees 2, 3 and 4 are mature, multi-stemmed ash trees with light-moderate ivy coverage. No obvious bat roosting features were observed.

Building 1 is a barn composed of corrugated metal sheeting supported by a metal frame. Large sections of the barn are open. No evidence of bats were noted.

Building 2 is an abandoned single-storey house composed of stone with a corrugated metal roof. The house is derelict and the branches of an adjacent tree are now growing within the building. No evidence of bats were noted.

Building 3 is located approximately 400m from the nearest proposed turbine. The building has two-storeys and is entirely covered in a thick layer of ivy. All windows panes and doors, and a large section of the roof are missing, providing potential access points. There is no enclosed attic spaces present due to an attic conversion. A couple of fresh bat droppings and several potential old bat droppings were observed adhered to the internal walls of the building. During a dusk emergence survey a single soprano pipistrelle was observed emerging from Building 3 at 20:25, 32 minutes after sunset. In addition, two soprano pipistrelles and a common pipistrelle were recorded commuting and foraging in the vicinity of the building.

In summary; one confirmed bat roost (building 3) and no additional potential bat roosts were recorded in 2018.

4.4. Overall Bat Activity

In total, a minimum of 4 bat species were recorded within the site. Species recorded were common pipistrelle (*Pipistrellus pipistrellus*), soprano pipistrelle (*Pipistrellus pygmaeus*) and Leisler's bat (*Nyctalus leisleri*). *Pipistrellus* sp. and *Myotis* sp. were also recorded but could not be confirmed to species level.

The overall bat activity levels when combining the results of the static detector and transect surveys are considered to be low for species at high risk of collision [Leisler's bat (0.73 BAI)]; moderate for species at medium risk [common pipistrelle (3.85 BAI), soprano pipistrelle (3.68 BAI) and pipistrelle species (0.55 BAI)]; and low for species at low risk [(*Myotis* sp. (0.11 BAI)].

Of the high collision-risk species, Leisler's bat had low activity levels at all 6 static locations. The majority of this activity was recorded at location 2, along the edge of conifer plantation facing open grassland.

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4.5. Static Detector Surveys

In total, 16,094 bat passes were recorded during 188 survey nights in 2018. A minimum of 4 bat species were recorded: common pipistrelle, soprano pipistrelle and Leisler's bat. In addition, there were a number of contacts identified as *Pipistrellus* sp. and *Myotis* sp., refer to Table 8.

A total BAI of 8.92 was recorded within the site across all monitoring locations. The most commonly recorded by BAI was common pipistrelle (3.84 BAI), followed by soprano pipistrelle (3.69 BAI). The remaining contacts were Leisler's bat (0.74 BAI), *Pipistrellus* sp. (0.55 BAI) and *Myotis* sp. (0.11 BAI).

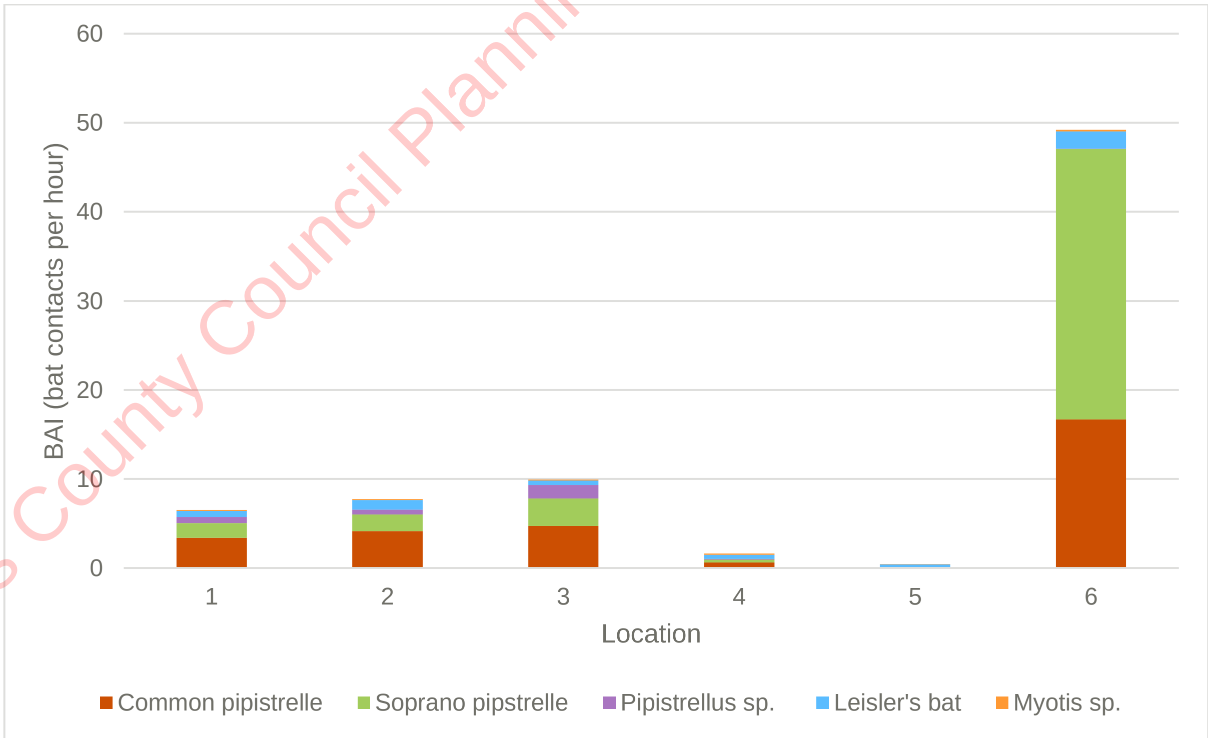
The highest level of activity was recorded at location 6, at the edge of coniferous plantation facing a treelined lane. The treelined lane represents a good commuting route and foraging area for bats. Furthermore, this location is in proximity (300 m) from a known soprano pipistrelle roost site.

The BAI across all monitoring locations in June was 11.47 BAI which decreased to 5.25 BAI in July and 2.84 BAI in August. Bat activity peaked in September (20.51 BAI), refer to Graph 2.

Table 8: Total number of bat passes recorded during static detector surveys within the site during 2018

Species	June	July	August	September	Total
Common pipistrelle	2362	1248	893	2419	6922
Soprano pipistelle	1056	774	404	4422	6656
Pipistellus sp.	780	204	0	238	997
Leisler's bat	576	210	238	302	1326
Myotis sp.	56	34	61	42	193

Graph 1: Bat activity index per species per static detector location



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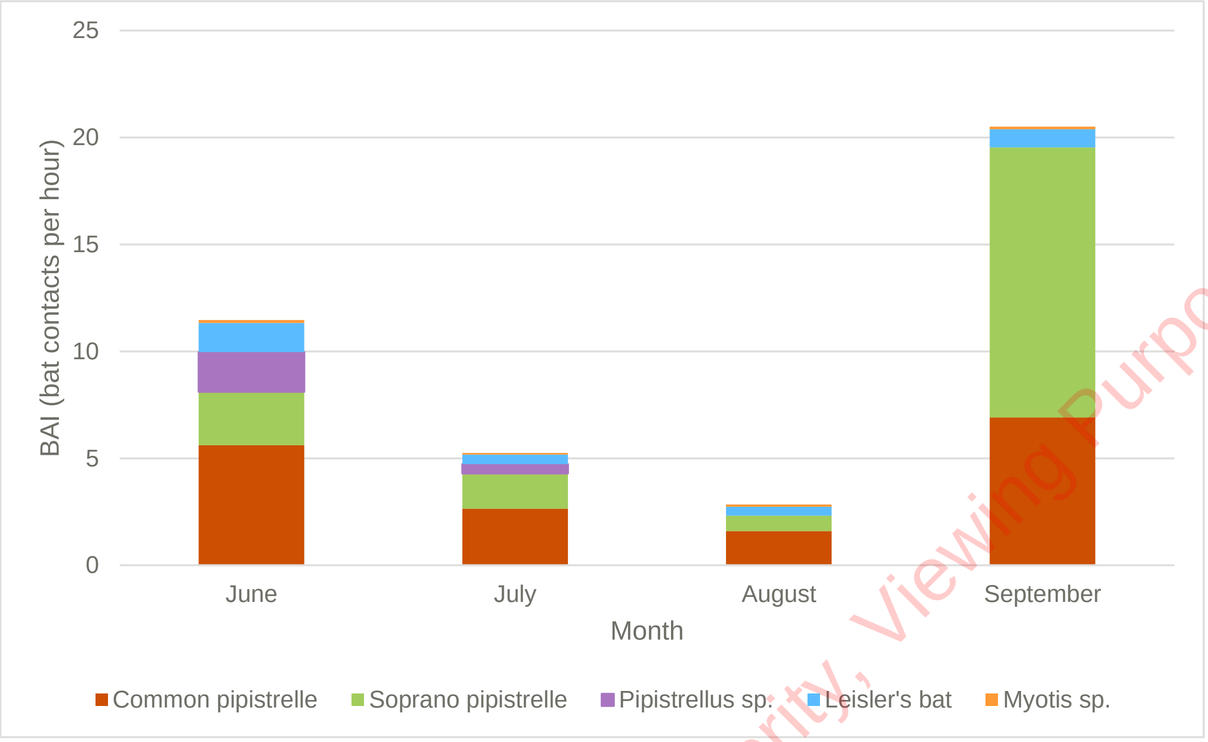
Graph 2: Bat activity index per species per month



4.6. Transect Surveys

Overall, 5 dusk surveys were undertaken (one/ month) between May and September 2018. In total, 76 bat passes were recorded during transect surveys, refer to Figure 3. A minimum of three bat species were recorded: common pipistrelle, soprano pipistrelle and Leisler's bat. The most commonly recorded species by BAI was common pipistrelle (5.31 BAI), followed by soprano pipistrelle (1.87 BAI) and Leisler's bat (0.29 BAI).

Bat passes in May had a combined BAI of 5 but decreased in June to a BAI of 3.43, refer to Graph 3. Activity increased in July to 9.66. In August, the highest number of bat registrations were recorded with a BAI of 10.67. Bat passes decreased in September to a BAI of 7.43.

Table 9: Total number of bat passes recorded during transect surveys within the site during 2018

Species	May	June	July	August	September	Total
Common pipistrelle	7	5	16	21	5	54
Soprano pipistrelle	2	0	6	3	8	19
Leisler's bat	1	1	1	0	0	3

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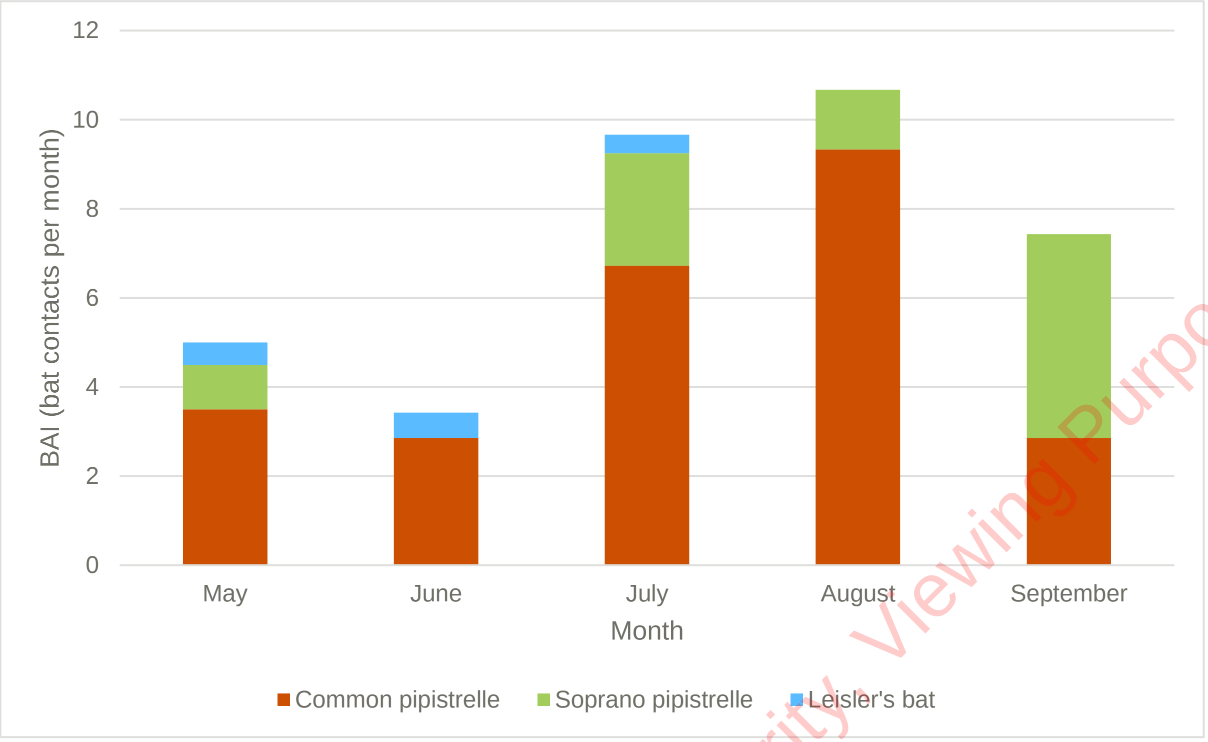
Graph 3: Bat activity index for transect surveys within the site during 2018



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5. Provisional Impact Assessment

5.1. Summary of Results

Overall, bat activity was considered to be moderate for the site; most activity was attributed to medium risk species, predominately common pipistrelle and soprano pipistrelle, and concentrated during the month of September. The highest concentration of bat activity was at static bat detector location 6 (49.19 BAI). This detector was located on the edge of conifer plantation facing a tree-lined lane, approximately 100 m from the nearest proposed turbine.

5.2. Construction Effects

During the construction phase, permanent habitat loss will occur as a result of felling of existing coniferous plantation, required to enable the construction of the proposed turbines and associated infrastructure. However, due to the creation of edge habitat and open areas, impact upon foraging and commuting opportunities for bats is considered to be minimal.

During the construction phase bats may be disturbed by lighting, noise and vibrations. This may lead to temporary avoidance of the area during the construction phase. The site is connected to moderate quality habitat for foraging and commuting bats. Therefore, should any individuals avoid the site due to disturbance, it is considered likely that they will utilise this adjacent habitat. In addition, any disturbance during the construction phase will be temporary.

The confirmed bat roost (Building 3 - derelict cottage) is located approximately 400m from the nearest proposed turbine location. The removal of this cottage is not anticipated in order to facilitate construction and therefore roost loss is not expected to occur. Furthermore, given the distances and species (Soprano pipistrelle) recorded from the nearest proposed turbine location, it is considered that disturbance is unlikely.

5.3. Operational Effects

The operational stage of a windfarm is identified as the key risk phase to local bats populations. During the operational phase, rotating turbines present a risk to bats as a result of potential collision and/or barotrauma. For the purposes of this assessment, the potential impacts from barotrauma are assumed to be the same as for collision risk. This is due to the lack of published empirical evidence in causes of bat fatalities around wind farms and the difficulties in determining whether bat fatalities are due to strikes (collisions) with the turbine blades or barotrauma.

Recent research work by Exeter University (DEFRA, 2016) found that most bat fatalities at UK wind farms were common pipistrelle bats, soprano pipistrelle bats and noctule (*Nyctalus noctula*). In addition, single carcasses of brown long-eared bat, Nathusius' pipistrelle bat and Natterer's bat were recorded. The study also found that the percentage casualty rates for soprano pipistrelle, common pipistrelle and noctule bats, were higher than the relative proportions of their calls recorded from ground level acoustic surveys.

Within the site, high, medium and low risk species were recorded. Following a full and comprehensive survey, bat activity was considered to be moderate across the site and the highest concentration of bat activity was recorded along edge habitats. The majority of the turbines are proposed to be constructed within coniferous plantation. It is within this habitat that the lowest bat activity was recorded (Location 5: 0.43 BAI) therefore based on this, collision effects may be considered low though this is complicated by potential usage of these areas once opened up/ cleared which may attract more bat activity.

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Bat activity levels on the site were low for species at high risk of collision (Leisler's bat) indicating that the collision risk of Leisler's bat is likely to be low. This assessment is provisional and based on one year of survey data conducted within the main bat activity season (May - September 2018 inclusive). Further additional survey in 2019 would provide improved multi-year temporal data for informing a bat impact assessment, in particular regarding usage of the area by "high risk" species including Leislers bat.

5.4. Decommissioning effects

Effects during the decommissioning phase are predicted to be similar as those given for the construction phase of the proposed development, particularly regarding disturbance by lighting, noise and vibrations.

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6. Recommendations

6.1. Buffer Zone

During the construction phase, tree felling will be required to facilitate the proposed development resulting in the creation of edge habitats. Evidence suggests that the majority of bat activity is in close proximity to habitat features (Natural England, 2014). However, activity was shown to decline when measured at fixed intervals up to 50 m away from treelines. This decline occurred both when bats were commuting and foraging. Therefore, a 50 m buffer around any feature (trees, hedges) into which no part of the turbine intrudes is recommended to reduce the risk of barotrauma and collision.

The recommended stand-off distance between the feature and the centre of the turbine, needed to maintain a minimum 50 m buffer from blade tip to feature top height, can be calculated using the following equation:

- $b = \sqrt{((50+bl)2 - (hh-fh)2)}$

Where bl = blade length; hh = hub height; and fh = feature height.

The buffer areas should be managed to ensure that they remain free of trees and tall shrub growth during the operation phase of the wind farm.

6.2. Removal of trees

Pre-construction surveys should be conducted on any trees with the potential to support roosting bats within a minimum of 30 m of working areas. This should include any tree clearance required on the turbine delivery access route. If bats are found, an application for a derogation licence should be made to the National Parks and Wildlife Service to allow its legal removal. Such trees should ideally be felled in the period late August to late October/early November (depending on overnight temperatures), in order to avoid disturbance of any roosting bats as per National Roads Authority guidelines (NRA 2006a and 2006b) and also to avoid the bird breeding season. Tree felling should also be completed by mid-November at the latest as bats roosting in trees are very vulnerable to disturbance during their hibernation period (November – April).

6.3. Retention of trees

Where possible, treelines and mature trees should be retained. Retained trees should be protected from root damage by machinery by an exclusion zone of at least 7m or equivalent to canopy height. Such protected trees will be fenced off by adequate temporary fencing prior to works commencing.

6.4. Lighting

Being nocturnal animals many bat species are adversely impacted by artificial lighting. Artificial lighting has been shown to disturb bat foraging and commuting activity, roosting and hibernation (BCT and ILP, 2018).

Therefore, the following mitigation measures are recommended:

- External lighting should be avoided wherever possible. Where external lighting is needed it should be designed to avoid and reduce light spill following best practice guidelines for lighting and bats (BCT 2009). Where external road lighting is needed the use of bollards with louvers should be considered to keep lighting directional and below head height. Timer or motion sensors should also be considered.

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- Security lighting should be directed away from wooded areas and watercourses.
- If construction work is required to be carried out during the hours of darkness in the vicinity of roosts lighting should not be utlised within an hour before dusk and after dawn as a minimum.

6.5. Operational Monitoring

As recommended under the EUROBATS guidelines (Rodrigues *et al*., 2015) and Bat Conservation Ireland Wind Farm Guidelines, post-construction monitoring should be undertaken for a minimum of three years once the wind farm becomes operational. Monitoring should be conducted one per month from March/April to October/November inclusive, during appropriate weather conditions (i.e. air temperatures not lower than 10 degrees, calm and dry). Monitoring should include detector surveys of bat activity near turbines and the continuing status of any nearby roosts, combined with a properly designed corpse-search regime at all turbine locations. This monitoring is recommended to inform if any measurable impacts are arising to bats and if further adaptive mitigation is advised.

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8. Appendices

Appendix 1: Guidelines for assessing the potential suitability of proposed development sites for bats.

Suitability	Roosting Habitats	Commuting and Foraging Habitats
Negligible	Negligible habitat features on site likely to be used by roosting bats.	Negligible habitat features on site likely to be used by commuting or foraging bats.
Low	A structure with one or more potential roost sites that could be used by individual bats opportunistically, However, these potential roost sites do not provide enough species, sheller, protection, appropriate conditions[1] and/or suitable surrounding habitat to be used on a regular basis by larger numbers of bats (i.e. unlikely to be suitable for maternity of hibernation[2]). A tree of sufficient size and age to contain potential roost features but with none seen from the ground or features seen with only very limited roosting potential.[3]	Habitat that could be used by small numbers of commuting bats such as a gappy hedgerow or unvegetated stream, but isolated, i.e. not very well connected to the surrounding landscape by other habitat. Suitable, but isolated habitats that could be used by small numbers of foraging bats such as a lone tree (not in a parkland situation) or a patch of scrub.
Moderate	A structure or tree with one of more potential roost sites that could be used by bats due to their size, shelter, protection, conditions[1] and surrounding habitat but unlikely to support a roost of high conservation status (with respect to roost type only – the assessments in this table are made irrespective of species conservation status, which is established after presence is confirmed).	Continuous habitat connected to the wider landscape that could be used by bats for commuting such as lines of trees and scrub or linked back gardens. Habitat that is connected to the wider landscape that could be used by bats for foraging such as trees, scrub, grassland or water.
High	A structure or tree with one or more potential roost sites that are obviously suitable for use by larger roost sires that are obviously suitable for use by larger numbers of bats on a more regular basis and potentially for longer periods of time due to their size, shelter, protection, conditions[1] and surrounding habitat.	Continuous, high-quality habitat that is well connected to the wider landscape that is likely to be used regularly by commuting bats such as river valleys, streams, hedgerows, lines of trees and woodland edge. High-quality habitat that is well connected to the wider landscape that is likely to be used regularly by foraging bats such as broadleaved woodland, tree-lined watercourses and grazed parkland. Site is close to and connected to known roosts.

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[1] For example, in terms of temperature, humidity, height above ground level, light levels or levels of disturbance.

[2] Evidence from the Netherlands shows mass swarming events of common pipistrelle bats in the autumn followed by mass hibernation in a diverse range of building types in urban environments (Korsten *et al*., 2015).

[3] This system of categorisation aligns with BS 8596:2015 Surveying for bats in trees and woodland (BSI, 2015).

Appendix 2: Photos Potential Bat Roost Features Surveyed

Photo 1: Building 1.

Photo 2: Building 2.

Photo 3: Building 3. Exterior view of the derelict ivy-clad abandoned building which is entirely covered in a thick layer of ivy.

Photo 4: Building 3. An internal view

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Photo 5: Showing a fresh bat dropping adhered to an internal wall of the cottage.

Photo 6: Tree 1

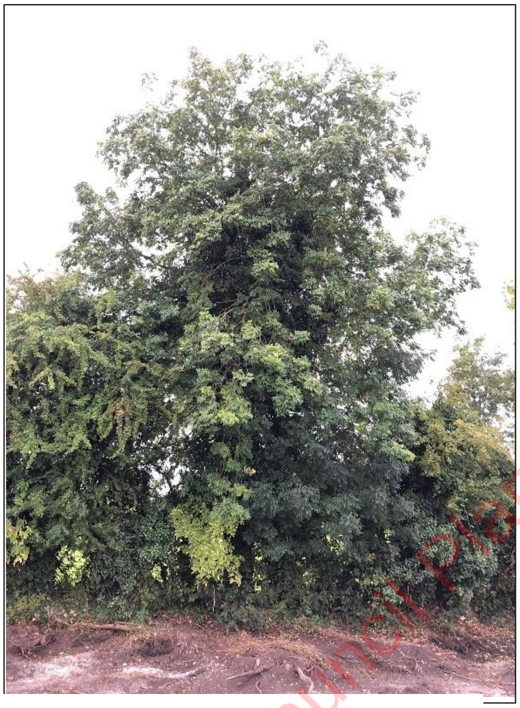

Photo 7: Tree 2

Photo 8: Tree 3

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Photo 9: Tree 4

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Appendix 3: Figures

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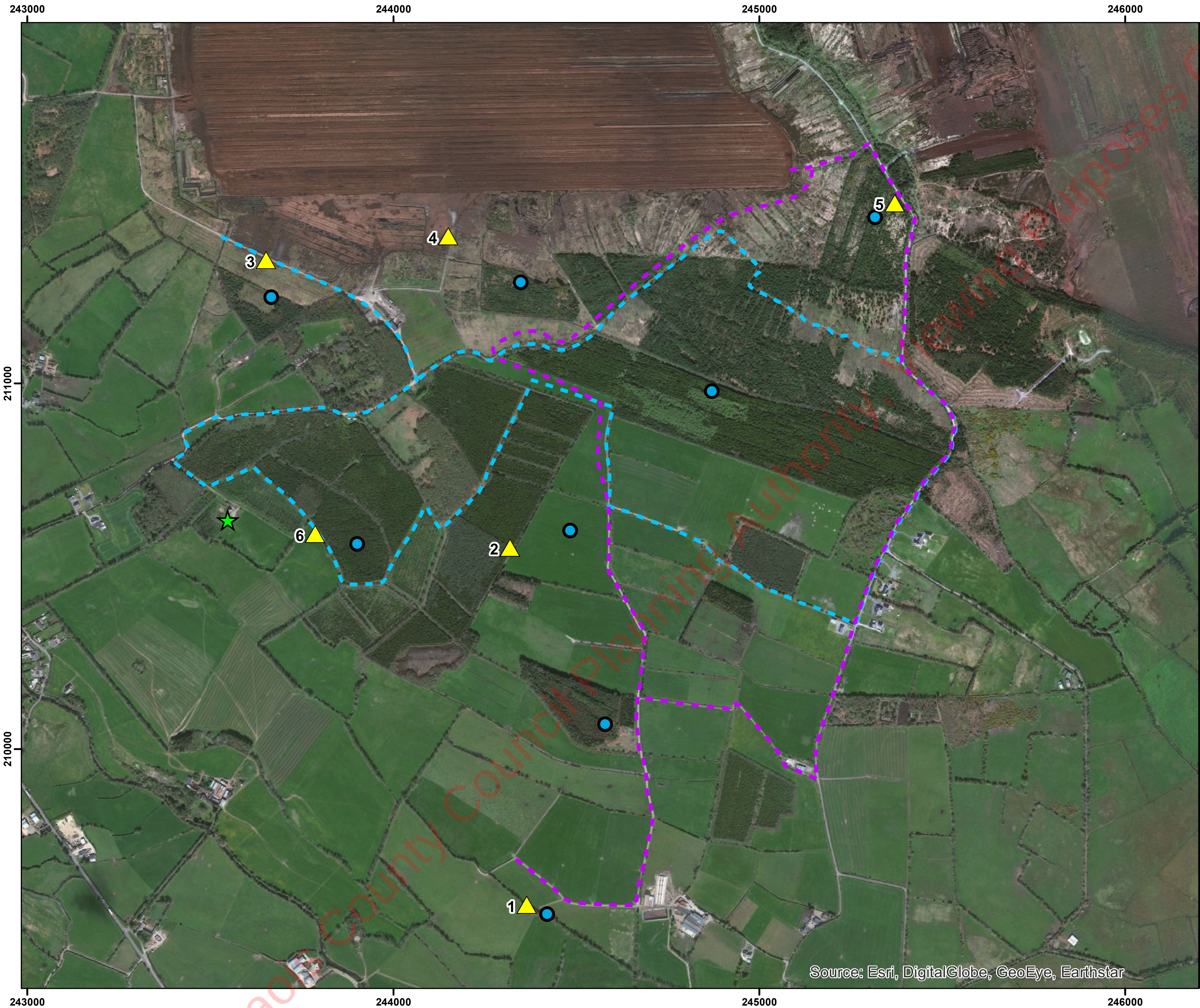

Project:

Baybridge Wind Farm, Co. Laois

Title:

Figure 2: Bat Transect Routes & Static Detector Location

Key

- Turbine
- Transect 1
- Transect 2
- Static detector
- Bat roost

Notes:

a) Information on this map is directly reproduced from digital and other material from different sources. Minor discrepancies may therefore occur. Where further clarification is considered necessary, this is noted through the use of text boxes on the map itself.

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Scale @ A3: 1:10,000

Coordinate System: TM65 Irish Grid

0 125 250 500 m

N

Date: 13-11-18	Prepared by: IW	Checked by: KO
Ref: IE201687_M_002_A	Layout: 120418_8t_R_A	

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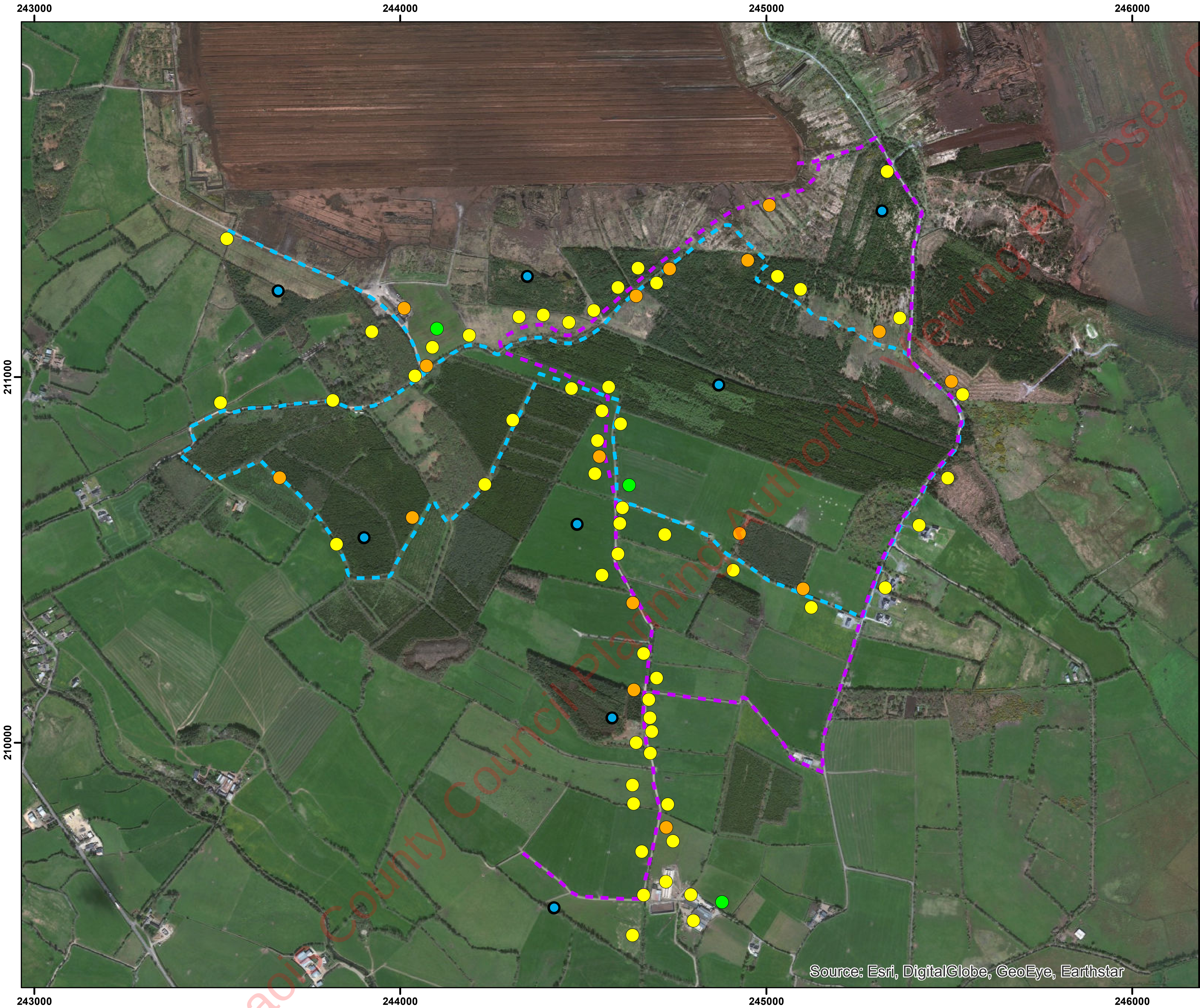

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Project:

Baybridge Wind Farm, Co. Laois

Title:

Figure 3: Bat Transect Survey Results 2018

Key

- Turbine
- Transect 1
- Transect 2

Species

- Common Pipistrelle
- Soprano Pipistrelle
- Leisler's Bat

Notes:

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Scale @ A3: 1:10,000

Coordinate System: TM65 Irish Grid

0 0.125 0.25 0.5 km

N

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Appendix 12.3

Natural Power Bat Report (2019)

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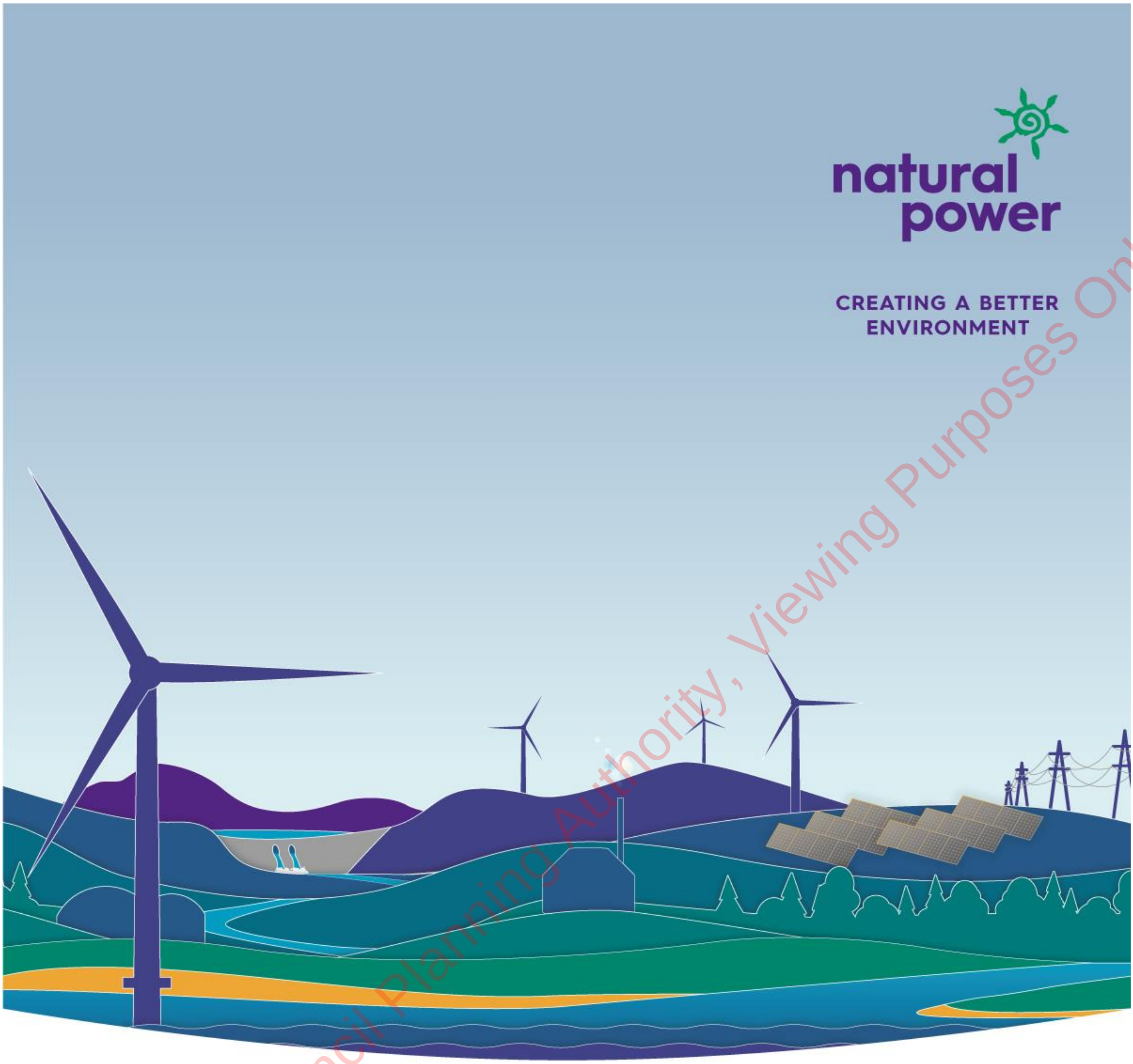

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Dernacart Wind Farm

Bat survey report 2019

29 November 2019

1204414

Confidential

Statkraft Ireland Ltd

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Document history

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Issue	Date	Revision Details
A	20/11/2019	First issue to Client
B	29/11/2019	Second issue to Client

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Contents

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1. Introduction

1.1. Site description

Natural Power have been asked by Statkraft Ireland to undertake automated static bat detector surveys and produce the associated bat report for the proposed Dernacart Wind Farm. The proposed wind farm site is located in Co. Laois, approximately 2 km north-east of the town of Mountmellick. The site comprises improved grassland for grazing, coniferous plantation and pockets of broadleaved woodland. An area of approximately 172 ha of cutover bog, which is presently subject to commercial peat harvesting, is situated immediately north of the site. There are several watercourses surrounding the site, including Cottoners Brook which abuts the eastern boundary and the River Barrow which lies along the southern site boundary. The N80 road also lies to the west of the site. The proposed development will encompass eight wind turbines and all associated ancillary works.

1.2. Previous surveys

In 2018, Natural Power conducted a suite of bat surveys on behalf of Statkraft Ireland within the proposed site and a 200 m buffer[1]. The surveys conducted include a preliminary roost assessment, a dusk emergence survey, static detector surveys and transect surveys. Four mature trees and three buildings were identified as potential bat roosts. A dusk emergence survey confirmed that one building supported a soprano pipistrelle roost. A minimum of four bat species were recorded within the site; common pipistrelle, soprano pipistrelle, Leisler's bat and *Myotis* sp.

1.3. Irish bats: Legislation

All Irish bat species are protected under the European Habitats Directive (92/43/EEC). They are listed on Annex IV of the Directive which requires the strict protection of individuals, their breeding sites and resting places. In addition to this, the lesser horseshoe bat is also listed on Annex II of the same Directive which requires the designation of special areas of conservation for these species. The Directive is transposed into Irish law through the European Communities (Birds and Natural Habitats) Regulations 2011. Bat species in Ireland are also afforded protection under the Wildlife (Amendment) Act, 2000 under which it is an offence to intentionally disturb, injure or kill a bat or disturb a bat roost.

1.4. Potential impacts

Based on available information of example flight heights, speeds, hunting techniques, habitat preference and migration (although not specifically in relation to behaviour near wind turbines); Scottish Natural Heritage (SNH) has produced guidance[2] which puts UK bats into different risk categories (high, medium and low) at both an individual and population level. This guidance has been accepted throughout the UK by all statutory nature conservation bodies (Natural Resource Wales, Natural England and Northern Ireland Environment Agency), and in the absence of additional guidelines is accepted to be relevant to the bats present in Ireland. Table 1.1 summarises the risk of wind turbines to individual bats of species that occur in Ireland.

[1] Natural Power (2018). Baybridge Bat Survey 2018/2019. Doc. Ref. 1176526.

[2] SNH (2019). Bats and onshore wind turbine – survey, assessment and mitigation. Version: January 2019.

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Table 1.1 Risk of wind turbines to individual bats of species that occur in Ireland

Low Risk	Medium Risk	High Risk
Myotis species		Leisler's bat
Brown long-eared bats		Nathusius' pipistrelle
Lesser horseshoe bats		Common pipistrelle
		Soprano pipistrelle

Source: SNH (2019)[2]

Potential effects on bat species from the operational phase of the proposed development are from accidental injury or deaths through turbine collision or barotrauma[3]. Other possible impacts include loss of foraging habitat (due to wind farm construction or because bats actively avoid the wind farm area) and fragmentation of habitat (wind farms may form barriers to commuting or seasonal movements).

[3] Barotrauma, injury caused by a change in air pressure, affecting typically the ear or the lung has previously been suggested as a potential cause of bat deaths at wind farms. However, it is unlikely to be a significant cause of bat fatalities. Modelling of changes of air pressure caused by rotating turbine blades suggests that the low-pressure region over the blade suction side is extremely localized and bats that experience the low-pressure region are likely to impact the blade. Furthermore, observations show that most bat deaths occur at low wind speeds near 5 m/s, when bats are the most active. Fatalities at higher wind speeds (> 5 m/s) are less common, likely because fewer bats are flying in these conditions. Considering that the pressure changes around wind turbine blades at low wind speeds are insignificant and that there are few bat deaths at higher wind speeds, it seems unlikely that barotrauma is a significant cause of bat fatalities around wind turbines, and that most bat fatalities are a result of blade strikes. See Lawson *et al*. 2018 Estimating the Likelihood of Bat Barotrauma using Computational Simulations and Analytical Calculations. NREL poster presentation to the AWEA siting meeting in March 2018.

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2. Methodology

2.1. Desk Study

Desk study information was obtained as part of the 2018 bat survey report[1]. An updated desk-based study was undertaken on the 1 November 2019 to identify whether there were any additional records submitted in the interim time. The search included relevant existing bat records for within the site and a 10 km radius. The following online sources were accessed:

- Bat Conservation Ireland (https://www.batconservationireland.org/)
- Biodiversity Ireland (https://maps.biodiversityireland.ie/Map)

The Bat Landscape Map (Lundy *et al.* 2011)[4] on the Biodiversity Ireland website was also accessed to view the suitability of habitat within the site and immediate surrounding area for bat species.

2.2. Automated static bat activity surveys (ground level)

Following guidance[2], a total of eight full spectrum SM4BAT detectors were deployed as close as possible to the eight proposed turbine locations. The eight detectors were deployed for a minimum of 10 consecutive nights during the summer season (June – mid-August) and 88 nights during the autumn season (mid-August – October). The detectors were programmed to commence recording 30 mins before sunset until 30 minutes after sunrise. A summary of the survey methodology is provided in Table 2.1 and 2.2 below.

Please refer to Appendix A for weather details.

Table 2.1. Location of bat detectors deployed during 2019

Turbine number/ Detector location	Irish grid ref.	Habitat
T1	N 43167 12257	Within coniferous plantation
T2	N 43284 11617	Sparse hedgerow bordering improved grassland
T3	N 43511 11414	Along edge of vegetated drain. Microphone facing towards cut-over bog
T4	N 44278 11276	Within coniferous plantation
T5	N 44801 11241	Within coniferous plantation
T6	N 45356 11453	Within coniferous plantation
T7	N 44477 10854	Edge of conifer plantation, microphone angled towards adjacent pastoral field
T8	N 44159 10376	Near edge of conifer plantation

Source: Natural Power

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[4] Lundy, M.G., Aughney, T., Montgomery, W.I., & Roche, N., (2011) Landscape conservation for Irish bats & species-specific roosting characteristics. Bat Conservation Ireland.

Table 2.2. Detector deployment summary for 2019

Season	Dates	Total no. of nights per detector per season	Average no. of hours per detector (hhh.mm)	Total recording time (hhhh.mm)
Summer	6 August – 15 August 2019	10	97.50	774.36
Autumn	11 September – 22 September 2019	12	134.34	1077.37

Source: Natural Power

2.3. Hibernation roost survey

Following good practice guidelines[5], a hibernation roost survey was conducted at two buildings, B1 and B2, (Photo 1 and 2, Section 3.3) considered to have low potential to support hibernating bats. B1 is located at N 43546 11060, while B2 is located at N 43554 10663. On the 15 January 2019, a detailed inspection of B1 and B2 was carried out from ground-level using torches with a red filter by an experienced bat surveyor. All cracks, crevices and voids were closely and systematically inspected for hibernating bats and field signs, including bat droppings and oil staining.

Automated static bat activity surveys are recommended for all structures with a moderate to high potential to support hibernating bats for a minimum of two weeks per month from December to February (inclusive)[5]. As B1 and B2 were both considered to have low potential to support hibernating bats it was determined that a single survey of two weeks using static bat detectors (SM2BAT detectors) was adequate to detect winter bat activity. This survey was conducted between 30 January and 15 February 2019.

2.4. Data analysis

All recordings were made in full spectrum, retaining all amplitude and harmonic information from the original bat call for subsequent analysis. Bat calls were analysed using Kaleidoscope Pro Software. All files were split to a maximum duration of 15 seconds and automatically identified to species level, or genus level as appropriate, using auto-ID bat classifiers. The species identification of a randomly generated 10% sample of the files were manually checked for quality assurance.

The data was then entered into Ecobat[6] and a report was subsequently generated. Ecobat is an online tool which makes assessments of bat activity levels by comparing data entered by the user with bat survey information from similar areas at the same time of year. Specifically, a median bat activity level is calculated which corresponds to a bat activity category (Table 2.3).

An individual bat can pass a particular feature on several occasions while foraging. It is therefore not possible to estimate the number of individual bats. In accordance with best practice guidance (Collins, 2016)[5] an activity index is used; calculated from bat records per hour which allows analysis of bat activity to estimate abundance and/ or activity. The calculation is as follows;

BAI (Bat Activity Index) = Total number of bat records / number of hours of recording

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

[6] www.ecobat.org.uk

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Table 2.3: Median percentile range and corresponding bat activity

Percentile Median	Bat Activity
81 to 100	High
61 to 80	Moderate to High
41 to 60	Moderate
21 to 40	Low to Moderate
0 to 20	Low

2.5. Survey and analysis limitations

The following potential limitations were experienced:

- Following SNH guidance[2], the minimum pre-application survey requirement of using static detectors for 10 nights in each of spring, summer and autumn was not met. Static detectors were only deployed during the summer and autumn seasons. This was due to a delay to the start of surveying because Natural Power were not commissioned until after June 2019;
- It is recommended that the Ecobat activity level assessment be based on a minimum of 2,000 nights of bat data previously submitted into the Ecobat data depository[6]. However, the current ability of Ecobat to compare activity levels within the proposed site is limited as only 50 nights of activity have previously been submitted. Therefore, the Ecobat activity level assessment should be treated with caution. However, the Ecobat tool was used in accordance with best practice guidelines[2].
- The automated static detectors are powered by 6 volt batteries and on four occasions during the summer season the battery charge was not sufficient to complete the full survey period, or the equipment malfunctioned. Specifically, the detector at T1 recorded four nights less than the recommended 10 nights per season, T3 recorded three nights less, T6 recorded two nights less and T8 recorded 1 night less. This small loss of data is noted considered to be a significant limitation.
- All bat surveys were conducted from ground level as no suitable structures currently exist on the site to conduct surveys at height;
- It is not always possible to identify a bat call to species level, especially for *Myotis* species, or if the recorded call is not clear. Recorded files from automated detectors may contain only fragments of a call, or the bat may be calling from a distance (from the detector) in which case it may not be clear enough to assign the call to a specific species;
- Some caution must be taken when comparing activity levels between species, as bias can be shown towards those species with 'louder' or 'lower frequency' echolocation calls. For example, *Nyctalus* species have louder and low frequency echolocation calls which carry further than the quieter and more broad-band brown long-eared bat echolocation calls; and
- A bat contact is defined as a single 15 second SM4BAT detector file which contains at least one bat call. Multiple contacts at any given detector location do not necessarily indicate the presence of more than one bat and should therefore be interpreted as a level of activity rather than the number of bats recorded.

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3. Results

3.1. Desk Study

An updated desk study was carried out on the 1 November 2019 and no additional records have become available since the desk study conducted in 2018.

3.2. Automated static bat activity surveys (ground level)

In total, 20,363 bat passes were recorded during the summer and autumn season 2019 (Table 3.1). A minimum of four bat species were recorded: common pipistrelle, soprano pipistrelle, Leisler's bat and brown long-eared bat. In addition, there were a number of contacts identified as *Pipistrellus* sp. and *Myotis* sp. The total number of bat passes recorded per detector during the summer and the autumn seasons individually is presented in Table B.1 and Table B.2, Appendix C.

Table 3.1: Total number of bat passes recorded per detector during the summer and autumn seasons 2019

Turbine number	Common pipistrelle	Soprano pipistrelle	*Pipistrellus* sp.	Leisler's bat	*Myotis* sp.	Brown long-eared bat	Total
T1	154	34	10	69	3	8	**278**
T2	2743	2036	174	174	121	35	**5283**
T3	234	190	42	79	28	8	**581**
T4	598	392	104	91	50	80	**1315**
T5	1732	148	34	163	26	15	**2118**
T6	109	30	6	141	5	19	**310**
T7	2810	3136	2104	255	81	12	**8398**
T8	854	661	135	97	315	18	**2080**
Total	**9234**	**6627**	**2609**	**1069**	**629**	**195**	**20363**

Source: Natural Power

A total Bat Activity Index (BAI) of 10.99 was recorded within the site. The most commonly recorded species by BAI was common pipistrelle (4.99 BAI), followed by soprano pipistrelle (3.58 BAI). The remaining contacts were *Pipistrellus* sp. (1.41 BAI), Leisler's bat (0.58 BAI), *Myotis* sp. (0.34 BAI) and brown long-eared bat (0.11 BAI). Common pipistrelle, soprano pipistrelle and Leisler's bat are high-risk species.

The highest concentration of bat activity was at T7 (Graph 3.1). This detector was located on the edge of conifer planation with the microphone of the detector facing the adjacent pastoral field. In contrast, the lowest levels of bat activity were recorded at T1 and T6, respectively (Graph 3.1). At these locations the detectors were located within coniferous plantation.

Overall, bat activity levels were higher during the summer season (17.33 BAI) compared to the autumn season (6.43 BAI) (Graph 3.2).

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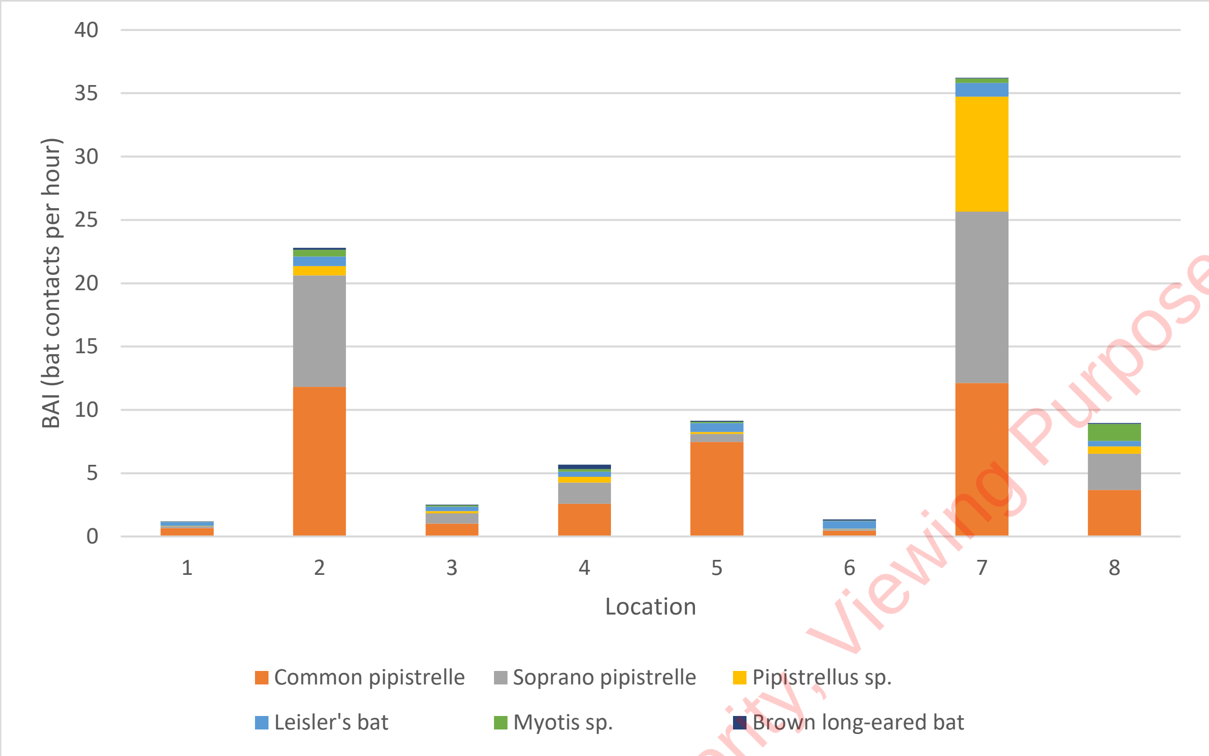
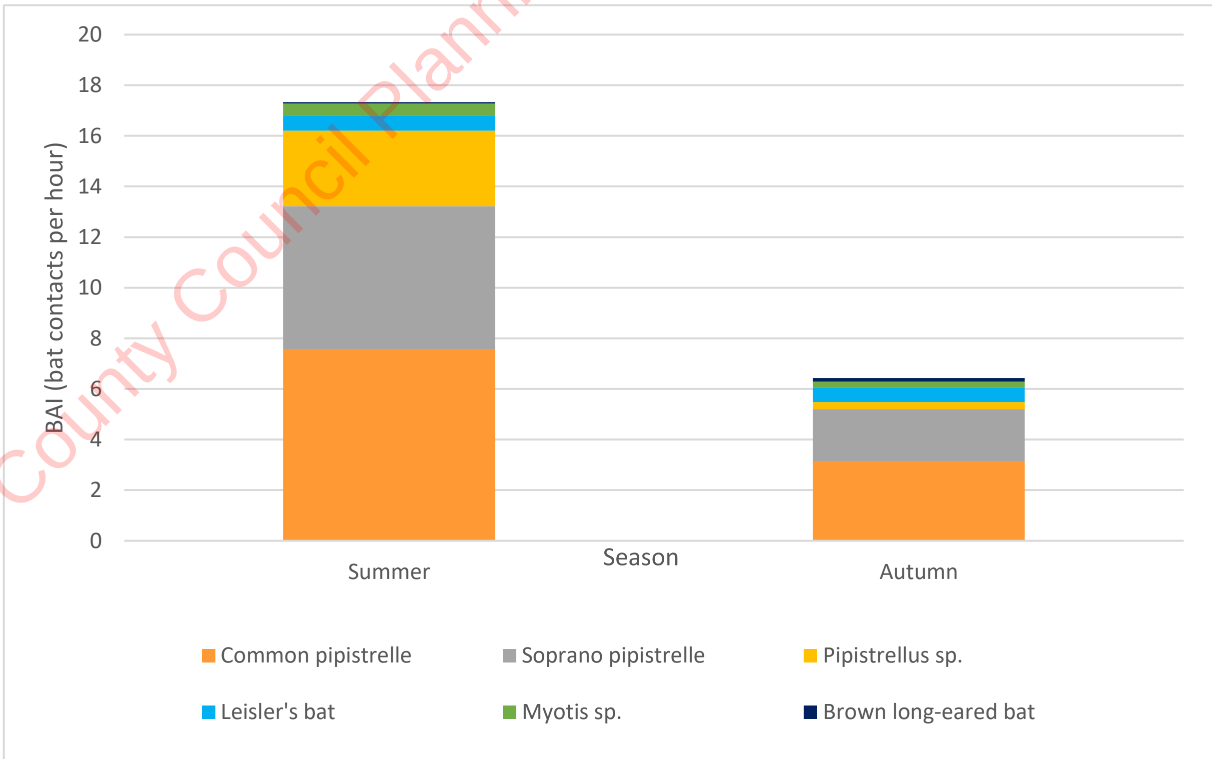
Graph 3.1: Bat activity index per species per turbine number

Source: Natural Power



Graph 3.2: Bat activity index per species per season

Source: Natural Power



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3.2.1. Ecobat results

A summary of the results generated from the Ecobat online tool[6] are presented within Table 3.2.

Further results from the Ecobat online tool are presented in Table B.1 to B.6 and Figures B.1.1. to B.1.8 in Appendix B.

Table 3.2: Number of nights of acoustic monitoring bat activity per species contained within each activity band per turbine during the summer and autumn season combined.

Detector ID	Species/Species Group	Nights of High Activity	Nights of Moderate/ High Activity	Nights of Moderate Activity	Nights of Low/ Moderate Activity	Nights of Low Activity	Percentile Median	Bat Activity Category
T1	Common pipistrelle	1	6	6	0	3	60	Moderate
T1	Soprano pipistrelle	0	0	2	4	7	19	Low
T1	*Pipistrellus* sp.	2	2	1	1	0	72	Moderate to High
T1	Leisler's bat	1	0	2	7	6	31	Low to Moderate
T1	*Myotis* sp.	0	0	0	0	2	10	Low
T1	Brown long-eared	0	0	0	0	6	4	Low
T2	Common pipistrelle	13	5	3	0	1	83	High
T2	Soprano pipistrelle	9	7	4	2	0	75	Moderate to High
T2	Pipistrellus sp.	17	1	1	0	0	90	High
T2	Leisler's bat	2	4	5	3	6	47	Moderate
T2	*Myotis* sp.	2	0	0	4	7	4	Low
T2	Brown long-eared	0	1	0	3	8	19	Low
T3	Common pipistrelle	3	6	4	2	1	69	Moderate to High
T3	Soprano pipistrelle	1	7	5	2	1	64	Moderate to High
T3	*Pipistrellus* sp.	6	3	0	0	1	82	High
T3	Leisler's bat	0	2	6	3	6	31	Low to Moderate
T3	*Myotis* sp.	0	0	0	5	7	19	Low
T3	Brown long-eared	0	0	0	1	5	4	Low
T4	Common pipistrelle	9	3	6	3	1	68	Moderate to High
T4	Soprano pipistrelle	4	9	2	5	2	65	Moderate to High
T4	*Pipistrellus* sp.	10	5	1	1	0	84	High
T4	Leisler's bat	0	2	6	4	8	35	Low to Moderate
T4	*Myotis* sp.	0	0	4	6	3	39	Low to Moderate
T4	Brown long-eared	0	5	2	3	4	44	Moderate

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T5	Common pipistrelle	10	5	1	2	2	81	High
T5	Soprano pipistrelle	0	5	4	3	3	57	Moderate
T5	*Pipistrellus* sp.	10	0	0	0	0	92	High
T5	Leisler's bat	0	6	5	2	6	47	Moderate
T5	*Myotis* sp.	0	0	1	8	3	24	Low to Moderate
T5	Brown long-eared	0	0	0	1	7	19	Low
T6	Common pipistrelle	2	0	5	1	4	50	Moderate
T6	Soprano pipistrelle	0	0	2	3	9	4	Low
T6	*Pipistrellus* sp.	1	1	1	2	0	46	Moderate
T6	Leisler's bat	1	5	2	4	6	28	Low to Moderate
T6	*Myotis* sp.	0	0	0	0	4	3	Low
T6	Brown long-eared	0	0	0	3	7	19	Low
T7	Common pipistrelle	18	1	1	1	0	90	High
T7	Soprano pipistrelle	15	5	1	1	0	92	High
T7	*Pipistrellus* sp.	19	0	0	0	0	98	High
T7	Leisler's bat	3	2	5	4	4	49	Moderate
T7	*Myotis* sp.	0	1	6	4	5	33	Low to Moderate
T7	Brown long-eared	0	0	0	2	5	1	Low
T8	Common pipistrelle	13	2	0	0	1	87	High
T8	Soprano pipistrelle	9	4	3	1	0	81	High
T8	*Pipistrellus* sp.	14	1	0	0	0	92	High
T8	Leisler's bat	0	3	4	3	6	39	Low to Moderate
T8	*Myotis* sp.	1	0	1	3	5	25	Low to Moderate
T8	Brown long-eared	0	0	0	3	5	19	Low

Source: Ecobat[6] generated report

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3.3. Hibernation roost survey

During the internal surveys, no evidence of wintering bats was identified in buildings B1 and B2 (Photo 1 and 2; below) and no bat activity was recorded during the automated static detector surveys.

Photo 1: B1

Photo 2: B2

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4. Discussion

Within the proposed wind farm site, high and low risk species were recorded. The high-risk species are as follows; common pipistrelle (4.99 BAI), soprano pipistrelle (3.58 BAI), *Pipistrellus* sp. (1.41 BAI) and Leisler's bat (0.58 BAI).

During 2019, the greatest number of bat passes, 8,398 passes across the summer and autumn season combined, was recorded at T7 (Table 3.1). The majority of this activity is attributed to soprano pipistrelle, common pipistrelle and *Pipistrellus* sp.. This turbine is proposed to be located close to the edge of a conifer plantation.

Conversely, the lowest number of bat passes, 278 across the summer and autumn season combined, were recorded at T1 (Table 3.1). This turbine along with three others are proposed to be keyholed into coniferous plantation. Keyhole felling facilitates the construction and operation of these turbines, however this will create edge habitat which may result in an increase bat activity.

Leisler's bats are assessed by SNH (2019)[2] guidance to be of high risk in terms of collision and threat to national populations. Leisler's bat were recorded at all eight detector locations in low numbers. T7 had the highest BAI of 1.10 for this species. The overall activity level of this species within the proposed site, according to Ecobat[6], was categorised as low to moderate. The highest activity category of moderate was recorded at a total of three turbines, namely, T2, T5 and T7. In addition, bat passes potentially indicating a nearby Leisler's roost were recorded at T6 and T7 (Figure C.1.6 and C.1.7).

Common and soprano pipistrelle are also assessed by SNH (2019)[2] guidance to be of high-risk in terms of collision. A study by DEFRA (2016) found that ground level monitoring of activity for both these species is a better predictor of fatality than recording at height. Common and soprano pipistrelle are the most common bat species within the proposed site and were recorded at all eight detector locations. The highest BAI for these species was recorded at T7. According to Ecobat[6], the overall activity levels of these two species are moderate to high. With regards to common pipistrelle, high and high to moderate activity categories were recorded at the following turbines: T2, T3, T4, T5, T7 and T8. With regards to soprano pipistrelle, high and high to moderate activity categories were recorded at T2, T3, T4, T7 and T8. Furthermore, bat passes potentially indicating nearby common pipistrelle and soprano pipistrelle roosts were recorded at T5 (Figure C.1.5).

Myotis sp. are assessed by SNH (2019)[2] to be of low risk in term of collision and threat to national populations. *Myotis* sp. was recorded at all detector locations with the highest BAI recorded at T8; near the edge of a conifer plantation. The overall activity level of this genus within the proposed site, according to Ecobat[6], was categorised as low to moderate.

Brown long-eared bats are considered by SNH (2019)[2] to be of low risk in terms of collision. This species was recorded at all eight detector locations in low numbers. T4 had the highest BAI of 0.35 for this species. According to Ecobat, the activity levels of brown long-eared bats within the proposed site are low.

As outlined in Section 2.1, static detector surveys were completed within the site during 2018. Overall, the total BAI recorded during 2018 and 2019 is similar at 8.92 and 10.99, respectively. Furthermore, during both survey years the most commonly recorded species by BAI was common pipistrelle, followed by soprano pipistrelle. However, brown long-eared bat was only recorded during the 2019 survey season. Although the location of the detectors was not the same during 2018 and 2019, it should be noted that during both survey years the highest level of activity was recorded along edge habitats, specifically at the edge of coniferous plantation. Furthermore, during 2018 and 2019 the lowest level of activity was recorded within coniferous plantation.

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5. Potential impacts

During the construction phase, permanent habitat loss will occur as a result of keyhole felling of existing coniferous plantation, required to enable the construction of the proposed turbines and associated infrastructure. However, due to the creation of edge habitat and open areas, impact upon foraging and commuting opportunities is considered to be minimal. Bats may also be disturbed by lighting, noise and vibrations. This may lead to temporary avoidance of the area during the construction phase. The site is connected to moderate quality habitat for foraging and commuting. Therefore, should any individuals avoid the site due to disturbance, it is considered likely that they will utilise this adjacent habitat.

During the operational phase, rotating turbines present a risk to bats as a result of potential collision.

Decommissioning effects are predicted to be of similar, or lower magnitude to the effect during construction. Felling at the extent proposed for site preparation will not be required during decommission.

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6. Recommendations and potential mitigation

A full impact assessment will be required before final recommendations and mitigation can be provided.

6.1. Buffer zone

At least four of the eight proposed turbines within the site are to be located within commercial coniferous plantation and are likely to require keyhole tree felling. Siting turbines within woodland can present additional risk through the creation of edge-effects attracting greater bat activity, as demonstrated by various studies showing that natural and logged clearings create edges that many species of bat favour[3.] According to SNH (2019) guidance[3], a 50 m buffer distance between blade tip and edge feature should be applied as a basic standard mitigation measure for all bat species occurring at proposed wind farms, including all key-holed sites.

6.2. Retention and removal of trees

Beyond the buffer zone, trees and treelines should be retained where possible.

Pre-construction surveys of potential bat roosts should be carried out on any trees or structures with potential to support roosting bats within a minimum of 30 m of working areas. This should include any tree clearance or bridge strengthening works on the turbine delivery access route.

6.3. Lighting

Many bat species are adversely impacted by artificial lighting which can disturb bat foraging and commuting activity, roosting and hibernation[7].

Therefore, the following mitigation measures are recommended:

- External lighting should be avoided wherever possible. Where external lighting is needed it should be designed to avoid and reduce light spill following best practice guidelines for lighting and bats[8]. Where external road lighting is needed the use of bollards with louvers should be considered to keep lighting directional and below head height. Timer or motion sensors should also be considered;
- Security lighting should be directed away from wooded areas and watercourses; and
- If construction work is required to be carried out during the hours of darkness in the vicinity of roosts lighting should not be utilised within an hour before dusk and after dawn as a minimum.

6.4. Operational monitoring

Following a full impact assessment, it is likely that operational monitoring will be required. This is likely to include static monitoring and carcass searching with dogs.

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[7] Stone, E.L. (2013). Bats and lighting. Overview of current evidence and mitigation guidance.

[8] Bat Conservation Trust (2009). Bats and Lighting in the UK. Bat Conservation Trust. London.

Appendices

A. Weather conditions

Table A.1: Weather conditions during detector deployment

Date	Temp (ºC) High/low	Precipitation (mm)	Wind (km/h)
06/08/2019	17/13	5	7.1
07/08/2019	21/13	1.6	3.8
08/08/2019	22/10	14.6	11.5
09/08/2019	22/15	20.8	9.9
10/08/2019	19/14	6.0	8.3
11/08/2019	17/10	0.2	4.2
12/08/2019	16/8	3.8	3.7
13/08/2019	18/8	4.2	6.0
14/08/2019	20/14	0.4	9.4
15/08/2019	20/12	5.6	8.6
16/08/2019	22/14	2.4	7.4
11/09/2019	18/11	0.0	6.7
12/09/2019	21/8	0.3	4.3
13/09/2019	17/6	0.2	3.4
14/09/2019	20/8	0.0	4.5
15/09/2019	18/15	1.0	5.3
16/09/2019	19/9	0.0	2.9
17/09/2019	18/5	0.0	1.6
18/09/2019	20/4	0.0	1.8
19/09/2019	22/6	0.0	3.4
20/09/2019	21/10	0.0	11.0
21/09/2019	21/13	6.6	9.2

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B. Ecobat results

Table B.1: Total number of bat passes recorded per detector during the summer season 2019

Turbine	Common pipistrelle	Soprano pipistrelle	*Pipistrellus* sp.	Leisler's bat	*Myotis* sp.	Brown long-eared bat	Total
T1	32	3	5	22	0	2	**64**
T2	2041	1591	112	49	10	18	**3821**
T3	74	66	32	36	5	3	**216**
T4	216	193	39	44	16	11	**519**
T5	1593	138	28	107	20	1	**1887**
T6	74	66	32	36	5	3	**216**
T7	1309	1901	1982	53	23	1	**5269**
T8	586	488	114	70	296	2	**1556**
Total	**5861**	**4394**	**2317**	**456**	**371**	**41**	**13440**

Source: Natural Power

Table B.2: Total number of bat passes recorded per detector during the autumn season 2019

Turbine	Common pipistrelle	Soprano pipistrelle	*Pipistrellus* sp.	Leisler's bat	*Myotis* sp.	Brown long-eared bat	Total
T1	122	31	5	47	3	6	**214**
T2	702	445	62	125	111	17	**1462**
T3	160	124	10	43	23	5	**365**
T4	382	199	65	47	34	69	**796**
T5	139	10	6	56	6	14	**231**
T6	99	16	1	66	4	16	**202**
T7	1501	1235	122	202	58	11	**3129**
T8	268	173	21	27	19	16	**524**
Total	**3373**	**2233**	**292**	**613**	**258**	**154**	**6,923**

Source: Natural Power

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Table B.3: Number of nights of static detector monitoring season contained witihn each activity band per species during the summer season.

Species/Species Group	Nights of High Activity	Nights of Moderate/ High Activity	Nights of Moderate Activity	Nights of Low/ Moderate Activity	Nights of Low Activity	Percentile Median	Bat Activity Category
Common pipistrelle	33	8	10	6	6	81	High
Soprano pipistrelle	22	15	8	10	9	72	Moderate to High
Pipistrellus sp.	39	9	4	4	1	87	High
Leisler's bat	0	16	16	14	18	43	Moderate
Myotis sp.	1	0	4	16	10	24	Low to Moderate
Brown long-eared bat	0	1	1	3	14	4	Low

Source: Ecobat[6] generated report

Table B.4: Number of nights of static detector monitoring contained witihn each activity band per season during the autumn season.

Species/Species Group	Nights of High Activity	Nights of Moderate/ High Activity	Nights of Moderate Activity	Nights of Low/ Moderate Activity	Nights of Low Activity	Percentile Median	Bat Activity Category
Common pipistrelle	36	20	16	3	7	73	Moderate to High
Soprano pipistrelle	16	22	15	11	13	59	Moderate
Pipistrellus sp.	40	4	0	0	0	91	High
Leisler's bat	7	8	19	16	30	36	Low to Moderate
Myotis sp.	2	1	8	14	26	19	Low
Brown long-eared bat	0	5	1	13	33	19	Low

Source: Ecobat[6] generated report

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Table B.5: Number of nights of acoustic monitoring bat activity per species contained within each activity band per turbine during the summer season.

Detector ID	Species/Species Group	Nights of High Activity	Nights of Moderate/ High Activity	Nights of Moderate Activity	Nights of Low/ Moderate Activity	Nights of Low Activity	Percentile Median	Bat Activity Category
T1	Common pipistrelle	0	1	2	0	3	25	Low to Moderate
T1	Soprano pipistrelle	0	0	0	0	3	4	Low
T1	*Pipistrellus* sp.	0	1	1	1	0	51	Moderate
T1	Leisler's bat	0	0	2	2	2	34	Low to Moderate
T1	Brown long-eared bat	0	0	0	0	2	4	Low
T2	Common pipistrelle	8	1	0	0	1	88	High
T2	Soprano pipistrelle	5	2	1	2	0	80	Moderate to High
T2	*Pipistrellus* sp.	9	0	1	0	0	91	High
T2	Leisler's bat	0	1	3	2	2	43	Moderate
T2	*Myotis* sp.	0	0	0	2	4	4	Low
T2	Brown long-eared bat	0	1	0	1	2	14	Low
T3	Common pipistrelle	1	1	3	1	0	53	Moderate
T3	Soprano pipistrelle	0	3	1	1	1	61	Moderate to High
T3	Pipistrellus sp.	2	3	0	0	1	77	Moderate to High
T3	Leisler's bat	0	1	2	1	3	24	Low to Moderate
T3	*Myotis* sp.	0	0	0	1	2	4	Low
T3	*Brown long-eared bat*	0	0	0	0	3	4	Low
T4	Common pipistrelle	2	2	3	2	1	51	Moderate
T4	Soprano pipistrelle	2	3	0	3	2	49	Moderate
T4	*Pipistrellus* sp.	4	3	1	1	0	79	Moderate to High
T4	Leisler's bat	0	1	2	1	4	22	Low to Moderate
T4	*Myotis* sp.	0	0	1	3	0	39	Low to Moderate
T4	Brown long-eared bat	0	0	1	1	2	14	Low
T5	Common pipistrelle	8	1	0	1	0	91	High
T5	Soprano pipistrelle	0	5	4	1	0	62	Moderate to High
T5	*Pipistrellus* sp.	8	0	0	0	0	95	High
T5	Leisler's bat	0	4	3	1	2	59	Moderate
T5	*Myotis* sp.	0	0	1	7	0	24	Low to Moderate

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T5	Brown long-eared bat	0	0	0	0	1	4	Low
T6	Common pipistrelle	0	0	1	1	1	24	Low to Moderate
T6	Soprano pipistrelle	0	0	1	2	3	14	Low
T6	*Pipistrellus* sp.	0	1	1	2	0	43	Moderate
T6	Leisler's bat	0	4	0	3	1	45	Moderate
T6	*Myotis* sp.	0	0	0	0	1	4	Low
T6	Brown long-eared bat	0	0	0	1	1	14	Low
T7	Common pipistrelle	8	0	1	1	0	89	High
T7	Soprano pipistrelle	9	0	0	1	0	94	High
T7	*Pipistrellus* sp.	9	0	0	0	0	99	High
T7	Leisler's bat	0	2	3	1	2	49	Moderate
T7	*Myotis* sp.	0	0	2	2	2	29	Low to Moderate
T7	Brown long-eared bat	0	0	0	0	1	4	Low
T8	Common pipistrelle	6	2	0	0	0	86	High
T8	Soprano pipistrelle	6	2	1	0	0	82	High
T8	*Pipistrellus* sp.	7	1	0	0	0	92	High
T8	Leisler's bat	0	3	1	3	2	39	Low to Moderate
T8	*Myotis* sp.	1	0	0	1	1	34	Low to Moderate
T8	Brown long-eared bat	0	0	0	0	2	4	Low

Source: Ecobat[6] generated report

Table B.6: Number of nights of acoustic monitoring bat activity per species contained within each activity band per turbine during the autumn season.

Detector ID	Species/Species Group	Month	Nights of High Activity	Nights of Moderate/ High Activity	Nights of Moderate Activity	Nights of Low/ Moderate Activity	Nights of Low Activity	Percentile Median	Bat Activity Category
T1	Common pipistrelle	Sep	1	5	4	0	0	63	Moderate to High
T1	Soprano pipistrelle	Sep	0	0	2	4	4	31	Low to Moderate
T1	*Pipistrellus* sp.	Sep	2	1	0	0	0	80	Moderate to High
T1	Leisler's bat	Sep	1	0	0	5	4	31	Low to Moderate
T1	*Myotis* sp.	Sep	0	0	0	0	2	10	Low
T2	Common pipistrelle	Sep	5	4	3	0	0	72	Moderate to High
T2	Soprano pipistrelle	Sep	4	5	3	0	0	74	Moderate to High

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T2	*Pipistrellus* sp.	Sep	8	1	0	0	0	87	High
T2	Leisler's bat	Sep	2	3	2	1	4	50	Moderate
T2	*Myotis* sp.	Sep	2	0	0	2	3	31	Low to Moderate
T2	Brown long-eared	Sep	0	0	0	2	6	19	Low
T3	Common pipistrelle	Sep	2	5	1	1	1	72	Moderate to High
T3	Soprano pipistrelle	Sep	1	4	4	1	0	64	Moderate to High
T3	*Pipistrellus* sp.	Sep	4	0	0	0	0	82	High
T3	Leisler's bat	Sep	0	1	4	2	3	39	Low to Moderate
T3	*Myotis* sp.	Sep	0	0	0	4	5	19	Low
T3	Brown long-eared	Sep	0	0	0	1	2	1	Low
T4	Common pipistrelle	Sep	7	1	3	1	0	81	High
T4	Soprano pipistrelle	Sep	2	6	2	2	0	67	Moderate to High
T4	*Pipistrellus* sp.	Sep	6	2	0	0	0	91	High
T4	Leisler's bat	Sep	0	1	4	3	4	36	Low to Moderate
T4	*Myotis* sp.	Sep	0	0	3	3	3	31	Low to Moderate
T4	Brown long-eared	Sep	0	5	1	2	2	55	Moderate
T5	Common pipistrelle	Sep	2	4	1	1	2	65	Moderate to High
T5	Soprano pipistrelle	Sep	0	0	0	2	3	1	Low
T5	*Pipistrellus* sp.	Sep	2	0	0	0	0	88	High
T5	Leisler's bat	Sep	0	2	2	1	4	31	Low to Moderate
T5	*Myotis* sp.	Sep	0	0	0	1	3	1	Low
T5	Brown long-eared	Sep	0	0	0	1	6	19	Low
T6	Common pipistrelle	Sep	2	0	4	0	3	52	Moderate
T6	Soprano pipistrelle	Sep	0	0	1	1	6	1	Low
T6	*Pipistrellus* sp.	Sep	1	0	0	0	0	89	High
T6	Leisler's bat	Sep	1	1	2	1	5	25	Low to Moderate
T6	Brown long-eared	Sep	0	0	0	2	6	19	Low
T7	Common pipistrelle	Sep	10	1	0	0	0	93	High
T7	Soprano pipistrelle	Sep	6	5	1	0	0	83	High
T7	*Pipistrellus* sp.	Sep	10	0	0	0	0	96	High
T7	Leisler's bat	Sep	3	0	2	3	2	48	Moderate
T7	*Myotis* sp.	Sep	0	1	4	2	3	42	Moderate

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T7	Brown long-eared	Sep	0	0	0	2	4	1	Low
T8	Common pipistrelle	Sep	7	0	0	0	1	88	High
T8	Soprano pipistrelle	Sep	3	2	2	1	0	74	Moderate to High
T8	*Pipistrellus* sp.	Sep	7	0	0	0	0	92	High
T8	Leisler's bat	Sep	0	0	3	0	4	19	Low
T8	*Myotis* sp.	Sep	0	0	1	2	4	19	Low
T8	Brown long-eared	Sep	0	0	0	3	3	25	Low to Moderate

Source: Ecobat[6] generated report

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Figure B.1 Bat passes potentially indicating close proximity to a roost

Figures show time from 15 minutes before to 90 minutes after sunset. Species-specific emergence time ranges are shown as grey bars. Bat passes overlapping species-specific grey bars, or occurring earlier than this time range, may potentially indicate the presence of a nearby roost.

Figure B.1.1 Bat passes at T1 potentially indicating close proximity to a roost

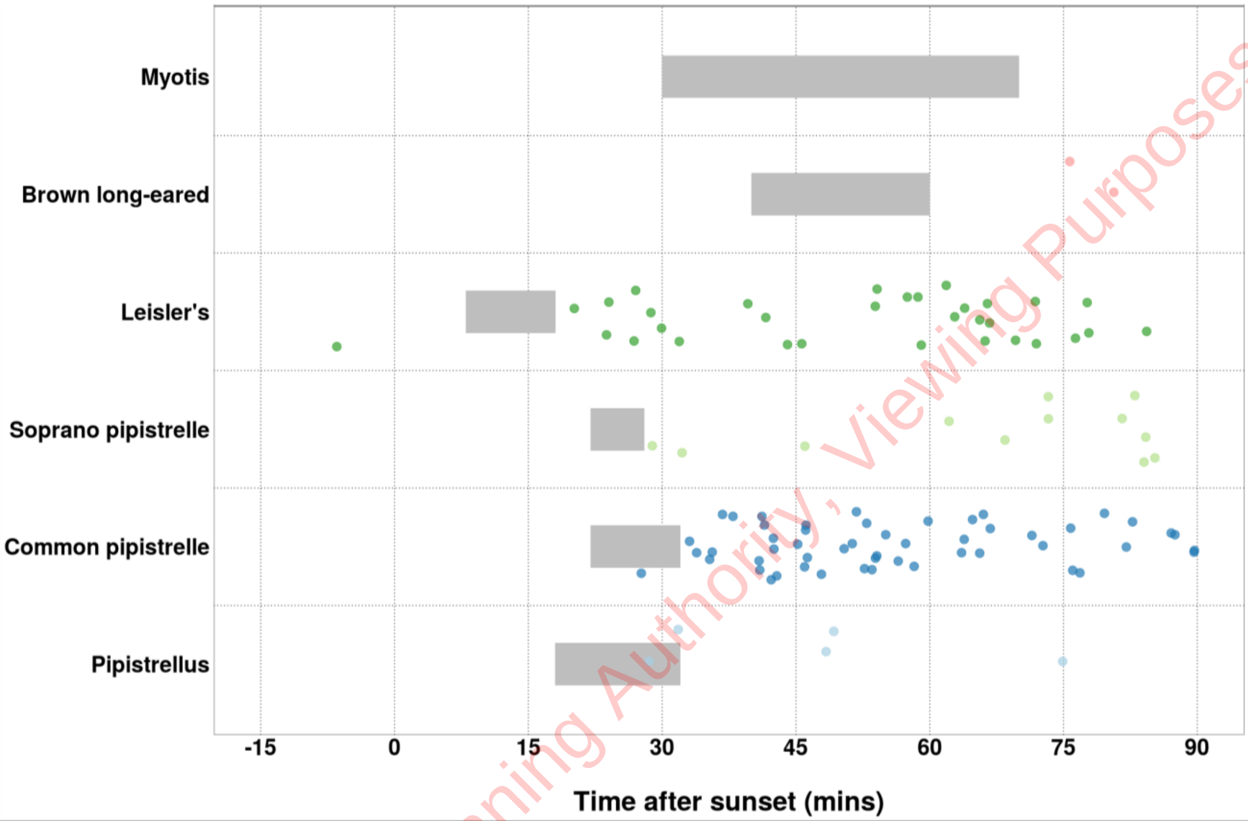

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Figure B.1.2 Bat passes at T2 potentially indicating close proximity to a roost

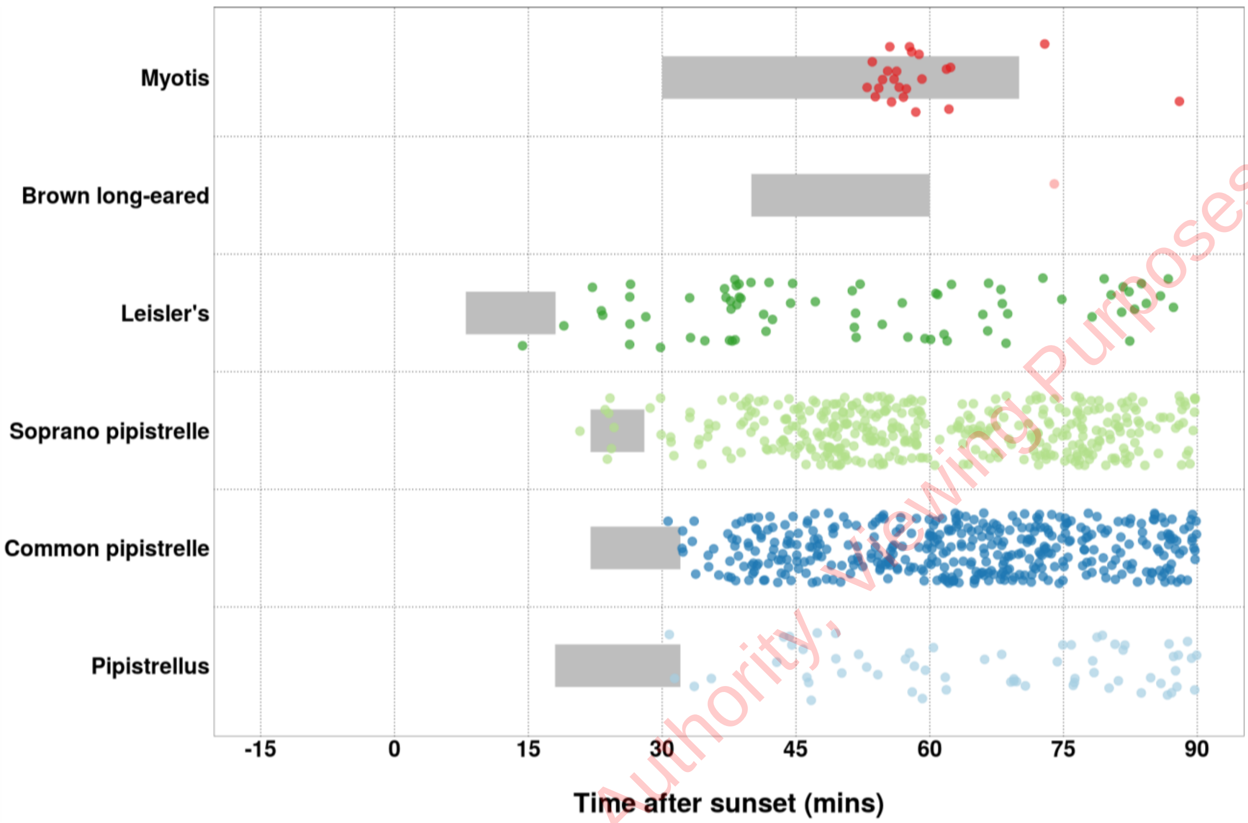

Figure B.1.3 Bat passes at T3 potentially indicating close proximity to a roost

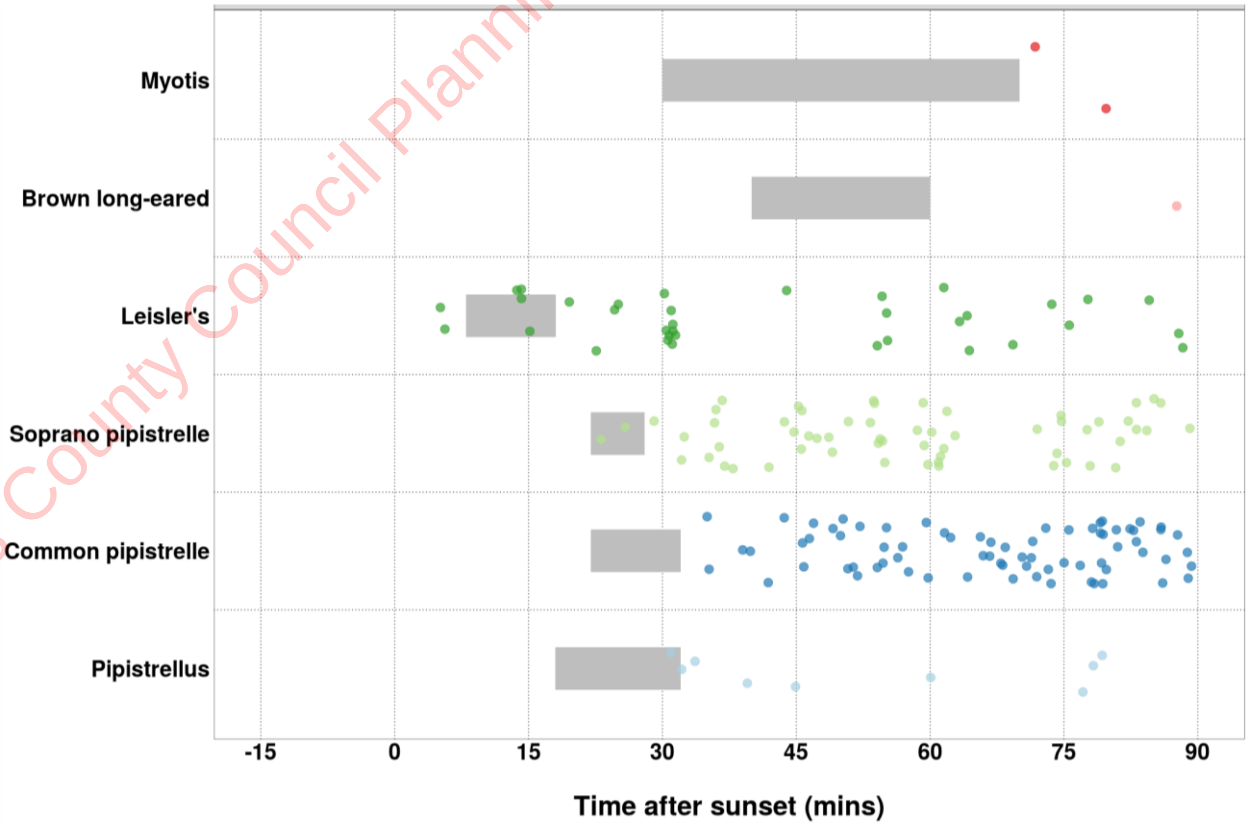

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Figure B.1.4 Bat passes at T4 potentially indicating close proximity to a roost

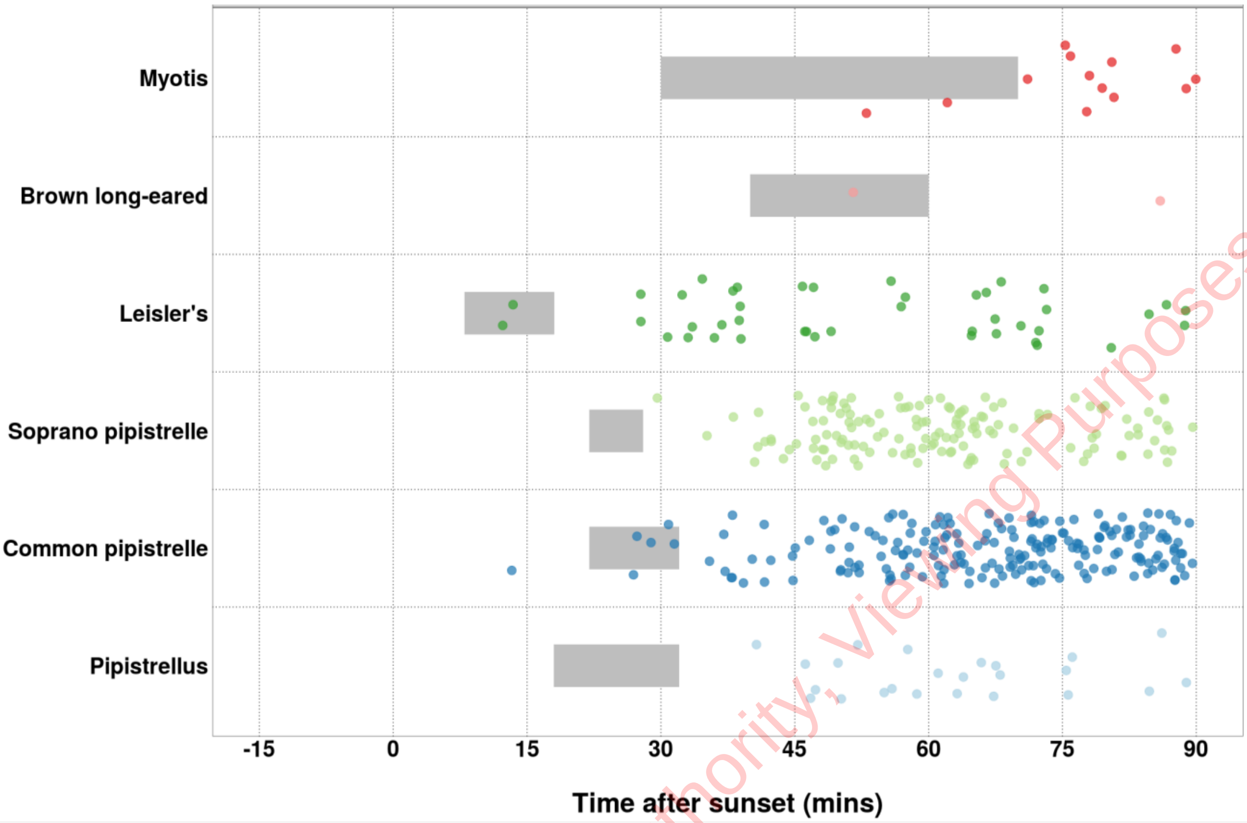

Figure B.1.5 Bat passes at T5 potentially indicating close proximity to a roost

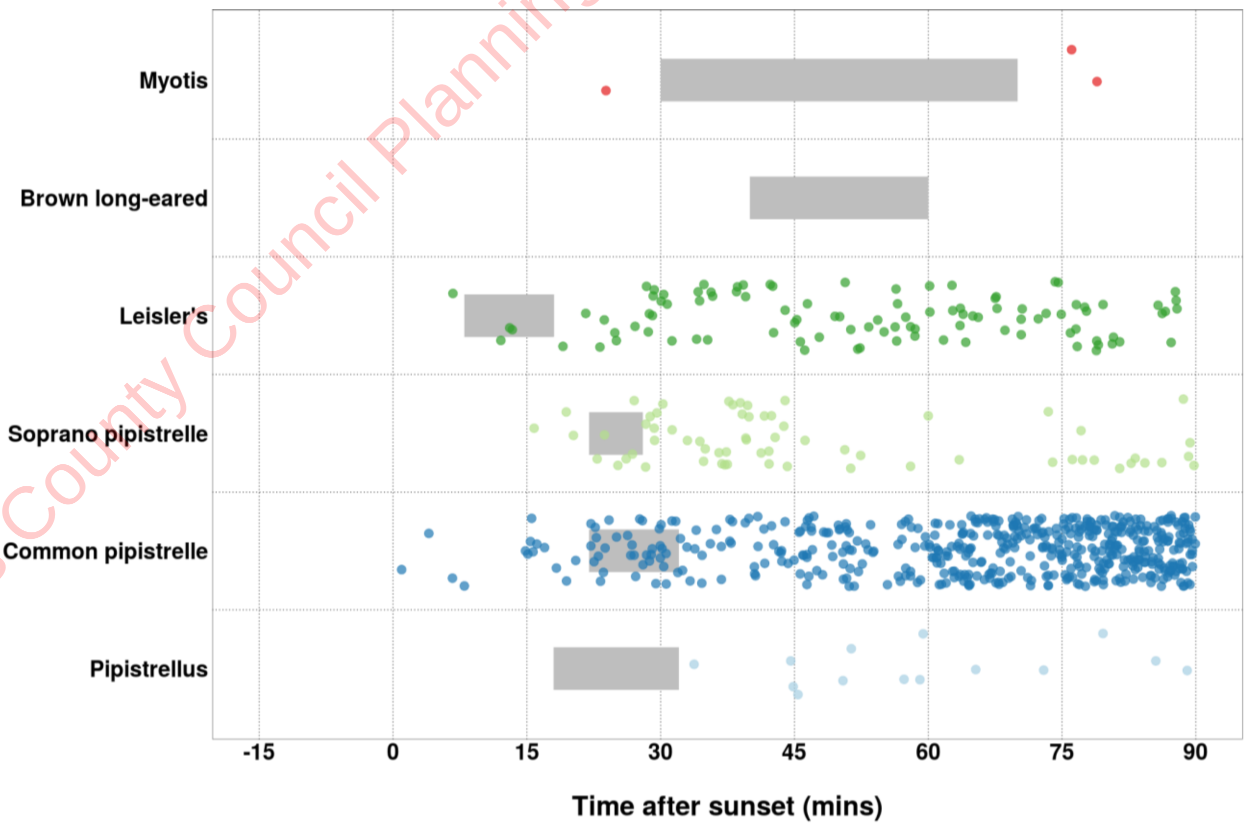

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Figure B.1.6 Bat passes at T6 potentially indicating close proximity to a roost

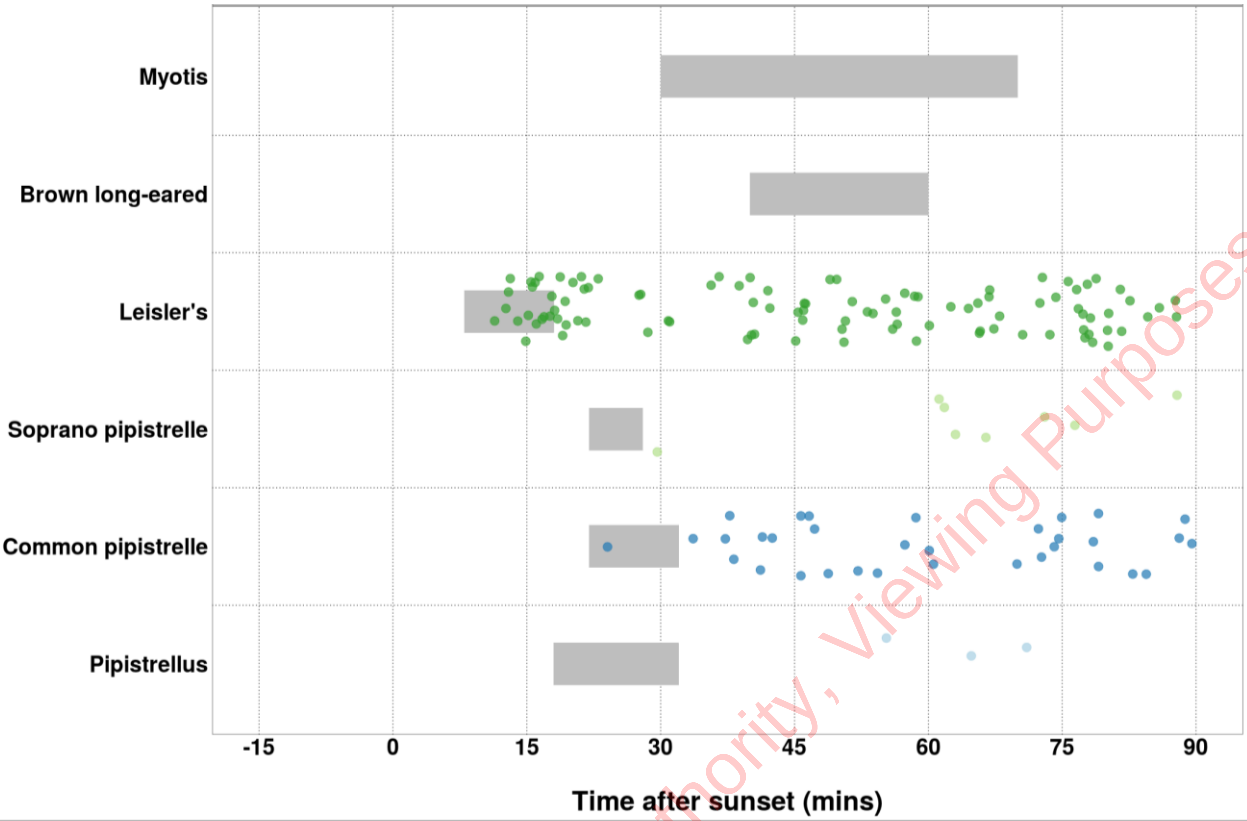

Figure B.1.7 Bat passes at T7 potentially indicating close proximity to a roost

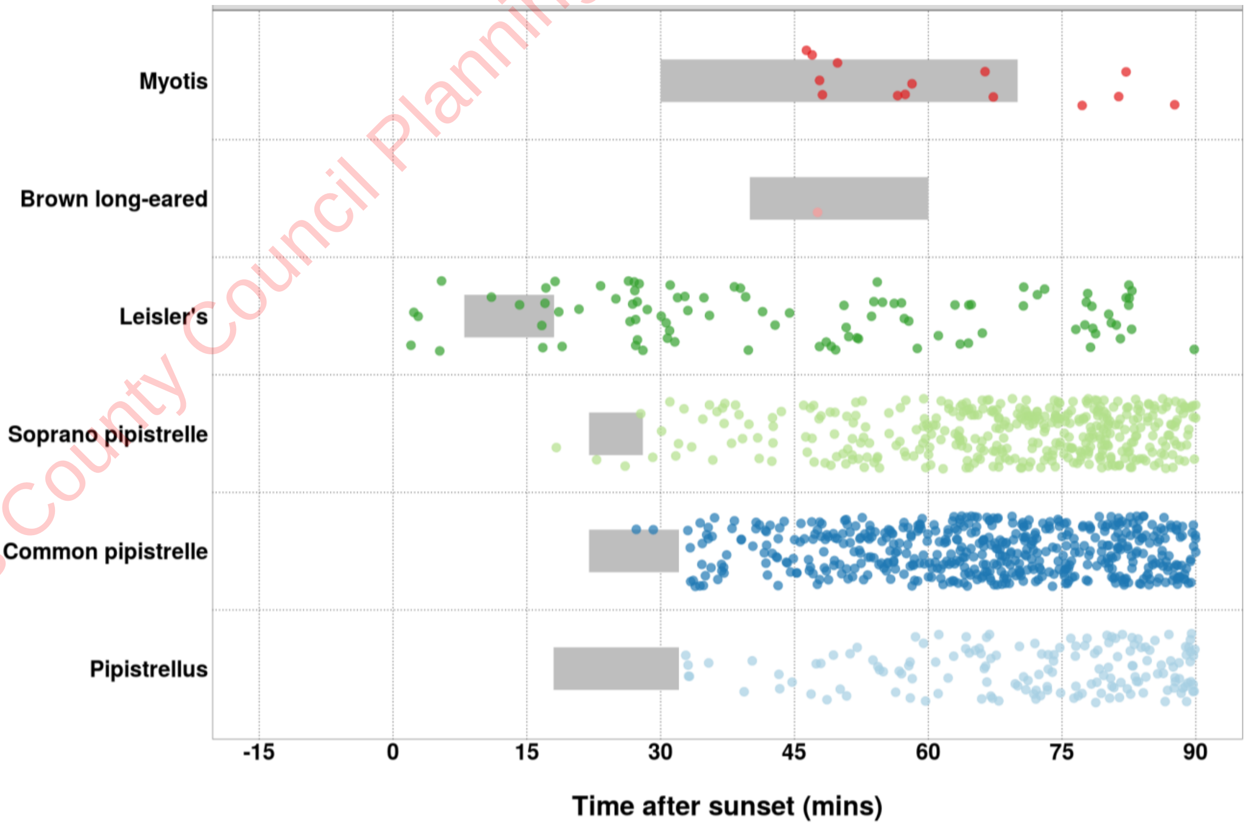

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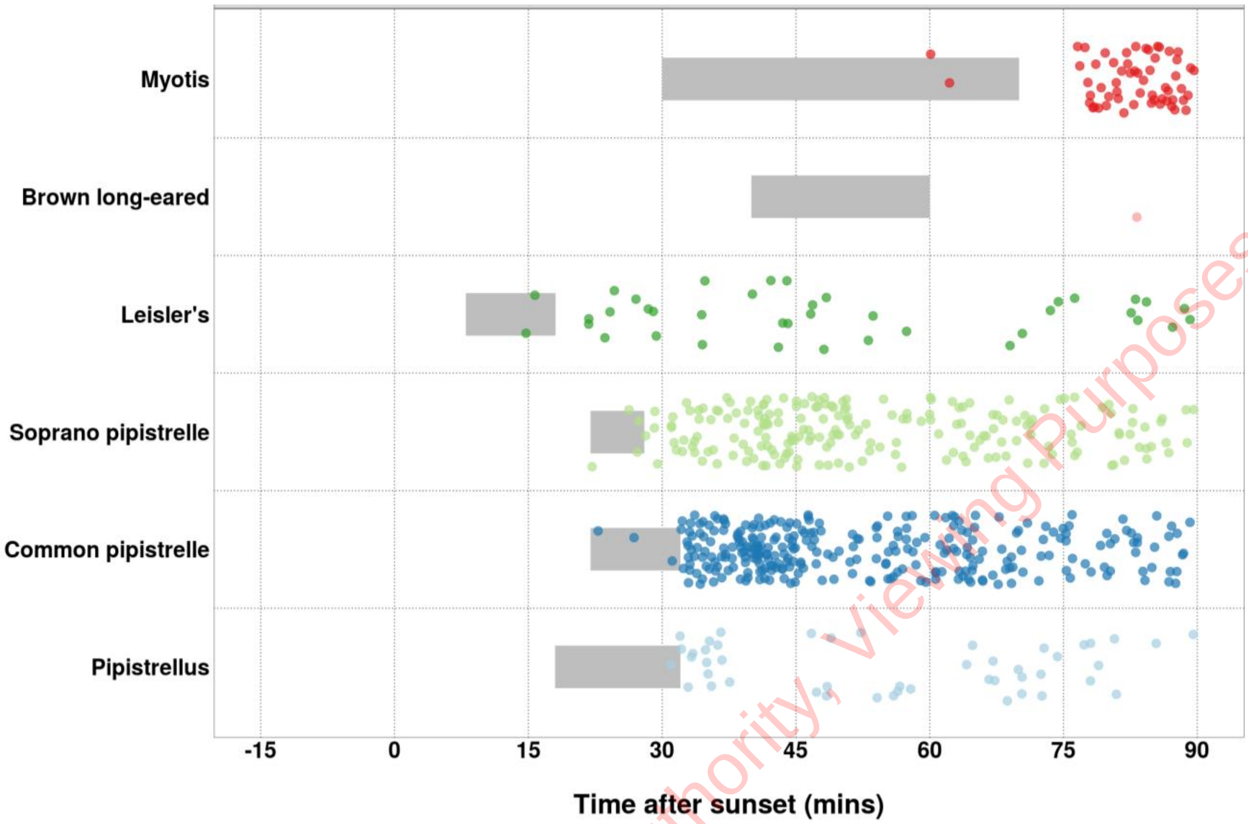
Figure B.1.8 Bat passes at T8 potentially indicating close proximity to a roost



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Appendix 12.4

Natural Power Ornithology Report (2019)

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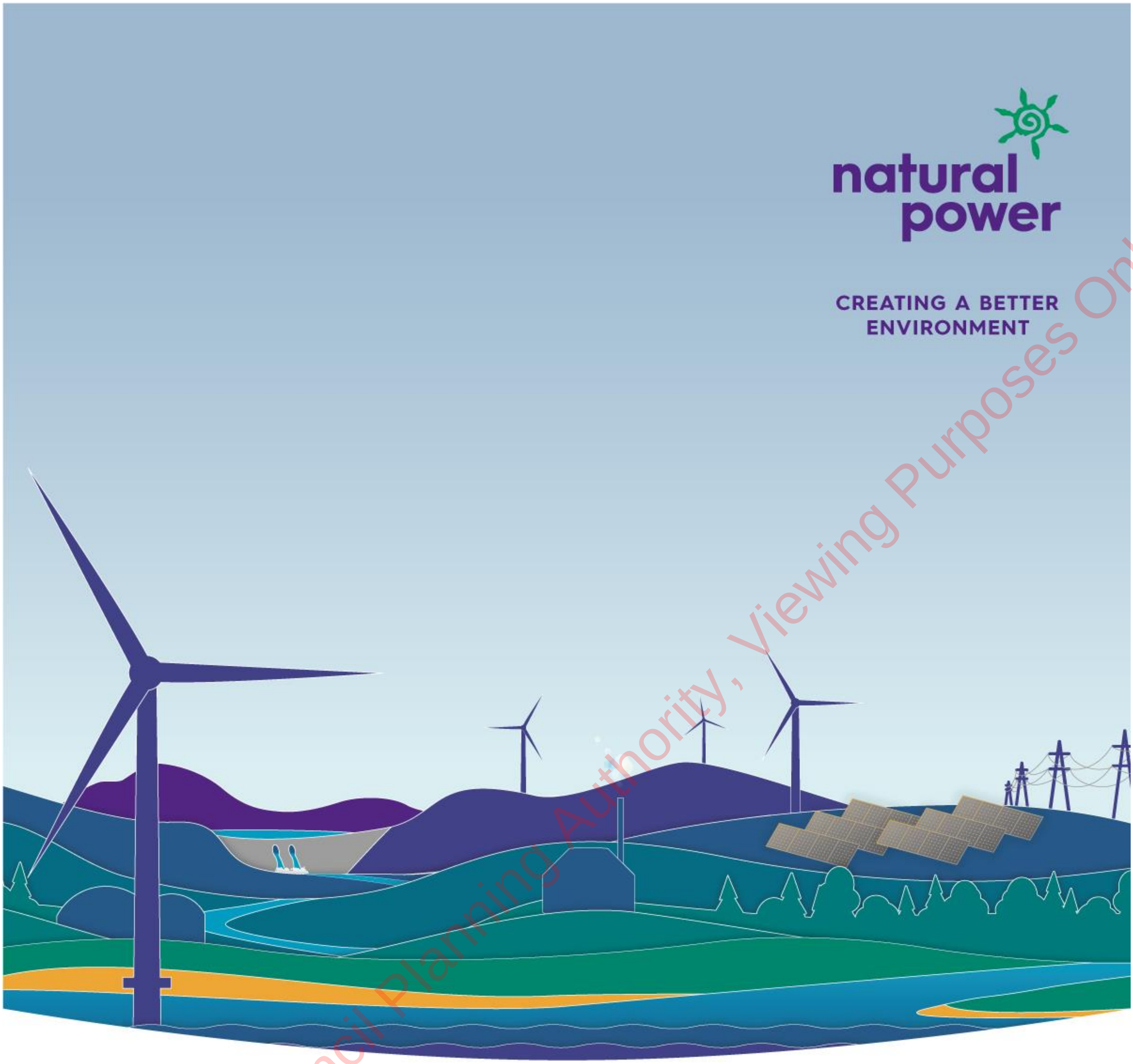

Dernacart Wind Farm

Ornithology survey report 2019

28th November 2019

1208924

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Statkraft Ireland

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Document history

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Issue	Date	Revision Details
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Contents

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1. Introduction

1.1. Site description

Natural Power have been asked by Statkraft Ireland to produce an ornithology report detailing the baseline ornithology surveys at the proposed Dernacart Wind Farm. The proposed Dernacart Wind Farm is located in Co. Laois, approximately 2 km north-east of the town of Mountmellick. The site comprises improved grassland for grazing, coniferous plantation and pockets of broadleaved woodland. A *c*. 172 ha area of cutover bog, which is presently subject to commercial peat harvesting, is situated immediately north of the site. There are several watercourses surrounding the site, including Cottoners Bank which abuts the eastern boundary and the River Barrow which lies just beyond the western site boundary. The N80 road also lies to the west of the site.

The proposed development will encompass up to eight wind turbines and all associated ancillary works.

2. Methodology

2.1. Flight activity surveys

Flight activity surveys were undertaken between April 2018 and September 2019 using vantage point (VP) surveys following the method outlined in SNH guidance (2017)[1]. This method focuses on identifying flight paths and flight heights of target species and allows any regular patterns of flight to be identified, collision risk modelling to be conducted and allows turbine locations to be designed to minimise collision risk to birds. The height bands used to record flight activity at the proposed development were:

- Band 1 = <20 m;
- Band 2 = 20 – 40 m;
- Band 3 = 40 – 140 m; and
- Band 4 = >140 m.

The primary target species for these surveys were all raptors and owls, with the exception of buzzard, all wild goose, swan and duck species, with the exception of Canada goose and mallard, and all wader species.

A total of six VP survey locations were used from April to November 2018 in order to provide coverage of the proposed wind farm turbine area (Figure 1, Appendix A). An additional VP was added in December 2018 due to alterations in the proposed turbine layout. Six hours per month, comprising 2 x 3 hour surveys, were conducted at each VP location. Surveys were undertaken during the breeding seasons, April 2018 – September 2018 and April 2019 – September 2019, and non-breeding season, October 2018 – March 2019. All surveys were conducted in conditions that do not adversely affect bird detection rates (e.g. avoiding high wind speeds, heavy rain, snow or fog). Please refer to Table 1, Appendix B for detailed weather information.

2.2. Breeding bird surveys

A moorland breeding bird survey was undertaken across areas of peat habitat within the proposed development (Figure 6, Appendix A). These surveys followed the adapted Brown & Shephard survey method as detailed in Gilbert

[1] SNH (2017). Recommended bird survey methods to inform impact assessment of onshore windfarms.

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et al. (1998)[2] which is appropriate for waders and other species of moorland passerines which are of conservation concern. An adapted Common Bird Census (CBC) methodology[3] was used for farmland areas of the site.

A total of four site visits were undertaken per breeding season i.e. between mid-April and early-July 2018 and mid-April and early-July 2019. On completion of the surveys, the records were examined to estimate the location of breeding territories using the territory analysis method outlined in Bibby *et al.* (1992)[4]. All surveys were conducted in conditions that do not adversely affect bird detection rates (e.g. avoiding high wind speeds, heavy rain, snow or fog). Please refer to Table 1, Appendix B for detailed weather information.

2.3. Breeding wader surveys

A separate breeding wader survey, targeting breeding woodcock, was undertaken at dusk following the methodology described in Gilbert *et al.* (1998)[2]. The survey comprised three visits in total per breeding season i.e. between early-April and late-June 2018, and early-April and late-June 2019. Secondary species for the breeding wader surveys were common sandpiper, curlew, lapwing, redshank, ringed plover, and snipe. The surveys spanned dusk to target the activity of woodcock.

Walkover surveys were undertaken within the proposed development site (Figure 7, Appendix A). A total of two transects were undertaken within the survey area as due to the large size of the proposed site, the survey area could not be surveyed within a single evening. In areas of coniferous forest, where access could not be gained, the surveyor stopped in suitable locations and scanned from a distance. All waders, observed or heard, were recorded as accurately as possible, using standard British Trust for Ornithology (BTO) notification (one/ two letter identity and activity codes), on an appropriately scaled field map for the site. All surveys were conducted in conditions that do not adversely affect bird detection rates (e.g. avoiding high wind speeds, heavy rain, snow or fog). Please refer to Table 1, Appendix B for detailed weather information.

2.4. Monthly wintering wader census

Walkover surveys were undertaken across areas of open habitat within the wind farm site and a 500 m buffer beyond the site boundary. The surveys followed appropriate methods for waders as detailed in Gilbert *et al.* (1998)[1]. A total of six survey visits were undertaken at regular intervals (monthly) between October 2018 and March 2019 (inclusive).

Birds were located by walking, listening and scanning by eye and with binoculars. All waders encountered were recorded on survey maps using BTO notation, with care taken to minimise the risk of double counting individuals. All surveys were conducted in conditions that do not adversely affect bird detection rates (e.g. avoiding high wind speeds, heavy rain, snow or fog). Please refer to Table 1, Appendix B for detailed weather information.

2.5. Hen harrier winter roost checks

Due to anecdotal evidence from a local that a hen harrier was observed on several occasions on the cutaway bog immediately north-east of the proposed wind farm site, hen harrier roost checks were undertaken in this area. Fixed-point watches were undertaken at dusk to target potential roosting hen harriers. The survey comprised three visits undertaken at regular intervals (monthly) between October and December. All raptor observations were recorded on field maps. All surveys were conducted in conditions that do not adversely affect bird detection rates (e.g. avoiding high wind speeds, heavy rain, snow or fog). Please refer to Table 1, Appendix B for detailed weather information.

---

[2] Gilbert, G., Gibbons, D.W. and Evans, J. (1998). Bird Monitoring Methods. RSPB, Sandy.

[3] Marchant, J.H. 1983. Common Birds Census instructions. BTO, Tring. 12pp

[4] Bibby, J.C., Burgess, N. D., Hill, D.A. and Mustoe, S. (2000). Bird Census Technique. 2nd Edition

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3. Results

3.1. Flight activity surveys

3.1.1. Breeding season surveys 2018 and 2019

A total of ten target species were recorded during the two years of breeding season flight activity surveys in 2018 and 2019. These species are detailed in Table 3.1. combining flights observed both inside the proposed wind farm and the 500 m survey buffer. Flight maps are provided in Figures 2 and 3, Appendix A. Full details of all target species are provided in section 3.6.

Table 3.1. Breeding season flight activity surveys - target species results

		2018		2019		Total	
Species	**Conservation status**	**No. of flights**	**No. of individuals**	**No. of flights**	**No. of individuals**	**No. of flights**	**No. of individuals**
Grey heron	Green	16	16	17	17	33	33
Sparrowhawk	Amber	19	19	24	24	43	43
Lapwing	Red			4	77	4	77
Golden plover	Annex 1; Red			4	54	4	54
Curlew	Red	4	6	5	16	9	22
Woodcock	Red			11	12	11	12
Snipe	Amber	5	6	4	7	9	13
Kestrel	Amber	31	31	79	79	110	110
Merlin	Annex 1; Amber			3	3	3	3
Peregrine	Annex 1; Green			2	2	2	2

KEY:

Annex 1: listed under Annex 1 of the European Birds Directive

Red/ Amber: Birds of Conservation Concern in Ireland 2014 – 2019[4]

3.1.2. Non-breeding season surveys

A total of ten target species were recorded during the six months of non-breeding season flight activity surveys. These are detailed in Table 3.2 and Figure 5, Appendix A. Kestrel was the most frequently recorded species, while lapwing had the largest number of individuals due to frequently being observed flying in flocks numbering up to 76. Full details of all target species is provided in section 3.6.

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Table 3.2. Non-breeding season flight activity surveys - target species results

Species	Conservation status	Number of flights	Number of individuals
Grey heron	Green	18	18
Sparrowhawk	Amber	10	10
Lapwing	Red	14	404
Golden plover	Annex 1; Red	8	239
Curlew	Red	7	26
Woodcock	Red	1	1
Snipe	Amber	10	21
Kestrel	Amber	64	64
Merlin	Annex 1; Amber	14	14
Peregrine	Annex 1; Green	3	3

KEY:

Annex 1: listed under Annex 1 of the European Birds Directive

Red/ Amber: listed in Birds of Conservation Concern in Ireland 2014 – 2019[4]

3.2. Breeding bird surveys

Table 3.3 below details up to 196 and 408 breeding bird territories recorded in 2018 and 2019, respectively. A total of 43 species considered to be breeding within the survey area were recorded across both survey seasons. The majority of these are common and widespread species; the most abundant breeding species was blackbird with an estimated 31 territories in 2018 and 36 territories in 2019. Wren was the next most abundant species with an estimated 26 and 33 territories in 2018 and 2019, respectively. Of the total number of species, 12 (28%) are recognised as being of conservation importance in Ireland. There were no species listed as Annex 1 recorded breeding within the survey area.

Table 3.3. Breeding bird survey results 2018 and 2019

Species	Conservation status	No. of territories	
		2018	2019
Barn swallow	Amber	3	6
Blackbird	Green	31	36
Blackcap	Green		10
Blue tit	Green	25	32
Bullfinch	Green		6
Buzzard	Green	2	4
Chaffinch	Green	5	28
Chiffchaff	Green	12	8
Coal tit	Green	8	6

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Species	Conservation status	No. of territories 2018	2019
Crossbill	Green		2
Cuckoo	Green	12	21
Dunnock	Green	2	23
Goldfinch	Green	2	8
Great tit	Green	5	18
Greenfinch	Amber		3
Hooded crow	Green	3	5
House martin	Amber	1	5
House sparrow	Amber		1
Jackdaw	Green	4	6
Jay	Green	1	2
Kestrel	Amber	2	5
Lesser redpoll	Green	1	10
Linnet	Amber		7
Long-tailed tit	Green		4
Mallard	Green	1	3
Magpie	Green	3	4
Meadow pipit	Red	4	4
Mistle thrush	Amber	2	4
Pied wagtail	Green	2	2
Raven	Green	1	4
Reed bunting	Green		7
Robin	Amber	5	27
Rook	Green	2	9
Siskin	Green		3
Snipe	Amber	3	5
Song thrush	Green	12	13
Starling	Amber	1	5
Stonechat	Amber		3
Treecreeper	Green		7
Willow warbler	Green	12	15
Woodcock	Red		2

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Species	Conservation status	No. of territories 2018	2019
Woodpigeon	Green	3	2
Wren	Green	26	33
Total	**12**	**196**	**408**
KEY: Red/ Amber: Birds of Conservation Concern in Ireland 2014 – 2019[4]			

3.3. Breeding wader surveys

The dedicated breeding wader surveys recorded the target species, woodcock, and one secondary species, snipe. Both these species are likely breeding within the proposed site. The registrations detailed in Table 3.4 below and Figure 4, Appendix A are additional to those recorded during the breeding bird surveys. Woodcock is a red listed species (breeding) on the Birds of Conservation Concern in Ireland 2014 – 2019 review[5]. Snipe is an amber listed species (breeding and wintering).

Table 3.4. Breeding wader survey results

Species	Conservation status	2018 No. of registrations	2019 No. of registrations
Woodcock	Red	0	20
Snipe	Amber	10	26

3.4. Monthly wader census

A total of three wader species were recorded within the survey area during 2018/ 2019 monthly wader census (Table 3.5). The wader species recorded were heron, lapwing and snipe. The survey in December recorded the highest number of waders (10) with a peak count of five for lapwing and snipe.

Table 3.5. Monthly wader census results

Species	Conservation status	Oct	Nov	Dec	Jan	Feb	Mar
Grey heron	Green	1			2		
Lapwing	Red		2	5	1		3
Snipe	Amber	0	4	5	3	1	2
Total	2	1	6	10	6	1	5
KEY: Red/ Amber: Birds of Conservation Concern in Ireland 2014 – 2019[4]							

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

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3.5. Hen harrier winter roost checks

No hen harriers were recorded during the winter roost checks.

3.6. Target species results

During the two breeding seasons, a total of 228 flights of ten target species were recorded during the VP surveys, with kestrel recorded most frequently (a total of 79 flights), followed by sparrowhawk with 24 flights, grey heron with 14 flights and woodcock with 11 flights. The remaining six species were recorded in low numbers (six flights or less per species). The same ten target species were recorded during the non-breeding VP surveys, with a total of 149 flights. Again, kestrel was recorded most frequently (a total of 64 flights), followed by grey heron (18 flights) and then with lapwing and merlin (14 flights). The remaining six species were recorded in lower number (10 or less flights per species).

Overall flight activity was high around the northern and south-western edge of the proposed wind farm. For example, the southern edge of Garryinch Bog borders scrub/ mixed woodland, where there are six proposed turbines, recorded a high concentration on flight activity from species such as kestrel, snipe and woodcock. The mixed woodland near turbines T92 and T85 also showed high levels of flight activity from kestrel and sparrowhawk. Flights were less frequently recorded within the array.

Table 3.1: Summary of target species flights during VP surveys between April 2018 and September 2019

Species	No. of flights (individuals)
Grey heron	51 (51)
Sparrowhawk	53 (53)
Lapwing	18 (481)
Golden plover	12 (293)
Curlew	16 (48)
Woodcock	12 (13)
Snipe	19 (34)
Kestrel	174 (174)
Merlin	17 (17)
Peregrine	5 (5)

3.6.1. Grey heron

This species was regularly observed with a total of 51 flights recorded during the VP surveys. Flight activity was widespread throughout the survey area, with numbers comparable during both breeding seasons (16 and 17) and the non-breeding season (18). A high proportion of flights were recorded within the proposed wind farm with individuals commuting across the site, generally in a northerly or southerly direction.

Grey heron was not recorded as breeding within the survey area, although birds were present on site during the monthly wader census with one in October 2018 and two in January 2019.

3.6.2. Sparrowhawk

A total of 53 flights were observed within the survey area with most birds recorded during both breeding seasons (19 and 24 respectively) with only ten flights in the non-breeding season. Much of the flight activity was of display and hunting/soaring behaviour, which was typically observed often above the wooded areas along the southwestern edge of the proposed wind farm, and in particular, around the three turbine locations, T2, T92 and T85. Flight activity

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is represented in Figures 2, 3 and 5, Appendix A showing activity concentrated at the locations with few flights straying into the array.

This species was not confirmed as breeding within the survey area, however displaying birds were observed over suitable habitat along the western edge of the turbine array, so it is possible a breeding attempt occurred during the 2018/19 season.

3.6.3. Lapwing

Lapwing were regularly recorded during the non-breeding season of 2018/19 with a total 14 flights (404 individuals). The majority of the flights were observed within the northeast part of the survey area, with birds flying from Garryinch Bog, which may have been used as a foraging/ roosting site. These flights generally headed in a south or south-west direction along the south-eastern edge of the proposed site with a large proportion near turbine T79. There were fewer flights recorded within the array. Birds were less frequently recorded during the breeding seasons with only four flights (77 individuals) between August and September 2019. Groups of birds were generally recorded commuting in small to medium sized flocks (ranging from four to 76 individuals) along the edges of the proposed wind farm.

This species was not recorded as breeding within the survey area during the breeding bird surveys in 2018/19. However, a small number of birds were present on site between November and March, recorded during the wader census, with a peak count of five in December.

3.6.4. Golden plover

This species was recorded during the non- breeding season with eight flights (239 individuals) between October and November 2018, with a further four flights (54 individuals) in August and September 2019. Most records were of birds (groups ranging from six to 68 individuals) circling over Garryinch Bog and where it borders the north edge of the proposed wind farm. There were very few flights recorded within the array. The high activity recorded over this area is shown in Appendix A, Figures 3 and 5. and would suggest that birds were using the area for foraging and possibly as a roost site during the non-breeding season.

This species was not recorded as breeding within the survey area.

3.6.5. Curlew

A total of 16 flights (48 individuals) were recorded during the VP surveys from July 2018 to March 2019 and then again from August to September 2019. This may suggest that most records were of post-breeding and wintering birds commuting over and around the site. During the non-breeding season flights were observed heading in a south-westerly direction along the edge of the proposed wind farm near turbines T4 and T85. Flights during the breeding season (August and September 2018) were more widespread and generally headed south or south-easterly direction from Garryinch Bog along.

This species was not recorded as breeding within the survey area.

3.6.6. Woodcock

Woodcock was recorded once during the 2018/19 non-breeding season. Between April and July 2019 11 flights (12 individuals) were recorded, all within the hour before sunrise and after sunset. Most flights were observed along the northern edge of the array (T2, T83 and T79) where the southern edge of Garryinch Bog borders an area of mixed woodland and scrub. Flight activity is presented in Appendix A, Figure 3, where direction of flight is shown to be typically recorded along a west to east axis above the fringe habitat of mixed woodland and bog. Birds were also recorded along the south-western edge of the proposed site near turbines T92 and T85. Fewer flights were recorded within the array.

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Additional flights were recorded during the survey targeting breeding woodcock in 2019. Between May and July a total of 20 flights were recorded. Mapped flights clearly show that birds were flying along the southern border of Garryinch bog and northern edge of the proposed wind farm between T79 and T84 (Appendix A, Figure 4). Analysis of these flights and behaviour suggests there are two breeding territories in the area.

3.6.7. Snipe

This species was recorded throughout the survey period with similar numbers of flights recorded during the two breeding seasons (four and five). The number of flights increased over the non-breeding season (ten). Most flights recorded were of birds flushed from human activities within Garryinch Bog i.e. dog walkers, peat cutters and farming. Bird flights were generally recorded flying along a west to east axis along the border between Garryinch Bog and the northern edge of the proposed wind farm.

This species was also recorded as breeding within the survey area with a total of three and five territories in 2018 and 2019 respectively. During the monthly wader census snipe was regularly recorded between October 2018 and March 2019 with a peak count of five in December.

3.6.8. Kestrel

A total of 174 flights (174 individuals) was recorded, this being the most frequently observed species during the VP surveys (breeding season 110, non-breeding season 64). The majority of flights were of birds searching/ hunting, favouring the areas to the north of the proposed wind farm where it borders the western and southern parts Garryinch Bog. Flight activity is shown in Appendix A, Figures 2, 3 and 5. Some flights did stray into the array, in particular around the proposed turbine locations T79, T80 and T85.

During the breeding bird surveys 2 and 5 breeding pairs were recorded within the survey area in 2018 and 2019 respectively. The high frequency of flights recorded would certainly be attributable to the number of breeding birds in the area.

3.6.9. Merlin

Merlin were recorded occasionally from October 2018 to March 2019 with 14 flights (14 individuals) and just three flights between August and September 2019. Almost all records were of immature/ juvenile birds and flying along the northern edge of the proposed wind farm that borders Garryinch Bog heading generally in an easterly direction. Five flights were also recorded near the proposed turbine T4, of which three were within the array. Most of the records were of juvenile/ immature birds and it is likely that these birds had dispersed from their natal sites, using the site for hunting.

This species was not recorded as breeding within the survey area.

3.6.10. Peregrine

This species was recorded on five occasions (5 individuals), three during the non-breeding season and two during the breeding season. All records were of juvenile/ immature birds with all flights widespread across the survey area, either heading south or south-easterly direction.

This species was not recorded as breeding within the survey area.

4. Discussion

Of the total number of species recorded within the survey area during 2018 and 2019, 17 are recognised as being of conservation importance. Sparrowhawk, golden plover and merlin are listed on Annex 1 of the EU Birds Directive and are listed as Birds of Conservation Concern in Ireland[4]. In addition, lapwing, curlew, woodcock and meadow

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pipit are red-listed species. A total of 12 amber-listed species were recorded, namely; sparrowhawk, snipe, kestrel, merlin, barn swallow, house martin, starling, mistle thrush, robin, stonechat, house sparrow and greenfinch.

Following the completion of collision risk modelling, a detailed impact assessment can be conducted to determine the likely impact of the proposed wind farm on the bird species recorded within the site.

4.1. Predicted effects

This section describes the potential impacts during construction, operation and decommissioning of the proposed development on birds.

4.1.1. Habitat loss

Construction of turbine bases, access tracks and other structures will lead to direct habitat loss and could also result in destruction or damage to nests, eggs and/ or chicks. The effects of habitat loss will depend upon the extent of land-take and the type of habitat affected. Under the Wildlife Act 1976 it is an offence to kill or injure any bird, or to damage or destroy nests and eggs. Mitigation measures (such as pre-construction nest checks by an Environmental Clerk of Works (ECoW)) will be implemented to protect breeding birds and their nests and eggs during the construction phase.

4.1.2. Disturbance and displacement

During the construction stage of the proposed development, the potential effects of associated noise and visual disturbance could lead to the temporary displacement or disruption of breeding and foraging birds. The level of impact depends on the timing of potentially disturbing activities, the extent of displacement (both spatially and temporally) and the availability of suitable habitats in the surrounding area for displaced birds to occupy.

Potential effects are likely to be greatest during the breeding season (predominantly between March and August inclusive). It is also likely that construction impacts will be greater on species that are intolerant of noise and other sources of disturbance. Larger bird species, those higher up the food chain or those that feed in flocks in the open tend to be more vulnerable to disturbance than small birds living in structurally complex or closed habitats such as woodland[6].

The potential effects associated with construction activities are only likely to occur for as long as the construction phase continues. They are thus short-term and can be readily mitigated by avoiding sensitive areas, (through the implementation of appropriately defined buffer zones) and by timing construction activities to avoid periods where sensitive species are present (if and where possible), such as the breeding season.

4.2. Effects during operation

4.2.1. Disturbance and displacement

The operation of turbines and associated human activities for maintenance purposes also has the potential to cause disturbance and displace birds from the proposed development. Disturbance effects during the operational phase may be less than during the construction phase, as species may become habituated to turbines, and disturbance due to human activities will be considerably reduced.

Individual turbines, or a 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 is subtle and difficult to predict with any degree of certainty. If birds regularly have to fly over or around obstacles or are forced into suboptimal

[6] Hill, D.A. Hockin, D. Price, D. Tucker, G. Morries, R. and Treweek, J. (1997). Bird Disturbance: Improving the quality of disturbance research. Journal of Applied Ecology 34, 275-288.

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habitats, this may result in reduced feeding efficiency and greater energy expenditure. By implication, this will reduce the efficiency with which they accumulate reserves, potentially affecting breeding success or survival.

4.2.2. Collision with turbines

Collision of a bird with turbine rotors is almost certain to result in the death of the bird. In low density populations (e.g. raptors) this could have a more adverse effect on the local population than in higher density populations (e.g. skylark) because a higher proportion of the local population would be affected in a low-density population. The frequency and likelihood of a collision occurring depends on a number of factors. These include aspects of the size and behaviour of the bird (including their use of a development site), the nature of the surrounding environment, and the structure and layout of the turbines.

Collision risk is perceived to be higher for birds that spend much of the time in the air, such as foraging raptors and those that have regular flight paths between feeding and breeding/ roosting grounds (e.g. geese). The risk of bird collisions at wind farms is considered greatest in areas where large concentrations of birds are present (such as on major migration routes).

Collision risk is also increased during poor flying conditions, such as rain, fog and strong winds that affect birds' ability to control flight manoeuvres, or on dark nights when visibility is reduced [7] [8].

4.2.3. Effects during decommissioning

Turbine removal may cause disturbance to birds breeding, foraging or roosting within the site. The level of impact will depend on the bird species present at the time of decommissioning and cannot be reliably predicted at this stage. However, as decommissioning activities are of a similar type and intensity as construction activities, it is considered that the potential effects of decommissioning will be similar in nature to the potential effects of construction, with the exception that habitat is likely to be restored and (where applicable) displaced birds will be able to return to abandoned territories.

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[7] Langston, R.H.W. and Pullan, J.D. (2003). Windfarms and Birds: an analysis of the effects of wind farms on birds and guidance on environmental assessment criteria and site selection issues. Report T-PVS/Inf. 2003, by BirdLife International to the Council of Europe, Bern Convention on the Conservation of European Wildlife and Natural Habitats. RSPB/ BirdLife in the UK.

[8] Drewitt, A.L. & Langston, R.H.W. (2006). Assessing the impacts of wind farms on birds. Ibis, 148: 29-42.

Appendices

A. Figures

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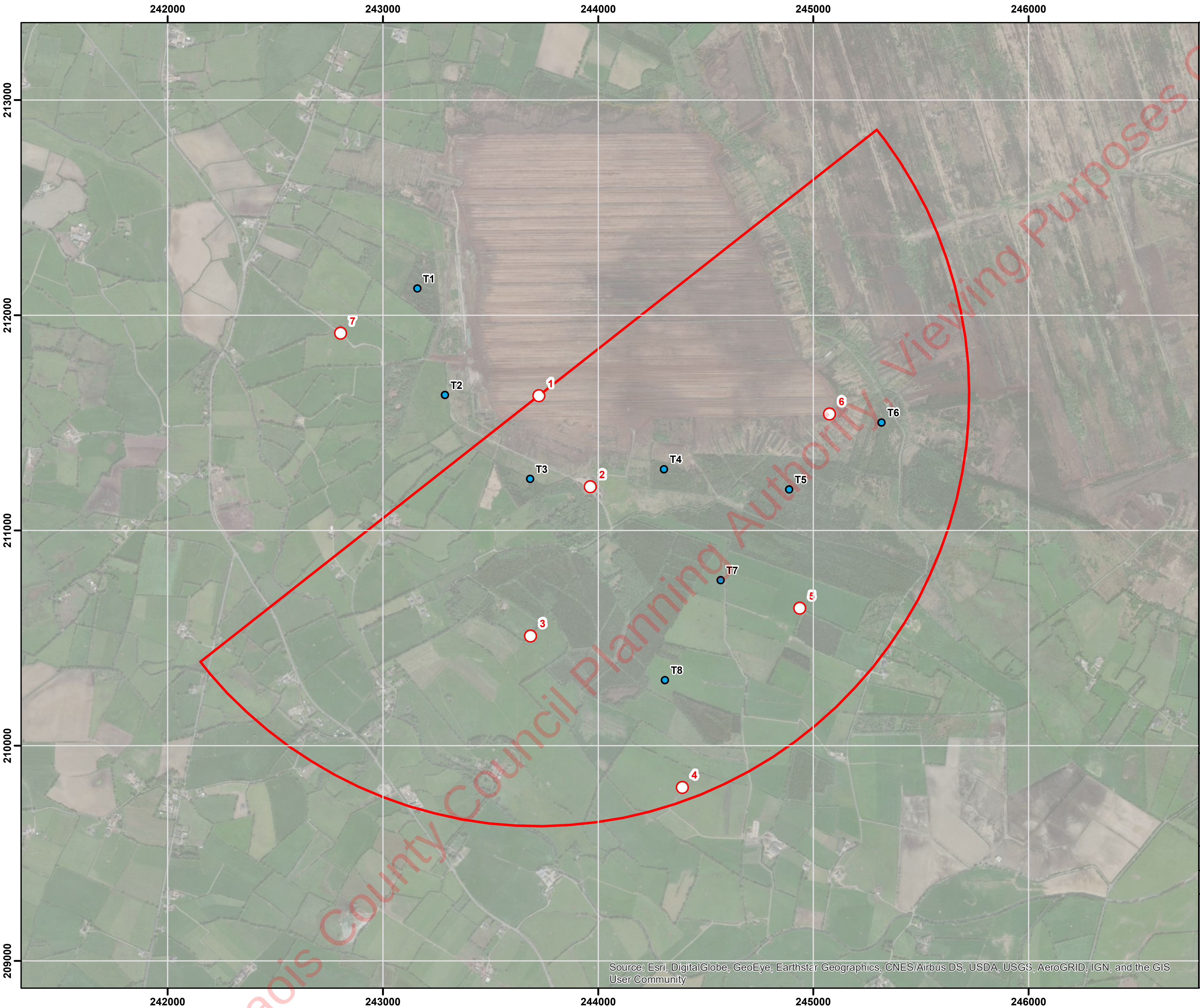

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Project:

Dernacart, Co. Laois

Title:

VP Survey Fieldmaps: Map 1 of 7

Key

- Turbine
- VP location
- VP1 (243724, 211626) viewshed

Site name	
Date	
Surveyor	
Survey	
Start time	
Finish time	
Notes	

Notes:

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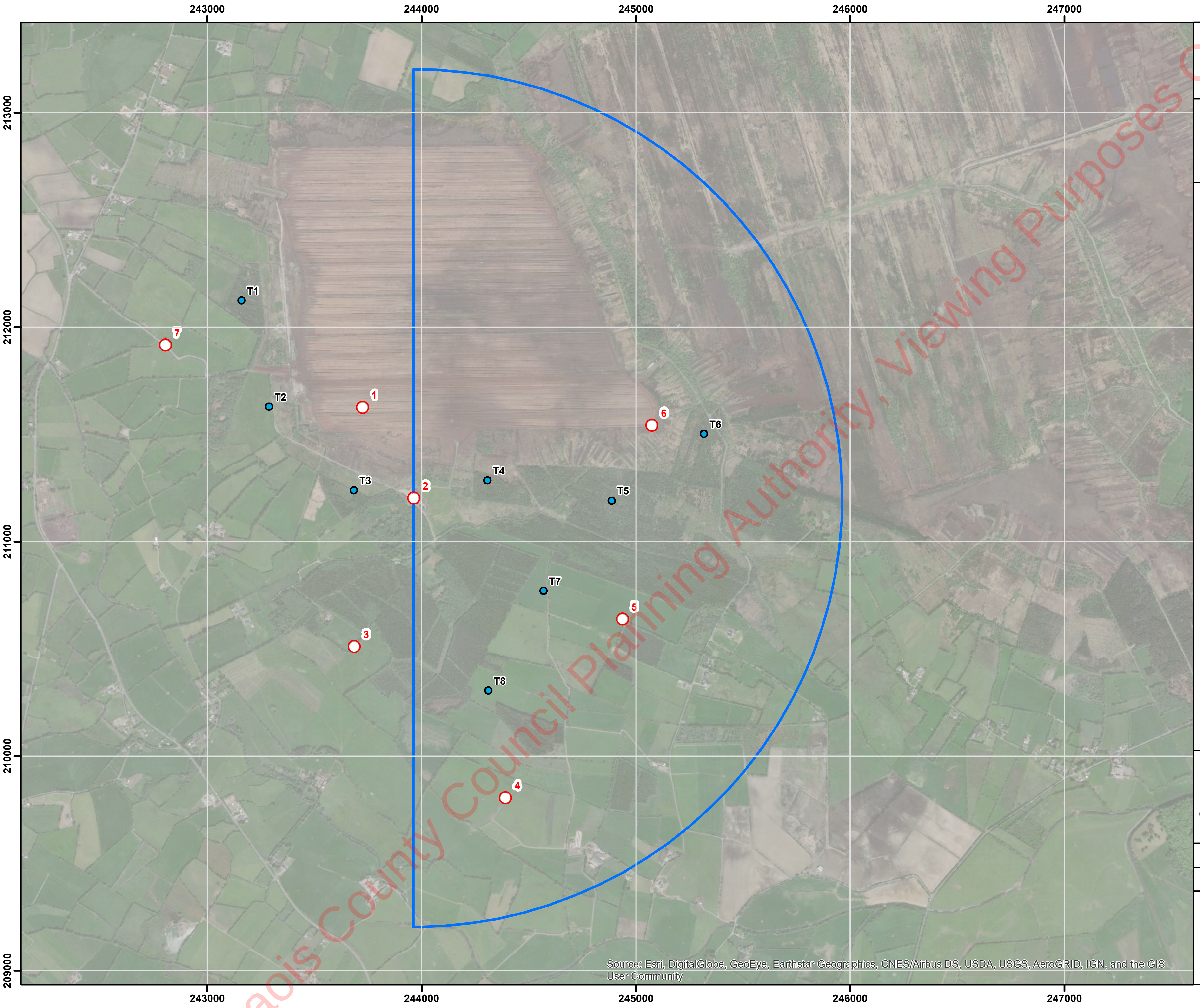

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Project:

Dernacart, Co. Laois

Title:

VP Survey Fieldmaps: Map 2 of 7

Key

- Turbine
- VP location
- VP2 (243963, 211203) viewshed

Site name	
Date	
Surveyor	
Survey	
Start time	
Finish time	
Notes	

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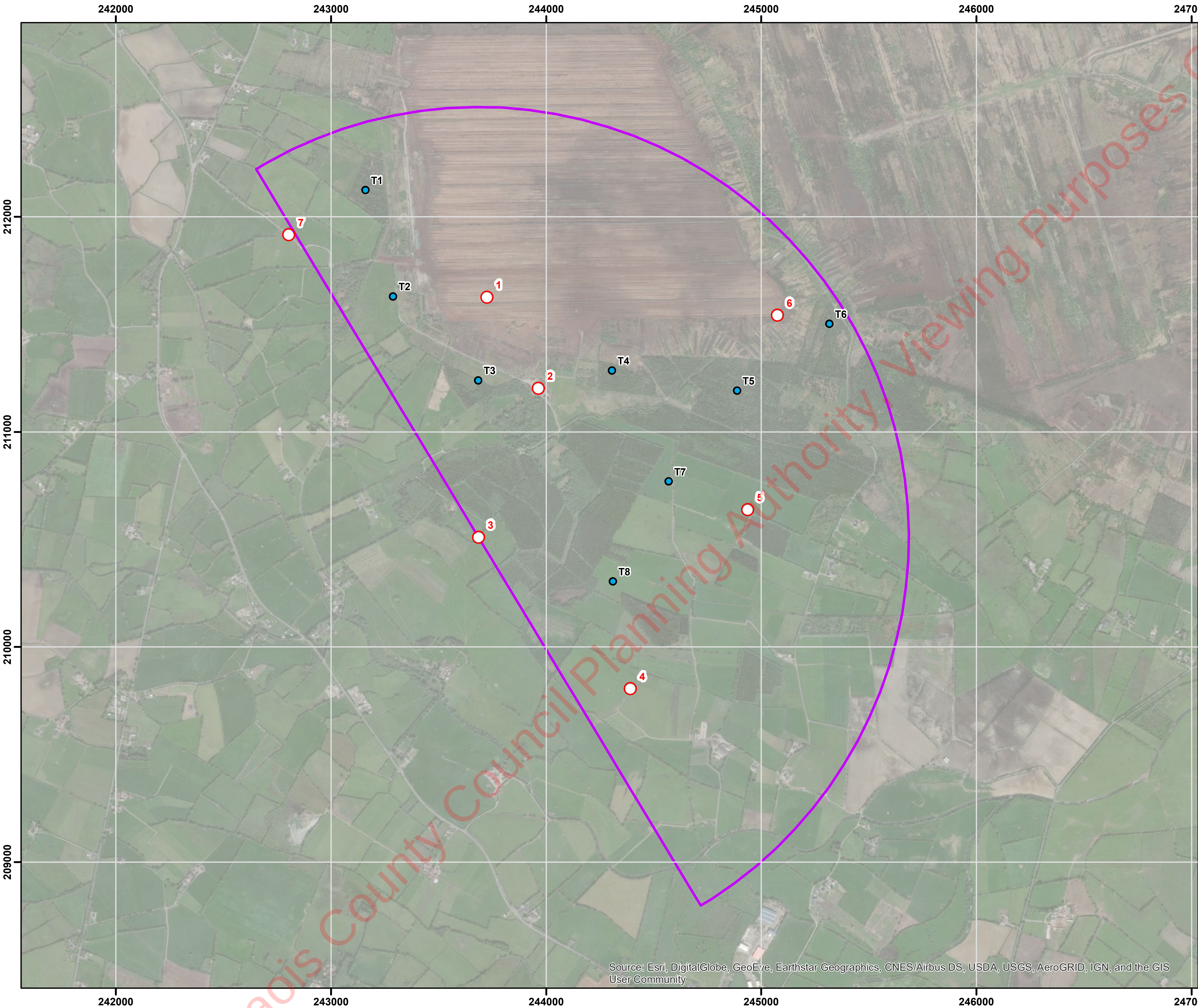
Project:
Dernacart, Co. Laois

Title:
VP Survey Fieldmaps: Map 3 of 7



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Key

- Turbine
- VP location
- VP3 (243686, 210510) viewshed

Site name	
Date	
Surveyor	
Survey	
Start time	
Finish time	
Notes	

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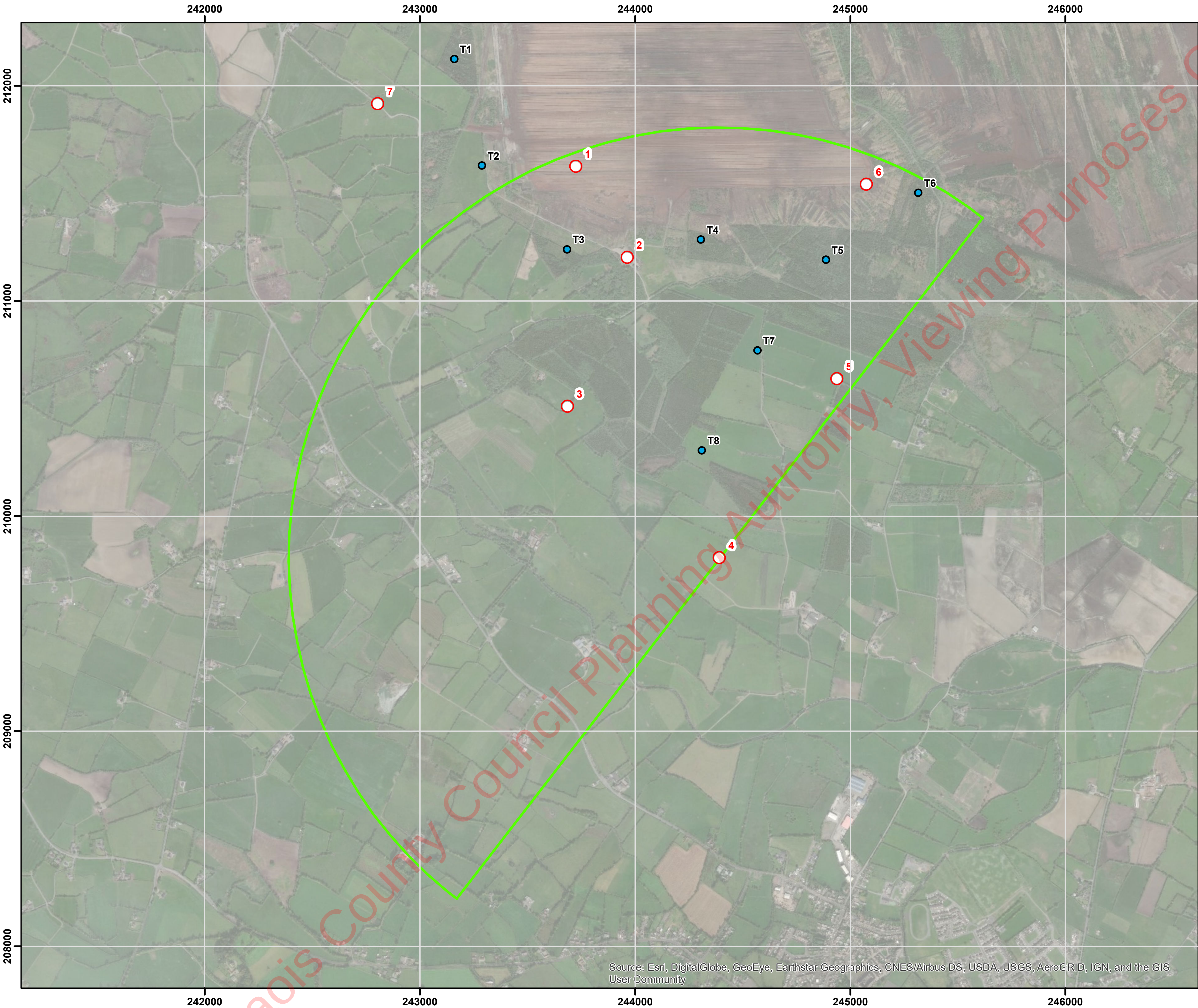

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Project:

Dernacart, Co. Laois

Title:

VP Survey Fieldmaps: Map 4 of 7

Key

- Turbine
- VP location
- VP4 (244391, 209806) viewshed

Site name	
Date	
Surveyor	
Survey	
Start time	
Finish time	
Notes	

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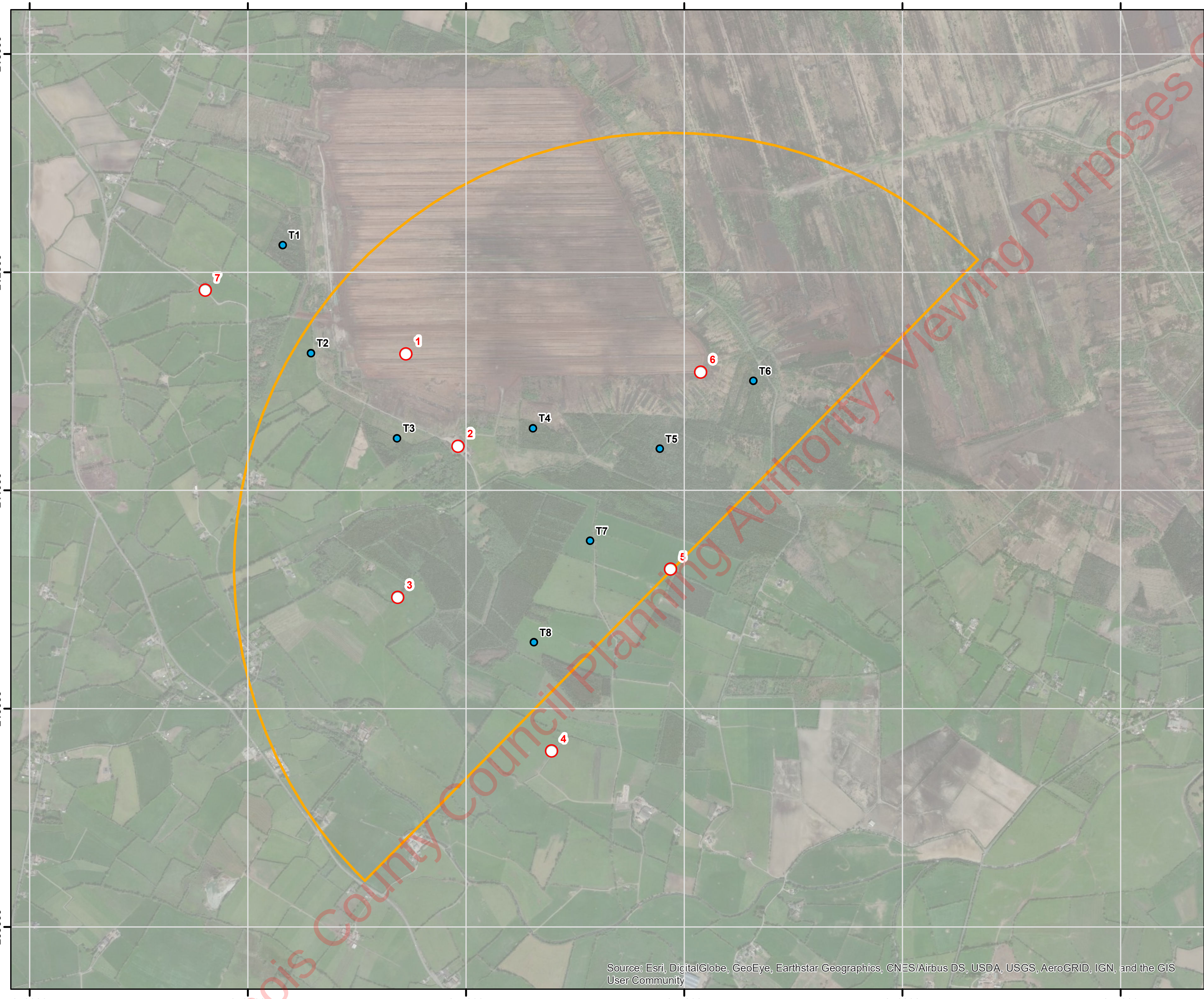

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Project:
Dernacart, Co. Laois

Title:
VP Survey Fieldmaps: Map 5 of 7

Key

- Turbine
- VP location
- VP5 (244937, 210639) viewshed

Site name	
Date	
Surveyor	
Survey	
Start time	
Finish time	
Notes	

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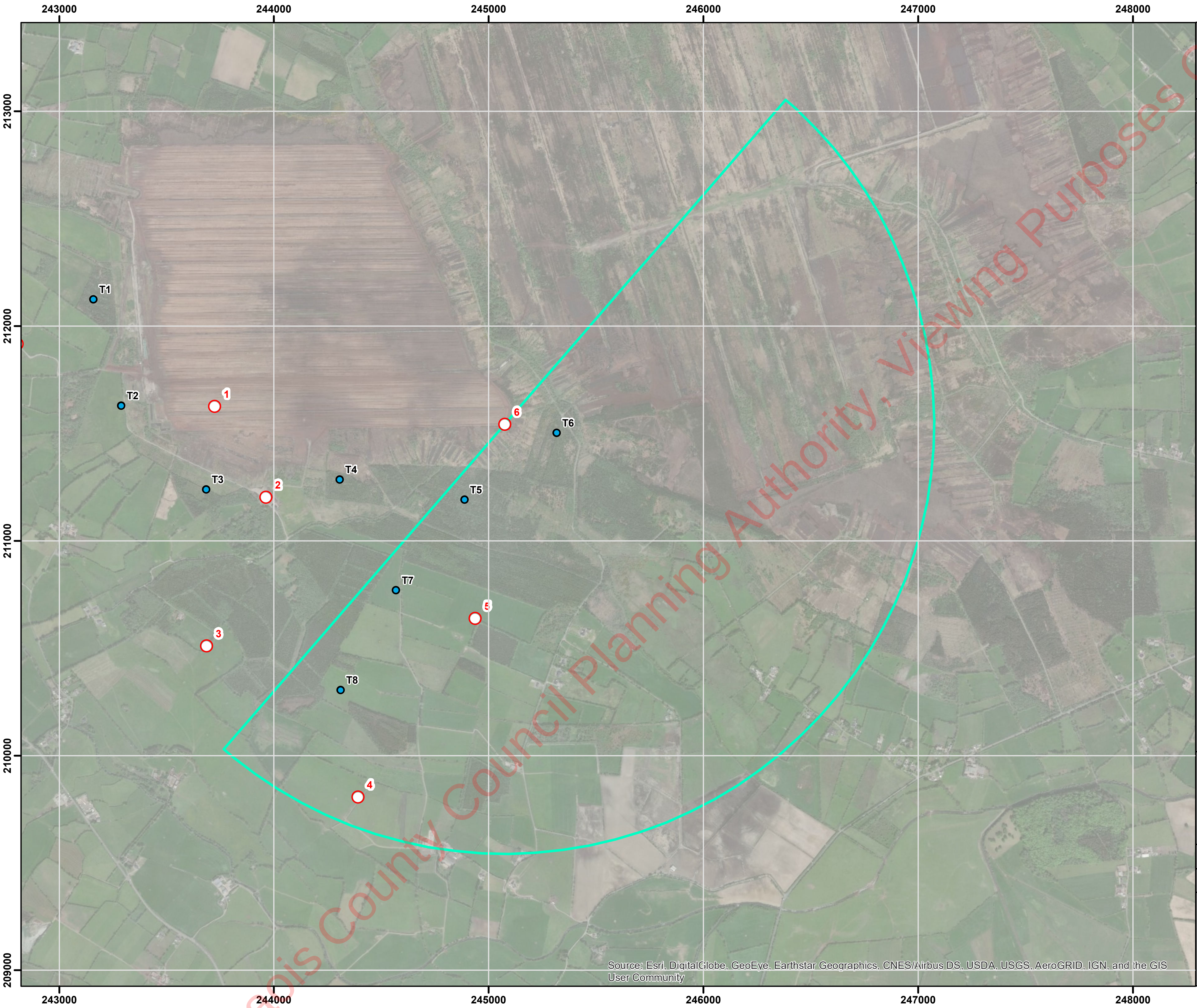

Project:

Dernacart, Co. Laois

Title:

VP Survey Fieldmaps: Map 6 of 7

Key

- Turbine
- VP location
- VP6 (245075, 211542) viewshed

Site name	
Date	
Surveyor	
Survey	
Start time	
Finish time	
Notes	

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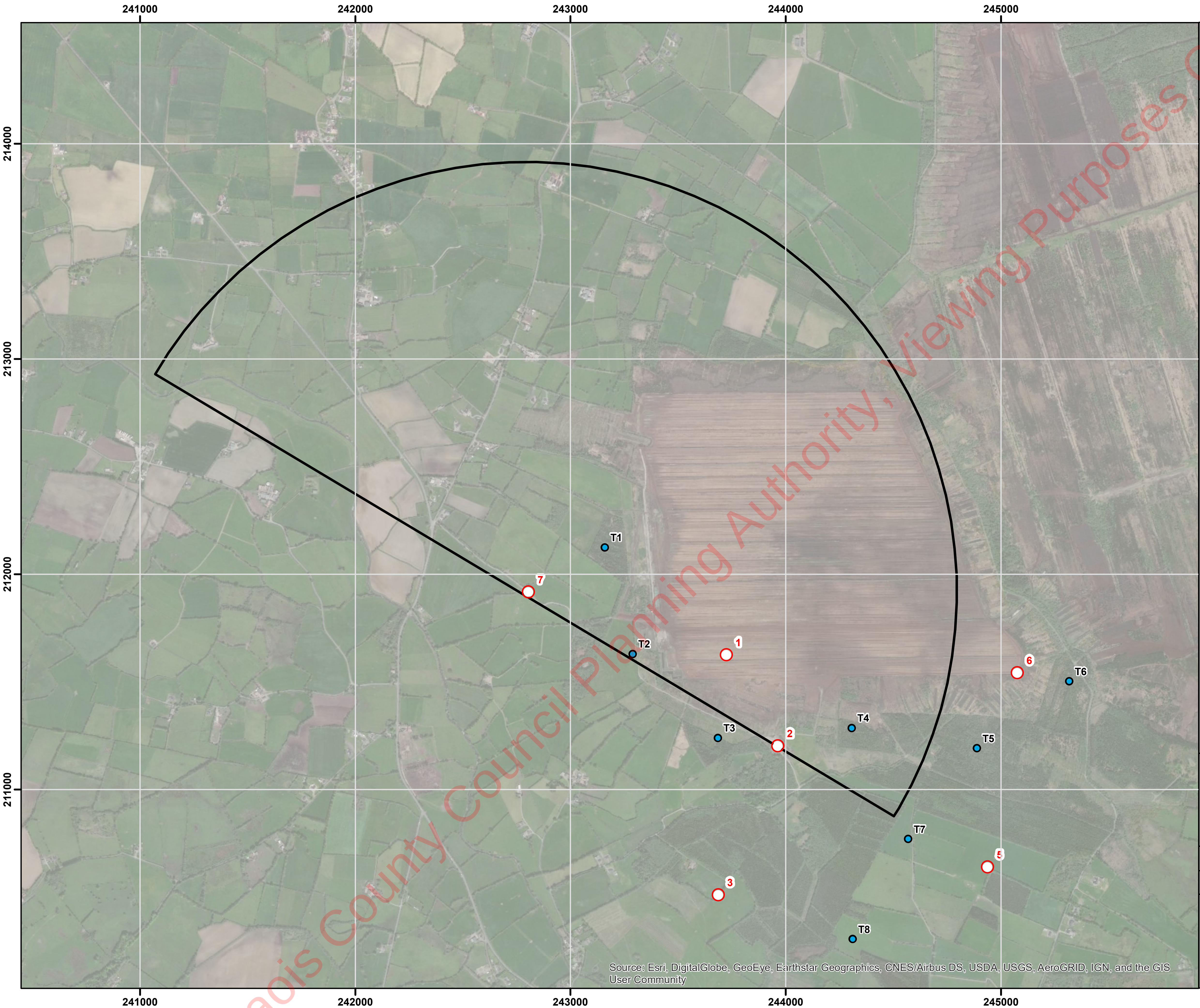

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Title:

VP Survey Fieldmaps: Map 7 of 7

Key

- Turbine
- VP location
- VP7 (242804, 211917) viewshed

Site name	
Date	
Surveyor	
Survey	
Start time	
Finish time	
Notes	

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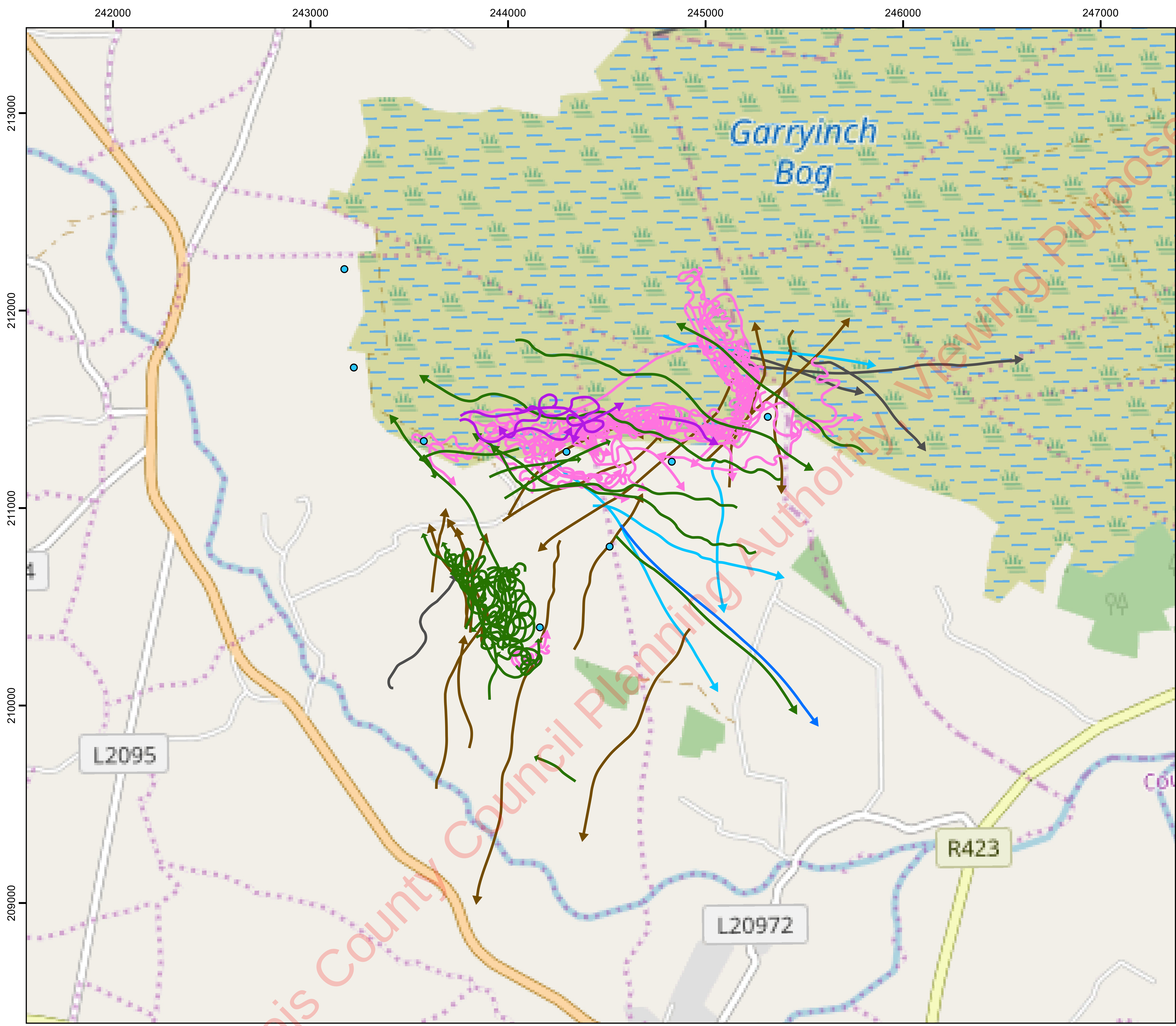

Project:

Dernacart/Baybridge Wind Farm, Co. Laois, Ireland

Title:

Figure 2: Vantage Point Survey Results: Breeding Season April - September 2018

Key

- Turbine
- Grey heron flight
- Sparrowhawk flight
- Curlew flight
- Snipe flight
- Black-headed gull flight
- Herring gull flight
- Lesser black-backed gull flight
- Kestrel flight

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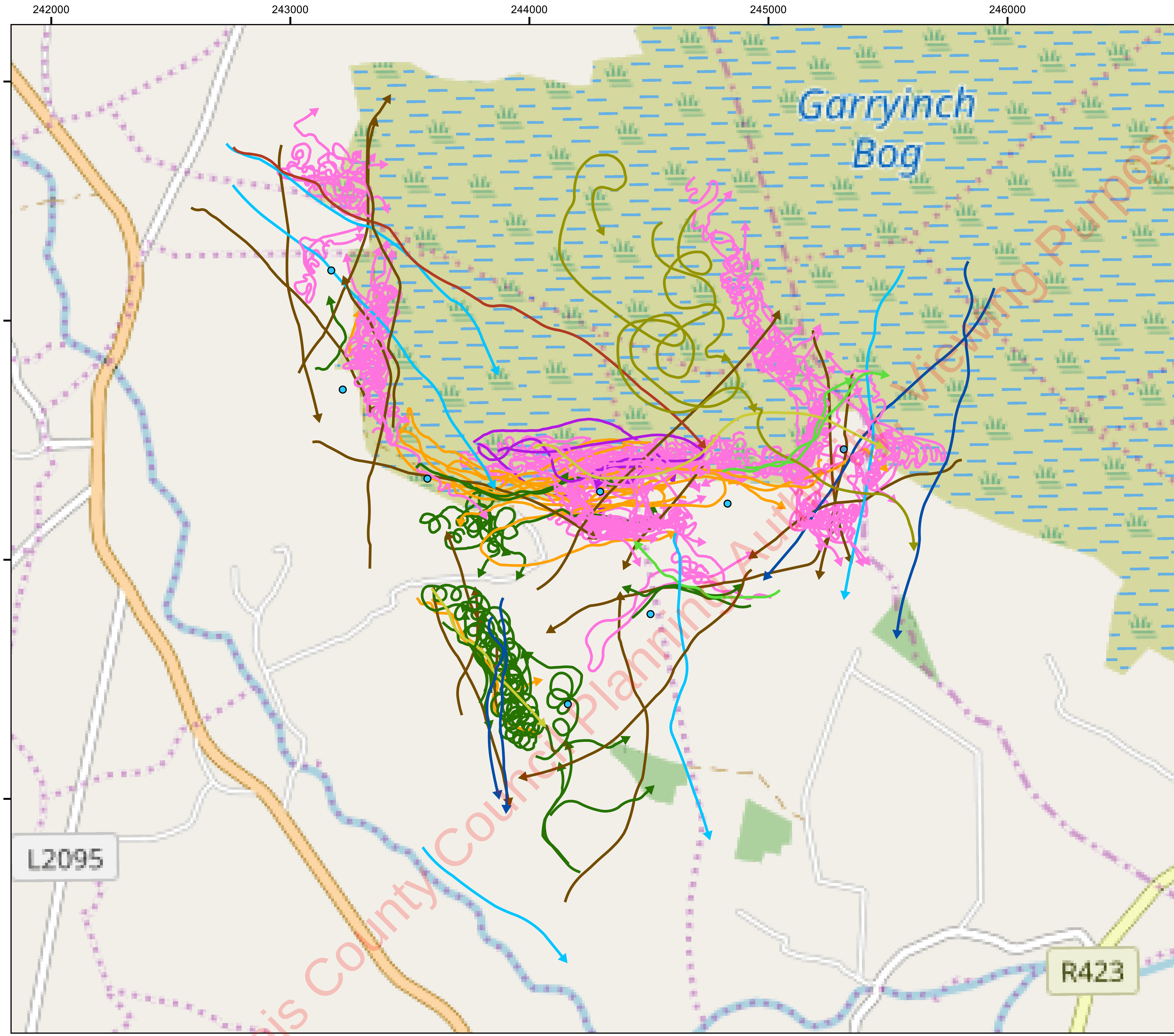

Project:

Dernacart Wind Farm, Co. Laois, Ireland

Title:

Figure 3: Vantage Point Survey Results: Breeding Season April - September 2019

Key

- Turbine
- Grey heron flight
- Sparrowhawk flight
- Lapwing flight
- Golden plover flight
- Curlew flight
- Woodcock flight
- Snipe flight
- Lesser black-backed gull flight
- Kestrel flight
- Merlin flight
- Peregrine flight

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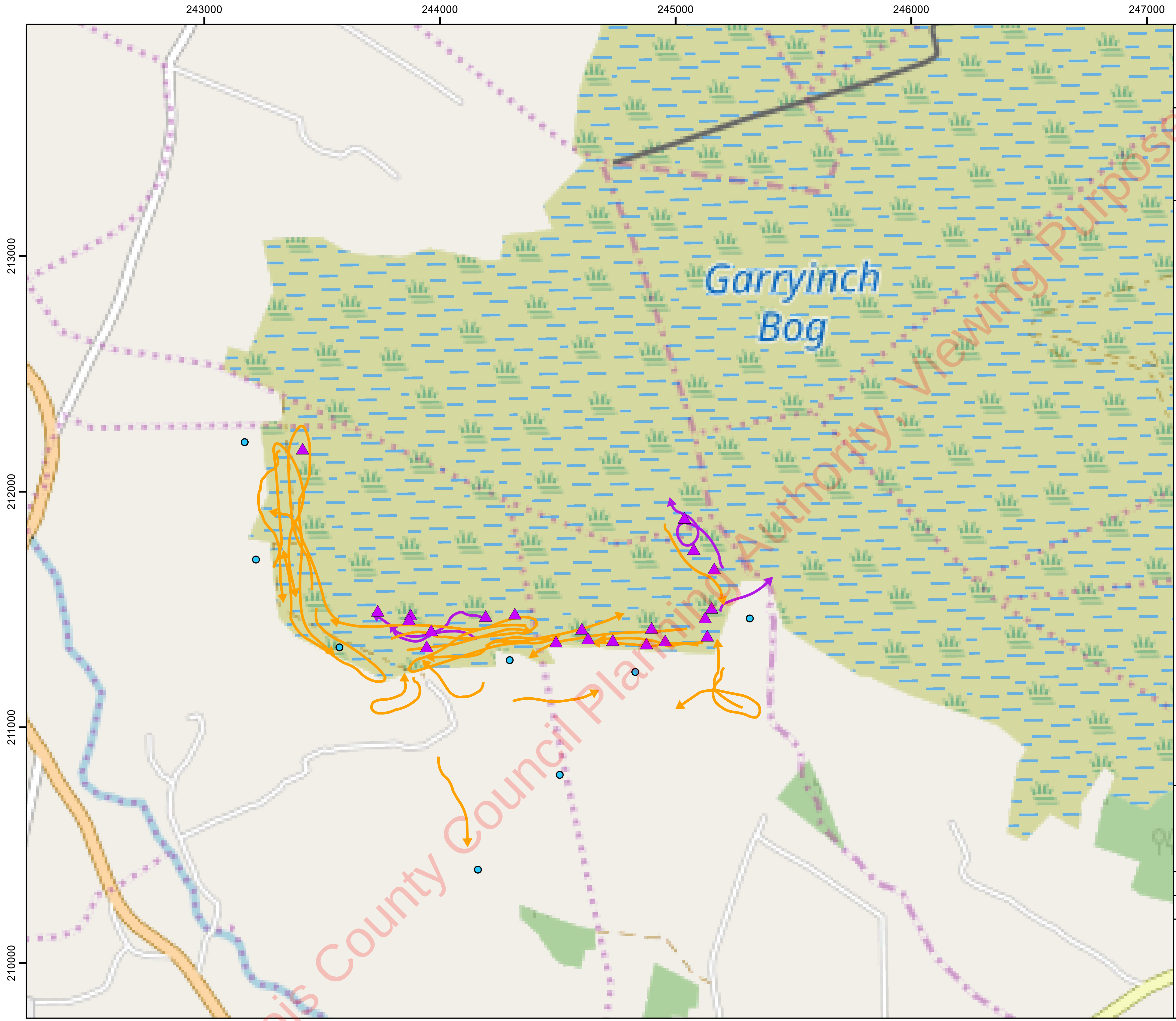

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Project:

Dernacart Wind Farm, Co. Laois, Ireland

Title:

Figure 4: Breeding Wader Survey Results: April -June, 2018 & 2019

Key

- Turbine
- Woodcock flight
- Snipe flight
- Snipe Individual

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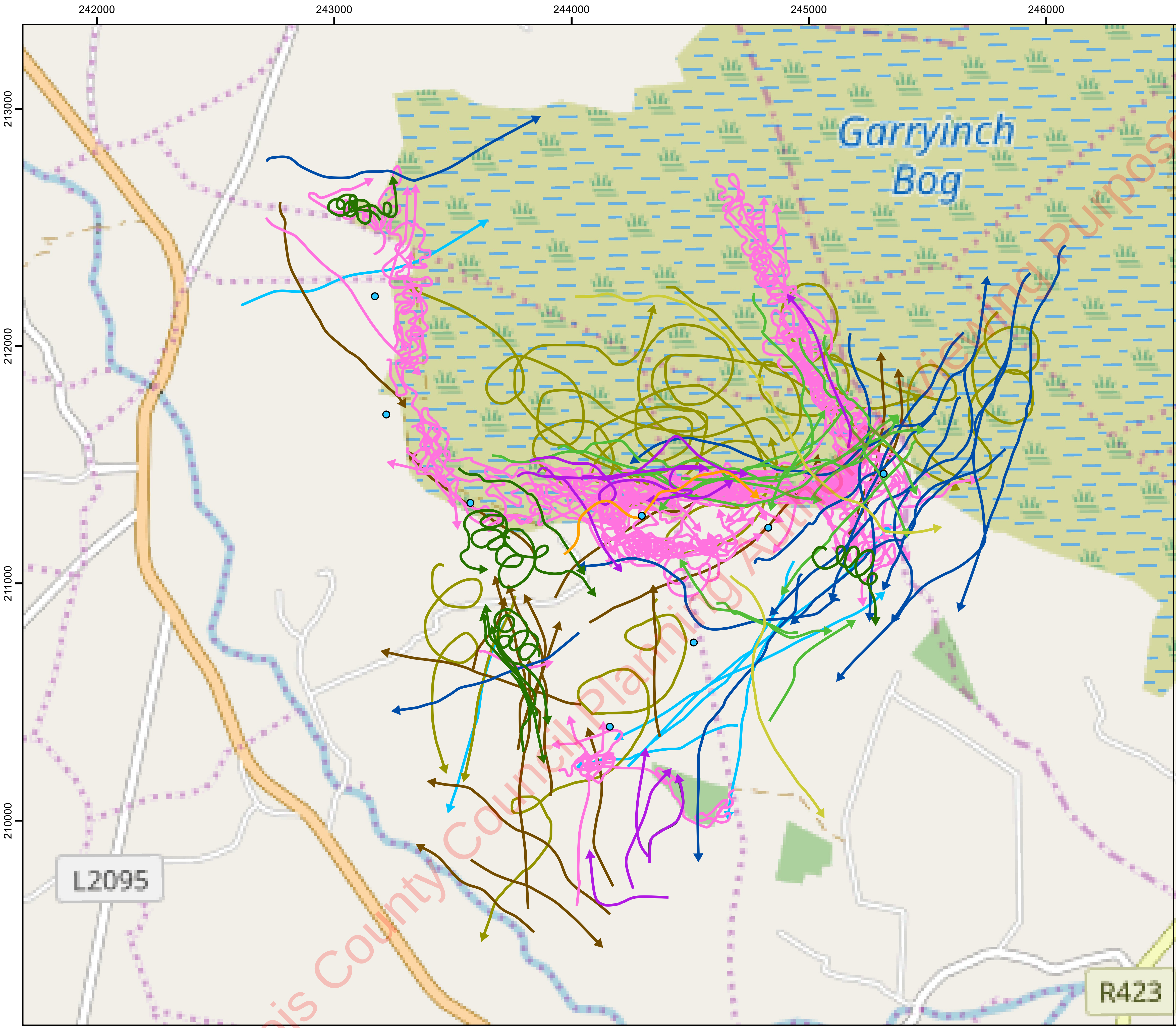

Project:

Dernacart Wind Farm, Co. Laois, Ireland

Title:

Figure 5: Vantage Point Survey Results: Non Breeding Season October 2018 - March 2019

Key

- Turbine
- Grey heron flight
- Sparrowhawk flight
- Lapwing flight
- Golden plover flight
- Curlew flight
- Woodcock flight
- Jack snipe flight
- Snipe flight
- Kestrel flight
- Merlin flight
- Peregrine flight

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Coordinate System: IRENET95 Irish Transverse Mercator

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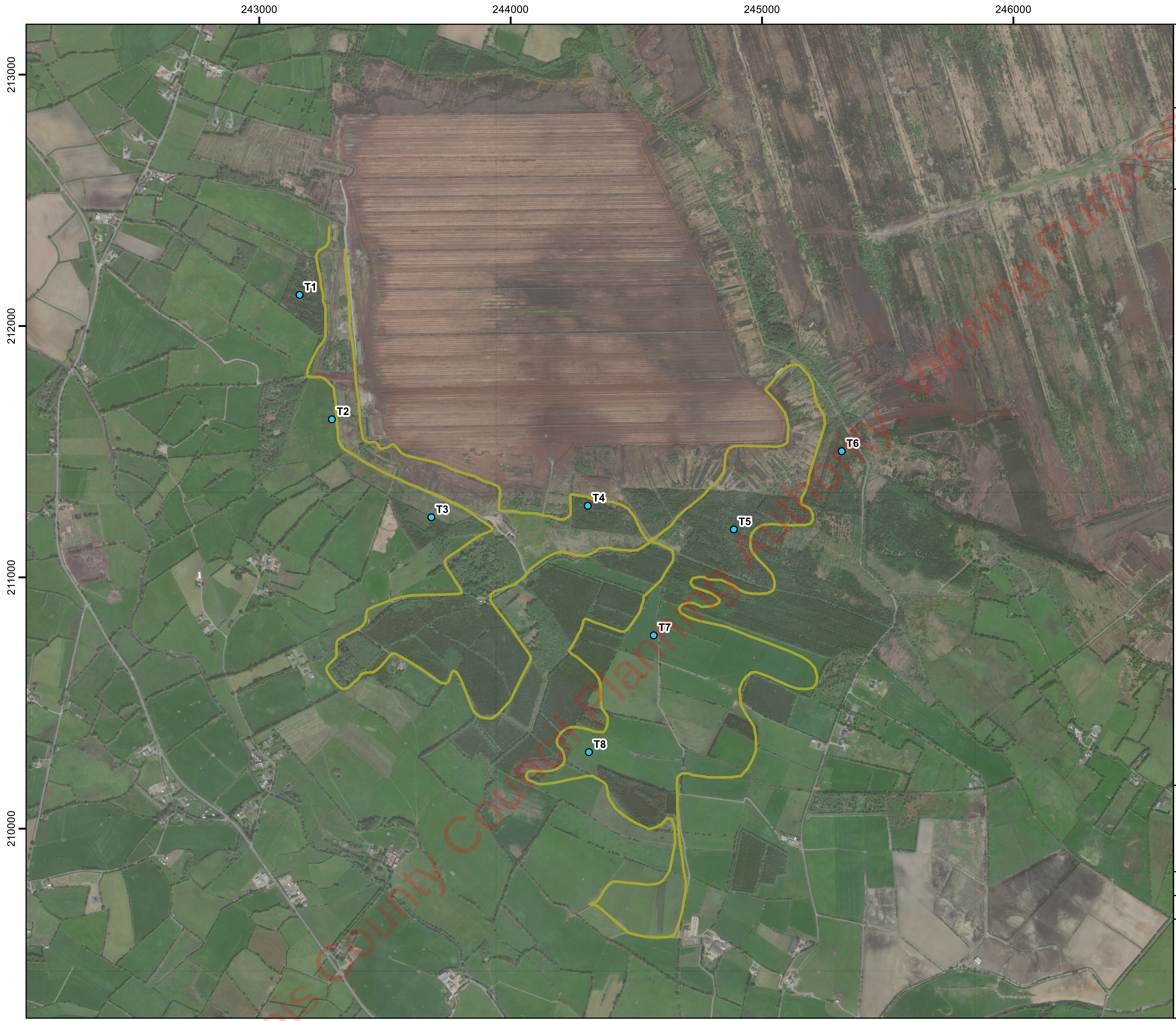

Project:

Dernacart, Co. Laois

Title:

Figure 6: Breeding Bird Survey Transect Routes

Key

- Turbine
- Transect route

Sources: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community.

Scale @ A3: 1:15,000

Coordinate System: TM65 Irish Grid

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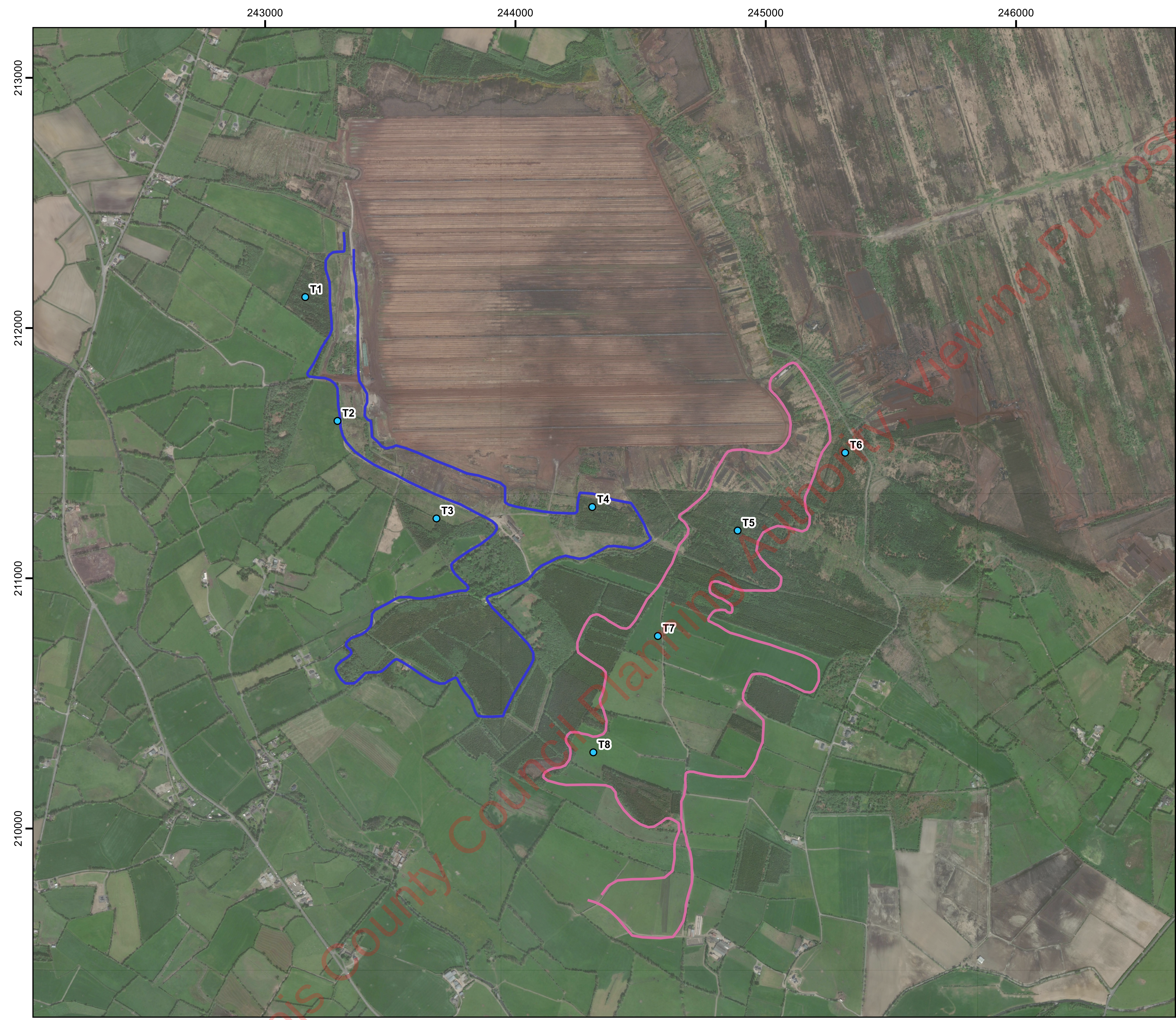

Project:

Dernacart, Co. Laois

Title:

Figure 7: Breeding Wader Survey Transect Routes

Key

- Turbine
- Transect route 1
- Transect route 2

Sources: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community.

Scale @ A3: 1:15,000

Coordinate System: TM65 Irish Grid

0 125 250 375 500 m

N

Date: 06-12-19	Prepared by: AM	Checked by: CG
Ref: IE201687_M_010_A	Layout: 211119_8t_A1	

Drawing by:

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B. Weather and Raw surveys results

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Table 1. Dates, times and weather conditions for surveys in 2018 and 2019

Date	Observer	Survey	Start time	Finish time	Wind speed	Wind direction	Precipitation	Cloud cover	Cloud height	Visibility	Frost / snow on ground
BREEDING SEASON 2018											
14/05/2018	NV	Breeding wader survey	20:25	22:30	1	Variable	0	5-6	2	2	0
18/05/2018	NV	Breeding wader survey	20:30	22:30	2	SE	0	4-5	2	2	0
04/06/2018	NV	Breeding wader survey	20:50	23:00	1	E	0	1	2	2	0
05/06/2018	NV	Breeding wader survey	20:45	22:50	0	-	0	0	-	2	0
16/07/2018	NV	Breeding wader survey	21:15	23:15	1	WSW	0	4-6	2	2	0
17/07/2018	NV	Breeding wader survey	21:15	23:15	2	W	0	4	2	2	0
31/05/2018	KR	Breeding bird survey	07:00	10:00	1	Variable	0	0	-	2	0
12/06/2018	KR	Breeding bird survey	06:30	11:00	2	W	0	3	2	2	0
25/07/2018	KR	Breeding bird survey	06:00	12:00	1	NW	0	0	-	2	0
18/04/2018	NV	VP2	11:00	12:00	3	SSE	1	6	2	2	0
18/04/2018	NV	VP2	12:00	13:00	4	SSE	0	5	2	2	0
18/04/2018	NV	VP2	13:00	14:00	4	S	0	4	2	2	0
18/04/2018	NV	VP6	18:04	19:04	5	SSE	0	4	2	2	0
18/04/2018	NV	VP6	19:04	20:04	5	S	0	3	2	2	0
18/04/2018	NV	VP6	20:04	21:04	4	S	0	3	2	2	0
19/04/2018	NV	VP1	09:30	10:30	2	SSW	0	5	2	2	0
19/04/2018	NV	VP1	10:30	11:30	4	S	0	6	2	2	0
19/04/2018	NV	VP1	11:30	12:30	4	SSW	0	6	2	2	0
19/04/2018	NV	VP3	13:30	14:30	4	SW	0	6	2	2	0
19/04/2018	NV	VP3	14:30	15:30	4	SW	0	4	2	2	0
19/04/2018	NV	VP3	15:30	16:30	3	SSW	0	3	2	2	0
20/04/2018	NV	VP4	10:00	11:00	3	WSW	0	3	2	2	0
20/04/2018	NV	VP4	11:00	12:00	3	W	0	2	2	2	0
20/04/2018	NV	VP4	12:00	13:00	3	W	0	4	2	2	0
20/04/2018	NV	VP5	05:45	06:45	2	SW	0	2	2	2	0
20/04/2018	NV	VP5	06:45	07:45	3	SW	0	2	2	2	0
20/04/2018	NV	VP5	07:45	08:45	3	WSW	0	3	2	2	0
24/04/2018	NV	VP1	05:36	06:36	3	WSW	0	6	2	2	0
24/04/2018	NV	VP1	06:36	07:36	4	SW	2	6	2	2	0
24/04/2018	NV	VP1	07:36	08:36	3	WSW	2	5	2	2	0
24/04/2018	NV	VP3	10:00	11:00	3	W	2	6	2	2	0
24/04/2018	NV	VP3	11:00	12:00	2	WNW	2	7	2	2	0
24/04/2018	NV	VP3	12:00	13:00	2	NW	1	7	1	1	0
26/04/2018	NV	VP2	05:30	06:30	4	SW	0	3	2	2	0
26/04/2018	NV	VP2	06:30	07:30	5	SW	0	2	2	2	0
26/04/2018	NV	VP2	07:30	08:30	5	WSW	0	4	2	2	0
26/04/2018	NV	VP5	10:00	11:00	5	WSW	0	4	2	2	0
26/04/2018	NV	VP5	11:00	12:00	5	WSW	2	5	2	2	0

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Date	Observer	Survey	Start time	Finish time	Wind speed	Wind direction	Precipitation	Cloud cover	Cloud height	Visibility	Frost / snow on ground
BREEDING SEASON 2018											
26/04/2018	NV	VP5	12:00	13:00	5	WSW	2	5	2	2	0
30/04/2018	NV	VP4	05:25	06:25	1	SW	0	3	2	2	1
30/04/2018	NV	VP4	06:25	07:25	1	S	0	2	2	2	0
30/04/2018	NV	VP4	07:25	08:25	1	S	0	3	2	2	0
30/04/2018	NV	VP6	09:50	10:50	1	Variable	0	3	2	2	0
30/04/2018	NV	VP6	10:50	11:50	1	NE	0	4	2	2	0
30/04/2018	NV	VP6	11:50	12:50	1	NE	0	3	2	2	0
02/05/2018	NV	VP4	09:45	10:45	4	WNW	3	4	2	2	0
02/05/2018	NV	VP4	10:45	11:45	5	WNW	0	4	2	2	0
02/05/2018	NV	VP4	11:45	12:45	5	W	2	3	2	2	0
02/05/2018	NV	VP5	05:24	06:24	3	WNW	0	6	2	2	0
02/05/2018	NV	VP5	06:24	07:24	3	WNW	0	4	2	2	0
02/05/2018	NV	VP5	07:24	08:24	4	WNW	0	4	2	2	0
03/05/2018	NV	VP1	13:20	14:20	3	SSW	2	6	2	2	0
03/05/2018	NV	VP1	14:20	15:20	2	SSW	1	7	2	2	0
03/05/2018	NV	VP1	15:20	16:20	2	SSW	1	7	2	2	0
03/05/2018	NV	VP2	18:28	19:28	4	SSW	0	6	2	2	0
03/05/2018	NV	VP2	19:28	20:28	3	SSW	0	6	2	2	0
03/05/2018	NV	VP2	20:28	21:28	3	SW	1	7	2	2	0
09/05/2018	NV	VP3	18:38	19:38	3	WSW	2	5	2	2	0
09/05/2018	NV	VP3	19:38	20:38	3	WSW	0	4	2	2	0
09/05/2018	NV	VP3	20:38	21:38	2	WSW	0	4	2	2	0
09/05/2018	NV	VP6	13:30	14:30	4	SSW	0	6	2	2	0
09/05/2018	NV	VP6	14:30	15:30	4	SSW	2	6	2	2	0
09/05/2018	NV	VP6	15:30	16:30	4	SSW	0	5	2	2	0
14/05/2018	NV	VP2	10:30	11:30	2	SSW	0	4	2	2	0
14/05/2018	NV	VP2	11:30	12:30	2	SW	0	5	2	2	0
14/05/2018	NV	VP2	12:30	13:30	1	S	0	6	2	2	0
14/05/2018	NV	VP5	15:00	16:00	1	Variable	0	3	2	2	0
14/05/2018	NV	VP5	16:00	17:00	2	S	0	4	2	2	0
14/05/2018	NV	VP5	17:00	18:00	2	SSE	0	3	2	2	0
16/05/2018	NV	VP4	18:50	19:50	3	E	0	2	2	2	0
16/05/2018	NV	VP4	19:50	20:50	3	E	0	3	2	2	0
16/05/2018	NV	VP4	20:50	21:50	2	ENE	0	2	2	2	0
16/05/2018	NV	VP6	14:00	15:00	4	ENE	0	3	2	2	0
16/05/2018	NV	VP6	15:00	16:00	3	E	0	3	2	2	0
16/05/2018	NV	VP6	16:00	17:00	3	E	0	2	2	2	0
18/05/2018	NV	VP1	16:30	17:30	3	ESE	0	4	2	2	0
18/05/2018	NV	VP1	17:30	18:30	3	SE	0	3	2	2	0
18/05/2018	NV	VP1	18:30	19:30	2	SE	0	3	2	2	0
28/05/2018	NV	VP3	04:35	05:35	1	Variable	0	2	2	2	0

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Date	Observer	Survey	Start time	Finish time	Wind speed	Wind direction	Precipitation	Cloud cover	Cloud height	Visibility	Frost / snow on ground
BREEDING SEASON 2018											
28/05/2018	NV	VP3	05:35	06:35	1	Variable	0	1	2	2	0
28/05/2018	NV	VP3	06:35	07:35	2	NNE	0	0	na	2	0
04/06/2018	NV	VP5	08:45	09:45	0	N/A	0	4	2	2	0
04/06/2018	NV	VP5	09:45	10:45	1	Variable	0	4	2	2	0
04/06/2018	NV	VP5	10:45	11:45	2	NE	0	5	2	2	0
04/06/2018	NV	VP6	04:30	05:30	0	N/A	0	2	2	2	0
04/06/2018	NV	VP6	05:30	06:30	0	N/A	0	2	2	2	0
04/06/2018	NV	VP6	06:30	07:30	0	N/A	0	1	2	2	0
05/06/2018	NV	VP3	04:30	05:30	1	ENE	0	3	2	2	0
05/06/2018	NV	VP3	05:30	06:30	2	ENE	0	3	2	2	0
05/06/2018	NV	VP3	06:30	07:30	2	E	0	4	2	2	0
05/06/2018	NV	VP4	08:30	09:30	3	E	0	6	2	2	0
05/06/2018	NV	VP4	09:30	10:30	3	E	0	8	2	2	0
05/06/2018	NV	VP4	10:30	11:30	3	E	0	8	2	2	0
12/06/2018	NV	VP1	19:30	20:30	1	Variable	0	3	2	2	0
12/06/2018	NV	VP1	20:30	21:30	2	WNW	0	2	2	2	0
12/06/2018	NV	VP1	21:30	22:30	1	Variable	0	3	2	2	0
12/06/2018	NV	VP2	15:00	16:00	1	Variable	0	5	2	2	0
12/06/2018	NV	VP2	16:00	17:00	1	Variable	0	4	2	2	0
12/06/2018	NV	VP2	17:00	18:00	1	Variable	0	3	2	2	0
15/06/2018	NV	VP3	15:30	16:30	2	WSW	0	3	2	2	0
15/06/2018	NV	VP3	16:30	17:30	2	WSW	0	3	2	2	0
15/06/2018	NV	VP3	17:30	18:30	2	WSW	0	2	2	2	0
15/06/2018	NV	VP5	19:30	20:30	2	WSW	0	3	2	2	0
15/06/2018	NV	VP5	20:30	21:30	3	WSW	0	2	2	2	0
15/06/2018	NV	VP5	21:30	22:30	2	SW	0	3	2	2	0
25/06/2018	NV	VP1	19:30	20:30	2	E	0	3	2	2	0
25/06/2018	NV	VP1	20:30	21:30	2	E	0	2	2	2	0
25/06/2018	NV	VP1	21:30	22:30	1	E	0	2	2	2	0
25/06/2018	NV	VP4	15:00	16:00	2	E	0	1	2	2	0
25/06/2018	NV	VP4	16:00	17:00	2	E	0	2	2	2	0
25/06/2018	NV	VP4	17:00	18:00	2	E	0	1	2	2	0
26/06/2018	NV	VP2	18:00	19:00	2	SE	0	0	2	2	0
26/06/2018	NV	VP2	19:00	20:00	1	SE	0	1	2	2	0
26/06/2018	NV	VP2	20:00	21:00	1	SE	0	1	2	2	0
26/06/2018	NV	VP6	04:30	05:30	1	Variable	0	0	na	2	0
26/06/2018	NV	VP6	05:30	06:30	1	Variable	0	0	na	2	0
26/06/2018	NV	VP6	06:30	07:30	1	Variable	0	0	na	2	0
02/07/2018	NV	VP2	08:30	09:30	1	Variable	0	1	2	2	0
02/07/2018	NV	VP2	09:30	10:30	1	ENE	0	0	na	2	0
02/07/2018	NV	VP2	10:30	11:30	2	NE	0	0	na	2	0

Date	Observer	Survey	Start time	Finish time	Wind speed	Wind direction	Precipitation	Cloud cover	Cloud height	Visibility	Frost / snow on ground
BREEDING SEASON 2018											
02/07/2018	NV	VP5	04:30	05:30	0	None	0	0	na	2	0
02/07/2018	NV	VP5	05:30	06:30	0	None	0	0	na	2	0
02/07/2018	NV	VP5	06:30	07:30	1	Variable	0	0	na	2	0
03/07/2018	NV	VP3	04:50	05:50	3	E	0	0	2	2	0
03/07/2018	NV	VP3	05:50	06:50	3	ENE	0	0	2	2	0
03/07/2018	NV	VP3	06:50	07:50	3	E	0	1	2	2	0
03/07/2018	NV	VP6	09:00	10:00	3	ENE	0	2	2	2	0
03/07/2018	NV	VP6	10:00	11:00	3	E	0	2	2	2	0
03/07/2018	NV	VP6	11:00	12:00	2	E	0	1	2	2	0
04/07/2018	NV	VP1	15:15	16:15	2	ESE	0	1	2	2	0
04/07/2018	NV	VP1	16:15	17:15	2	ESE	0	1	2	2	0
04/07/2018	NV	VP1	17:15	18:15	2	ESE	0	0	na	2	0
04/07/2018	NV	VP4	19:25	20:25	2	SE	0	3	2	2	0
04/07/2018	NV	VP4	20:25	21:25	1	SE	0	2	2	2	0
04/07/2018	NV	VP4	21:25	22:25	1	SE	0	2	2	2	0
16/07/2018	NV	VP4	04:50	05:50	2	WSW	0	7	2	2	0
16/07/2018	NV	VP4	05:50	06:50	2	WSW	1	6	2	2	0
16/07/2018	NV	VP4	06:50	07:50	2	W	1	7	1	2	0
16/07/2018	NV	VP5	09:00	10:00	2	WSW	0	7	2	2	0
16/07/2018	NV	VP5	10:00	11:00	2	WSW	1	7	1	2	0
16/07/2018	NV	VP5	11:00	12:00	2	WSW	0	8	1	2	0
17/07/2018	NV	VP1	12:00	13:00	2	SW	0	6	2	2	0
17/07/2018	NV	VP1	13:00	14:00	2	WSW	0	7	2	2	0
17/07/2018	NV	VP1	14:00	15:00	2	WSW	0	7	2	2	0
17/07/2018	NV	VP2	16:00	17:00	2	SW	0	6	2	2	0
17/07/2018	NV	VP2	17:00	18:00	2	SSW	0	7	2	2	0
17/07/2018	NV	VP2	18:00	19:00	2	SSW	0	7	2	2	0
23/07/2018	NV	VP3	19:10	20:10	3	SW	0	4	2	2	0
23/07/2018	NV	VP3	20:10	21:10	2	SW	0	5	2	2	0
23/07/2018	NV	VP3	21:10	22:10	2	SW	1	5	2	2	0
23/07/2018	NV	VP6	15:00	16:00	2	SW	0	3	2	2	0
23/07/2018	NV	VP6	16:00	17:00	3	SW	0	2	2	2	0
23/07/2018	NV	VP6	17:00	18:00	2	SW	0	3	2	2	0
01/08/2018	NV	VP5	09:15	10:15	4	SSW	0	6	2	2	0
01/08/2018	NV	VP5	10:15	11:15	3	SSW	2	7	2	2	0
01/08/2018	NV	VP5	11:15	12:15	3	SSW	2	7	2	2	0
01/08/2018	NV	VP6	05:15	06:15	3	SSW	0	3	2	2	0
01/08/2018	NV	VP6	06:15	07:15	3	SSW	0	5	2	2	0
01/08/2018	NV	VP6	07:15	08:15	3	SSW	0	6	2	2	0
03/08/2018	NV	VP1	05:16	06:16	2	SW	0	6	2	2	0
03/08/2018	NV	VP1	06:16	07:16	2	WSW	1	7	1	1	0

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Date	Observer	Survey	Start time	Finish time	Wind speed	Wind direction	Precipitation	Cloud cover	Cloud height	Visibility	Frost / snow on ground
BREEDING SEASON 2018											
03/08/2018	NV	VP1	07:16	08:16	3	WSW	1	7	1	1	0
03/08/2018	NV	VP3	09:20	10:20	2	WSW	0	4	2	2	0
03/08/2018	NV	VP3	10:20	11:20	3	SW	0	3	2	2	0
03/08/2018	NV	VP3	11:20	12:20	3	SW	0	3	2	2	0
14/08/2018	NV	VP2	05:35	06:35	2	WSW	0	5	2	2	0
14/08/2018	NV	VP2	06:35	07:35	2	WSW	0	6	2	2	0
14/08/2018	NV	VP2	07:35	08:35	3	SW	1	7	2	2	0
14/08/2018	NV	VP4	09:40	10:40	3	WSW	2	6	2	2	0
14/08/2018	NV	VP4	10:40	11:40	4	WSW	0	5	2	2	0
14/08/2018	NV	VP4	11:40	12:40	3	WSW	0	5	2	2	0
15/08/2018	NV	VP5	05:40	06:40	3	SSW	0	6	2	2	0
15/08/2018	NV	VP5	06:40	07:40	3	SW	0	5	2	2	0
15/08/2018	NV	VP5	07:40	08:40	4	SW	0	5	2	2	0
15/08/2018	NV	VP6	18:25	19:25	3	WSW	0	6	2	2	0
15/08/2018	NV	VP6	19:25	20:25	2	WSW	0	5	2	2	0
15/08/2018	NV	VP6	20:25	21:25	2	WSW	0	7	2	2	0
20/08/2018	NV	VP1	18:15	19:15	1	Variable	0	3	2	2	0
20/08/2018	NV	VP1	19:15	20:15	0	na	0	2	2	2	0
20/08/2018	NV	VP1	20:15	21:15	0	na	0	3	2	2	0
20/08/2018	NV	VP4	05:45	06:45	1	Variable	0	4	2	2	0
20/08/2018	NV	VP4	06:45	07:45	1	SW	0	5	2	2	0
20/08/2018	NV	VP4	07:45	08:45	1	Variable	1	6	1	1	0
28/08/2018	NV	VP2	18:00	19:00	2	SSW	0	3	2	2	0
28/08/2018	NV	VP2	19:00	20:00	2	SSW	0	3	2	2	0
28/08/2018	NV	VP2	20:00	21:00	2	SW	0	4	2	2	0
30/08/2018	NV	VP3	06:05	07:05	1	W	0	3	2	2	0
30/08/2018	NV	VP3	07:05	08:05	1	Variable	0	2	2	2	0
30/08/2018	NV	VP3	08:05	09:05	1	Variable	0	3	2	2	0
04/09/2018	NV	VP4	15:00	16:00	2	NNW	0	6	2	2	0
04/09/2018	NV	VP4	16:00	17:00	2	NNW	0	5	2	2	0
04/09/2018	NV	VP4	17:00	18:00	1	NW	0	5	2	2	0
04/09/2018	NV	VP6	10:00	11:00	2	NNW	0	5	2	2	0
04/09/2018	NV	VP6	11:00	12:00	2	N	0	5	2	2	0
04/09/2018	NV	VP6	12:00	13:00	2	N	0	6	2	2	0
05/09/2018	NV	VP2	10:15	11:15	2	NNW	0	5	2	2	0
05/09/2018	NV	VP2	11:15	12:15	3	NW	0	4	2	2	0
05/09/2018	NV	VP2	12:15	13:15	3	NW	0	4	2	2	0
05/09/2018	NV	VP4	06:15	07:15	2	N	0	3	2	2	0
05/09/2018	NV	VP4	07:15	08:15	2	N	0	5	2	2	0
05/09/2018	NV	VP4	08:15	09:15	2	NNW	0	6	2	2	0
07/09/2018	NV	VP1	06:20	07:20	3	W	0	4	2	2	0

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Date	Observer	Survey	Start time	Finish time	Wind speed	Wind direction	Precipitation	Cloud cover	Cloud height	Visibility	Frost / snow on ground
BREEDING SEASON 2018											
07/09/2018	NV	VP1	07:20	08:20	3	WSW	0	3	2	2	0
07/09/2018	NV	VP1	08:20	09:20	3	WSW	0	3	2	2	0
07/09/2018	NV	VP3	10:20	11:20	3	WSW	0	4	2	2	0
07/09/2018	NV	VP3	11:20	12:20	3	SW	0	3	2	2	0
07/09/2018	NV	VP3	12:20	13:20	3	SW	0	4	2	2	0
11/09/2018	NV	VP4	06:30	07:30	1	Variable	0	3	2	2	0
11/09/2018	NV	VP4	07:30	08:30	1	Variable	0	4	2	2	0
11/09/2018	NV	VP4	08:30	09:30	2	N	0	4	2	2	0
11/09/2018	NV	VP4	11:00	12:00	2	N	0	5	2	2	0
11/09/2018	NV	VP4	12:00	13:00	2	N	0	5	2	2	0
11/09/2018	NV	VP4	13:00	14:00	2	NNW	0	6	2	2	0
12/09/2018	NV	VP1	10:00	11:00	3	W	0	0	na	2	0
12/09/2018	NV	VP1	11:00	12:00	2	W	0	0	na	2	0
12/09/2018	NV	VP1	12:00	13:00	2	W	0	1	2	2	0
12/09/2018	NV	VP2	06:30	07:30	2	WSW	0	0	na	2	0
12/09/2018	NV	VP2	07:30	08:30	3	WSW	0	0	na	2	0
12/09/2018	NV	VP2	08:30	09:30	3	W	0	0	na	2	0
18/09/2018	NV	VP3	13:30	14:30	1	Variable	0	2	2	2	0
18/09/2018	NV	VP3	14:30	15:30	1	Variable	0	3	2	2	0
18/09/2018	NV	VP3	15:30	16:30	1	WSW	0	1	2	2	0
18/09/2018	NV	VP6	17:35	18:35	1	Variable	0	1	2	2	0
18/09/2018	NV	VP6	18:35	19:35	1	W	0	2	2	2	0
18/09/2018	NV	VP6	19:35	20:35	1	W	0	2	2	2	0
Date	**Observer**	**Survey**	**Start time**	**Finish time**	**Wind speed**	**Wind direction**	**Precipitation**	**Cloud cover**	**Cloud height**	**Visibility**	**Frost / snow on ground**
NON-BRREEDING SEASON 2018- 2019											
26/10/2018	RM	Monthly wader census	11:30	16:10	2	SE	0	4	2	2	0
22/11/2018	KR	Monthly wader census	09:30	12:00	3	E	0	4	2	2	0
11/12/2018	RM	Monthly wader census	10:00	13:15	2	SW	0	3-4	2	2	0
15/01/2018	KR	Monthly wader census	10:45	14:00	2	W	0	8	1	2	0
22/02/2019	RM	Monthly wader census	10:00	12:30	3	S	1	7-8	2	2	0
27/03/2019	KR	Monthly wader census	11:00	16:00	2-3	NE	0	3-4	2	2	0
26/10/2018	RM	Hen harrier winter roost check	16:30	19:30	2	SE	0	4	2	2	0
22/11/2018	KR	Hen harrier winter roost check	14:45	17:45	2	E	0	4	2	2	0
11/12/2018	RM	Hen harrier winter roost check	14:30	17:30	2	SW	0	4	2	2	0
10/10/2018	NV	VP1	07:15	08:15	2	SE	0	2	2	2	0
10/10/2018	NV	VP1	08:15	09:15	3	SE	0	2	2	2	0
10/10/2018	NV	VP1	09:15	10:15	3	SSE	0	3	2	2	0
10/10/2018	NV	VP2	11:15	12:15	3	SSE	0	2	2	2	0
10/10/2018	NV	VP2	12:15	13:15	4	SE	0	1	2	2	0

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Date	Observer	Survey	Start time	Finish time	Wind speed	Wind direction	Precipitation	Cloud cover	Cloud height	Visibility	Frost / snow on ground
NON-BRREEDING SEASON 2018- 2019											
10/10/2018	NV	VP2	13:15	14:15	4	SE	0	0	na	2	0
15/10/2018	NV	VP3	10:00	11:00	2	NNW	0	3	2	2	0
15/10/2018	NV	VP3	11:00	12:00	2	N	0	2	2	2	0
15/10/2018	NV	VP3	12:00	13:00	2	N	0	3	2	2	0
15/10/2018	NV	VP4	13:30	14:30	2	NNW	0	6	2	2	0
15/10/2018	NV	VP4	14:30	15:30	2	NNW	0	5	2	2	0
15/10/2018	NV	VP4	15:30	16:30	1	NW	0	5	2	2	0
16/10/2018	NV	VP5	07:25	08:25	0	na	0	2	3	3	0
16/10/2018	NV	VP5	08:25	09:25	1	Variable	0	4	3	3	0
16/10/2018	NV	VP5	09:25	10:25	2	S	1	5	3	3	0
16/10/2018	NV	VP6	11:25	12:25	1	Variable	1	7	0	1	0
16/10/2018	NV	VP6	12:25	13:25	1	Variable	1	8	1	1	0
16/10/2018	NV	VP6	13:25	14:25	2	S	0	6	2	2	0
19/10/2018	NV	VP1	07:30	08:30	3	WSW	0	4	2	2	0
19/10/2018	NV	VP1	08:30	09:30	3	WSW	0	3	2	2	0
19/10/2018	NV	VP1	09:30	10:30	3	WSW	0	3	2	2	0
19/10/2018	NV	VP2	11:00	12:00	2	SSW	0	5	2	2	0
19/10/2018	NV	VP2	12:00	13:00	2	SW	0	6	2	2	0
19/10/2018	NV	VP2	13:00	14:00	2	SW	0	6	2	2	0
23/10/2018	NV	VP3	07:40	08:40	3	W	0	6	2	2	0
23/10/2018	NV	VP3	08:40	09:40	4	W	0	7	2	2	0
23/10/2018	NV	VP3	09:40	10:40	4	WNW	0	7	2	2	0
23/10/2018	NV	VP4	11:40	12:40	3	WNW	0	6	2	2	0
23/10/2018	NV	VP4	12:40	13:40	4	WNW	0	7	2	2	0
23/10/2018	NV	VP4	13:40	14:40	4	WNW	0	6	2	2	0
31/10/2018	NV	VP5	10:30	11:30	2	S	0	4	2	2	0
31/10/2018	NV	VP5	11:30	12:30	2	S	0	4	2	2	0
31/10/2018	NV	VP5	12:30	13:30	2	SSW	0	5	2	2	0
31/10/2018	NV	VP6	06:55	07:55	1	Variable	0	3	2	1	0
31/10/2018	NV	VP6	07:55	08:55	1	Variable	0	4	2	2	0
31/10/2018	NV	VP6	08:55	09:55	2	S	0	3	2	2	0
05/11/2018	NV	VP3	07:06	08:06	2	SSE	2	7	1	2	0
05/11/2018	NV	VP3	08:06	09:06	2	SSE	2	8	1	2	0

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Date	Observer	Survey	Start time	Finish time	Wind speed	Wind direction	Precipitation	Cloud cover	Cloud height	Visibility	Frost / snow on ground
NON-BRREEDING SEASON 2018- 2019											
05/11/2018	NV	VP3	09:06	10:06	2	SE	0	6	1	2	0
05/11/2018	NV	VP4	10:45	11:45	3	SSE	0	6	2	2	0
05/11/2018	NV	VP4	11:45	12:45	2	SSE	0	6	2	2	0
05/11/2018	NV	VP4	12:45	13:45	3	SSE	0	5	2	2	0
06/11/2018	NV	VP6	07:10	08:10	3	SSE	0	8	2	2	0
06/11/2018	NV	VP6	08:10	09:10	3	SE	1	8	1	2	0
06/11/2018	NV	VP6	09:10	10:10	3	SE	0	8	1	2	0
06/11/2018	NV	VP5	10:40	11:40	3	SE	2	7	1	2	0
06/11/2018	NV	VP5	11:40	12:40	4	SE	0	5	2	2	0
06/11/2018	NV	VP5	12:40	13:40	4	SE	0	4	2	2	0
13/11/2018	NV	VP3	07:20	08:20	2	WSW	0	4	2	2	0
13/11/2018	NV	VP3	08:20	09:20	2	WSW	0	5	2	2	0
13/11/2018	NV	VP3	09:20	10:20	2	SW	0	6	2	2	0
13/11/2018	NV	VP4	10:50	11:50	2	SSW	0	7	2	2	0
13/11/2018	NV	VP4	11:50	12:50	2	SSW	0	6	2	2	0
13/11/2018	NV	VP4	12:50	13:50	2	S	0	7	2	2	0
14/11/2018	NV	VP2	13:45	14:45	2	S	0	5	2	2	0
14/11/2018	NV	VP2	14:45	15:45	2	S	0	6	2	2	0
14/11/2018	NV	VP2	15:45	16:45	2	S	0	6	2	2	0
14/11/2018	NV	VP1	08:30	09:30	3	S	0	8	2	2	0
14/11/2018	NV	VP1	09:30	10:30	3	S	0	8	2	2	0
14/11/2018	NV	VP1	10:30	11:30	3	S	0	8	2	2	0
15/11/2018	NV	VP6	07:20	08:20	3	SSW	0	2	2	2	0
15/11/2018	NV	VP6	08:20	09:20	3	SSW	0	2	2	2	0
15/11/2018	NV	VP6	09:20	10:20	3	SW	0	2	2	2	0
15/11/2018	NV	VP5	11:00	12:00	3	SSW	0	3	2	2	0
15/11/2018	NV	VP5	12:00	13:00	3	S	0	5	2	2	0
15/11/2018	NV	VP5	13:00	14:00	3	S	0	7	2	2	0
21/11/2018	NV	VP2	14:00	15:00	2	SSE	0	6	1	2	0
21/11/2018	NV	VP2	15:00	16:00	2	SSE	2	7	1	2	0
21/11/2018	NV	VP2	16:00	17:00	2	SSE	2	8	1	1	0
21/11/2018	NV	VP1	10:15	11:15	2	SSE	1	6	1	1	0

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Date	Observer	Survey	Start time	Finish time	Wind speed	Wind direction	Precipitation	Cloud cover	Cloud height	Visibility	Frost / snow on ground
NON-BRREEDING SEASON 2018- 2019											
21/11/2018	NV	VP1	11:15	12:15	2	SSE	0	7	1	2	0
21/11/2018	NV	VP1	12:15	13:15	2	SSE	2	7	1	2	0
06/12/2018	NV	VP5	08:40	09:40	3	SW	1	7	1	1	0
06/12/2018	NV	VP5	09:40	10:40	3	SW	0	8	1	1	0
06/12/2018	NV	VP5	10:40	11:40	3	SW	0	8	2	2	0
06/12/2018	NV	VP6	13:45	14:45	2	S	1	6	2	2	0
06/12/2018	NV	VP6	14:45	15:45	2	SSW	0	5	2	2	0
06/12/2018	NV	VP6	15:45	16:45	1	SW	0	4	2	2	0
07/12/2018	NV	VP1	07:50	08:50	3	SW	0	2	2	2	0
07/12/2018	NV	VP1	08:50	09:50	4	SW	0	4	2	2	0
07/12/2018	NV	VP1	09:50	10:50	4	SW	0	5	2	2	0
07/12/2018	NV	VP2	11:20	12:20	4	SW	0	5	2	2	0
07/12/2018	NV	VP2	12:20	13:20	3	WSW	0	5	2	2	0
07/12/2018	NV	VP2	13:20	14:20	4	WSW	0	4	2	2	0
10/12/2018	NV	VP7	09:40	10:40	3	WSW	0	6	1	2	0
10/12/2018	NV	VP7	10:40	11:40	3	SSW	2	7	1	2	0
10/12/2018	NV	VP7	11:40	12:40	3	SW	0	6	1	2	0
10/12/2018	NV	VP4	13:20	14:20	3	WSW	0	6	2	2	0
10/12/2018	NV	VP4	14:20	15:20	2	SW	0	5	2	2	0
10/12/2018	NV	VP4	15:20	16:20	2	SSW	0	5	2	2	0
13/12/2018	NV	VP3	10:00	11:00	4	SE	2	8	1	1	0
13/12/2018	NV	VP3	11:00	12:00	4	SE	2	8	1	1	0
13/12/2018	NV	VP3	12:00	13:00	4	SE	0	7	1	2	0
13/12/2018	NV	VP6	13:35	14:35	3	WSW	0	6	1	2	0
13/12/2018	NV	VP6	14:35	15:35	3	WNW	0	5	2	2	0
13/12/2018	NV	VP6	15:35	16:35	3	WNW	0	3	2	2	0
17/12/2018	NV	VP7	08:10	09:10	2	SSW	0	3	2	2	0
17/12/2018	NV	VP7	09:10	10:10	2	S	0	3	2	2	0
17/12/2018	NV	VP7	10:10	11:10	2	SE	0	3	2	2	0
17/12/2018	NV	VP5	11:40	12:40	3	SE	0	4	2	2	0
17/12/2018	NV	VP5	12:40	13:40	4	SE	0	5	2	2	0
17/12/2018	NV	VP5	13:40	14:40	5	SE	0	6	2	2	0

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Date	Observer	Survey	Start time	Finish time	Wind speed	Wind direction	Precipitation	Cloud cover	Cloud height	Visibility	Frost / snow on ground
NON-BRREEDING SEASON 2018- 2019											
18/12/2018	NV	VP4	08:10	09:10	3	S	2	6	1	1	0
18/12/2018	NV	VP4	09:10	10:10	2	SSW	0	5	1	2	0
18/12/2018	NV	VP4	10:10	11:10	2	SSW	4	8	1	1	0
18/12/2018	NV	VP3	12:00	13:00	4	SSW	2	6	1	1	0
18/12/2018	NV	VP3	13:00	14:00	3	SSW	4	8	1	1	0
18/12/2018	NV	VP3	14:00	15:00	3	SSW	0	5	2	2	0
20/12/2018	NV	VP2	10:00	11:00	2	N	1	7	1	1	0
20/12/2018	NV	VP2	11:00	12:00	1	na	0	6	1	2	0
20/12/2018	NV	VP2	12:00	13:00	2	SW	0	5	2	2	0
20/12/2018	NV	VP1	13:45	14:45	2	SW	1	6	0	1	0
20/12/2018	NV	VP1	14:45	15:45	2	WSW	1	7	1	1	0
20/12/2018	NV	VP1	15:45	16:45	2	W	1	8	1	1	0
02/01/2019	NV	VP3	08:13	09:13	2	SSE	0	3	2	2	0
02/01/2019	NV	VP3	09:13	10:13	2	SSE	0	4	2	2	0
02/01/2019	NV	VP3	10:13	11:13	3	SE	0	2	2	2	0
02/01/2019	NV	VP4	11:45	12:45	3	SE	0	4	2	2	0
02/01/2019	NV	VP4	12:45	13:45	3	SSE	0	3	2	2	0
02/01/2019	NV	VP4	13:45	14:45	3	S	0	3	2	2	0
09/01/2019	NV	VP6	14:03	15:03	1	NW	1	7	1	1	0
09/01/2019	NV	VP6	15:03	16:03	1	NW	0	6	1	2	0
09/01/2019	NV	VP6	16:03	17:03	2	NW	0	6	1	1	0
09/01/2019	NV	VP5	10:00	11:00	0	na	1	8	1	1	0
09/01/2019	NV	VP5	11:00	12:00	0	na	0	8	1	2	0
09/01/2019	NV	VP5	12:00	13:00	1	NW	0	8	1	2	0
10/01/2019	NV	VP7	10:00	11:00	2	NW	1	8	1	2	0
10/01/2019	NV	VP7	11:00	12:00	2	NW	1	8	1	2	0
10/01/2019	NV	VP7	12:00	13:00	2	WNW	0	6	1	2	0
10/01/2019	NV	VP2	13:45	14:45	2	WSW	0	5	2	2	0
10/01/2019	NV	VP2	14:45	15:45	2	S	0	6	2	2	0
10/01/2019	NV	VP2	15:45	16:45	2	S	0	6	2	2	0
15/01/2019	NV	VP1	08:05	09:05	2	SW	0	7	2	2	0
15/01/2019	NV	VP1	09:05	10:05	2	SW	0	7	2	2	0

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Date	Observer	Survey	Start time	Finish time	Wind speed	Wind direction	Precipitation	Cloud cover	Cloud height	Visibility	Frost / snow on ground
NON-BRREEDING SEASON 2018- 2019											
15/01/2019	NV	VP1	10:05	11:05	2	SSW	0	6	2	2	0
15/01/2019	NV	VP3	11:40	12:40	3	SSW	0	7	2	2	0
15/01/2019	NV	VP3	12:40	13:40	3	SW	0	8	2	2	0
15/01/2019	NV	VP3	13:40	14:40	2	SW	0	7	2	2	0
16/01/2019	NV	VP5	14:13	15:13	2	WSW	0	3	2	2	0
16/01/2019	NV	VP5	15:13	16:13	2	W	0	3	2	2	0
16/01/2019	NV	VP5	16:13	17:13	2	W	0	2	2	2	0
16/01/2019	NV	VP4	09:50	10:50	2	SW	0	2	2	2	0
16/01/2019	NV	VP4	10:50	11:50	2	WSW	0	3	2	2	0
16/01/2019	NV	VP4	11:50	12:50	2	WSW	0	3	2	2	0
17/01/2019	NV	VP7	08:00	09:00	1	NNW	0	0	na	2	1
17/01/2019	NV	VP7	09:00	10:00	1	na	0	0	na	2	1
17/01/2019	NV	VP7	10:00	11:00	1	W	0	1	2	2	0
17/01/2019	NV	VP2	11:30	12:30	1	WSW	0	0	na	2	1
17/01/2019	NV	VP2	12:30	13:30	1	WSW	0	0	na	2	0
17/01/2019	NV	VP2	13:30	14:30	2	WSW	0	1	2	2	0
23/01/2019	NV	VP6	07:55	08:55	2	WNW	0	4	2	2	1
23/01/2019	NV	VP6	08:55	09:55	2	WNW	0	5	2	2	1
23/01/2019	NV	VP6	09:55	10:55	2	WNW	0	6	2	2	0
23/01/2019	NV	VP1	11:30	12:30	2	W	0	6	2	2	0
23/01/2019	NV	VP1	12:30	13:30	2	WSW	0	6	2	2	0
23/01/2019	NV	VP1	13:30	14:30	2	WSW	0	5	2	2	0
06/02/2019	NV	VP3	07:34	08:34	3	S	0	6	2	2	0
06/02/2019	NV	VP3	08:34	09:34	3	SSW	0	6	2	2	0
06/02/2019	NV	VP3	09:34	10:34	3	SSW	0	5	2	2	0
06/02/2019	NV	VP2	11:15	12:15	3	SSW	0	6	2	2	0
06/02/2019	NV	VP2	12:15	13:15	3	SSW	0	5	2	2	0
06/02/2019	NV	VP2	13:15	14:15	3	SSW	0	6	2	2	0
11/02/2019	NV	VP4	07:25	08:25	2	W	0	0	na	2	1
11/02/2019	NV	VP4	08:25	09:25	2	W	0	0	na	2	1
11/02/2019	NV	VP4	09:25	10:25	2	W	0	1	2	2	0
11/02/2019	NV	VP5	11:00	12:00	2	W	0	1	2	2	0

Date	Observer	Survey	Start time	Finish time	Wind speed	Wind direction	Precipitation	Cloud cover	Cloud height	Visibility	Frost / snow on ground
NON-BRREEDING SEASON 2018- 2019											
11/02/2019	NV	VP5	12:00	13:00	1	WSW	0	3	2	2	0
11/02/2019	NV	VP5	13:00	14:00	2	SW	0	4	2	2	0
12/02/2019	NV	VP6	11:10	12:10	3	SSW	0	7	2	2	0
12/02/2019	NV	VP6	12:10	13:10	3	SSW	0	6	2	2	0
12/02/2019	NV	VP6	13:10	14:10	3	SW	0	7	2	2	0
12/02/2019	NV	VP1	15:05	16:05	3	SW	0	6	2	2	0
12/02/2019	NV	VP1	16:05	17:05	3	SW	0	6	2	2	0
12/02/2019	NV	VP1	17:05	18:05	2	SW	0	7	2	2	0
19/02/2019	NV	VP7	15:17	16:17	2	S	2	8	1	2	0
19/02/2019	NV	VP7	16:17	17:17	2	S	2	7	1	2	0
19/02/2019	NV	VP7	17:17	18:17	2	S	3	8	1	2	0
19/02/2019	NV	VP4	11:15	12:15	3	SSW	0	7	1	2	0
19/02/2019	NV	VP4	12:15	13:15	3	SSW	2	8	1	2	0
19/02/2019	NV	VP4	13:15	14:15	3	SW	2	7	1	2	0
20/02/2019	NV	VP1	11:40	12:40	4	SSW	0	6	2	2	0
20/02/2019	NV	VP1	12:40	13:40	4	SSW	0	5	2	2	0
20/02/2019	NV	VP1	13:40	14:40	4	SSW	0	6	2	2	0
20/02/2019	NV	VP2	15:20	16:20	3	SSW	2	7	1	2	0
20/02/2019	NV	VP2	16:20	17:20	3	SSW	0	7	1	2	0
20/02/2019	NV	VP2	17:20	18:20	3	SSW	0	6	2	2	0
21/02/2019	NV	VP3	07:05	08:05	3	SW	0	2	2	2	0
21/02/2019	NV	VP3	08:05	09:05	2	SW	0	3	2	2	0
21/02/2019	NV	VP3	09:05	10:05	2	SW	0	3	2	2	0
21/02/2019	NV	VP5	11:20	12:20	3	SSW	0	6	2	2	0
21/02/2019	NV	VP5	12:20	13:20	3	SSW	0	6	2	2	0
21/02/2019	NV	VP5	13:20	14:20	4	SSW	0	5	2	2	0
28/02/2019	NV	VP6	06:50	07:50	1	na	0	1	2	2	0
28/02/2019	NV	VP6	07:50	08:50	0	na	0	1	2	2	0
28/02/2019	NV	VP6	08:50	09:50	0	na	0	0	na	2	0
28/02/2019	NV	VP7	10:30	11:30	4	na	0	3	2	2	0
28/02/2019	NV	VP7	11:30	12:30	1	W	0	4	2	2	0
28/02/2019	NV	VP7	12:30	13:30	2	W	0	5	2	2	0

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Date	Observer	Survey	Start time	Finish time	Wind speed	Wind direction	Precipitation	Cloud cover	Cloud height	Visibility	Frost / snow on ground
NON-BRREEDING SEASON 2018- 2019											
06/03/2019	NV	VP2	10:05	11:05	3	S	0	7	2	2	0
06/03/2019	NV	VP2	11:05	12:05	3	SSW	0	5	0	2	0
06/03/2019	NV	VP2	12:05	13:05	3	S	0	6	1	2	0
06/03/2019	NV	VP1	06:35	07:35	3	SSW	2	6	1	2	0
06/03/2019	NV	VP1	07:35	08:35	3	SSW	0	6	1	2	0
06/03/2019	NV	VP1	08:35	09:35	3	S	0	7	1	2	0
07/03/2019	NV	VP4	10:00	11:00	4	SSW	0	5	2	2	0
07/03/2019	NV	VP4	11:00	12:00	4	S	0	7	2	2	0
07/03/2019	NV	VP4	12:00	13:00	5	S	0	6	2	2	0
07/03/2019	NV	VP3	06:30	07:30	3	SSW	0	6	2	2	0
07/03/2019	NV	VP3	07:30	08:30	3	S	0	6	2	2	0
07/03/2019	NV	VP3	08:30	09:30	3	SSW	0	7	2	2	0
11/03/2019	NV	VP6	10:00	11:00	3	WNW	1	7	1	1	1
11/03/2019	NV	VP6	11:00	12:00	2	WNW	0	6	2	2	1
11/03/2019	NV	VP6	12:00	13:00	1	W	0	6	2	2	1
11/03/2019	NV	VP5	06:25	07:25	2	W	0	4	2	2	1
11/03/2019	NV	VP5	07:25	08:25	2	W	0	5	2	2	1
11/03/2019	NV	VP5	08:25	09:25	2	WSW	0	6	2	2	1
13/03/2019	NV	VP1	13:15	14:15	4	WNW	0	6	1	2	0
13/03/2019	NV	VP1	14:15	15:15	4	WNW	0	5	2	2	0
13/03/2019	NV	VP1	15:15	16:15	5	WNW	2	6	1	2	0
13/03/2019	NV	VP7	09:45	10:45	5	W	0	1	2	2	0
13/03/2019	NV	VP7	10:45	11:45	5	W	0	3	2	2	0
13/03/2019	NV	VP7	11:45	12:45	4	WNW	2	5	1	2	0
14/03/2019	NV	VP3	09:50	10:50	4	W	0	6	1	2	0
14/03/2019	NV	VP3	10:50	11:50	4	W	0	5	2	2	0
14/03/2019	NV	VP3	11:50	12:50	5	W	0	6	2	2	0
14/03/2019	NV	VP2	06:15	07:15	4	W	2	7	1	1	0
14/03/2019	NV	VP2	07:15	08:15	4	W	2	8	1	2	0
14/03/2019	NV	VP2	08:15	09:15	4	WNW	2	7	1	2	0
21/03/2019	NV	VP5	09:30	10:30	2	WSW	0	6	2	2	0
21/03/2019	NV	VP5	10:30	11:30	2	SW	0	8	2	2	0

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Date	Observer	Survey	Start time	Finish time	Wind speed	Wind direction	Precipitation	Cloud cover	Cloud height	Visibility	Frost / snow on ground
NON-BRREEDING SEASON 2018- 2019											
21/03/2019	NV	VP5	11:30	12:30	1	SW	0	7	2	2	0
21/03/2019	NV	VP4	06:00	07:00	2	WSW	1	7	1	1	0
21/03/2019	NV	VP4	07:00	08:00	2	WSW	0	8	1	2	0
21/03/2019	NV	VP4	08:00	09:00	2	W	0	7	2	2	0
28/03/2019	NV	VP7	09:20	10:20	2	SSW	0	0	na	2	0
28/03/2019	NV	VP7	10:20	11:20	1	SW	0	1	2	2	0
28/03/2019	NV	VP7	11:20	12:20	1	SSW	0	1	2	2	0
28/03/2019	NV	VP6	05:45	06:45	1	SSW	0	0	na	2	0
28/03/2019	NV	VP6	06:45	07:45	1	SSW	0	0	na	2	0
28/03/2019	NV	VP6	07:45	08:45	1	SW	0	0	na	2	0
Date	Observer	Survey	Start time	Finish time	Wind speed	Wind direction	Precipitation	Cloud cover	Cloud height	Visibility	Frost / snow on ground
BREEDING SEASON 2019											
13/05/2019	NV	Breeding wader survey	20:30	21:25	1	Variable	0	5	2	2	0
13/05/2019	NV	Breeding wader survey	20:30	21:30	1	SE	0	0	0	2	0
13/05/2019	NV	Breeding wader survey	21:30	22:30	1	SE	0	0	0	2	0
13/05/2019	NV	Breeding wader survey	22:30	23:30	1	SE	0	0	0	2	0
25/05/2019	NV	Breeding wader survey	20:40	21:40	2	WSW	0	7	2	2	0
25/05/2019	NV	Breeding wader survey	21:40	22:40	2	WSW	0	5	2	2	0
25/05/2019	NV	Breeding wader survey	22:40	23:40	2	WSW	0	6	2	2	0
03/06/2019	NV	Breeding wader survey	20:30	21:30	2	SW	0	7	2	2	0
03/06/2019	NV	Breeding wader survey	21:30	22:30	2	SW	0	6	2	1	0
03/06/2019	NV	Breeding wader survey	22:30	23:30	2	WSW	0	7	2	0	0
17/06/2019	NV	Breeding wader survey	20:55	21:55	3	WSW	0	6	2	2	0
17/06/2019	NV	Breeding wader survey	21:55	22:55	2	WSW	0	5	2	2	0
17/06/2019	NV	Breeding wader survey	22:55	23:55	2	W	0	3	2	1	0
15/07/2019	NV	Breeding wader survey	20:55	21:55	2	SW	0	6	2	2	0
15/07/2019	NV	Breeding wader survey	21:55	22:55	2	SW	0	7	2	2	0
15/07/2019	NV	Breeding wader survey	22:55	23:55	2	SSW	0	6	2	2	0
16/07/2019	NV	Breeding wader survey	20:50	21:50	2	ESE	0	2	2	2	0

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Date	Observer	Survey	Start time	Finish time	Wind speed	Wind direction	Precipitation	Cloud cover	Cloud height	Visibility	Frost / snow on ground
BREEDING SEASON 2019											
16/07/2019	NV	Breeding wader survey	21:50	22:50	1	SE	0	1	2	2	0
16/07/2019	NV	Breeding wader survey	22:50	23:13	1	S	0	1	2	1	0
25/04/2019	NV	Breeding bird survey	07:00	11:10	1	Variable	0	0	-	2	0
26/04/2019	NV	Breeding bird survey	07:20	11:00	2	W	0	3	2	2	0
16/05/2019	NV	Breeding bird survey	06:30	11:45	1	NW	0	0	-	2	0
17/05/2019	NV	Breeding bird survey	06:30	11:30	1	Variable	0	0	-	2	0
21/06/2019	NV	Breeding bird survey	06:20	11:00	2	W	0	2	2	2	0
22/06/2019	NV	Breeding bird survey	06:20	12:00	1	NE	1	1	-	2	0
10/07/2019	NV	Breeding bird survey	06:30	11:00	2	W	0	1	2	2	0
15/07/2019	NV	Breeding bird survey	06:00	12:00	1	N	0	0	-	2	0
08/04/2019	NV	VP6	10:00	11:00	2	ENE	1	7	1	1	0
08/04/2019	NV	VP6	11:00	12:00	2	ENE	0	6	1	2	0
08/04/2019	NV	VP6	12:00	13:00	2	ENE	0	7	1	1	0
08/04/2019	NV	VP7	06:17	07:17	1	ENE	1	7	0	1	0
08/04/2019	NV	VP7	07:17	08:17	1	ENE	1	8	1	1	0
08/04/2019	NV	VP7	08:17	09:17	1	E	1	7	1	2	0
09/04/2019	NV	VP4	17:48	18:48	2	ENE	0	6	2	2	0
09/04/2019	NV	VP4	18:48	19:48	2	ENE	0	5	2	2	0
09/04/2019	NV	VP4	19:48	20:48	2	ENE	0	4	2	2	0
09/04/2019	NV	VP5	14:18	15:18	2	ENE	0	5	2	2	0
09/04/2019	NV	VP5	16:18	17:18	3	ENE	0	5	2	2	0
09/04/2019	NV	VP5	15:18	16:18	2	ENE	0	4	2	2	0
10/04/2019	NV	VP1	14:20	15:20	2	E	0	1	2	2	0
10/04/2019	NV	VP1	15:20	16:20	2	E	0	0	0	2	0
10/04/2019	NV	VP1	16:20	17:20	2	E	0	0	0	2	0
10/04/2019	NV	VP3	17:50	18:50	2	E	0	0	0	2	0
10/04/2019	NV	VP3	18:50	19:50	2	E	0	0	0	2	0
10/04/2019	NV	VP3	19:50	20:50	1	E	0	1	2	2	0
11/04/2019	NV	VP2	06:09	07:09	0	SSE	0	0	0	2	1

Date	Observer	Survey	Start time	Finish time	Wind speed	Wind direction	Precipitation	Cloud cover	Cloud height	Visibility	Frost / snow on ground
BREEDING SEASON 2019											
11/04/2019	NV	VP2	07:09	08:09	0	SSE	0	0	0	2	1
11/04/2019	NV	VP2	08:09	09:09	1	SSE	0	0	0	2	0
11/04/2019	NV	VP7	09:50	10:50	1	SSE	0	2	2	2	0
11/04/2019	NV	VP7	10:50	11:50	1	SSE	0	3	2	2	0
11/04/2019	NV	VP7	11:50	12:50	2	SSE	0	2	2	2	0
26/04/2019	NV	VP5	14:50	15:50	3	S	2	6	1	2	0
26/04/2019	NV	VP5	15:50	16:50	4	S	0	8	1	2	0
26/04/2019	NV	VP5	16:50	17:50	4	S	2	8	1	2	0
26/04/2019	NV	VP6	11:20	12:20	3	WSW	0	5	1	2	0
26/04/2019	NV	VP6	12:20	13:20	3	SW	0	6	1	2	0
26/04/2019	NV	VP6	13:20	14:20	3	SW	2	6	1	2	0
29/04/2019	NV	VP3	13:30	14:30	3	SE	0	6	2	2	0
29/04/2019	NV	VP3	14:30	15:30	3	SSE	0	7	2	2	0
29/04/2019	NV	VP3	15:30	16:30	3	SSE	0	6	2	2	0
29/04/2019	NV	VP4	10:00	11:00	3	SE	0	4	1	2	0
29/04/2019	NV	VP4	11:00	12:00	3	SE	0	5	1	2	0
29/04/2019	NV	VP4	12:00	13:00	3	SE	0	5	2	2	0
30/04/2019	NV	VP1	05:24	06:24	2	SE	0	8	1	1	0
30/04/2019	NV	VP1	06:24	07:24	2	ESE	2	8	1	2	0
30/04/2019	NV	VP1	07:24	08:24	3	ESE	0	8	1	2	0
30/04/2019	NV	VP2	09:05	10:05	2	SE	0	5	2	2	0
30/04/2019	NV	VP2	10:05	11:05	3	SE	0	8	2	2	0
30/04/2019	NV	VP2	11:05	12:05	3	SE	0	8	2	2	0
02/05/2019	NV	VP4	14:30	15:30	3	WNW	0	5	2	2	0
02/05/2019	NV	VP4	15:30	16:30	3	WNW	2	6	1	2	0
02/05/2019	NV	VP4	16:30	17:30	2	NW	0	6	1	2	0
02/05/2019	NV	VP5	18:25	19:25	1	WNW	0	6	2	2	0
02/05/2019	NV	VP5	19:25	20:25	1	WNW	0	7	2	2	0

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Date	Observer	Survey	Start time	Finish time	Wind speed	Wind direction	Precipitation	Cloud cover	Cloud height	Visibility	Frost / snow on ground
BREEDING SEASON 2019											
02/05/2019	NV	VP5	20:25	21:25	0	NW	0	6	2	2	0
09/05/2019	NV	VP7	05:10	06:10	1	NW	1	8	0	1	0
09/05/2019	NV	VP7	06:10	07:10	1	NNW	1	7	0	1	0
09/05/2019	NV	VP7	07:10	08:10	2	NNW	0	6	1	2	0
09/05/2019	NV	VP6	08:40	09:40	2	NNW	2	8	1	2	0
09/05/2019	NV	VP6	09:40	10:40	2	NW	2	8	1	2	0
09/05/2019	NV	VP6	10:40	11:40	2	NW	2	8	1	2	0
13/05/2019	NV	VP2	17:00	18:00	2	SE	0	1	2	2	0
13/05/2019	NV	VP2	18:00	19:00	2	SSE	0	3	2	2	0
13/05/2019	NV	VP2	19:00	20:00	1	SSE	0	5	2	2	0
13/05/2019	NV	VP1	13:30	14:30	3	SE	0	0	0	2	0
13/05/2019	NV	VP1	14:30	15:30	3	SE	0	0	0	2	0
13/05/2019	NV	VP1	15:30	16:30	3	SE	0	0	0	2	0
15/05/2019	NV	VP3	04:55	05:55	0	na	0	0	0	2	0
15/05/2019	NV	VP3	05:55	06:55	1	SE	0	0	0	2	0
15/05/2019	NV	VP3	06:55	07:55	1	SE	0	0	0	2	0
15/05/2019	NV	VP4	08:30	09:30	1	SE	0	0	0	2	0
15/05/2019	NV	VP4	09:30	10:30	2	SE	0	0	0	2	0
15/05/2019	NV	VP4	10:30	11:30	2	SE	0	1	2	2	0
16/05/2019	NV	VP5	16:05	17:05	3	ESE	0	2	2	2	0
16/05/2019	NV	VP5	17:05	18:05	3	ESE	0	5	2	2	0
16/05/2019	NV	VP5	18:05	19:05	3	E	0	5	2	2	0
16/05/2019	NV	VP6	12:30	13:30	2	ESE	0	1	2	2	0
16/05/2019	NV	VP6	13:30	14:30	2	ESE	0	1	2	2	0
16/05/2019	NV	VP6	14:30	15:30	2	E	0	0	0	2	0
23/05/2019	NV	VP1	19:00	20:00	1	WSW	0	6	2	2	0
23/05/2019	NV	VP1	20:00	21:00	1	WSW	0	5	2	2	0
23/05/2019	NV	VP1	21:00	22:00	1	WSW	0	4	2	2	0

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Date	Observer	Survey	Start time	Finish time	Wind speed	Wind direction	Precipitation	Cloud cover	Cloud height	Visibility	Frost / snow on ground
BREEDING SEASON 2019											
23/05/2019	NV	VP7	15:30	16:30	2	W	0	6	1	2	0
23/05/2019	NV	VP7	16:30	17:30	1	WSW	0	6	1	2	0
23/05/2019	NV	VP7	17:30	18:30	1	SW	0	7	1	2	0
24/05/2019	NV	VP3	08:20	09:20	1	WSW	0	6	2	2	0
24/05/2019	NV	VP3	09:20	10:20	2	WSW	0	5	2	2	0
24/05/2019	NV	VP3	10:20	11:20	2	SW	0	5	2	2	0
24/05/2019	NV	VP2	04:45	05:45	2	W	0	6	2	2	0
24/05/2019	NV	VP2	05:45	06:45	2	WSW	0	5	2	2	0
24/05/2019	NV	VP2	06:45	07:45	2	WSW	0	6	2	2	0
03/06/2019	NV	VP2	17:00	18:00	4	WSW	2	8	1	2	0
03/06/2019	NV	VP2	18:00	19:00	3	WSW	2	7	1	2	0
03/06/2019	NV	VP2	19:00	20:00	2	SW	0	8	2	2	0
03/06/2019	NV	VP1	13:30	14:30	3	SW	2	5	1	2	0
03/06/2019	NV	VP1	14:30	15:30	3	WSW	0	4	2	2	0
03/06/2019	NV	VP1	15:30	16:30	3	WSW	0	6	2	2	0
12/06/2019	NV	VP4	08:00	09:00	4	NNE	2	8	1	2	0
12/06/2019	NV	VP4	09:00	10:00	4	N	2	8	1	2	0
12/06/2019	NV	VP4	10:00	11:00	4	NNW	3	8	1	1	0
12/06/2019	NV	VP3	04:28	05:28	3	N	0	8	1	1	0
12/06/2019	NV	VP3	05:28	06:28	3	NNE	2	8	1	2	0
12/06/2019	NV	VP3	06:28	07:28	4	N	2	8	1	2	0
17/06/2019	NV	VP6	17:40	18:40	3	WSW	0	5	2	2	0
17/06/2019	NV	VP6	18:40	19:40	2	SW	0	5	2	2	0
17/06/2019	NV	VP6	19:40	20:40	2	WSW	0	5	2	2	0
17/06/2019	NV	VP5	13:45	14:45	3	WSW	0	8	2	2	0
17/06/2019	NV	VP5	14:45	15:45	3	WSW	0	6	2	2	0
17/06/2019	NV	VP5	15:45	16:45	3	WSW	0	5	2	2	0
18/06/2019	NV	VP2	14:30	15:30	2	SE	0	5	2	2	0

Date	Observer	Survey	Start time	Finish time	Wind speed	Wind direction	Precipitation	Cloud cover	Cloud height	Visibility	Frost / snow on ground
BREEDING SEASON 2019											
18/06/2019	NV	VP2	15:30	16:30	2	SE	0	5	2	2	0
18/06/2019	NV	VP2	16:30	17:30	3	SE	0	3	2	2	0
18/06/2019	NV	VP7	10:40	11:40	2	SW	0	5	2	2	0
18/06/2019	NV	VP7	11:40	12:40	2	SSW	0	6	2	2	0
18/06/2019	NV	VP7	12:40	13:40	2	SSW	0	4	2	2	0
20/06/2019	NV	VP3	16:00	17:00	3	SW	0	4	2	2	0
20/06/2019	NV	VP3	17:00	18:00	2	WSW	0	3	2	2	0
20/06/2019	NV	VP3	18:00	19:00	2	WSW	0	2	2	2	0
20/06/2019	NV	VP1	19:30	20:30	2	WSW	0	2	2	2	0
20/06/2019	NV	VP1	20:30	21:30	2	WSW	0	2	2	2	0
20/06/2019	NV	VP1	21:30	22:30	1	WSW	0	1	2	2	0
22/06/2019	NV	VP5	16:05	17:05	2	E	0	5	2	2	0
22/06/2019	NV	VP5	17:05	18:05	2	E	0	4	2	2	0
22/06/2019	NV	VP5	18:05	19:05	2	E	0	2	2	2	0
22/06/2019	NV	VP4	12:30	13:30	3	SE	0	6	2	2	0
22/06/2019	NV	VP4	13:30	14:30	3	ESE	0	5	2	2	0
22/06/2019	NV	VP4	14:30	15:30	3	ESE	0	5	2	2	0
26/06/2019	NV	VP6	08:10	09:10	3	NE	0	6	2	2	0
26/06/2019	NV	VP6	09:10	10:10	4	NE	0	4	2	2	0
26/06/2019	NV	VP6	10:10	11:10	3	NE	0	3	2	2	0
26/06/2019	NV	VP7	04:34	05:34	3	NE	0	8	2	2	0
26/06/2019	NV	VP7	05:34	06:34	3	NE	0	8	2	2	0
26/06/2019	NV	VP7	06:34	07:34	3	ENE	0	7	2	2	0
09/07/2019	NV	VP4	08:20	09:20	2	WSW	0	5	2	2	0
09/07/2019	NV	VP4	09:20	10:20	2	SW	0	5	2	2	0
09/07/2019	NV	VP4	10:20	11:20	3	SW	0	6	2	2	0
09/07/2019	NV	VP5	04:40	05:40	1	WSW	0	7	2	2	0
09/07/2019	NV	VP5	05:40	06:40	1	WSW	0	6	2	2	0

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Date	Observer	Survey	Start time	Finish time	Wind speed	Wind direction	Precipitation	Cloud cover	Cloud height	Visibility	Frost / snow on ground
BREEDING SEASON 2019											
09/07/2019	NV	VP5	06:40	07:40	2	SW	0	6	2	2	0
10/07/2019	NV	VP1	16:00	17:00	2	S	0	5	2	2	0
10/07/2019	NV	VP1	17:00	18:00	2	SW	0	7	2	2	0
10/07/2019	NV	VP1	18:00	19:00	2	SSW	2	7	1	2	0
10/07/2019	NV	VP7	12:30	13:30	2	SW	2	6	1	2	0
10/07/2019	NV	VP7	13:30	14:30	2	SW	0	5	1	2	0
10/07/2019	NV	VP7	14:30	15:30	2	WSW	0	5	1	2	0
12/07/2019	NV	VP3	08:15	09:15	4	WNW	0	6	2	2	0
12/07/2019	NV	VP3	09:15	10:15	4	WNW	0	6	2	2	0
12/07/2019	NV	VP3	10:15	11:15	4	WNW	0	5	2	2	0
12/07/2019	NV	VP2	04:42	05:42	3	WNW	0	6	2	2	0
12/07/2019	NV	VP2	05:42	06:42	3	WNW	0	7	2	2	0
12/07/2019	NV	VP2	06:42	07:42	4	WNW	0	6	2	2	0
15/07/2019	NV	VP6	13:00	14:00	3	SE	0	2	2	2	0
15/07/2019	NV	VP6	14:00	15:00	2	ESE	0	1	2	2	0
15/07/2019	NV	VP6	15:00	16:00	2	ESE	0	3	2	2	0
16/07/2019	NV	VP7	17:45	18:45	2	SW	0	3	2	2	0
16/07/2019	NV	VP7	18:45	19:45	2	SW	0	4	2	2	0
16/07/2019	NV	VP7	19:45	20:45	1	WSW	0	3	2	2	0
22/07/2019	NV	VP3	08:30	09:30	4	SW	0	6	2	2	0
22/07/2019	NV	VP3	09:30	10:30	4	SW	0	4	2	2	0
22/07/2019	NV	VP3	10:30	11:30	4	SW	0	3	2	2	0
22/07/2019	NV	VP4	04:55	05:55	4	SW	0	6	2	2	0
22/07/2019	NV	VP4	05:55	06:55	4	SW	0	4	2	2	0
22/07/2019	NV	VP4	06:55	07:55	3	WSW	0	2	2	2	0
25/07/2019	NV	VP5	14:30	15:30	4	SE	0	8	1	2	0
25/07/2019	NV	VP5	15:30	16:30	3	SSE	0	7	1	2	0
25/07/2019	NV	VP5	16:30	17:30	3	SSE	0	5	2	2	0

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Date	Observer	Survey	Start time	Finish time	Wind speed	Wind direction	Precipitation	Cloud cover	Cloud height	Visibility	Frost / snow on ground
BREEDING SEASON 2019											
25/07/2019	NV	VP2	11:00	12:00	3	SE	0	7	1	2	0
25/07/2019	NV	VP2	12:00	13:00	3	ESE	0	8	1	2	0
25/07/2019	NV	VP2	13:00	14:00	3	SE	1	8	1	1	0
29/07/2019	NV	VP1	15:15	16:15	2	SSE	0	2	2	2	0
29/07/2019	NV	VP1	16:15	17:15	3	SSE	0	3	2	2	0
29/07/2019	NV	VP1	17:15	18:15	2	SE	0	1	2	2	0
29/07/2019	NV	VP6	18:55	19:55	3	SE	0	2	2	2	0
29/07/2019	NV	VP6	19:55	20:55	2	SE	0	1	2	2	0
29/07/2019	NV	VP6	20:55	21:55	1	SE	0	0	0	2	0
13/08/2019	NV	VP7	12:30	13:30	3	W	0	4	2	2	0
13/08/2019	NV	VP7	13:30	14:30	3	WSW	0	7	2	2	0
13/08/2019	NV	VP7	14:30	15:30	3	WSW	2	8	2	2	0
13/08/2019	NV	VP6	09:00	10:00	2	WSW	0	2	2	2	0
13/08/2019	NV	VP6	10:00	11:00	3	W	0	3	2	2	0
13/08/2019	NV	VP6	11:00	12:00	2	W	0	3	2	2	0
14/08/2019	NV	VP5	09:10	10:10	2	SW	2	8	1	2	0
14/08/2019	NV	VP5	10:10	11:10	3	W	0	8	1	2	0
14/08/2019	NV	VP5	11:10	12:10	3	W	2	8	1	2	0
14/08/2019	NV	VP4	05:31	06:31	2	SE	0	8	1	2	0
14/08/2019	NV	VP4	06:31	07:31	2	SE	2	8	1	2	0
14/08/2019	NV	VP4	07:31	08:31	3	SE	2	8	1	2	0
15/08/2019	NV	VP2	09:05	10:05	4	WNW	0	7	1	2	0
15/08/2019	NV	VP2	10:05	11:05	4	WNW	4	8	1	2	0
15/08/2019	NV	VP2	11:05	12:05	4	WNW	0	8	1	2	0
15/08/2019	NV	VP3	05:35	06:35	4	W	2	6	1	1	0
15/08/2019	NV	VP3	06:35	07:35	4	W	2	7	1	2	0
15/08/2019	NV	VP3	07:35	08:35	4	WNW	0	6	1	2	0
19/08/2019	NV	VP7	09:15	10:15	3	WSW	0	2	2	2	0

Date	Observer	Survey	Start time	Finish time	Wind speed	Wind direction	Precipitation	Cloud cover	Cloud height	Visibility	Frost / snow on ground
BREEDING SEASON 2019											
19/08/2019	NV	VP7	10:15	11:15	3	WSW	0	4	2	2	0
19/08/2019	NV	VP7	11:15	12:15	3	W	2	5	2	2	0
19/08/2019	NV	VP1	05:40	06:40	2	WSW	0	0	0	2	0
19/08/2019	NV	VP1	06:40	07:40	2	SW	0	0	0	2	0
19/08/2019	NV	VP1	07:40	08:40	3	SW	0	1	2	2	0
20/08/2019	NV	VP5	18:15	19:15	3	WSW	0	5	2	2	0
20/08/2019	NV	VP5	19:15	20:15	3	WSW	0	7	2	2	0
20/08/2019	NV	VP5	20:15	21:15	1	WSW	0	6	2	2	0
20/08/2019	NV	VP6	14:45	15:45	2	SSW	2	7	1	2	0
20/08/2019	NV	VP6	15:45	16:45	2	SW	0	6	2	2	0
20/08/2019	NV	VP6	16:45	17:45	3	WSW	0	5	2	2	0
21/08/2019	NV	VP4	09:30	10:30	3	SSW	0	6	1	2	0
21/08/2019	NV	VP4	10:30	11:30	4	SSW	0	8	1	2	0
21/08/2019	NV	VP4	11:30	12:30	4	SSW	3	8	1	2	0
21/08/2019	NV	VP3	05:43	06:43	2	S	0	5	2	2	0
21/08/2019	NV	VP3	06:43	07:43	2	SSW	0	6	2	2	0
21/08/2019	NV	VP3	07:43	08:43	3	SSW	0	7	1	2	0
26/08/2019	NV	VP2	15:00	16:00	3	S	0	1	2	2	0
26/08/2019	NV	VP2	16:00	17:00	2	SSE	0	0	0	2	0
26/08/2019	NV	VP2	17:00	18:00	2	SE	0	0	0	2	0
26/08/2019	NV	VP1	10:45	11:45	2	WSW	0	0	0	2	0
26/08/2019	NV	VP1	11:45	12:45	2	SW	0	0	0	2	0
26/08/2019	NV	VP1	12:45	13:45	3	S	0	1	2	2	0
09/09/2019	NV	VP7	10:00	11:00	4	NNW	0	6	1	2	0
09/09/2019	NV	VP7	11:00	12:00	3	NNW	0	7	1	2	0
09/09/2019	NV	VP7	12:00	13:00	3	NNW	0	7	1	2	0
09/09/2019	NV	VP2	06:20	07:20	2	WNW	2	6	1	2	0
09/09/2019	NV	VP2	07:20	08:20	3	WNW	0	8	1	2	0

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Date	Observer	Survey	Start time	Finish time	Wind speed	Wind direction	Precipitation	Cloud cover	Cloud height	Visibility	Frost / snow on ground
BREEDING SEASON 2019											
09/09/2019	NV	VP2	08:20	09:20	4	NW	0	8	1	2	0
12/09/2019	NV	VP6	10:45	11:45	3	WSW	0	6	2	2	0
12/09/2019	NV	VP6	11:45	12:45	3	W	0	6	2	2	0
12/09/2019	NV	VP6	12:45	13:45	4	WNW	0	7	2	2	0
12/09/2019	NV	VP1	07:15	08:15	2	SSW	0	6	2	2	0
12/09/2019	NV	VP1	08:15	09:15	3	SSW	0	6	2	2	0
12/09/2019	NV	VP1	09:15	10:15	3	SW	0	5	2	2	0
13/09/2019	NV	VP3	13:45	14:45	2	WNW	0	3	2	2	0
13/09/2019	NV	VP3	14:45	15:45	3	W	0	4	2	2	0
13/09/2019	NV	VP3	15:45	16:45	2	WNW	0	3	2	2	0
13/09/2019	NV	VP5	17:15	18:15	2	SSE	0	3	2	2	0
13/09/2019	NV	VP5	18:15	19:15	2	SSE	0	1	2	2	0
13/09/2019	NV	VP5	19:15	20:15	2	SSE	0	1	2	2	0
16/09/2019	NV	VP7	10:00	11:00	3	NNE	0	8	1	2	0
16/09/2019	NV	VP7	11:00	12:00	2	NE	0	6	1	2	0
16/09/2019	NV	VP7	12:00	13:00	1	NNE	0	6	2	2	0
16/09/2019	NV	VP4	06:28	07:28	1	ENE	1	8	0	1	0
16/09/2019	NV	VP4	07:28	08:28	2	NE	0	8	1	2	0
16/09/2019	NV	VP4	08:28	09:28	2	NE	0	8	1	2	0
17/09/2019	NV	VP1	10:15	11:15	2	N	0	2	2	2	0
17/09/2019	NV	VP1	11:15	12:15	2	NE	0	2	2	2	0
17/09/2019	NV	VP1	12:15	13:15	2	NE	0	1	2	2	0
17/09/2019	NV	VP2	06:30	07:30	2	WNW	0	0	0	2	0
17/09/2019	NV	VP2	07:30	08:30	2	N	0	0	0	2	0
17/09/2019	NV	VP2	08:30	09:30	1	NNE	0	0	0	2	0
20/09/2019	NV	VP3	13:00	14:00	2	SE	0	0	0	2	0
20/09/2019	NV	VP3	14:00	15:00	2	SE	0	1	2	2	0
20/09/2019	NV	VP3	15:00	16:00	2	E	0	1	2	2	0

Date	Observer	Survey	Start time	Finish time	Wind speed	Wind direction	Precipitation	Cloud cover	Cloud height	Visibility	Frost / snow on ground
BREEDING SEASON 2019											
20/09/2019	NV	VP6	17:00	18:00	3	SE	0	1	2	2	0
20/09/2019	NV	VP6	18:00	19:00	2	ESE	0	0	0	2	0
20/09/2019	NV	VP6	19:00	20:00	1	E	0	0	0	2	0
30/09/2019	NV	VP4	11:30	12:30	2	E	0	8	1	2	0
30/09/2019	NV	VP4	12:30	13:30	3	E	0	8	1	2	0
30/09/2019	NV	VP4	13:30	14:30	3	ESE	2	8	1	2	0
30/09/2019	NV	VP5	15:15	16:15	3	E	0	7	1	2	0
30/09/2019	NV	VP5	16:15	17:15	3	ESE	2	8	1	2	0
30/09/2019	NV	VP5	17:15	18:15	4	ESE	1	8	1	2	0

Source: Natural Power

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Table 2: VP results

Date	Observer	VP	Survey Start	Survey Finish	Species	Sex/ age	No. of birds	Start time	Duration (s)	Start height band	Number of 15 second intervals in each height band				
											1	2	3	4	5
18/04/2018	NV	2	11:00	14:00	K.		1	11:47	95	1	4	2			
18/04/2018	NV	2	11:00	14:00	K.		1	11:54	165	1	6	5			
18/04/2018	NV	2	11:00	14:00	K.		1	12:34	93	1	3	3			
18/04/2018	NV	2	11:00	14:00	K.		1	12:38	122	1	3	5			
18/04/2018	NV	2	11:00	14:00	K.		1	13:36	128	1	6	2			
18/04/2018	NV	6	18:04	21:04	K.		1	19:32	168	1	8	3			
19/04/2018	NV	1	09:30	12:30	LB	Adults	2	12:02	181	2		12			
19/04/2018	NV	3	13:30	16:30	SH	Male	1	14:09	152	1	4	6			
19/04/2018	NV	3	13:30	16:30	LB	Adult	1	15:13	93	2		6			
20/04/2018	NV	4	10:00	13:00	SH	Male	1	10:37	176	1	4	7			
24/04/2018	NV	1	05:36	08:36	LB	Adults	2	-	-						
24/04/2018	NV	3	10:00	13:00	SH	Male	1	11:13	175	1	1	6	4		
26/04/2018	NV	2	05:30	08:30	K.		1	08:23	116	1	5	2			
26/04/2018	NV	5	10:00	13:00	LB	Adults	2	10:26	128	2		7	1		
30/04/2018	NV	4	05:25	08:25	SH	Male	1	08:04	122	1		5	3		
30/04/2018	NV	4	05:25	08:25	BH	Adults	2	08:18	148	2	4	5			
30/04/2018	NV	6	09:50	12:50	K.		1	11:16	172	1	7	4			
02/05/2018	NV	4	09:45	12:45	LB	Adults	2	10:54	187	2		1	2		
03/05/2018	NV	1	13:20	16:20	K.		1	16:08	135	1	4	4			
09/05/2018	NV	6	13:30	16:30	LB		2	14:06	127	2		8			
14/05/2018	NV	2	10:30	13:30	K.		1	13:21	227	2	5	8	2		
14/05/2018	NV	5	15:00	18:00	SH		1	17:40	108	2		5	2		
16/05/2018	NV	6	14:00	17:00	K.		1	16:27	94	3		5	1		
18/05/2018	NV	1	16:30	19:30	K.		1	18:43	102	2		7			
28/05/2018	NV	3	04:35	07:35	H.		1	07:12	70	2		4			
04/06/2018	NV	5	08:45	11:45	SH	Male	1	11:08	126	2		2	6		
04/06/2018	NV	6	04:30	07:30	K.	Male	1	07:10	145	1	5	4			
05/06/2018	NV	4	08:30	11:30	K.	Male	1	11:19	115	1		7			
12/06/2018	NV	1	19:30	22:30	K.	Female	1	21:06	205	1	8	5			
12/06/2018	NV	2	15:00	18:00	K.	Male	1	16:17	215	1	7	7			

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Date	Observer	VP	Survey Start	Survey Finish	Species	Sex/ age	No. of birds	Start time	Duration (s)	Start height band	Number of 15 second intervals in each height band				
											1	2	3	4	5
15/06/2018	NV	3	15:30	18:30	H.		1	17:04	48	2	1	2			
25/06/2018	NV	1	19:30	22:30	SN		1	19:39	48	1	3				
25/06/2018	NV	1	19:30	22:30	SN		1	19:41	55	1	3				
25/06/2018	NV	1	19:30	22:30	K.	Male	1	20:08	235	1	1	5			
26/06/2018	NV	2	18:00	21:00	SN		1	18:51	35	1	2				
26/06/2018	NV	2	18:00	21:00	SN		1	18:52	68	1	4				
26/06/2018	NV	6	04:30	07:30	H.		1	06:12	58	1	3				
26/06/2018	NV	6	04:30	07:30	SN		1								
26/06/2018	NV	6	04:30	07:30	SN		1								
02/07/2018	NV	2	08:30	11:30	SH	Male	1	11:13	28	2		1			
03/07/2018	NV	3	04:50	07:50	H.		1	06:08	32	2		2			
03/07/2018	NV	6	09:00	12:00	BH	Adults	2	11:16	110	2		5	2		
04/07/2018	NV	1	15:15	18:15	SH	Female	1	15:42	22	1		1			
04/07/2018	NV	1	15:15	18:15	K.	Male	1	17:07	148	1	3	6			
04/07/2018	NV	4	19:25	22:25	SH	Male	1	20:01	32	2	2				
04/07/2018	NV	4	19:25	22:25	H.		1	21:42	155	3		5	5		
17/07/2018	NV	1	12:00	15:00	K.		1	12:26	75	1	3	2			
23/07/2018	NV	3	19:10	22:10	SH	Male	1	20:53	31	1	1	1			
23/07/2018	NV	6	15:00	18:00	BH		2	17:23	85	3			1	4	
01/08/2018	NV	6	05:15	08:15	H.		1	05:52	71	3		2	2		
01/08/2018	NV	6	05:15	08:15	K.		1	06:34	129	2	5	3			
01/08/2018	NV	6	05:15	08:15	BH		2	07:31	104	3				6	
03/08/2018	NV	3	09:20	12:20	SH	Male	1	10:08	32	1	1	1			
03/08/2018	NV	1	05:16	08:16	CU		1								
14/08/2018	NV	2	05:35	08:35	H.		1	06:19	52	2		3			
14/08/2018	NV	4	09:40	12:40	SH	Female	1	11:41	33	2		2			
15/08/2018	NV	5	05:40	08:40	H.		1	06:14	132	2		8			
15/08/2018	NV	5	05:40	08:40	CU	Adults	2	07:20	58	2		1	2		
15/08/2018	NV	6	18:25	21:25	K.		1	18:55	185	1	11	1			
15/08/2018	NV	6	18:25	21:25	K.		1	19:39	42	2	1	1			
15/08/2018	NV	6	18:25	21:25	SN		2	20:04	9	1					
20/08/2018	NV	1	18:15	21:15	SH	Male	1	20:01	36	2	2				

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Date	Observer	VP	Survey Start	Survey Finish	Species	Sex/ age	No. of birds	Start time	Duration (s)	Start height band	Number of 15 second intervals in each height band				
											1	2	3	4	5
28/08/2018	NV	2	18:00	21:00	H.		1	20:26	125	2		3	5		
30/08/2018	NV	3	06:05	09:05	SH	Female	1	08:31	25	1	1				
30/08/2018	NV	3	06:05	09:05	H.		1	08:53	45	2		3			
04/09/2018	NV	4	15:00	18:00	SH	Female	1	15:41	14	1					
04/09/2018	NV	4	15:00	18:00	SH	Male	1	16:32	95	2		2	4		
04/09/2018	NV	4	15:00	18:00	H.		1	17:18	27	1		1			
04/09/2018	NV	6	10:00	13:00	K.	Female	1	10:53	157	2		1			
04/09/2018	NV	6	10:00	13:00	CU	Adult	1	11:22	125	2		6	2		
04/09/2018	NV	6	10:00	13:00	SN		2	09:56							
05/09/2018	NV	2	10:15	13:15	SH	Male	1	10:26	29	2	1				
05/09/2018	NV	2	10:15	13:15	K.		1	12:18	94	2		6			
05/09/2018	NV	5	06:15	09:15	CU	Adult	1	07:36	74	3			4		
07/09/2018	NV	1	06:20	09:20	K.	Male	1	07:28	172	2		11			
07/09/2018	NV	1	06:20	09:20	K.	Female	1	08:48	124	2	1	7			
07/09/2018	NV	3	10:20	13:20	H.		1	11:47	32	1	1	1			
07/09/2018	NV	1	06:20	09:20	SN		2	06:15							
11/09/2018	NV	4	06:30	09:30	H.		1	08:07	59	2		3			
11/09/2018	NV	4	06:30	09:30	LB	Adults	2	08:29	78	3			5		
11/09/2018	NV	4	06:30	09:30	HG		5	08:29	78	3			5		
12/09/2018	NV	1	10:00	13:00	K.	Female	1	11:18	160	2	1	1			
12/09/2018	NV	1	10:00	13:00	K.	Male	1	12:45	49	2	3				
12/09/2018	NV	2	06:30	09:30	H.		1	07:04	52	2	1	2			
12/09/2018	NV	2	06:30	09:30	K.	Male	1	08:51	78	2		5			
18/09/2018	NV	3	13:30	16:30	SH	Female	1	13:52	28	2		1			
18/09/2018	NV	6	17:35	20:35	K.	Male	1	17:42	182	1	9	3			
10/10/2018	NV	1	07:15	10:15	H.		1	08:21	42	1	2				
10/10/2018	NV	1	07:15	10:15	K.		1	09:06	92	1	5	1			
10/10/2018	NV	1	07:15	10:15	K.		1	10:08	198	2	5	7	1		
10/10/2018	NV	1	07:15	10:15	GP		12	10:11	85	3	1	3	1		
10/10/2018	NV	1	07:15	10:15	ML	Male	1	10:12	63	1	4				
10/10/2018	NV	2	11:15	14:15	GP		12	11:19	65	1		3	1		
10/10/2018	NV	2	11:15	14:15	PE	Juvenile/Female	1	11:19	31	1	2				

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Date	Observer	VP	Survey Start	Survey Finish	Species	Sex/ age	No. of birds	Start time	Duration (s)	Start height band	Number of 15 second intervals in each height band				
											1	2	3	4	5
15/10/2018	NV	3	10:00	13:00	H.		1	11:02	38	2		1	1		
15/10/2018	NV	3	10:00	13:00	SH	Female	1	12:17	27	1	1				
15/10/2018	NV	4	13:30	16:30	K.	Male	1	15:51	225	1	10	5			
16/10/2018	NV	5	07:25	10:25	L.		12	09:26	58	2	2	1			
16/10/2018	NV	5	07:25	10:25	GP		68	09:57	182	3	1	3	8		
16/10/2018	NV	6	11:25	14:25	K.	Male	1	12:42	70	1	2	2			
16/10/2018	NV	6	11:25	14:25	L.		16	14:06	52	1	3				
16/10/2018	NV	6	11:25	14:25	GP		36	14:17	230	3		5	10		
19/10/2018	NV	1	07:30	10:30	ML	Male	1	10:01	42	1	2				
19/10/2018	NV	1	07:30	10:30	GP		36	10:12	109	1			7		
19/10/2018	NV	2	11:00	14:00	K.	Male	1	11:13	220	1	11	4			
19/10/2018	NV	2	11:00	14:00	H.		1	12:41	42	2		2			
19/10/2018	NV	2	11:00	14:00	K.	Female	1	13:10	115	2	4	3			
23/10/2018	NV	3	07:40	10:40	GP		14	08:51	29	3			1		
23/10/2018	NV	4	11:40	14:40	K.	Male	1	12:41	95	1	4	2			
23/10/2018	NV	4	11:40	14:40	GP		6	13:08	182	3			12		
31/10/2018	NV	5	10:30	13:30	K.	Female	1	11:31	50	3		1	2		
31/10/2018	NV	6	06:55	09:55	H.		1	07:22	46	2		3			
31/10/2018	NV	6	06:55	09:55	K.	Male	1	08:17	185	1	6	6			
31/10/2018	NV	6	06:55	09:55	L.		46	09:06	71	3			4		
31/10/2018	NV	6	06:55	09:55	L.		23	09:41	62	2		1	3		
05/11/2018	NV	4	10:45	13:45	H.	Adult	1	11:02	45	2		3			
05/11/2018	NV	3	07:06	10:06	SH	Male	1	09:20		1					
05/11/2018	NV	4	10:45	13:45	SH	Female	1	13:10		1					
06/11/2018	NV	6	07:10	10:10	L.		76	08:43	130	2		9			
06/11/2018	NV	6	07:10	10:10	H.	Adult	1	07:42	44	2		3			
06/11/2018	NV	6	07:10	10:10	K.	Male	1	08:23	128	1	4	4			
06/11/2018	NV	6	07:10	10:10	K.	Female	1	09:56	61	2	1	3			
06/11/2018	NV	6	07:10	10:10	HG	Immature	3	09:55		3					
06/11/2018	NV	5	10:40	13:40	SH	Male	1	12:10		1					
13/11/2018	NV	3	07:20	10:20	GP	Adult	55	07:40	68	3			4		
13/11/2018	NV	3	07:20	10:20	CU	Adult	5	07:55	32	3			2		

Date	Observer	VP	Survey Start	Survey Finish	Species	Sex/ age	No. of birds	Start time	Duration (s)	Start height band	Number of 15 second intervals in each height band 1	2	3	4	5
13/11/2018	NV	4	10:50	13:50	SN	Adult	3	11:31	35	1	1	1			
14/11/2018	NV	1	08:30	11:30	K.	Male	1	09:03	75	1	4	1			
15/11/2018	NV	5	11:00	12:00	ML	Immature	1	11:32	28	1	2				
15/11/2018	NV	5	11:00	12:00	CU	Adult	6	12:11	63	2	1	3			
15/11/2018	NV	5	11:00	12:00	H.	Adult	1	12:41	55	2		4			
15/11/2018	NV	6	07:20	10:20	L.	Adult	68	08:01	47	2		3			
15/11/2018	NV	6	07:20	10:20	K.	Female	1	08:44	185	2	1	2			
15/11/2018	NV	6	07:20	10:20	SN	Adult	2	09:23	25	1	1	1			
15/11/2018	NV	6	07:20	10:20	ML	Juvenile	1	09:32	35	1	2				
21/11/2018	NV	2	14:00	17:00	K.	Female	1	14:32	75	1	5				
21/11/2018	NV	2	14:00	17:00	K.	Male	1	15:38	105	1	4	3			
21/11/2018	NV	2	14:00	17:00	SN	Adult	2	16:34	43	1	1	2			
06/12/2018	NV	5	08:40	11:40	ML	Immature	1	12:38	25	1	2				
06/12/2018	NV	6	13:45	16:45	K.	Male	1	15:21	215	1	12	3			
06/12/2018	NV	6	13:45	16:45	ML	Immature	1	16:04	30	2	1	1			
07/12/2018	NV	1	07:50	10:50	K.	Female	1	09:12	128	1	5	1			
07/12/2018	NV	2	11:20	14:20	SN	Adult	2	12:10	28	1	1	1			
10/12/2018	NV	4	13:20	16:20	SN	Adult	2	13:20	30	1	1	1			
10/12/2018	NV	4	13:20	16:20	JS	Adult	1	13:20	30	1	1	1			
10/12/2018	NV	7	09:40	12:40	K.	Female	1	09:52	85	1	5	1			
10/12/2018	NV	7	09:40	12:40	L.	Adult	22	10:38	40	2		3			
10/12/2018	NV	7	09:40	12:40	K.	Male	1	11:09	90	1	5	1			
10/12/2018	NV	7	09:40	12:40	CU	Adult	5	12:03	43	2		2	1		
10/12/2018	NV	4	13:20	16:20	SH	Male	1	13:50		1					
13/12/2018	NV	6	13:35	16:35	K.	Female	1	13:52	185	1	1	2			
13/12/2018	NV	6	13:35	16:35	K.	Female	1	14:07	245	2	5	11			
13/12/2018	NV	6	13:35	16:35	K.	Female	1	15:41	115	2	3	5			
13/12/2018	NV	6	13:35	16:35	ML	Immature Male	1	16:08	46	1	2	1			
13/12/2018	NV	6	13:35	16:35	L.	Adult	28	16:23	92	3			6		
13/12/2018	NV	3	10:00	13:00	SH	Female	1	12:45		1					
17/12/2018	NV	5	11:40	14:40	CU	Adult	2	11:37	30	1	2				
17/12/2018	NV	7	08:10	11:10	K.	Male	1	09:28	125	1	7	1			

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Date	Observer	VP	Survey Start	Survey Finish	Species	Sex/ age	No. of birds	Start time	Duration (s)	Start height band	Number of 15 second intervals in each height band 1	2	3	4	5
18/12/2018	NV	4	08:10	09:10	H.	Adult	1	08:51	50	3			4		
18/12/2018	NV	4	08:10	09:10	K.	Adult	1	10:36	46	2	1	2			
20/12/2018	NV	1	13:45	16:45	K.	Female	1	16:01	135	1	8	1			
20/12/2018	NV	2	10:00	13:00	K.	Female	1	11:07	129	2	5	4			
20/12/2018	NV	2	10:00	13:00	WK	Adult	1	12:28	32	2	1	1			
02/01/2019	NV	3	08:13	11:13	SH	Male	1	09:22	28	1	1	2			
02/01/2019	NV	3	08:13	11:13	H.	Adult	1	09:36	55	3			4		
02/01/2019	NV	3	08:13	11:13	L.	Adult	29	10:07	46	3			3		
02/01/2019	NV	4	11:45	14:45	H.	Adult	1	14:33	50	2		3			
09/01/2019	NV	6	14:03	17:03	K.	Male	1	14:13	145	1	9	1			
09/01/2019	NV	6	14:03	17:03	ML	Immature	1	15:43	38	1	3				
10/01/2019	NV	7	10:00	13:00	K.	Female	1	12:18	135	2	3	3			
10/01/2019	NV	7	10:00	13:00	K.	Female	1	12:49	110	2	4	3			
10/01/2019	NV	2	13:45	16:45	K.	Male	1	14:43	185	1	9	3			
10/01/2019	NV	2	13:45	16:45	K.	Female	1	15:58	120	1	6	2			
15/01/2019	NV	1	08:05	11:05	K.	Female	1	09:12	103	1	6	1			
15/01/2019	NV	1	08:05	11:05	SH	Male	1	10:27	28	1	2				
15/01/2019	NV	1	08:05	11:05	SN	Adult	2	10:46	13	1	1				
15/01/2019	NV	3	11:40	14:40	SH	Female	1	12:09	19	2	1				
15/01/2019	NV	3	11:40	14:40	H.	Adult	1	13:10	32	2		2			
16/01/2019	NV	5	14:13	17:13	CU	Adult	18	14:05	0	1					
16/01/2019	NV	5	14:13	17:13	ML	Young Male	1	14:43	36	1	2				
16/01/2019	NV	5	14:13	17:13	CU	Adult	4	16:33	47	2		3			
17/01/2019	NV	2	11:30	14:30	K.	Male	1	12:09	183	1	11	1			
17/01/2019	NV	2	11:30	14:30	K.	Female	1	13:34	75	1	4	1			
17/01/2019	NV	7	08:00	11:00	LB	Adult	1	10:50		2					
23/01/2019	NV	6	07:55	10:55	K.	Male	1	09:46	105	2	6	1			
23/01/2019	NV	6	07:55	10:55	L.	Adult	47	09:58	90	3			6		
23/01/2019	NV	6	07:55	10:55	K.	Male	1	10:34	30	1	2				
23/01/2019	NV	1	11:30	14:30	K.	Female	1	11:49	43	2	2	1			
23/01/2019	NV	1	11:30	14:30	K.	Male	1	13:17	125	1	7	1			
06/02/2019	NV	3	07:34	10:34	H.	Adult	1	08:42	46	2		3			

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Date	Observer	VP	Survey Start	Survey Finish	Species	Sex/ age	No. of birds	Start time	Duration (s)	Start height band	Number of 15 second intervals in each height band				
											1	2	3	4	5
11/02/2019	NV	4	07:25	10:25	H.	Adult	1	08:06	47	2		3			
11/02/2019	NV	4	07:25	10:25	K.	Male	1	09:19	36	2		2			
11/02/2019	NV	5	11:00	14:00	CU	Adult	2	11:24	32	2		2			
12/02/2019	NV	6	11:10	14:10	K.	Male	1	11:54	165	2	9	2			
12/02/2019	NV	6	11:10	14:10	L.	Adult	14	12:11	62	3		1	3		
12/02/2019	NV	6	11:10	14:10	L.	Adult	10	12:13	50	3			3		
12/02/2019	NV	6	11:10	14:10	ML	Immature	1	13:49	32	1	2				
12/02/2019	NV	1	15:05	18:05	K.	Male	1	15:28	118	2	5	3			
12/02/2019	NV	1	15:05	18:05	SH	Male	1	16:04	74	2		3	2		
12/02/2019	NV	1	15:05	18:05	SN	Adult	2	18:05	32	1	1	1			
19/02/2019	NV	7	15:17	18:17	K.	Female	1	17:20	58	2	1	3			
20/02/2019	NV	1	11:40	14:40	K.	Male	1	12:17	74	1	4	1			
20/02/2019	NV	1	11:40	14:40	K.	Male	1	13:39	190	1	10	2			
20/02/2019	NV	2	15:20	18:20	K.	Female	1	15:27	215	2	10	4			
20/02/2019	NV	2	15:20	18:20	K.	Male	1	15:51	122	2	6	2			
20/02/2019	NV	2	15:20	18:20	ML	Immature	1	16:17	36	2		2			
21/02/2019	NV	3	07:05	10:05	H.	Adult	1	07:43	31	2		2			
21/02/2019	NV	3	07:05	10:05	SH	Male	1	09:50	137	2	1	3	5		
21/02/2019	NV	5	11:20	14:20	K.	Female	1	11:53	41	2		3			
21/02/2019	NV	5	11:20	14:20	L.	Adult	9	13:24	50	3			3		
28/02/2019	NV	6	06:50	09:50	K.	Female	1	08:36	182	1	10	2			
28/02/2019	NV	6	06:50	09:50	K.	Female	1	09:27	28	2		2			
28/02/2019	NV	6	06:50	09:50	SH	Male	1	09:41	105	3			7		
28/02/2019	NV	7	10:30	13:30	K.	Female	1	11:19	72	2	3	2			
06/03/2019	NV	2	10:05	13:05	K.	Male	1	11:01	138	1	7	2			
06/03/2019	NV	1	06:35	09:35	SN	Adult	2	06:35	25	1	2				
06/03/2019	NV	1	06:35	09:35	K.	Female	1	08:23	136	1	7	2			
06/03/2019	NV	1	06:35	09:35	SH	Male	1	09:11	92	1	1	2	3		
07/03/2019	NV	4	10:00	13:00	H.	Adult	1	11:24	65	2		4			
07/03/2019	NV	3	06:30	09:30	SH	Male	1	08:35	28	1	2				
11/03/2019	NV	6	10:00	13:00	K.	Male	1	10:24	180	1	10	2			
11/03/2019	NV	6	10:00	13:00	L.	Adult	4	11:33	55	3			4		

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Date	Observer	VP	Survey Start	Survey Finish	Species	Sex/ age	No. of birds	Start time	Duration (s)	Start height band	Number of 15 second intervals in each height band				
											1	2	3	4	5
13/03/2019	NV	1	13:15	16:15	K.	Female	1	13:38	62	1	4				
13/03/2019	NV	1	13:15	16:15	K.	Female	1	14:57	47	2	2	1			
14/03/2019	NV	2	06:15	09:15	K.	Male	1	07:57	125	1	8				
14/03/2019	NV	2	06:15	09:15	H.	Adult	1	08:06	58	2		3	1		
14/03/2019	NV	2	06:15	09:15	K.	Female	1	09:06	225	1	13	2			
21/03/2019	NV	5	09:30	12:30	CU	Adult	2	09:49	75	2		4	1		
21/03/2019	NV	5	09:30	12:30	PE	Immature	1	11:52	40	3			3		
28/03/2019	NV	7	09:20	12:20	SH	Male	1	09:56	185	2		4	8		
28/03/2019	NV	7	09:20	12:20	H.	Adult	1	10:18	47	2		3			
28/03/2019	NV	7	09:20	12:20	K.	Female	1	11:26	62	2		4			
28/03/2019	NV	6	05:45	08:45	ML	Immature	1	07:57	30	1	2				
28/03/2019	NV	6	05:45	08:45	K.	Male	1	08:28	18	1	1				
08/04/2019	NV	6	10:00	13:00	K.	Male/Adult	1	11:02	145	2	2	8			
08/04/2019	NV	7	06:17	09:17	K.	Male/Adult	1	08:26	49	2	1	3			
08/04/2019	NV	7	06:17	09:17	SH	Male/Adult	1	08:52	16	1	1				
09/04/2019	NV	4	17:48	20:48	SH	Male/Adult	1	19:59	265	2		4	14		
10/04/2019	NV	1	14:20	17:20	K.	Female/Adult	1	15:08	270	2	2	16			
10/04/2019	NV	1	14:20	17:20	K.	Male/Adult	1	16:20	205	2	2	12			
10/04/2019	NV	1	14:20	17:20	SH	Male/Adult	1	16:22	190	2		7	6		
10/04/2019	NV	1	14:20	17:20	SN	Adult	2	17:19	32	1	1	1			
10/04/2019	NV	3	17:50	20:50	SH	Male/Adult	1	18:28	235	2	1	11	4		
10/04/2019	NV	3	17:50	20:50	H.	Adult	1	19.51	38	2		2			
10/04/2019	NV	3	17:50	20:50	WK	Adult	1	20:35	27	2		3			
10/04/2019	NV	3	17:50	20:50	WK	Adult	2	20:41	31	2		2			
11/04/2019	NV	7	09:50	12:50	K.	Male/Adult	1	10:06	155	2	5	10			
11/04/2019	NV	7	09:50	12:50	K.	Male/Adult	1	11:23	65	2		3			
11/04/2019	NV	7	09:50	12:50	H.	Adult	1	12:01	35	2		2			
26/04/2019	NV	5	14:50	17:50	K.	Female	1	15:47	50	2		3	1		
26/04/2019	NV	6	11:20	14:20	K.	Male/Adult	1	11:44	75	2	1	4			
26/04/2019	NV	6	11:20	14:20	K.	Male/Adult	1	12:11	105	2	2	5			
26/04/2019	NV	6	11:20	14:20	K.	Male/Adult	1	13:49	90	2	1	5			
29/04/2019	NV	3	13:30	16:30	SH	Male/Adult	1	14:54	255	2		1	7	9	

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Date	Observer	VP	Survey Start	Survey Finish	Species	Sex/ age	No. of birds	Start time	Duration (s)	Start height band	Number of 15 second intervals in each height band				
											1	2	3	4	5
30/04/2019	NV	1	05:24	08:24	K.	Male/Adult	1	08:04	95	2	1	6			
30/04/2019	NV	1	05:24	08:24	SN	Adult	2	08:22	45	1	1	2			
30/04/2019	NV	2	09:05	12:05	K.	Male/Adult	1	09:08	205	2	2	12			
30/04/2019	NV	2	09:05	12:05	K.	Male/Adult	1	10:27	135	2	1	8			
30/04/2019	NV	2	09:05	12:05	K.	Female	1	12:01	240	2	2	14			
02/05/2019	NV	4	14:30	17:30	SH	Male/Adult	1	15:07	28	1	2				
02/05/2019	NV	4	14:30	17:30	H.	Adult	1	17:09	55	2	3	1			
02/05/2019	NV	5	18:25	21:25	H.	Adult	1	19:17	74	2		74			
02/05/2019	NV	5	18:25	21:25	K.	Male/Adult	1	19:53	52	2	25	27			
02/05/2019	NV	5	18:25	21:25	K.	Adult	1	21:18	95	1	80	15			
09/05/2019	NV	7	05:10	08:10	K.	Male/Adult	1	07:46	135	2	105	30			
09/05/2019	NV	7	05:10	08:10	K.	Female/Adult	1	08:02	155	1	140	15			
09/05/2019	NV	7	05:10	08:10	SN	Adult	2	08:05	45						
09/05/2019	NV	6	08:40	11:40	K.	Male/Adult	1	09:31	75	1	60	15			
09/05/2019	NV	6	08:40	11:40	K.	Male/Adult	1	10:28	95	2	75	20			
13/05/2019	NV	2	17:00	20:00	K.	Male/Adult	1	17:34	290	1	15	5			
13/05/2019	NV	2	17:00	20:00	K.	Male	1	18:01	170	1	10	20			
13/05/2019	NV	2	17:00	20:00	K.	Female/Adult	1	18:54	105	1	6	1			
13/05/2019	NV	2	17:00	20:00	SN	Adult	2	19:46	60						
13/05/2019	NV	2	17:00	20:00	K.	Male/Adult	1	19:51	245	1	15	1			
13/05/2019	NV	1	13:30	16:30	SN	Adult	1	13:30	30						
13/05/2019	NV	1	13:30	16:30	K.	Male/Adult	1	13:42	105	1	6	1			
13/05/2019	NV	1	13:30	16:30	K.	Male/Adult	1	14:06	120	1	7	10			
13/05/2019	NV	1	13:30	16:30	SH	Male/Adult	1	15:57	210	3		2	12		
15/05/2019	NV	3	04:55	07:55	SH	Female	1	06:38	15	1	1				
16/05/2019	NV	6	12:30	15:30	K.	Female/Adult	1	12:51	150	1	140	10			
16/05/2019	NV	6	12:30	15:30	K.	Male/Adult	1	13:16	205	2	170	20	15		
16/05/2019	NV	6	12:30	15:30	H.	Adult	1	14:50	40	2		40			
16/05/2019	NV	5	16:05	19:05	K.	Male/Adult	1	17:12	65	2		65			
16/05/2019	NV	5	16:05	19:05	SH	Female	1	18:29	35	1	35				
23/05/2019	NV	1	19:00	23:00	K.	Male	1	19:24	55	1	4				
23/05/2019	NV	1	19:00	23:00	K.	Male/Adult	1	19:51	180	2	10	2			

Date	Observer	VP	Survey Start	Survey Finish	Species	Sex/ age	No. of birds	Start time	Duration (s)	Start height band	Number of 15 second intervals in each height band 1	2	3	4	5
23/05/2019	NV	1	19:00	23:00	K.	Female/Adult	1	20:29	135	1	8	1			
23/05/2019	NV	1	19:00	23:00	WK	Adult	1	21:48	50	1	3				
23/05/2019	NV	7	15:30	18:30	K.	Male/Adult	1	16:03	125	2	110	15			
23/05/2019	NV	7	15:30	18:30	K.	Male/Adult	1	17:28	155	1	135	20			
24/05/2019	NV	3	08:20	11:20	SH	Male/Adult	1	09:29	30	1	2	5			
24/05/2019	NV	3	08:20	11:20	H.	Adult	1	10:17	45	2		3			
24/05/2019	NV	2	04:45	07:45	WK	Adult	1	04:47	65	1	4				
24/05/2019	NV	2	04:45	07:45	WK	Adult	1	04:53	70	1	5				
24/05/2019	NV	2	04:45	07:45	K.	Male/Adult	1	06:42	125	1	7	1			
24/05/2019	NV	2	04:45	07:45	K.	Female/Adult	1	07:19	185	1	10	2			
03/06/2019	NV	2	17:00	20:00	K.	Male/Adult	1	19:08	105	1	90	15			
03/06/2019	NV	2	17:00	20:00	H.	Adult	1	19:47	28	2		27			
03/06/2019	NV	1	13:30	16:30	K.	Male	1	13:43	106	1	95	11			
03/06/2019	NV	1	13:30	16:30	K.	Female/Adult	1	15:02	65	1	65				
12/06/2019	NV	4	08:00	11:00	SH	Male/Adult	1	09:12	20	1	20				
12/06/2019	NV	3	04:28	07:28	H.	Adult	1	06:11	38	2		38			
12/06/2019	NV	3	04:28	07:28	SH	Male/Adult	1	07:13	18	1	13	5			
17/06/2019	NV	6	17:50	20:40	K.	Male/Adult	1	17:58	65	1	45	20			
17/06/2019	NV	6	17:50	20:40	K.	Female/Adult	1	18:32	135	2	65	70			
17/06/2019	NV	6	17:50	20:40	SN		1	20:45	35	1	25	10			
18/06/2019	NV	2	14:30	17:30	K.	Male/Adult	1	15:18	175	1	155	20			
18/06/2019	NV	2	14:30	17:30	K.	Female/Adult	1	16:01	190	2	150	40			
18/06/2019	NV	2	14:30	17:30	SH	Female/Adult	1	17:10	25	1	20	5			
18/06/2019	NV	7	10:40	13:40	K.	Female/Adult	1	11:02	128	1	105	23			
18/06/2019	NV	7	10:40	13:40	K.	Female/Adult	1	11:53	62	2	50	12			
18/06/2019	NV	7	10:40	13:40	K.	Male/Adult	1	12:47	106	2	34	72			
20/06/2019	NV	3	16:00	19:00	SH	Male/Adult	1	17:25	155	2		20	70	65	
20/06/2019	NV	1	19:30	22:30	K.	Male/Adult	1	19:47	135	2	100	35			
20/06/2019	NV	1	19:30	22:30	K.	Male/Adult	1	21:04	195	1	160	35			
20/06/2019	NV	1	19:30	22:30	H.	Adult	1	21:38	38	2		38			
20/06/2019	NV	1	19:30	22:30	WK	Adult	1	22:07	75	1	75				
20/06/2019	NV	1	19:30	22:30	SN	Adult	1	22:32	20	1	20				

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Date	Observer	VP	Survey Start	Survey Finish	Species	Sex/ age	No. of birds	Start time	Duration (s)	Start height band	Number of 15 second intervals in each height band				
											1	2	3	4	5
22/06/2019	NV	4	12:30	15:30	SH	Male/Adult	1	14:37	110	2		50	70		
26/06/2019	NV	6	08:10	11:10	K.	Female	1	08:42	105	2	75	20			
26/06/2019	NV	6	08:10	11:10	K.	Female/Adult	1	10:17	135	2	120	15			
26/06/2019	NV	7	04:34	07:34	WK	Adult	1	04:38	11	1	11				
26/06/2019	NV	7	04:34	07:34	H.	Adult	1	06:04	49	2		49			
09/07/2019	NV	4	08:20	11:20	SH	Male/Adult	1	09:47	105	2		25	80		
09/07/2019	NV	5	04:40	07:40	SH	Male/Adult	1	07:23	22	1	22				
10/07/2019	NV	1	16:00	19:00	K.	Male/Adult	1	16:07	130	1	115	15			
10/07/2019	NV	1	16:00	19:00	K.	Female/Adult	1	18:11	45	1	40	5			
10/07/2019	NV	1	16:00	19:00	H.	Adult	1	18:51	75	2		75			
10/07/2019	NV	7	12:30	15:30	K.	Female/Adult	1	12:49	105	2	85	20			
10/07/2019	NV	7	12:30	15:30	K.	Female/Adult	1	12:53	115	1	90	25			
10/07/2019	NV	7	12:30	15:30	K.	Male/Adult	1	15:02	165	2	130	35			
12/07/2019	NV	3	08:15	11:15	PE	Juvenile	1	10:04	22	2		22			
12/07/2019	NV	2	04:42	07:42	WK	Adult	1	04:45	55	1	45	10			
12/07/2019	NV	2	04:42	07:42	SN	Adult	2	04:46	140						
12/07/2019	NV	2	04:42	07:42	K.	Male/Adult	1	07:27	235	2	210	25			
15/07/2019	NV	6	13:00	16:00	K.	Male/Adult	1	13:48	105	2	65	40			
15/07/2019	NV	6	13:00	16:00	K.	Male/Adult	1	14:01	185	1	140	35	10		
15/07/2019	NV	6	13:00	16:00	SN		3	16:02	25	1	15	10			
16/07/2019	NV	7	17:45	20:45	K.	Female/Adult	1	18:21	40	1	40				
16/07/2019	NV	7	17:45	20:45	K.	Female/Adult	1	19:06	25	1	15	10			
16/07/2019	NV	7	17:45	20:45	H.	Adult	1	20:37	75	2	10	65			
25/07/2019	NV	2	11:00	14:00	K.	Female/Adult	1	11:29	270	1	260	10			
25/07/2019	NV	2	11:00	14:00	K.	Male/Adult	1	12:50	140	1	140				
29/07/2019	NV	1	15:15	18:15	K.	Female/Adult	1	15:50	255	1	235	20			
29/07/2019	NV	1	15:15	18:15	SH	Female/Adult	1	16:12	34	2	34				
29/07/2019	NV	1	15:15	18:15	K.	Female/Adult	1	16:43	95	1	80	15			
29/07/2019	NV	6	18:55	21:55	K.	Male/Adult	1	19:26	155	1	135	20			
29/07/2019	NV	6	18:55	21:55	H.	Adult	1	20:47	45	2		45			
29/07/2019	NV	6	18:55	21:55	WK	Adult	1	21:19	26	1	26				
29/07/2019	NV	6	18:55	21:55	WK	Adult	1	21:36	29	1	29				

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Date	Observer	VP	Survey Start	Survey Finish	Species	Sex/ age	No. of birds	Start time	Duration (s)	Start height band	Number of 15 second intervals in each height band				
											1	2	3	4	5
13/08/2019	NV	6	09:00	12:00	K.	Male	1	09:57	95	1	80	15			
13/08/2019	NV	6	09:00	12:00	L.		8	11:52	65	3			65		
15/08/2019	NV	2	09:05	12:05	K.	Male/Adult	1	09:51	100	1	90	10			
15/08/2019	NV	2	09:05	12:05	CU	Adult	2	10:43	45	3			45		
15/08/2019	NV	2	09:05	12:05	SN	Adult	1	11:17	20	2	10	10			
19/08/2019	NV	7	09:15	12:15	K.	Female/Adult	1	09:56	225	1	185	40			
19/08/2019	NV	7	09:15	12:15	CU	Pair	2	11:48	70	3		20	50		
19/08/2019	NV	1	05:40	08:40	SN	Adult	1	05:35							
19/08/2019	NV	1	05:40	08:40	SH	Male/Adult	1	06:29	38	1	38				
19/08/2019	NV	1	05:40	08:40	K.	Male/Adult	1	07:17	55	1	50	5			
19/08/2019	NV	1	05:40	08:40	H.	Adult	1	07:24	35	2		35			
20/08/2019	NV	5	18:15	21:15	K.	Male/Adult	1	18:52	50	2	35	15			
20/08/2019	NV	5	18:15	21:15	ML	Male/Immature	1	19:06	33	2	20	13			
20/08/2019	NV	6	14:45	17:45	K.	Male/Adult	1	15:18	110	2	95	15			
20/08/2019	NV	6	14:45	17:45	K.	Male/Adult	1	15:25	125	2	105	20			
20/08/2019	NV	6	14:45	17:45	ML	Male/Immature	1	17:11	24	1	24				
21/08/2019	NV	4	09:30	12:30	CU		4	10:17	42	3		10	32		
21/08/2019	NV	4	09:30	12:30	SH	Male/Adult	1	12:01	32	1	32				
21/08/2019	NV	3	05:43	08:43	SH	Female	1	08:29	15	1	15				
26/08/2019	NV	2	15:00	18:00	K.	Female/Adult	1	15:16	55	1	55				
26/08/2019	NV	2	15:00	18:00	GP		9	16:25	42	2	10	32			
26/08/2019	NV	2	15:00	18:00	GP		9	17:09	51	1	8	15	28		
26/08/2019	NV	1	10:45	13:45	K.	Female/Adult	1	11:46	130	1	120	10			
26/08/2019	NV	1	10:45	13:45	SN	Adult	2	13:47	30	1	30				
09/09/2019	NV	7	10:00	01:00	K.	Female/Adult	1	11:16	110	1	110				
09/09/2019	NV	7	10:00	01:00	CU	Adult	4	12:42	41	2	0	41			
09/09/2019	NV	2	06:20	09:20	K.	Male/Adult	1	07:54	135	2	120	15			
09/09/2019	NV	2	06:20	09:20	H.	Adult	1	08:09	65	2	0	65			
12/09/2019	NV	6	10:45	13:45	L.	Adult	23	11:08	52	3	0	0	51		
12/09/2019	NV	6	10:45	13:45	K.	Female/Adult	1	12:36	85	2	75	10			
12/09/2019	NV	6	10:45	13:45	K.	Male/Adult	1	12:37	215	1	195	20			
12/09/2019	NV	1	07:15	10:15	SN	Adult	2	07:11	25	1	18	7			

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Date	Observer	VP	Survey Start	Survey Finish	Species	Sex/ age	No. of birds	Start time	Duration (s)	Start height band	Number of 15 second intervals in each height band				
											1	2	3	4	5
12/09/2019	NV	1	07:15	10:15	SH	Male/Adult	1	10:02	18	1	18				
13/09/2019	NV	5	17:15	20:15	CU	Adult	4	17:27	44	3		15	29		
16/09/2019	NV	7	10:00	13:00	LB	Adult	4	10:51	95	3			95		
16/09/2019	NV	7	10:00	13:00	H.		1	11:02	70	2		55	15		
16/09/2019	NV	4	06:28	09:28	CU		3	06:27	25	1	25				
16/09/2019	NV	4	06:28	09:28	SH	Female/Adult	1	07:24	23	1	23				
17/09/2019	NV	1	10:15	13:15	K.	Female/Adult	1	13:01	225	2	190	35			
17/09/2019	NV	2	06:30	09:30	GP	Adult	18	06:53	45	1	20	25			
17/09/2019	NV	2	06:30	09:30	GP	Adult	18	07:12	18	1	5	13			
17/09/2019	NV	2	06:30	09:30	PE	Immature	1	07:12	42	2	10	32			
17/09/2019	NV	2	06:30	09:30	K.	Male/Adult	1	09:05	105	1	75	30			
20/09/2019	NV	3	13:00	16:00	L.	Adult	32	15:29	52	3			52		
20/09/2019	NV	3	13:00	16:00	L.	Adult	14	15:32	56	3			56		
20/09/2019	NV	6	17:00	20:00	ML	Male/Juvenile	1	18:27	36	1	30	6			
30/09/2019	NV	5	15:15	18:15	CU		4	15:11	28	1	10	18			
30/09/2019	NV	5	15:15	18:15	H.	Adult	1	15:37	65		65				

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Table 3: Breeding wader survey results

Date	Observer	Survey Start	Survey Finish	Flight or point?	Species	Sex/ age	No. of birds
04/06/2018	NV	20:50	23:00	Point	SN		1
04/06/2018	NV	20:50	23:00	Flight	SN		1
05/06/2018	NV	20:45	22:50	Point	SN		1
05/06/2018	NV	20:45	22:50	Point	SN		1
05/06/2018	NV	20:45	22:50	Flight	SN		1
16/07/2018	NV	21:15	23:15	Point	SN		1
16/07/2018	NV	21:15	23:15	Point	SN		1
16/07/2018	NV	21:15	23:15	Flight	SN		1
17/07/2018	NV	21:15	23:15	Point	SN		1
17/07/2018	NV	21:15	23:15	Flight	SN		2
13/05/2019	NV	20:30	23:30	Flight	WK	Adult	1
13/05/2019	NV	20:30	23:30	Flight	WK	Adult	1
13/05/2019	NV	20:30	23:30	Flight	WK	Adult	1
13/05/2019	NV	20:30	23:30	Flight	WK	Adult	1
13/05/2019	NV	20:30	23:30	Flight	WK	Adult	1
13/05/2019	NV	20:30	23:30	Flight	WK	Adult	1
13/05/2019	NV	20:30	23:30	Flight	WK	Adult	1
25/05/2019	NV	20:40	23:40	Flight	WK	Adult	1
03/06/2019	NV	20:30	23:22	Point	SN	Adult	1
03/06/2019	NV	20:30	23:22	Flight	WK	Adult	1
03/06/2019	NV	20:30	23:22	Flight	WK	Adult	1
03/06/2019	NV	20:30	23:22	Point	SN	Adult	1
03/06/2019	NV	20:30	23:22	Flight	WK	Adult	1
03/06/2019	NV	20:30	23:22	Flight	WK	Adult	1
03/06/2019	NV	20:30	23:30	Flight	WK		1
17/06/2019	NV	20:55	23:40	Flight	WK	Adult	1
17/06/2019	NV	20:55	23:40	Flight	WK	Adult	1
17/06/2019	NV	20:55	23:40	Point	SN	Adult	3
17/06/2019	NV	20:55	23:40	Point	SN	Adult	3
17/06/2019	NV	20:55	23:40	Point	SN	Adult	3
17/06/2019	NV	20:55	23:40	Flight	WK	Adult	1
15/07/2019	NV	20:55	23:55	Flight	WK	Adult	1
15/07/2019	NV	20:55	23:55	Point	SN	Adult	1
15/07/2019	NV	20:55	23:55	Flight	WK	Adult	1
15/07/2019	NV	20:55	23:55	Point	SN	Adult	2
16/07/2019	NV	20:50	23:50	Flight	WK	Adult	1

16/07/2019	NV	20:50	23:50	Point	SN	Adult	1
16/07/2019	NV	20:50	23:50	Flight	WK	Adult	1

Source: Natural Power

Table 4: Winter walkover survey results

Date	Observer	Survey start	Survey finish	Species	No. of birds
26/10/2018	KO	12:00	15:30	H.	1
26/10/2018	KO	12:00	15:30	LI	50
22/11/2018	KO	11:00	16:45	LI	75
22/11/2018	KO	11:00	16:45	SN	4
22/11/2018	KO	11:00	16:45	RO/JD	200
22/11/2018	KO	11:00	16:45	CU	1
22/11/2018	KO	11:00	16:45	BZ	1
22/11/2018	KO	11:00	16:45	L.	1
22/11/2018	KO	11:00	16:45	L.	1
11/12/2018	RM			L.	5
11/12/2018	RM			K.	1
11/12/2018	RM			M.	1
11/12/2018	RM			LR	1
11/12/2018	RM			BU	1
11/12/2018	RM			SN	5
11/12/2018	RM			SG	1
11/12/2018	RM			CH	1
11/12/2018	RM			CT	1
11/12/2018	RM			GT	1
15/01/2019	KO	10:15	13:20	L.	1
15/01/2019	KO	10:15	13:20	H.	1
15/01/2019	KO	10:15	13:20	H.	1
15/01/2019	KO	10:15	13:20	SN	3
15/01/2019	KO	10:15	13:20	K.	1

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15/01/2019	KO	10:15	13:20	LI	150
27/03/2019	KO	11:00	16:00	SN	2

Source: Natural Power

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Appendix 12.5

Potential Annex 1 Habitats Quadrat Surveys

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Recolonising Cutover Bog Habitats/Mosaics

Area 1 ITM 643248 712381

Scrub/improved agricultural grassland/[recolonising] cutover bog WS1/PB4/GA1 mosaic

Quadrat	Dominant	Abundant	Frequent	Occasional	Rare
1	Bramble		*Pseudoscleropodium purum* Yorkshire Fog Ling heather		Birch Purple moor-grass
2	Purple moor-grass	Tormentil Ling heather	*Pseudoscleropodium purum*	Lesser stitchwort Bush vetch Ribwort plantain Yorkshire Fog	Birch
3	Bramble		Heather Bush vetch Tormentil Purple moor-grass *Pseudoscleropodium purum* Yorkshire Fog	Bracken	
4	Bracken	Tormentil Meadowsweet Purple moor-grass		Gorse Birch Yorkshire Fog	

Area 4 ITM 643312 711601

Wet grassland/[recolonising] cutover bog (GS4/PB4) Mosaic

Quadrat	Dom	Abundant	Frequent	Occasional	Rare
1	Meadowsweet	Soft juncus knapweed	Yorkshire fog	Sliverweed	
2	Birch	Meadowsweet			
3	Meadowsweet		Perennial Yorkshire fog Thistle		
4	Birch	Meadowsweet			
5	Ling heather Birch	Sliverweed Tormentil	Cross leaved heath Cat's ear	Dock	Vetch
6	Bracken			Birch Tormentil	

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Quadrat	Dom	Abundant	Frequent	Occasional	Rare
7	Marsh Thistle Nettle	Sliverweed Yorkshire fog		Wild Angelica Ragwort	
8	Bracken	Knapweed Sliverweed		Meadow buttercup Ribwort plantain Meadowsweet Purple moor grass White clover	Ragwort

Area 6 ITM 644306 711359

[Recolonising] cutover bog PB4

Quadrat	Dominant	Abundant	Frequent	Occasional	Rare
1	Cotton-grass	Jointed rush	Heather Birch Tormentil Purple moor-grass	Marsh thistle Cat's ear Willow	Devils bit scabious
2	Birch	Purple moor-grass Ling heather Soft Rush *Dicranum scoparium*	Cross-leaved heath	Cat's ear	
3	Cotton-grass	Ling heather Purple moor-grass Gorse	Birch	Cross-leaved heath Soft rush *Dicranum scoparium*	Bramble
4	Gorse Willow	Cotton-grass	Bracken Soft rush	Birch Tormentil Ling heather St John's wort	
5	Cotton-grass Heather	Purple moor-grass Gorse	Birch *Spaghnum magellanicum* Cross leaved heath	Cat's ear	
6	Birch Jointed Rush	Ling heather Tormentil Cats ear Purple moor-grass *Dicranum scoparium* Cotton-grass			

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Quadrat	Dominant	Abundant	Frequent	Occasional	Rare
7	Purple moor-grass	Ling heather Bracken/ferns		Tormentil St John's wort Cotton-grass	Cross-leaved heath Willowherb
8	Cotton-grass Ling heather	Soft rush Bent grass Birch Purple moor-grass	Cat's ear Tormentil		

Area 1: **Scrub/improved agricultural grassland/[recolonising] cutover bog mosaic**

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Bog Woodland Habitats/Mosaics

Area 2 ITM 643296 712383

Bog woodland WN7

Quadrat	Dominant	Abundant	Frequent	Occasional	Rare
1	Birch	Nettle		Bramble *Thuidium tamariscinum*	
2	Birch			*Thuidium tamariscinum* Purple moor-grass	
3	*Thuidium tamariscinum*		Bracken	Birch Nettle	
4	Bracken				Bramble Purple moor-grass *Thuidium tamariscinum*

Area 3 ITM 644092 711312

Bog woodland WN7

Quadrat	Dominant	Abundant	Frequent	Occasional	Rare
1	Birch	Yorkshire Fog Sliverweed Willow		Thistle	
2	Birch		Ling heather	Bramble *Thuidium tamariscinum*	Hawthorn
3	Birch	Willow Willowherb	Thistle Nettle Sliverweed		
4	Birch		Heath-spotted orchid Yorkshire fog	Meadowsweet Bramble	

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Area 5 ITM 645248   710627

Bog woodland/Improved agricultural grassland/scrub (GA1/WN7/WS1) mosaic

Quadrat	Dominant	Abundant	Frequent	Occasional	Rare
1	Willow	Gorse Bramble		Hawthorn	
2	Willow	Bramble Nettle Yorkshire fog		Hawthorn	
3	Yorkshire fog	Bracken	Bramble	Birch Sliverweed	
4	Birch	Bramble	Yorkshire fog	Ivy	
5	Birch	Bramble	Yorkshire fog Gorse		
6	Willow	Bramble	Gorse	Hawthorn	
7	Birch	Willow Bramble			
8	Rosebay-willowherb	Nettles Yorkshire fog			

Area 7 ITM 645333 711576

Bog Woodland WN7

Quadrat	Dominant	Abundant	Frequent	Occasional	Rare
1	Bracken		Sliverweed Bent-grass Yorkshire fog Thistle		
2	Birch Willow		Bracken		Field Bindweed
3	Willow		Nettle Bracken Ivy	Purple moor-grass	
4	Willow	Bracken Ivy		Herb Robert Bramble Harts-tongue Fern	

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Area 8 ITM 644181 711375

Bog woodland WN7

Quadrat	Dom	Abundant	Frequent	Occasional	Rare
1	Birch (immature)		*Dicranum scoparium*	Cat's ear Heather	Bramble
2	Birch (immature)	*Dicranum scoparium*			
3	Birch (immature)	*Dicranum scoparium*		Cat's ear	
4	Birch (immature)	*Dicranum scoparium*		Cat's ear	Heather

Area 2: Bog Woodland

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Appendix 12.6

Ecofact
Aquatic Ecology Report

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DERNACART WIND FARM
AQUATIC ECOLOGY ASSESSMENT

10th December 2019 (FINAL)

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Laois County Council Planning Authority - Viewing Purposes Only!

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1. INTRODUCTION

This report addresses the potential impact of the proposed Dernacart wind farm project on the receiving aquatic environment. The proposed Dernacart Wind farm is located North of Mountmellick in County Laois. This document provides an assessment of the impact of the proposed development on aquatic habitats, aquatic ecological communities, and individual aquatic species. The aims of the aquatic ecology assessment are:

- To carry out a desktop study in order to determine the surface water features affected by the proposed development and surrounding area;
- To carry out a baseline fisheries and aquatic ecological survey of the affected aquatic areas;
- To predict the potential direct, indirect and cumulative impacts of the proposed development on aquatic species and habitats.
- To propose mitigation measures in the construction and operation of the wind farm so as to minimise potential impacts on fisheries and aquatic ecology receptors.

Surveys to inform this aquatic ecology assessment were completed during September 2019. The surveys included aquatic habitat assessments, fish/lamprey surveys (electrical fishing), kick sampling and presence/absence surveys for Freshwater Pearl Mussels and White-clawed crayfish. Figure 1 gives the location of the proposed Dernacart wind farm with respect to the River Barrow and River Nore SAC and watercourses in the Barrow catchment.

2. METHODOLOGY

2.1 Relevant Guidance

The current assessment has been prepared taking account of relevant guidance published by the Environmental Protection Agency (EPA) including '*Guidelines on the Information to be contained in Environmental Impact Assessment Reports*' (EPA, 2017) and '*Advice Notes for Preparing Environmental Impact Statements*' (EPA, 2015). In addition, the impact assessment also takes account of the '*Guidelines for Ecological Impact Assessment in the UK and Ireland (Terrestrial, Freshwater, Coastal and Marine)*' (Chartered Institute of Ecology and Environmental Management, 2018). The Heritage Council publication '*Best Practice Guidance for Habitat Survey & Mapping'* (The Heritage Council, 2011) is also referenced.

Relevant guidance published by the National Roads Authority (NRA), and applicable to assessing watercourses in Ireland, was also followed, including '*Guidelines for the Assessment of Ecological Impacts of National Road Schemes – Revision 2*' (NRA 2009a), '*Ecological surveying techniques for protected flora and fauna during the planning of National Road Schemes – Version 2*' (NRA 2009b), '*Environmental Impact Assessment of National Road Schemes – A practical guide*' (NRA 2008a) and '*Guidelines for the Crossing of Watercourses during the Construction of National Road Schemes'* (NRA 2008b).

2.2 Legislative Context

A diversity of flora and fauna, rare at a national level, are protected under the provisions of the Wildlife Act, 1976 and Wildlife (Amendment) Act, 2000; which includes the Flora Protection Order (2015). The Habitats Directive 1992 has been transposed into Irish legislation as the European Union (Natural Habitats) Regulations SI 94/1997 and amended in 1998 and 2005. The Habitat Regulations have been

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updated in 2011 as the European Communities (Birds and Natural Habitats) Regulations (2011) to bring the Irish transposition of these regulations into line with the requirements of the EU Habitats Directive (1992).

Under the Fisheries (Consolidation) Act, 1959, it is an offence to disturb the bed of a river; therefore, it will be necessary to get written permission from Inland Fisheries Ireland to proceed with the works in any areas where disturbance to the spawning and nursery areas of both salmonids and lampreys will occur as a result of the proposed development. Salmon, all lamprey species and their habitats are further protected under the EU Habitats Directive, 1992.

Under Section 3 of the Local Government (Water Pollution) Act, 1977 (as amended by Sections 3 and 24 of the 1990 Act) it is an offence to cause or permit any polluting matter to enter waters. Suspended solids would be a key parameter here. Likewise, any visual evidence of oil/fuel in the river would constitute an offence.

Section 171 of the Fisheries (Consolidation) Act 1959 creates the offence of throwing, emptying, permitting or causing to fall onto any waters deleterious matter. Deleterious matter is defined as not only as any substance that is liable to injure fish but is also liable to damage their spawning grounds or the food of any fish or to injure fish in their value as human food or to impair the usefulness of the bed and soil of any waters as spawning grounds or other capacity to produce the food of fish.

2.3 Selection of Watercourses for Assessment

All watercourses / water bodies which could be affected directly (i.e. within the site) or indirectly (i.e. drain areas close to the site) were considered as part of the current appraisal. A total of 11 sites were selected for detailed assessment. The sites selected for assessment are given in Table 1 and the location of these sites is shown in Figures 1 and 2.

The surveys completed at each site were at a level required to make an evaluation of biological water quality, fisheries value, aquatic habitat value, and presence of rare/protected/notable aquatic species at each site. Generally, watercourses were observed from public roads and this allowed such watercourses to be adequately evaluated for the purpose of the current appraisal.

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Table 1 Location of the aquatic ecology sites assessed for the proposed Dernacart Wind Farm site.

Site No.	Catchment	Sub- Catchment	Water-course Name	Water-course Order	Segment Code	EPA Code
1	Barrow	Barrow_SC_30 Barrw_SC_20	Barrow	5	14_10477	14B01
2	Barrow	Barrow_SC_30	Clonygowan	3	14_1770	14C51
3	Barrow	Barrow_SC_30	Cottoners Brook	2	14_1840	14C15
4	Barrow	Barrow_SC_30	Cottoners Brook	3	14_1031	14C15
5	Barrow	Barrow_SC_010	Barrow	4	14_1043	14B01
6	Barrow	Barrow_SC_010	White Hill (E) Stream	1	14_1748	14W01
7	Barrow	Barrow_SC_010	White Hill (E) Stream	2	14_322	14W01
8	Barrow	Barrow_SC_010	Forest_Upper	1	14_1592	14F07
9	Barrow	Barrow_SC_010	Forest_Upper	2	14_1057	14F07
10	Barrow	Barrow_SC_010	Barrow	4	14_1053	14B01
11	Barrow	Barrow_SC_010	White Hill (W) Stream	2	14_1124	14W02

2.4 Aquatic Surveys

Aquatic surveys were carried out at all of the survey sites in September 2019. The majority of the watercourses were categorised as watercourses of insignificant aquatic ecological importance. Each site was assessed for potential lamprey, salmon and white-clawed crayfish habitat.

An electrical fishing survey was undertaken at the 11 sites during September 2019. This was completed under authorisation from the Department of Communication, Energy and Natural Resources under Section 14 of the Fisheries Act (1980). Sites were surveyed following the methodology outlined in the CFB (2008) guidance "*Methods for the Water Framework Directive - Electric fishing in wadable reaches*". A portable electrical fishing unit (Smith Root-LR 24 backpack) was used during the assessments. Fishing was carried out continuously for 5 minutes at each of the sites. Captured fish were collected into a container of river water using dip nets. On completion of the survey fish were then anaesthetised using a solution of 2-phenoxyethanol, identified, and measured to the nearest mm using a measuring board. Subsequent to this the fish were allowed to recover in a container of river water and were the released alive and spread evenly over the sampling area. No mortalities were recorded. Strict biosecurity measures were followed during all fieldwork (IFI, 2010).

Juvenile lamprey surveys generally followed the methodology for ammocoete surveys given in the manual 'Monitoring the River, Brook and Sea Lamprey, *Lampetra fluviatilis*, *L. planeri* and *Petromyzon marinus* by Harvey & Cowx (2003). Electrical fishing for juvenile lampreys was carried out at three 1m^2 habitat patches where available. A total of 3 x 1 m^2 enclosures were fished at each site where suitable habitat was present and where conditions allowed. It is noted that most of the sites did not have optimal juvenile lamprey habitats. Dip/sweep netting was also undertaken at each site. This was undertaken due to the difficulty in surveying most of the river channels due to heavy vegetation growths.

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Qualitative sampling of benthic (or bottom dwelling) macroinvertebrates was undertaken at all survey sites using kick-sampling (Toner *et al.*, 2005). This procedure involved the use of a 'D' shaped hand net (mesh size 0.5 mm; 350 mm diameter) which was submerged on the riverbed with its mouth directed upstream. The substrate upstream of the net was then kicked for one minute in order to dislodge invertebrates, which were subsequently caught in the net. Where possible, this procedure was undertaken at three points along/across the watercourse. Stone washings and vegetation sweeps were also undertaken to ensure a representative sample of the fauna present at each site was collected. Macroinvertebrates were identified onsite with some specimens fixed in alcohol. The relative abundance of macroinvertebrates was recorded on-site at each site. The Q-rating biotic index were used to rate the biological status of the study sites. It is noted that 7 of the sites assessed were too small (or dry) so a Q rating could not be assigned. An estimated Quality Status is assigned where possible.

Specific sweep netting assessments were completed for White-clawed crayfish. Also, electrical fishing work was completed which would also have captured crayfish. Mussels were surveyed using visual assessments using a bathyscope at each site.

Table 2 Relationship between Q-value and Ecological Status for macroinvertebrates.

Q Value*	WFD Status	Pollution	Condition**
Q5, Q4-5	High	Unpolluted	Satisfactory
Q4	Good	Unpolluted	Satisfactory
Q3-4	Moderate	Slightly polluted	Unsatisfactory
Q3, Q2-3	Poor	Moderately polluted	Unsatisfactory
Q2, Q1-2, Q1	Bad	Seriously polluted	Unsatisfactory

** These values are based primarily on the relative proportions of pollution sensitive to tolerant macroinvertebrates (the young stages of insects primarily but also snails, worms, shrimps etc.) resident at a river site.*
*** "Condition" refers to the likelihood of interference with beneficial or potential beneficial uses*

2.5 Evaluation

The evaluation of impact significance is a combined function of the value of the affected feature (its ecological importance), the type of impact and the magnitude of the impact. It is therefore necessary to identify the value of ecological features within the study area in order to evaluate the significance and magnitude of possible impacts. Ecological features are assessed on a scale ranging from international-national-county-local. The local scale is approximately equivalent to one 10 km square but can be operationally defined to reflect the character of the area of interest.

2.6 Consultation

A letter of consultation from Inland Fisheries Ireland (IFI), dated; the 18th of July 2019 is provided in Appendix 1. The letter details the following concerns of IFI with regard to the proposed project;

- Aquatic biodiversity assessment must be carried out on any watercourses that will receive drainage from the main construction site and the access routes. This assessment should have emphasis on the importance of the overall habitat and environment suitability for the aquatic community and the avoidance of altering river morphology.
- The aquatic habitat and the physical nature of any affected watercourses should be adequately surveyed and described in detail, including the riparian zones to a distance of at least 10 m on

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both banks, to ensure the survey is representative of the habitat. Sections upstream and downstream of any points of impact on the watercourses, and/or tributaries of the affected watercourse should also be incorporated in the survey, in order to assess the effect that the discharge may have in other areas. Un-impacted stream should be surveyed as a control in the EIA.

- Quantitative electro-fishing surveys should be carried out on all waters in relation to all fish species, but the main focus of which will be on the presence of salmonid species, crayfish, and lamprey species. This will be carried out by experienced authorised personnel whom must comply with all conditions of the Department of Communications, Energy and Natural Resources' electro-fishing permits.
- There are significant concerns in relation to works on the turbines and access tracks having direct or indirect (vibrations) impacts on soil stability.
- It is highly recommended the soil strength and suitability of all turbines and access track ground is thoroughly assessed by specialist personnel. Assessment of the potential for landslides as part of the EIA is particularly important due to the peat soils in the area.
- It is important that hydrology is considered where excavation is required, including for road construction. Natural flow paths (above and/or below ground) should not be altered in a way that may cause erosion or soil instability.
- Drainage should be carefully managed during both construction and operational phases. Sufficient water retention time in the settlement pond is particularly important during the construction phase to prevent deleterious matter in the discharge. Settlement ponds should be used during the operational phase for the settlement of suspended solids and sediments and prevent any deleterious matter from discharge in watercourses. Silt traps should be designed to allow for the rainfall levels and intensity that may cause hydraulic overload on the trap so that movement of silt will be minimised in such cases. Settlement ponds and silt traps should be accessible for appropriate monitoring and maintenance. A licence to discharge water s must be obtained if required from the local authority.
- Interception of constructed roads and flow paths of surface water must be considered in order to maintain normal flow paths throughout the project, as the roads are likely to provide preferential flow paths. Material used in the construction of the roads should be suitable. Material, such as shale, with poor tensile strength should be avoided as heavy vehicles will cause the release of fine sediment, potentially causing water pollution. Specialist expertise on the matter, with particular consideration given to the pressures on the roads during the construction period, is recommended.
- Careful consideration must be given to material stockpile locations in relation to runoff and drainage. Confined areas may be required, and any toxic poisonous material will require full containment and will not be permitted to discharge to any waters.
- IFI should be consulted in relation to watercourse crossings or temporary diversions and the final design is to be approved by IFI (length, slope and width of in-stream structures must be considered). Clear span bridges are the recommended crossing option.
- Appropriate scheduling of works that may impact on watercourses is necessary to avoid impacting on aquatic habitats during spawning season. The open season for carrying out these works is the 1st of July to 30th of September.
- Streams that may be temporarily dry but have potential hydrological connection to the River Barrow should be included in the drainage assessments.
- The cable route watercourse crossings must be carefully examined, particularly at the proposed Barrow crossing south-west of Portarlington and the crossing of Cottoner's Brook.

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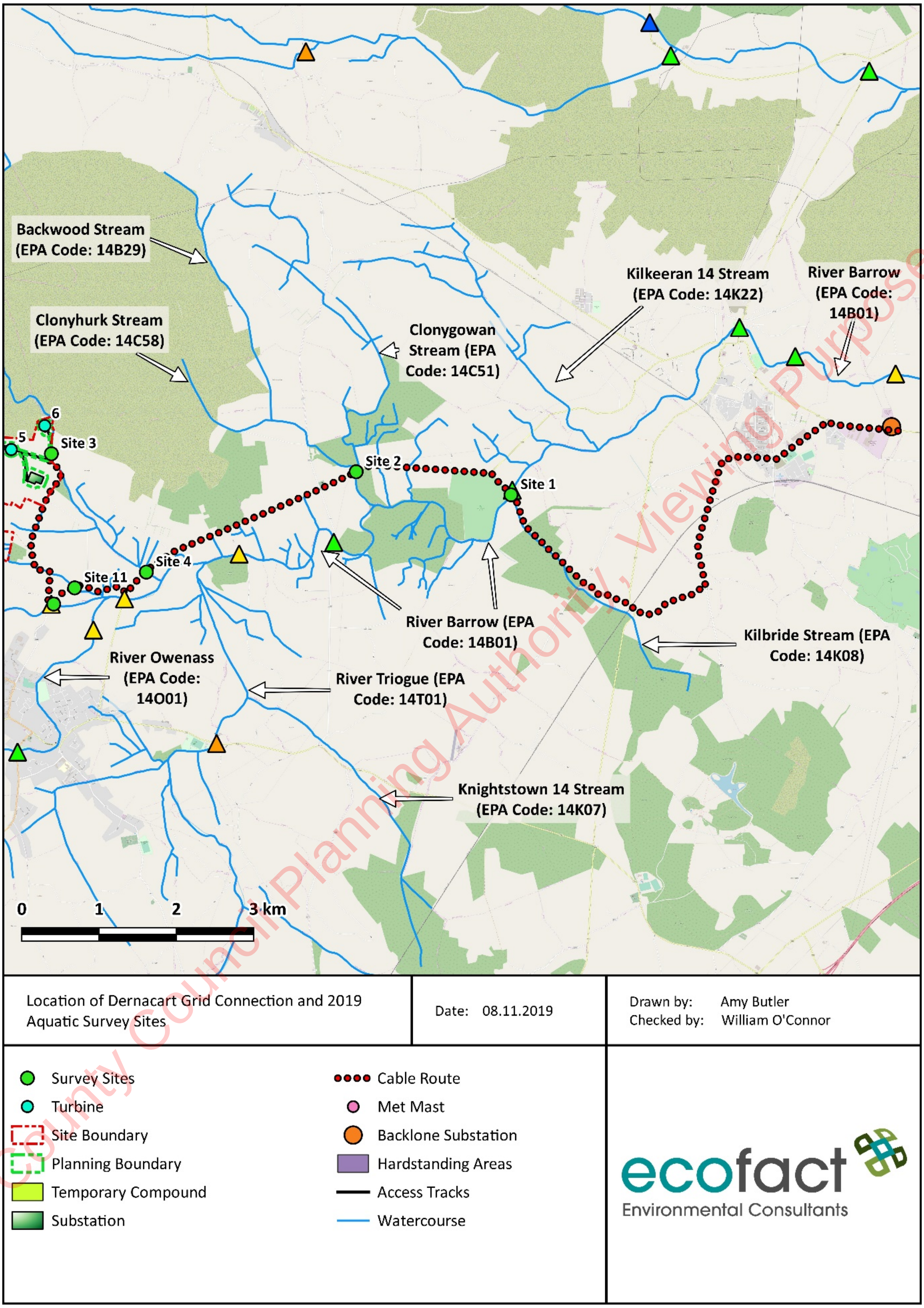

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Figure 1(a) Location of Wind Farm, grid connection route and 2019 aquatic ecology survey sites

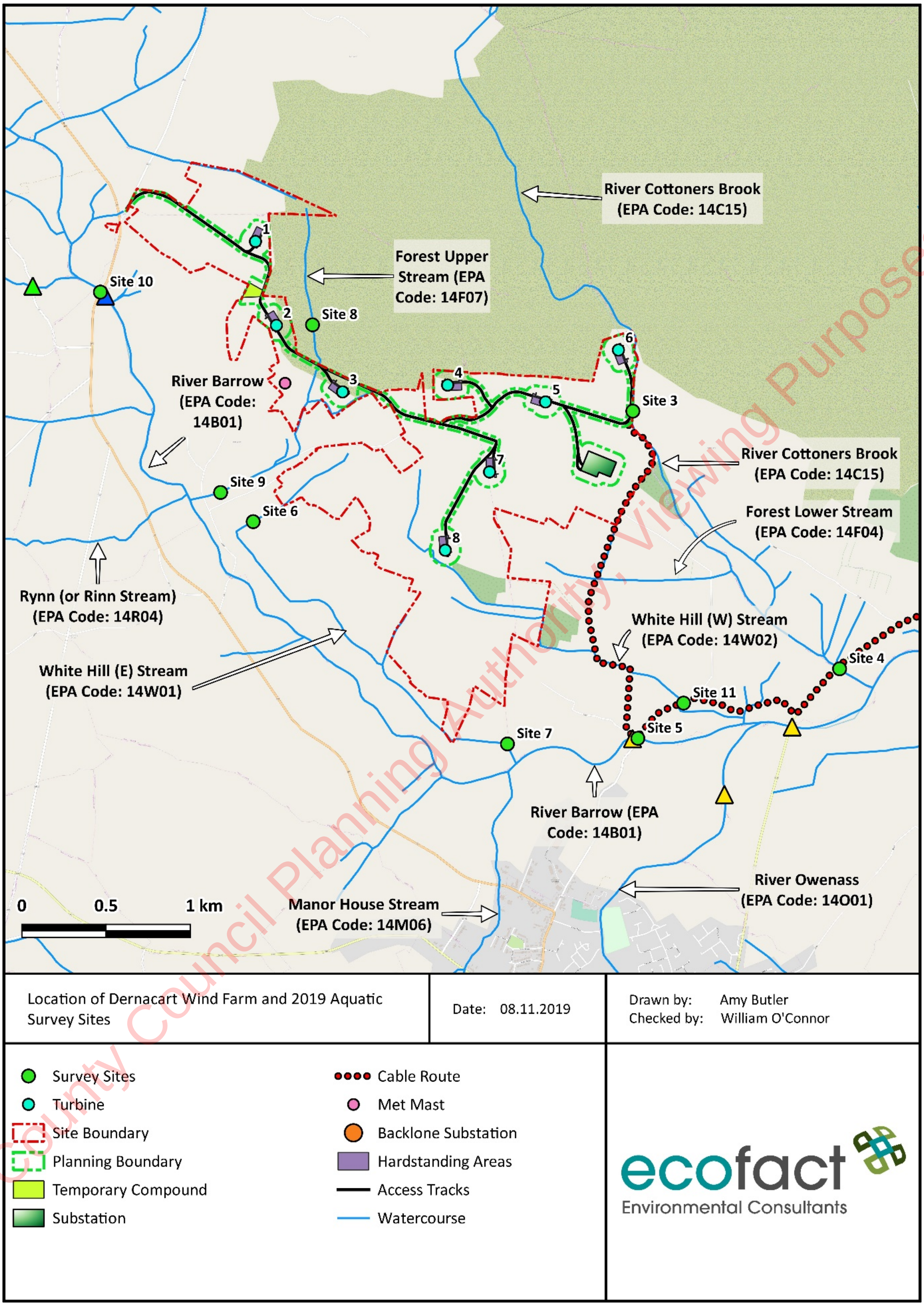

Figure 1(b) Location of Wind Farm, grid connection route and 2019 aquatic ecology survey sites.

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3. RECEIVING ENVIRONMENT

3.1 SACs Designated for aquatic qualifying interests

The only Natura 2000 river system in the study area with a downstream hydrological connection to the proposed Dernacart Wind Farm site is the River Barrow and River Nore SAC (Site Code: 002162). The River Barrow and River Nore SAC comprises of the freshwater element of the of the River Barrow and the River Nore catchments as far upstream as the Slieve Bloom Mountains, and it includes the tidal areas and estuary as far downstream as Creadun Head in Waterford.

This SAC site is selected for the following habitats on Annex I of the EU Habitats Directive (* = priority; numbers in brackets are the Natura 2000 codes); estuaries [1130], tidal mudflats and sand flats [1140], reefs [1170], *Salicornia* mud [1310], Atlantic salt meadows [1330], Mediterranean salt meadows [1410], floating river vegetation [3260], dry heath [4030], hydrophilous tall herb communities [6430], petrifying springs [7220], old oak woodlands [91A0] and alluvial forests [91E0]. The site is also listed for the following Annex II species; Desmoulin's whorl snail [1016], freshwater pearl mussel [1029], white-clawed crayfish [1092], sea lamprey [1095], brook lamprey [1096], river lamprey [1099], twaite shad [1103], Atlantic salmon [1106], otter [1355], Killarney fern [1421] and Nore freshwater pearl mussel [1990].

The shortest distance between the proposed development site boundary and the River Barrow and River Nore SAC is c.500m via the White Hill Stream. This is between the site boundary and the Barrow. There is no infrastructure in this area or anywhere near the white hill (E). The Forest upper stream intersects an access track 1.25km u/s of Barrow but this is an existing track

3.2 Barrow Catchment

The proposed Dernacart Wind Farm is located within the Barrow catchment. The main channel of the river rises in the Slieve Bloom Mountains in County Laois. The Barrow catchment consists of the area drained by the River Barrow upstream of the River Nore confluence and all estuarine streams between the Barrow railway bridge at Great Island and Ringwood, Co. Kilkenny. The total area drained by the Barrow catchment is 3,025 km^2**.** The main urban centres within the Barrow catchment include New Ross, Graiguenamanagh, Athy, Portlaoise, Mountmellick, Portarlington, Monasterevin and Kildare.

The River Barrow supports a range of fish species including Atlantic salmon, Brown Trout, Twaite Shad, Dace, Bream, Perch, Rudd, Roach, Tench, and Pike. The Barrow is known to support the only sizeable spawning population of Twaite Shad in Ireland – however this species does not occur in the study area as migration of Shad in the river is blocked by the weir at St. Mullins (King, 2006).

Lampreys are rare in the study area – an investigation into the status of Lamprey in the Barrow catchment, which was commissioned by NPWS (King, 2006) reported that in general the tributaries of the River Barrow tend to have limited habitat for juvenile Lamprey. Compared to other catchments in Ireland, such as the Slaney and Munster Blackwater and the Moy, the Barrow has relatively limited ammocoete populations. The study highlighted the unusual occurrence of recurring negative results along individual channels in the Barrow catchment.

The Barrow also supports populations of the protected White-clawed Crayfish. This species is threatened on a global scale and Ireland holds one of the world's largest populations of the species. In 2017 large Crayfish mortality events occurred in the catchment between Graignamanagh in Kilkenny and upstream as far as Carlow. DNA tests from 4 different locations along this stretch confirmed the

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presence of Crayfish plague. According to catchments.ie the highly infectious disease has spread through the main Barrow channel and it is now widespread in the river. It was been recorded as far upstream in the main channel as Monasterevin in 2018. In May of this year (2019) an additional infected location has been identified in the River Slate at Rathangan.

According to the EPA's most recent assessment of the River Barrow; *"The Barrow was sampled across 2017 and 2018 due to the outbreak of crayfish plague. Of the 12 stations sampled along the Barrow in 2017, stations 0200, 0780, 1300, 1500, 2900 were in Good ecological condition, while the two uppermost stations maintained High ecological quality (0050 & 0100). A decline to unsatisfactory Moderate quality occurred at Station 1000 (Pass Bridge) and the lowermost station at Graiguenamanagh (3500). In 2018, station 0300 (Twomile Br) improved to High ecological quality, while station 1900 (Tankardstown Br) declined to unsatisfactory Poor quality. The latter site had an overabundance of Potamopyrgus snails and too much instream algae. Station 0700 (Kilnahown Br) retained Good ecological quality and stations 0500, 2200, 2455, 2600 and 2680 all remained at unsatisfactory Moderate ecological quality."* (EPA, 2018).

3.3 Water Quality

3.3.1 Barrow

The River Barrow (EPA Cod: 14B01) is the second longest river in Ireland. The river source is located at Glenbarrow in the Slieve Bloom Mountains in County Laois. There are several EPA monitoring stations located along the main Channel of the River Barrow. The area of the River Barrow's main channel which runs closest to the proposed wind farm site is the in the upper part of the River above Mountmellick. This stretch of the river currently has an assigned WFD status of 'at risk'.

The closest upstream site on the main channel of the River Barrow monitored by the EPA is rated as Q4-5, corresponding to WFD status ‘High’ (EPA Code: 14B01 0300. This site was last monitored in 2018. Following this, downstream of the Whitehill (W) Stream, which drains the proposed site, confluence with the River Barrow, there is another monitoring station which is rated as Q3-4 (EPA Code: 14B01 0500). This corresponds to WFD status ‘Moderate’ and this site was last monitored in 2018. Downstream of the proposed wind farm site, another monitoring station was rated as Q4 in 2011 (EPA Code: 14B01 0600). Immediately downstream of the Kilbride Stream confluence with the River Barrow, where the proposed grid connection route will cross, there is another EPA biological monitoring station. This site was rated as Q4 in 2018, equivalent to WFD status ‘Good’ (EPA Code: 14B01 0700). Lastly, another monitoring station in Portarlington town was rated as Q4 in 2000, corresponding to WFD status ‘Good’ (EPA Code: 14B01 0760).

The proposed Dernacart Wind Farm development, including the access and cable route connection overlaps, or is partly within the following River Barrow subcatchments; Barrow_SC_010 and Barrow_SC_030. Seven of the eleven survey sites are within the Barrow_SC_010, which includes the White Hill (E) Stream, the White Hill (W) Stream, Forest Upper and the relevant section of the River Barrow. The remaining four survey sites are located in the Barrow_SC_030 sub catchment, on the Clonygowan River and Cottoner's Brook, and Site 1 is on the Barrow and can also be included in the Barrow_SC_020. The two mainly affected sub catchments have been subject to WFD assessment and the majority of the watercourses within these two sub catchments are considered to be either 'at risk' or are under 'review' with the need for water quality assessment identified. All the affected watercourses have been deemed to be under significant pressure. The main sources of pressure for these two sub catchments are agriculture, forestry, hydrological pressures caused by channelisation and peat extraction, with pressure also from industry and urban wastewater in some parts of the sub catchments.

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3.3.2 Clonygowan

Clonygowan stream (EPA Code: 14C51) rises to the East of Garryinch Bog and flows South. The stream meets the wind farm cable route connection at Site 2, as shown in Figure 2. This stream has not been assigned an ecological status by the EPA due to its small size.

3.3.3 Cottoner's Brook

Cottoner's Brook (EPA Code: 14C15) rises to the North of Garryinch Bog near Kilcavan cross. The brook flows along the County Laois border with County Offaly and continues its path through Garryinch Bog. It emerges from the south of the bog and flows along the edge of the proposed wind farm site, along a section of the site's border, beside an existing access track to the site. The watercourse continues on towards the River Barrow. It intercepts the wind farm cable route at Site 4 before it's confluence with the River Barrow. Cottoner's Brook is not monitored by the EPA - again presumably due to its small size.

3.3.4 White Hill (E) Stream

White Hill (E) Stream (EPA Code: 14W01) rises within the proposed wind farm site. The stream flows in a south-westerly direction out of the wind farm site towards the River Barrow. There are two National Water Monitoring Stations (RS14W010100 and RS14W010200) on this section of the watercourse (EPA segment code: 14_1748). The watercourse then meanders to a south-easterly direction and flows parallel to the main channel of the River Barrow for over 1.5 km before the two rivers intersect.

3.3.5 White Hill (W) Stream

The source of the White Hill (W) Stream (EPA Code: 14W02) is located within the proposed wind farm site, just upstream of the White Hill (W) Stream National Water Monitoring Station (RS14W020100). The stream flows through the wind farm site in south-easterly direction passing south of Turbine 8 and continuing its path out of the site. It flows briefly alongside the L20978 road before passing under the L20972 road at Site 11. The watercourse then intercepts another 2nd order stream before joining the River Barrow along the 14_1042 segment of the Barrow.

3.3.6 Forest Upper

The Forest Upper (EPA Code: 14F07) rises in Garryinch bog, within the proposed wind farm site. The watercourse then exits the wind farm site before re-entering it further downstream and flowing in a southerly direction towards its confluence with the River Barrow through the site and intercepting the access tracks between turbine 2 and 3 on site. It is noted that there is an existing access track in this area.

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3.4 Fish status

Inland Fisheries Ireland (IFI) carried out an electrofishing survey of the entire River Barrow Catchment as part of the National Research Survey Programme in 2015, including 35 sites on the main river channel and canal cuts and 118 sites across 21 sub-catchments.

In the survey Dace and Roach were found to be widely distributed throughout the main River Barrow channel being recorded at 91% and 80% of sites respectively. Atlantic salmon occurred at 57% of sites surveyed. The numbers of juvenile Atlantic salmon were generally low and that they seemed to be largely confined to fast-flowing, non-navigable areas downstream of weirs, as were Brown Trout which were only recorded at 46% of the main channel sites. Perch were widely distributed in the main channel, recorded at 74% of survey sites, but were poorly represented in the sub-catchments. Pike were also scarce in the sub-catchment watercourses. Although no Bream was recorded in the survey there were Roach x Bream hybrids found in the main channel indicating their presence. Minnow and Gudgeon were widely distributed. European Eel, Stone Loach, Flounder and Three-spined Sticklebacks were also recorded in the 2015 survey.

According to the IFI assessment of the fish stocks in the River Barrow Catchment, the fish status in the upper section of the main channel of the River Barrow itself, above Mountmellick were Good. This section of the River Barrow is the closest part of the main river channel to the proposed wind farm site, and Site 10 of the current assessment is located on this section of the River Barrow. However, the main wind farm site lies across upper sub-catchments of the Barrow rather than on the main River Barrow channel. The IFI survey identified a trend across the sub-catchments whereby the sub-catchments of the upper area of the Barrow Catchment tended to be assigned a fish status of moderate or less compared to better status in the downstream sub-catchments. The likely cause of the poorer fish stocks is mainly due to poor water quality, poor habitat, barriers impeding migratory fish passage and competition with invasive Dace.

In the entire survey of the catchment there were only 5 sites of the 153, that were assessed, i.e. 3% of the survey sites, that had a High fish stock status. More than 50% of the survey sites across the entire Barrow Catchment were recorded as having Moderate or lower fish status. It was also noted that there have been recurring problems in the Barrow Catchment relating to water quality in the past.

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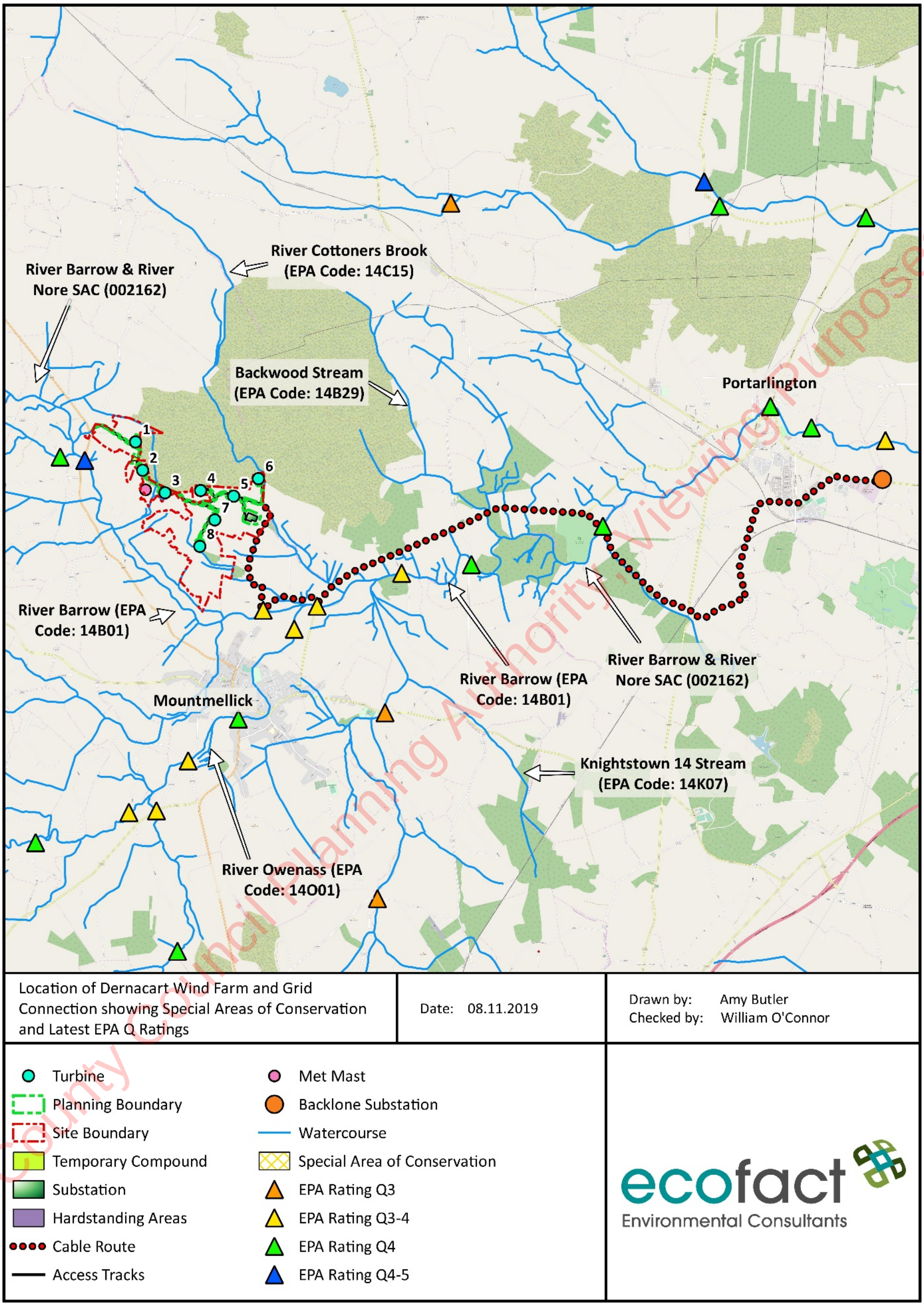

Figure 2 Location of Dernacart Wind Farm and grid connection, showing SACs and latest EPA Q ratings.

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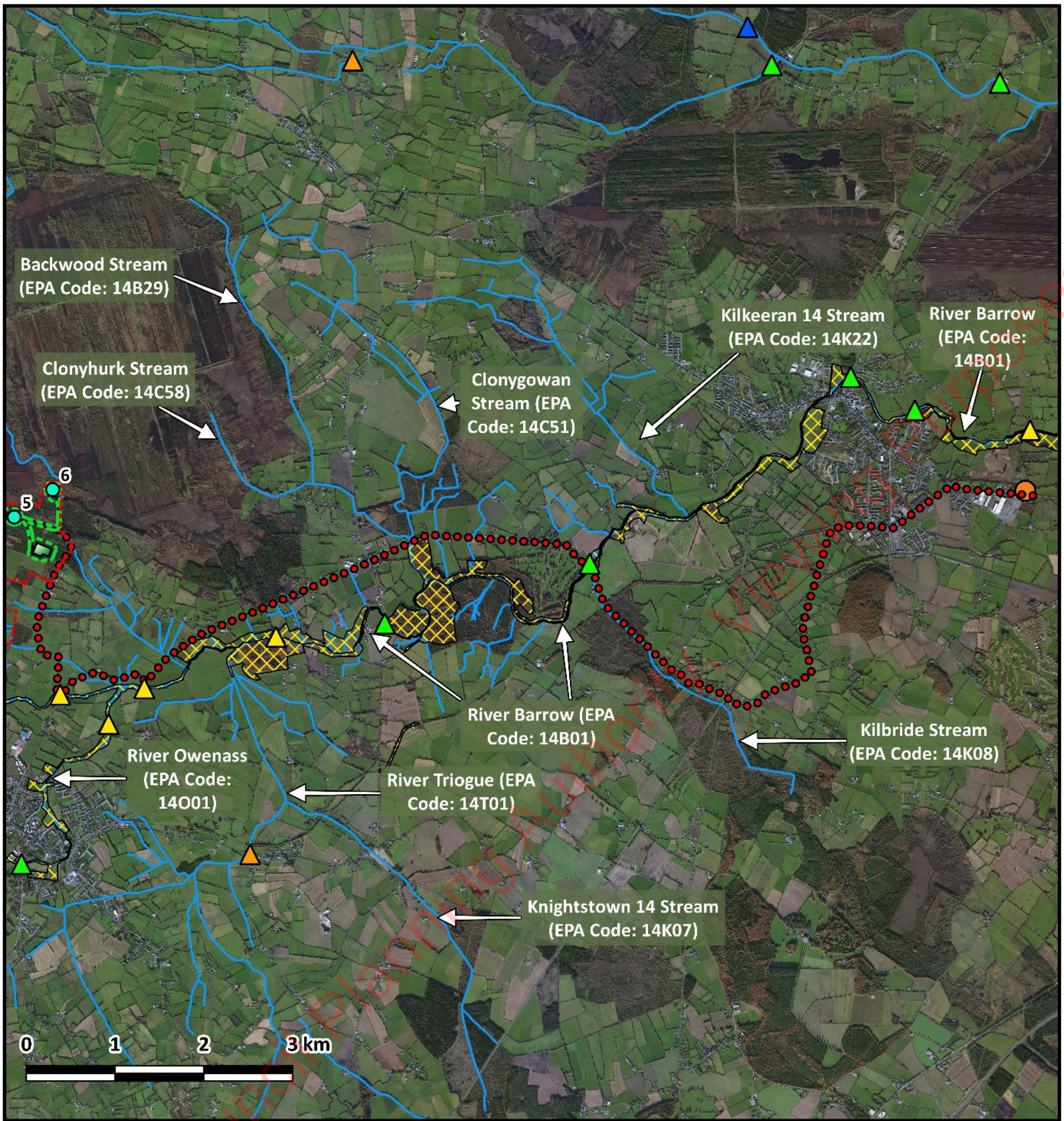

Location of Dernacart Grid Connection Showing Special Areas of Conservation and Latest EPA Q Ratings	Date: 08.11.2019	Drawn by: Amy Butler Checked by: William O'Connor

- Turbine
- Planning Boundary
- Site Boundary
- Temporary Compound
- Substation
- Hardstanding Areas
- Cable Route
- Access Tracks
- Met Mast
- Backlone Substation
- Watercourse
- Special Area of Conservation
- EPA Rating Q3
- EPA Rating Q3-4
- EPA Rating Q4
- EPA Rating Q4-5

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Figure 3(a) Location of the proposed Dernacart Wind Farm, showing SACs and latest EPA Q ratings, with aerial photography.

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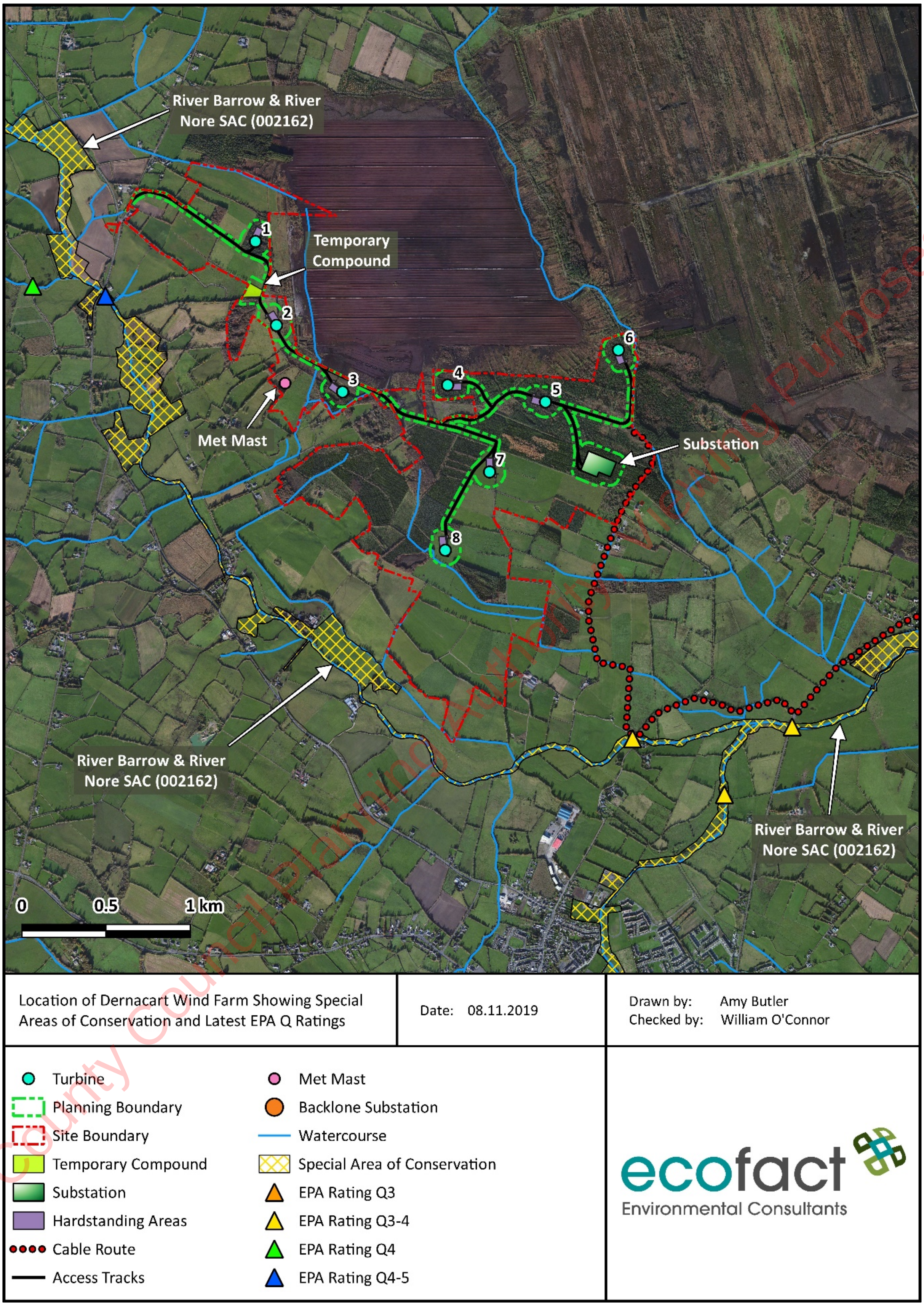

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Figure 3(b) Location of proposed Dernacart grid connection, showing SACs and latest EPA Q ratings, with aerial photography.

3.5 Results of the current aquatic surveys

3.5.1 Introduction

The survey sites are located on watercourses that both drain – or run close to - the proposed Dernacart wind farm site. All of the sites selected are located within the Barrow catchment, and the Barrow sub-catchments 010, 020 and 030. Three of the eleven sites surveyed are located on the main channel of the River Barrow which is monitored by the EPA. The remaining sites are not monitored by the EPA likely due to the fact that they are smaller watercourses. The watercourses surveyed are the River Barrow, the Clonygowan Stream, the Cottoner's Brook stream, White Hill (W) Stream, the White Hill (E) Stream and the Forest Upper Stream. A description of the watercourses in relation to their interaction with the proposed wind farm site is provided below.

The watercourses on the proposed Dernacart Wind Farm site were assessed during the current survey and none were found to be of aquatic ecological significance. The 1st order Dernacart Stream (EPA Segment Code: 14_1948) is located on the northern boundary of the site. There are no direct interactions with this stream as it is located on the edge of the boundary, i.e. no access tracks or turbines are to be located here. It is not located within the planning boundary. The proposed access track near the junction of the L2092 Road with the N80 to Turbine 1 is located near to where an unnamed 1st order stream rises (EPA Segment Code: 14_917). The access road from Turbine 2 to Turbine 3 crosses, via an existing track, over the 1st order Forest Upper Stream (EPA Segment Code: 14_1592) as it passes through Garryinch Bog. The access track from Turbine 3 to Turbine 4 crosses, via an existing track, close to where an unnamed tributary of the Forest Upper Stream rises (EPA Segment Code: 14_1351). Some of the access track from Turbine 5 to Turbine 6 runs adjacent to the 2nd order Cottoner's Brook Stream (EPA Segment Code: 14_1840). The only watercourse crossing for the proposed access tracks is via an existing track between proposed Turbine 2 and Turbine 3 over the Forest Upper Stream.

Other watercourses present within the site boundary but are not directly within the footprint of any access tracks or turbines are the 1st order White Hill (E) Stream (EPA Code: 14W01, 1st order White Hill (W) Stream (EPA Code: 14W02). The only watercourses within the direct footprint of the planning boundary is the Forest Upper Stream and the Cottoner's Brook stream.

The cable route runs from near the proposed substation south of turbine 6 at the eastern wind farm site border. It runs along a section of the site border beside the 2nd order Cottoner's Brook (EPA Segment Code: 14_1840) at Site 3 and running alongside the stream for a further 213 m. The route then travels in a southerly direction, running alongside an unnamed stream (EPA Segment Code: 14_919) for c. 450m and crosses the 2nd order Forest Lower Stream via an existing track (EPA Segment Code: 14_418). The route then travels south and crosses over the 2nd order White Hill (W) Stream (EPA Segment Code: 14_1124), following the route of the existing L20978 road. This road runs adjacent to this stream for c. 315m. The route then crosses this stream again before turning south and then north, following the L20972 road and crossing the White Hill (W) Stream for the third time. After this it crosses another unnamed stream (EPA Segment Code: 14_863) which flows into the White Hill (W) Stream. After this it connects with the R423 Road and the route continues north-east and intersects the 3rd order Cottoner's Brook (EPA Segment Code: 14_1031) again at Site 4 which is along the existing road. The route then continues north-east along the R423, intersecting the 3rd order Clonygowan Stream (EPA Segment Code: 14_1770) at Site 2 and also an unnamed 1st order stream (EPA Segment Code: 14_1715) and the 1st order Rathmore Stream (EPA Segment Code: 14_1514) which are all existing crossings. It then follows the L71762 Road around Portarlington Golf course and intersects the 5th order River Barrow (EPA Segment Code: 14_1644) at Kilnahown Bridge (Site 1) near the Kilbride Stream

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confluence. The cable route then runs directly alongside the 1st order Kilbride Stream (EPA Segment Code: 14_1645) for approximately 1.1 km. From here, the cable route does not cross any further watercourses along its route.

The ten survey sites are discussed in detail below in Section 4.1. All affected watercourses on the proposed development site were surveyed.

3.5.2 Baseline aquatic surveys

3.5.2.1 Site 1

The proposed wind farm cable route crosses the 5th order River Barrow (EPA Segment Code: 14_10477) at Site 1. This site is located at Kilnahown Bridge which is also a National Water Monitoring Station (Station code: RS14B010700). This segment of the River Barrow has been classified as 'not at risk' according to WFD. The waterbody has also been assigned a Good WFD (2010-2015) status. EPA monitoring is carried out at the site and the most recent water quality rating recorded was a Q value of 4, indicating 'Good' WFD water quality status.

Electrical fishing assessment of Site 1 in September 2019 determined that Atlantic salmon and Brown Trout were common with 0.8 fish/min and 1.2 fish/min CPUE recorded respectively. Minnow and Stone Loach were found at the site in small numbers. Dace were present at the site, with a CPUE recording of 0.2 fish/min from the assessment. The site also provided suitable Lamprey habitat and very low densities of Brook/River lamprey ammocoetes were present.

A total of 27 macroinvertebrate families were recorded at Site 1. Two Class A species were recorded at this site: *Ephemera danica* and *Ecdyonurus* sp. There were four Class B species recorded at this site, all in 'present' abundance with the exception of the cased caddis larvae *Sericostoma personatum* which was recorded in scarce / few numbers. A total of 15 Class C species were recorded at Site 1. Present in scarce/few numbers were the mayfly larvae *Serratella ignita*, the caseless caddis *Hydropsyche* sp, and the bug *Gerris* sp. The following Class C macroinvertebrates were present in Small Numbers: *Baetis rhodani, Similium* sp., Green chironomid, *Gyrinus* sp., and one species from the Veliidae family. Four group D species were recorded including *Asellus aquaticus* and Sphaeridae. No Class E species were recorded at this site.

This site was rated Q4 which is the equivalent to WFD status 'Good'. The rating was based on the presence of two Class A indicators being present. However, there was siltation and some algae growth at this site. No crayfish were recorded. No mussels were recorded however this stretch is likely to contain *Anodonta* spp. mussels. There is no suitable habitat for Freshwater Pearl Mussel at this site and this species does not occur in this part of the SAC.

3.5.2.2 Site 2

Site 2 is located on the 3rd order Clonygowan (EPA Segment Code: 14_1770) at the point where the R423 road, which the proposed cable route also runs along, crosses the watercourse. This site is located at the edge of the River Barrow and River Nore SAC, approximately 550 m upstream from where the Clonygowan tributary intersects the main River Barrow channel. The Clonygowan River's waterbody risk level has not been classified. The river has also not been assigned a WFD (2010-2015) status). This river segment is not monitored by the EPA and has no assigned Q ratings on record.

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The electrical fishing sampling that was carried out determined that there was very little fish in the Clonygowan River. Brown Trout and Three-spined Sticklebacks were the only fish present during the assessment of Site 2. Brown Trout were caught at a rate of 0.2 fish per minute and Sticklebacks were caught at a rate of 2 fish per minute. There was no potential Lamprey habitat at the site.

A total of 10 macroinvertebrate families were recorded at this site. No Class A species were recorded at this site. Only one group B species was recorded which was from the damselfly family Coenagrionidae present in small numbers. A total of 6 Class C species were recorded at Site 2. Class C species recorded as present were *Baetis rhodani, Gyrinus* sp., Haliplidae and Helphoridae. Present in scarce/ few numbers were *Serratella ignita* and *Gammarus duebeni*. Two Group D species were recorded: Dytiscidae and Lymnaeidae in small numbers and present, respectively. No Group E species were recorded at this site.

Site 2 was rated as Q3 which is the equivalent to WFD status 'Moderate'. This is a tiny stream and is not affected by the proposed wind farm – only the grid connection route. It does provide marginal habitat for Brown Trout and trout were recorded.

3.5.2.3 Site 3

Site 3 is located on the 2nd order Cottoner's Brook (EPA Segment Code: 14_1840), downstream of Garryinch Bog. This site is on proposed site's east border, parallel to a proposed access track, between turbines 5 and 6. There is an existing access track here. This watercourse is under review regarding the risk classification of the waterbody. There is no WFD (2010-2915) status assigned to the river either. The site is not monitored by the EPA.

This is a tiny polluted stream and no fish were present. This stream does not provide any potential habitat for fish. The site was heavily silted and there had been illegal rubbish dumping. Even during higher water levels this stream could not provide habitat for salmonids.

A total of 3 macroinvertebrate families were recorded at this site. No Class A or Class B species were recorded at this site. All species recorded at this site were Class C species. The macroinvertebrates recorded at this site were *Gyrinus* sp., *Gammarus duebeni* and one species from the family Veliidae.

This site is not suitable for applying a Q-rating however it is assessed as having 'Bad' water quality status.

3.5.2.4 Site 4

Site 4 is located on the 3rd order Cottoner's Brook (EPA Segment Code: 14_1031) less than 250 m upstream of its River Barrow confluence and approximately 2 km downstream of Site 3. The R423, and the wind farm cable route, crosses the Brook at this site. This waterbody's WFD risk level requires reviewing; there is currently no classification available from the EPA. There has also been no WFD (2010-2015) status assigned to the watercourse. This site is a National Water Monitoring Station (Station code: RS 14C150500). However, there are no up-to-date EPA Q ratings available for this site.

This site is heavily silted and modified and is little more than a drain. It could not support salmonids and lampreys even during higher flows. Its only importance is that it provides a pathway for conveying pollutants to the River Barrow.

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This is again a very small, polluted and heavily modified stream. It is not of any importance to fish or aquatic ecology. Only Three spined-sticklebacks and Minnows were recorded in small numbers. The stream was walked down to the River Barrow confluence and there is no suitable salmonid or lamprey habitat present. The site was also surveyed just upstream of the River Barrow confluence and again only small numbers of sticklebacks and minnows were recorded.

A total of 8 macroinvertebrate families were recorded at this site. No Class A or B species were recorded at this site. Five Class C species were recorded consisting of *Gyrinus* sp., *Gammarus duebeni*, Veliidae, *Hydrometra stagnorum* and *Gerris* sp. Class D species recorded at Site 3 comprised Hydrophillidae and Lymnaeidae which were recorded as being 'present'.

This site is not suitable for applying a Q-rating however it is assessed as having 'Poor' water quality status.

3.5.2.5 Site 5

Site 5 is located at Bay Bridge (EPA Segment Code: 14_1043) where the L20972 crosses the 4th order River Barrow downstream of the proposed site. This segment of the River Barrow is classified as 'at risk' by the WFD and has been given an WFD (2010-2015) status of Moderate. This site at Bay Bridge is also a National Water Monitoring Station (Station code: RS14B010400). The last EPA water quality rating recorded for this site was Q4 in 1989, indicating WFD status of 'Good'.

Electrical fishing was carried out at Site 5. Atlantic Salmon were present and were caught at a rate of 1.6 fish/min. Brown Trout were also present, with 2.4 fish caught per minute of fishing. Minnow were common with 5 fish caught per minute during the survey. Roach were also recorded at this site, with 1.4 individuals being caught per minute. An additional 3-minute juvenile Lamprey survey was also carried out as there was suitable Lamprey habitat at the site. However, no Lamprey was recorded in the survey.

There is salmon and trout spawning and nursery habitat at this site and these fish species were both present. No crayfish were recorded. No mussels were recorded however this stretch is likely to contain *Anodonta* spp. mussels. There is no suitable habitat for Freshwater Pearl Mussel at this site and this species does not occur in this part of the SAC.

A total of 23 macroinvertebrate families were recorded at this site. Only one Group A species was recorded at this site: *Ecdyonurus* sp. in present numbers (one specimen from below the bridge). A total of 6 Group B species were recorded at this site. Species in present numbers were recorded as *Limnephilus* sp., *Potamophylax* spp., Goeridae and Calopterygidae. Groupd B species present in scarce/few numbers were *Sericostoma personatum* and Coenagrionidae. Eleven Group C species were recorded at Site 5 on the River Barrow. Group C species recorded in small numbers consisted of *Baetis rhodani,* Green chironomid, *Gyrinus* sp. and *Potamopyrgus jenkinsi*. *Similium* sp. were present in common numbers. A total of 3 Group D species were recorded consisting of Lymnaeidae, Sphaeridae and *Asellus aquaticus.*

Site 5 was rated as Q3-4 which is the equivalent to WFD status 'Moderate'.

3.5.2.6 Site 6

Site 6 is located on the 1st order White Hill Stream (EPA Segment Code: 14_1748) near the White Hill (E) Stream water monitoring station (Station code: RS14W010200). The source of the White Hill (E)

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Stream is located in the proposed wind farm site. Site 6 is located a short south-westerly distance downstream of its source (which is located within the proposed wind farm site) and of the proposed site. The White Hill (E) Stream is an 'at risk' waterbody according to the WFD. This stream also has a WFD (2010-2015) status of Moderate.

Site 6 was dry at the time of the 2019 survey. It can therefore be concluded that this site is not of any significant ecological importance for Lamprey or other aquatic fauna. Additionally, no biological water quality assessment could be carried out at this site. Even if there was a flow at this site during wetter conditions this stream could not be of any aquatic ecological importance. It was just too small and is rated as not being of aquatic ecological importance. It is noted that the current survey was completed after a wet summer and this site was still dry.

3.5.2.7 Site 7

Site 7 is also located on the 2nd order White Hill (E) Stream (EPA Segment Code: 14_322), downstream from Site 6, close to the confluence of the stream with the River Barrow. The White Hill (E) Stream is classified as 'at risk' by the WFD and has a WFD (2010-2015) status of Moderate. The only water monitoring stations on this water course are located upstream of site 6 but there has been no recent monitoring and therefore there are no Q ratings available for this stream.

The aquatic survey carried out at Site 7 resulted in no fish being found. The site does not provide ideal habitat for salmonids or other fish species. Since no fish were present at this site and the Stream was partially dry during the survey (upstream at Site 6) was dry, the White Hill (E) Stream is therefore not considered to be an important watercourse for aquatic ecology. A total of 6 macroinvertebrate families were recorded at Site 7. No Class A or Class B species were recorded at this site Group C species recorded consisted of *Baetis rhodani,* Green Chironomid, *Gammarus duebeni* and Veliidae. One group D species was recorded at this site: Lumbriculidae. *Chironomus* sp. was the only Group E species recorded.

No Q rating could be assigned to this site due to the low number of macroinvertebrates recorded, but it is rated as being “Poor” status.

3.5.2.8 Site 8

Site 8 is located on the 1st order Forest Upper Stream (EPA Segment Code: 14_1592) in Garryinch Bog. The site is located south of the stream's source, which is in the northern section of the proposed wind farm site. This watercourse is classified as 'at risk' by the WFD and has a WFD (2010-2015) status of Moderate. This area is not monitored by the EPA and there is therefore no Q rating available for it.

No fish were present in the Forest Upper Stream at Site 8 during the September 2019 survey. There was no potential Lamprey habitat at this site. This site is not of fisheries / aquatic ecological importance. A total of 5 macroinvertebrate families were recorded at this site. Group C species that were recorded as present at this site were *Gyrinus* sp. and *Gerris* sp. Present in scarce/ few at this site was the Group C species *Gammarus duebeni* and Group D species Lymnaeidae. Veliidae were also present in common numbers. No Q Rating could be assigned to Site 8 - it is rated as being “Poor” status.

3.5.2.9 Site 9

Site 9 is located on the 2nd order Forest Upper (EPA Segment Code: 14_1057), downstream of Site 8 and of the proposed wind farm site, which the stream flows through. The site is a short distance

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(approximately 65 m) upstream of its confluence with the River Barrow. The Forest Upper Stream is classified as 'at risk'. It has a WFD status of Moderate. There are no water monitoring stations located on the Forest Upper Stream and no Q values have been assigned to the watercourse.

Similar to Site 8, which is also located on the Forest Upper Stream, at Site 9 no fish were present. A total of 3 macroinvertebrate families were recorded at Site 9, therefore no Q rating could be assigned due to low numbers. No Class A or Class B species were recorded at this site. Present at this site were the Group C species *Gyrinus* sp., Veliidae and *Gerris* sp. No Q Rating could be assigned to Site 8 - it is rated as being “Poor” status.

3.5.2.10 Site 10

Site 10 is located on the 4th order River Barrow (EPA segment code: 14_1053) to the West of the proposed site. The N80 crosses the River Barrow, at site 10, approximately 5km North-West of Mountmellick. There is a National Water Monitoring Station, Twomile Bridge (Station code: RS14B010300), located at this site where biological water monitoring is carried out. In 2018 this site was rated Q4-5 by the EPA, corresponding to a 'High' WFD status. The waterbody is classified as 'not at risk' by the WFD at this point. This watercourse also has a WFD (2010-2015) status of 'Good'.

Juvenile Atlantic salmon and Brown Trout were present at this site. The CPUE for each from the survey was 0.4 Salmon per minute and 1.2 Trout per minute. Stone Loach and Three-spined stickleback were Common. Dace were present and recorded at a CPUE rate of 0.8 fish per minute. No Lamprey were found during the surveying. No mussels were recorded however this stretch is likely to contain *Anodonta* spp. mussels. There is no suitable habitat for Freshwater Pearl Mussel at this site and this species does not occur in this part of the SAC.

A total of 20 macroinvertebrate families were recorded at this site. Only one Class A species was recorded: *Ephemera danica*. Three Group B species were recorded at this site and consisted of *Potamophylax* spp., Calopterygidae, and Aeshnidae. *Baetis rhodani* and Similium sp., both Group C species, were present in Numerous numbers. *Hydropsyche* spp. another Group C species, was present in small numbers. Group C species recorded as present at this site consisted of *Dicronota* sp., *Anodonta anatine*, Nepidae, Corixidae, *Gerris* sp. and water mites. Two Group D species were recorded at this site: Sphaeridae and *Asellus aquaticus.* Site 10 was rated as Q3-4 which is the equivalent of WFD status ‘Moderate’. This rating is lower than the EPA rating given in 2018. However, there was only one Class A indicator recorded in the kick sample completed for the current survey, and the river was visibly silted with filamentous algae also present. Further monitoring would be required at this site to establish the discrepancy between the EPA rating in 2018 and the current assessment. However, the EPA rating of Q4-5 would seem to be very high for a channelised watercourse draining a catchment with extensive agricultural activities and bog workings. If one additional Class A indicator was recorded in the current survey the rating would have been Q4. Biological water quality ratings can vary from year to year and the extreme drought in the summer of 2018 followed by the wet summer of 2019 will have influenced the biological community at this location.

3.5.2.11 Site 11

Site 11 is located on the 2nd order White Hill (W) Stream (EPA segment code: 14_1124), south-east of the proposed Wind Farm site, where the L20972 road crosses the watercourse. This site is located approximately 400 m upstream of the White Hill (W) confluence with the Barrow. The WFD classify the White Hill (W) Stream as being 'at risk' and it has a WFD (2010-2015) status of Moderate. There has

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been no recent EPA water quality monitoring on the watercourse and there are no Q ratings available for the stream.
Electrical fishing was not carried out at Site 11 as there was no suitable habitat available at the location. The White Hill (W) Stream is not important for aquatic ecology and is a tiny and heavily modified stream.

A total of 5 macroinvertebrate families were recorded at this site. Only one Group B species was recorded at this site, Calopterygidae in scarce/few numbers. Green chironomid, a Group C species, were also present in scarce/few numbers. Group C species recorded as present at this site consisted of Veliidae, *Gerris* sp., and water mites. *Gammarus duebeni* were numerous at Site 11. No Q Rating could be assigned to Site 11 - it is rated as being “Poor” status.

3.5.3 Annex I habitat

The Annex I habitat ‘Water courses of plain to montane levels with the *Ranunculion fluitantis* and *Callitricho-Batrachion* vegetation [3260]’ was not present at any of the survey sites.

3.5.4 Non-native invasive species

The Jenkin’s spire shell *Potamopyrgus jenkinsi* was recorded at Sites 1 and 5. No other non-native invasive species were noted at any of the survey sites.

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4. GENERAL POTENTIAL IMPACTS

4.1 Proposed Wind Farm Site

The proposed Dernacart Wind Farm site is located to the north of the town of Mountmellick. The proposed site lies between the north-eastern banks of the River Barrow and the south-western borders of Garryinch Bog. The 1st order Dernacart Stream (EPA Segment Code: 14_1948) forms the most northerly border of the site. The site is narrow as it extends southwards, along the western edge of the bog. The site widens out to the south of the bog and extends as far east as the 2nd order Cottoner's Brook (EPA Segment Code: 14_1840). The area includes several streams, mainly 1st order streams, of the Barrow catchment.

The furthest upstream watercourse is the 1st order Dernacart Stream (EPA Segment Code: 14_1351). This insignificant stream is on the boundary of the site and would not receive any drainage from construction areas. There is a ridge between this stream and the nearest proposed construction area at T1. Moving downstream the site is also near a 1st order unnamed tributary of the Dernacart South Stream (EPA Segment Code: 14_917), a 1st order tributary of the Forest Upper Stream (EPA Segment Code: 14_1351), 1st order and 2nd order sections of the Forest Upper Stream (EPA Segment Codes: 14_1592 and 14_1055), the 1st order White Hill (E) Stream (EPA Segment Code: 14_1748) and an unnamed 1st order tributary of the White Hill (E) Stream (EPA Segment Code: 14_870). The 1st order White Hill (W) Stream (EPA Segment Code: 14_1732) and an unnamed 1st order tributary of the same stream (EPA Segment Code: 14_1441) rise within, and flow through, the centre of the main site area. The site also covers part of the 2nd order Cottoner's Brook (EPA Segment Code: 14_1840) at the eastern border.

The main concerns for the aforementioned receiving watercourses with the construction of the wind farm is regarding indirect impacts affecting water quality, such as accidental releases of silt laden runoff. There is also potential for the project to impact on aquatic ecology due to the risk of accidental spillages of cement or hydrocarbons that will be stored on site which may be an issue in terms of the effect on water quality. Waste from on-site toilets and wash facilities also have the potential to impact on aquatic ecology. There will also be felling of forestry on the site; the unnamed tributary of the Forest Upper stream is within the felling buffer for T3 and the White Hill (W) stream passes though the felling buffer around T8. Disturbance of soil during site preparation including felling will cause disturbance of soil which could increases runoff of suspended solids.

The aquatic assessments at survey sites on White Hill (E), White Hill (W), Forest Upper and Cottoner's Brook determined that these watercourses are not of aquatic ecological significance and therefore, should not be sensitive to significant impacts from the proposed wind farm. All wind turbines are more than 50 m from any watercourse on the site providing a sufficient buffering zone which will limit any possible impacts of excavation and construction works on the water. The watercourses on the proposed wind farm site are also all small, low gradient with many being partially dry. This limits their ability to convey pollutants downstream to the River Barrow.

The River Barrow is designated with the River Barrow and River Nore SAC within the study area. However, this part of the river is already very degraded as a result of existing background activities, especially agriculture. It does not contain highly sensitive species such as Freshwater Pearl Mussel. The small size and low gradient of the watercourses draining the proposed development site will make it relatively easy to protect water quality with standard water quality protection mitigation.

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4.2 Internal Access Track

Most of the access tracks and cable routes to be used for the site will be existing roads, some of which cross or run alongside watercourses. Although these roads are already in place many will require significant works and improvements in order to facilitate the heavy vehicles to and from the site. Therefore, these works must be included in terms of having potential impacts on the nearby streams.

Access tracks will be built within the wind farm site to access proposed turbine locations. The proposed internal tracks will begin at the source of an unnamed 1st order stream (EPA Segment Code: 14_917), near the junction of the L2092 Road with the N80. The tracks then progress south to Turbine 1 and south-east to Turbine 2 in the wind farm site. The track crosses the 1st order Forest Upper Stream as it passes through the Garryinch Bog before Turbine 3. As the track leaves the south side of the bog (north edge of the wind farm site), it also passes the source of another 1st order stream (an unnamed tributary of the Forest Upper Stream) (EPA Segment Code: 14_1351). After this point the track divides in two directions. One track moves northerly to Turbines 4, 5 and 6. This track ends at Turbine 6, after it runs alongside the 2nd order River Cottoner's Brook (EPA Segment Code: 14_1840) for 285 m (Site 3 on the wind farm site border). The other fork of the track extends in the opposite direction towards the southerly Turbine 7 and Turbine 8.

There is potential for the proposed access tracks to have a negative effect on water quality in the streams which theses tracks intersect or come in close proximity to. Although these access tracks mainly consist of pre-existing roads it is likely that these roads will require improvements to facilitate large machinery. These works have potential to alter flow paths and disturb sediment which could result in run-off entering the nearby watercourses causing pollution of water both localised and potentially in downstream watercourses, including the River Barrow, also.

Aquatic assessment of the Forest Upper Stream and of Cottoner's Brook watercourse indicate that these watercourses are not ecologically important for fish and therefore the access tracks that come within close proximity to these watercourses do not pose a significant threat to the localised aquatic habitats and/or fauna at the proposed wind farm site. The small size and low gradient of the watercourses draining the proposed development site will make it relatively easy to protect water quality with standard water quality protection mitigation.

4.3 Cable Route

The cable route begins on the access track between Turbine 5 and Turbine 6 at the eastern site border. It runs along a section of the site border beside the 2nd order Cottoner's Brook (EPA Segment Code: 14_1840) at Site 3 and running alongside the stream for a further 213 m. The route then travels in a southerly direction, running alongside an unnamed stream (EPA Segment Code: 14_919) for c. 450m and crosses the 2nd order Forest Lower Stream via an existing track (EPA Segment Code: 14_418). The route then travels south and crosses over the 2nd order White Hill (W) Stream (EPA Segment Code: 14_1124), following the route of the existing L20978 road. This road runs adjacent to this stream for c. 315m. The route then crosses this stream again before turning south and then north, following the L20972 road and crossing the White Hill (W) Stream for the third time. After this it crosses another unnamed stream (EPA Segment Code: 14_863) which flows into the White Hill (W) Stream. After this it connects with the R423 Road and the route continues north-east and intersects the 3rd order Cottoner's Brook (EPA Segment Code: 14_1031) again at Site 4 which is along the existing road.The route continues along the R423 path in that direction, intersecting the 3rd order Clonygowan Stream (EPA Segment Code: 14_1770) at Site 2 and also an unnamed 1st order stream (EPA Segment Code: 14_1715) and the 1st order Rathmore Stream (EPA Segment Code: 14_1514). It then follows the

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L71762 Road around Portarlington Golf course and intersects the 5th order River Barrow (EPA Segment Code: 14_1644) at Kilnahown Bridge (Site 1) near the Kilbride Stream confluence. The cable route then runs directly alongside the 1st order Kilbride Stream (EPA Segment Code: 14_1645) for approximately 1.1 km. The route then moves in a more north-easterly direction to Doolough cross and then follows the L3157 Road north towards Portarlington town. The route then incepts the Canal Road and continues on the same path through Portarlington to the Lea Road. The cable route ends on the Lea Road, after Jamestown Profiling Ltd. and Lyman's Crossroads.

Although the impacts of the cable route construction would not be as significant as the impacts from the works on the main wind farm site, the cable route connection is the only part of the proposed constructions that comes into direct contact with the main channel of the River Barrow and the River Barrow and River Nore SAC. Excavation work on cable works has the potential to destabilise sediment and cause run-off into watercourses impacting on the water quality and ecological habitat. Most of the cable route connection runs alongside rivers and along pre-existing roads therefore these areas should not be of particularly sensitive to the impacts of the cable route. However, the main concern relates to where the route directly crosses watercourse, particularly the River Barrow where there is a higher risk of sediment entering the water and impacting on the aquatic ecology.

These majority of the watercourses with which the cable route comes into contact with or within close proximity which have been included in the current aquatic surveying have not been found to be of significant aquatic ecological importance. The main area of concern is where the cable route crosses the main channel of the River Barrow. Detailed site-specific mitigation will be required for here.

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5. GENERAL MITIGATION MEASURES

The following proposed mitigation measures are general. Since the proposed wind farm site and cable route intersects and comes within close proximity to various watercourses within the Barrow catchment the project has potential to impact on the River Barrow and River Nore SAC. For this reason, the project will require a Natura Impact Statement (NIS) outlining the impacts that the project will have on these watercourses and subsequently on the SAC.

5.1 Proposed Wind Farm Site

A Construction Environmental Management Plan (CEMP) will be prepared on the final project plan. This will be distributed and discussed for consultation and with all parties involved in the project to ensure the protection of aquatic interests within the study area. A Surface Water Management Plan will be included in the CEMP and will have regard to the '*Guidelines for the crossing of watercourses during the construction of national road schemes*' (NRA, 2008b), the '*Guidelines on Protection of Fisheries During Construction Works in and Adjacent to Waters*' (IFI, 2016) and the '*Forestry and Water Quality Guidelines'* by Forest Service (2000). This is considered to be the key mitigation measure for the protection of aquatic species located in downstream receiving waters. The Surface Water Management Plan will set out measures to avoid siltation, erosion, surface water run-off and accidental pollution events which all have the potential to adversely affect water quality within the site during the construction phase. It will also include preparatory works on the site, including the installation of silt fences and bunds.

The risk of sedimentation runoff will be minimised through designing access tracks that require minimal excavation on site. It is noted that there are no new watercourse crossings proposed, but existing tracks will have to be upgraded. The access track crossing the Forest Upper stream between T2 and T3 will be upgraded with a pre-cast bottomless culvert. There will be sealed silt fences placed at both sides of watercourse crossing points and to a minimum of 10m upstream and downstream of each crossing at both sides of the road as well as any locations where works run adjacent to watercourses. A berm will be constructed on the access track to Turbine 6 which runs adjacent to the Cottoner's brook stream.

Turbines and infrastructure will be constructed at a minimum of 50m from any watercourses within the site with the exception of watercourse crossings and site tracks that are pre-existing. Any of the existing watercourse crossings that have to be upgraded will not involve any instream works, and if changes to the crossings are required, only clear span bridges / bottomless culverts will be used. Silt fences will also be used for protecting streams where access tracks come within proximity. An on-site quality management system will be set out in the CEMP and will include maintenance and monitoring of the silt fences. In constructing and designing silt traps, attention will be paid to rainfall levels and intensity. The silt traps should be designed to minimise the movement of silt especially during intense precipitation events where the trap maybe hydraulically overloaded. It is essential that they are located with good access to facilitate monitoring sampling and maintenance.

Spoil heaps from excavations for turbine bases and cable trenches will be covered with geotextiles. Any stockpiling of materials will be at least 50m back from any watercourses. Sediment from surface water run-off and excavated material will be filtered by surrounding silt fences. Berms will be covered with a geo-textile matting to avoid sediment runoff; and will be surrounded by silt fencing until vegetation has been established in the following growing season. If cables will be installed on site in trenches, they will be located underneath and directly adjacent to access tracks as far as possible. Trench excavation will take place during dry periods where possible in short sections and left open for minimal periods to avoid acting as channel for surface water flows.

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An Emergency Erosion and Silt Control Response Plan will be included as a precautionary measure in the CEMP which will detail the required measures to implement in the event of a 'worst case' scenario on the site. Timing of the proposed works near any watercourse or other works which may impact directly on a watercourse will also take account of the fisheries constraints (such as the salmonid open season from 1st July to the 30th of September) within the study area.

Secure concrete washout areas will be designated on site and not located within 50m of any watercourse. Standing water in the excavations at the turbine bases will contain an increased concentration of suspended solids. Therefore, excavations will be pumped into temporary lined settlement basins as necessary which will be constructed prior to the excavations and will drain into existing or proposed drainage channels on the site. Settlement ponds will be maintained, where appropriate, during the operational phase to allow for the adequate settlement of suspended solids and sediments and prevent any deleterious matter from discharging into any natural waters.

Wheel washing facilities, which drain to silt traps will be provided at the site entrance. Additional silt fencing will be kept on site for ongoing maintenance. Portaloos will be used as toilet facilities for site personnel. Sanitary waste will be removed from site via a licensed waste disposal contractor and will not be discharged on site.

Any diesel or fuel oils stored on site will be bunded to 110% of the capacity of the storage tank and will not be located near any drain or watercourse. Fuel tanks will be designed and stored in accordance with best practice guidelines. Refuelling will be carried out on a designated concrete pad, draining to an oil interceptor, away from watercourses. Drip trays and spill kits will be available on site, as well as appropriate containment facilities to ensure that any spills from the vehicles are contained and removed off site.

Appropriate preventative measures will be detailed within the CEMP to ensure that non-native aquatic/riparian species are not introduced into the site. These measures should follow as relevant the manual *'The Management of Noxious Weeds and Non-Native Invasive Plant Species on National Roads*' by NRA (2010).

5.2 Cable Route

A Construction Environmental Management Plan (CEMP) will also be prepared for the final cable route. This will again include a Surface Water Management Plan will be included in the CEMP. The Surface Water Management Plan will set out measures to avoid siltation, erosion, surface water run-off and accidental pollution events which all have the potential to adversely affect water quality within the site during the construction phase of the cable route.

There will be no instream works. Watercourse crossings will be undertaken by directional drilling within the bridge structures. This will ensure that there is no direct impact on the River Barrow channel. The other watercourses will also be crossed in this way. Strict mitigation will be used to protect water quality. Strict biosecurity measures will be also be implemented. A detailed CEMP/WMP will be prepared and relevant NRA and IFI guidelines (given in Section 5.1) will be followed.

During the construction of the proposed cable route, waste materials may be generated such as excavated soil/stone and other materials during the trenching phase for any underground routes and constructing the pole sets for any overhead lines. This waste will be disposed of through a registered waste company and will not be used for infilling any areas other than those areas excavated in the proposed grid route. There will be no permanent stockpiles above existing ground levels. Any temporary

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storage of excavated material will be in assigned areas, in habitats of low ecological value (artificial surfaces, etc.) and 50m back from any watercourses. Any spoil heaps from excavations for cable trenches will be covered with geotextiles. If cables will be installed in trenches, they will be located underneath and directly adjacent to access tracks as far as possible. Portaloos will be used to provide toilet facilities for site personnel in fenced off site compounds on habitats of low ecological value (artificial surfaces, etc.). Silt fences should be installed along the length of the cable route that runs adjacent to the Kilbride Stream. If trenches will be dug for the cable route along this stretch, a berm will be constructed on the south-west side facing the Kilbridge stream to ensure no surface water run-off reaches this stream. Upon completion of the works at each section of any underground sections of the proposed grid route, there will be a site cleanup.

Appropriate preventative measures have been detailed within the outline CEMP to ensure that non-native aquatic/riparian species are not introduced into the site. These measures should follow as relevant the manual by NRA (2010).

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6. RESIDUAL IMPACTS

The proposed Dernacart Wind Farm has the potential to have a negative localised impact on aquatic ecology and the River Barrow and River Nore SAC during the construction of the project. However, most of the streams affected by the construction are very small 1st order streams and do not support a significant level of aquatic ecology. There can therefore be no direct impact (even without mitigation) on salmon, lampreys or crayfish populations as they do not exist in these watercourses.

The slight impacts that the project would have can be reduced and minimised to an imperceptible level if the proposed mitigation measures are implemented and adhered to. The small size and low gradient of the watercourses draining the proposed development site will make it relatively easy to protect water quality with standard water quality protection mitigation.

The main concerns with the project are in relation to required watercourse crossings and developments involving any access tracks that run alongside watercourses. However, the limitation through the mitigation measures of indirect impacts arising from water quality pollution events such as siltation and run-off of suspended solids will significantly reduce the potential for impacts affecting aquatic ecology impacts within the site.

All mitigation measures provided for the protection of aquatic ecology and fisheries within the proposed development site, as well as the mitigation measures for water quality protection to be detailed in the CEMP/Surface Water Management Plan, will effectively protect aquatic ecological interests downstream of the proposed development.

It is important to note that if the mitigation measures proposed for the minimisation of impacts affecting aquatic ecology and fisheries are not implemented, it would negate the results of the impact assessment provided in the current assessment.

Table 3 Impacts, Mitigation measures and residual impacts for the affected watercourses on the proposed wind farm site.

Watercourse	Impacts	Mitigation Measures	Residual Impacts
Dernacart Stream (EPA Code: 14D08)	Water Quality (surface water run-off, suspended solids, accidental spillages of cement / hydrocarbons, waste from on-site toilets)	Strict mitigation will be used to protect water quality. Strict biosecurity measures will be implemented on the site. A detailed CEMP/WMP will be prepared and NRA and IFI guidelines will be followed.	Imperceptible water quality impacts
Forest Upper Stream (EPA Code: 14F07)	Water Quality (surface water run-off, suspended solids, accidental spillages of cement / hydrocarbons, waste from on-site toilets), Direct impacts due to upgrades of existing track over this watercourse (access track from T2 to T3)	Strict mitigation will be used to protect water quality. Strict biosecurity measures will be implemented on the site. A detailed CEMP/WMP will be prepared and NRA and IFI guidelines will be followed.	Imperceptible water quality impacts
Unnamed tributary of Forest Upper Stream (EPA Segment Code: 14_1351)	Water Quality (surface water run-off, suspended solids, accidental spillages of cement / hydrocarbons, waste from on-site toilets)	Strict mitigation will be used to protect water quality. Strict biosecurity measures will be implemented on the site. A detailed CEMP/WMP will be prepared and NRA and IFI guidelines will be followed.	Imperceptible water quality impacts
White Hill (E) Stream (EPA Code: 14W01)	Water Quality (surface water run-off, suspended solids, accidental spillages of cement /	Strict mitigation will be used to protect water quality. Strict biosecurity measures will be implemented on the site. A detailed	Imperceptible water quality impacts

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Watercourse	Impacts	Mitigation Measures	Residual Impacts
	hydrocarbons, waste from on-site toilets)	CEMP/WMP will be prepared and NRA and IFI guidelines will be followed.	
Unnamed tributary of White Hill (E) Stream (EPA Segment Code: 14_870)	Water Quality (surface water run-off, suspended solids, accidental spillages of cement / hydrocarbons, waste from on-site toilets)	Strict mitigation will be used to protect water quality. Strict biosecurity measures will be implemented on the site. A detailed CEMP/WMP will be prepared and NRA and IFI guidelines will be followed.	Imperceptible water quality impacts
White Hill (W) Stream (EPA Code: 14W02)	Water Quality (surface water run-off, suspended solids, accidental spillages of cement / hydrocarbons, waste from on-site toilets)	Strict mitigation will be used to protect water quality. Strict biosecurity measures will be implemented on the site. A detailed CEMP/WMP will be prepared and NRA and IFI guidelines will be followed.	Imperceptible water quality impacts
Unnamed Tributary of White Hill (W) Stream (EPA Segment Code: 14_1441)	Water Quality (surface water run-off, suspended solids, accidental spillages of cement / hydrocarbons, waste from on-site toilets)	Strict mitigation will be used to protect water quality. Strict biosecurity measures will be implemented on the site. A detailed CEMP/WMP will be prepared and NRA and IFI guidelines will be followed.	Imperceptible water quality impacts
Cottoner's Brook (EPA Code: 14C15)	Water Quality (surface water run-off, suspended solids, accidental spillages of cement / hydrocarbons, waste from on-site toilets), Access track to T6 runs adjacent so potential for water quality impacts arising from construction of track and from operational phase of wind farm	Strict mitigation will be used to protect water quality. Strict biosecurity measures will be implemented on the site. A detailed CEMP/WMP will be prepared and NRA and IFI guidelines will be followed.	Imperceptible water quality impacts

Table 4 Impacts, Mitigation measures and residual impacts for the affected watercourses along the proposed cable route.

Watercourse	Impacts	Mitigation Measures	Residual Impacts
Cottoner's Brook (EPA Code: 14C15)	Habitat loss/disturbance, water pollution and non-native invasive species are key potential impacts. Only River Barrow contains significant aquatic ecological receptors, but other streams can act as pathway for water pollution.	Crossing will be undertaken within the existing bridge using directional drilling. A detailed method statement for this will be prepared and included in the NIS. There will be no instream works in any of these streams or the River Barrow. There will therefore be no direct impacts on any of these watercourses. Strict mitigation will be used to protect water quality. Strict biosecurity measures will be implemented on the site. A detailed CEMP/WMP will be prepared and NRA and IFI guidelines will be followed.	Imperceptible water quality impacts
Forest Lower Stream (EPA Segment Code: 14_418)			
Unnamed 1st order stream (EPA Segment Code: 14_863)			
Clonygowan Stream (EPA Segment Code: 14_1770)			
Unnamed 1st order stream (EPA Segment Code: 14_1715)			
Rathmore Stream (EPA Segment Code: 14_1514)			
River Barrow (EPA Segment Code: 14_1644)			
Kilbride Stream (EPA Segment Code: 14_1645)			

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PLATES

Plate 1 Site 1 on the River Barrow during September 2019.

Plate 2 Electrical fishing survey at Site 1 on the River Barrow during September 2019.

Plate 3 Juvenile Atlantic salmon and Stone Loach from Site 1 on the River Barrow during September 2019.

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Plate 4 Dace from Site 1 on the River Barrow during September 2019.

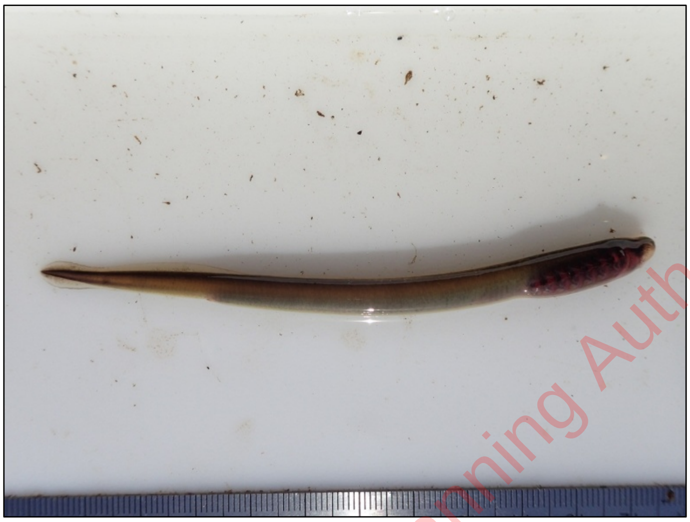

Plate 5 Brook/River lamprey ammocoete from Site 1 on the River Barrow during September 2019. Only one lamprey was recorded during the current survey.

Plate 6 Site 2 on the Clonygowan Stream during September 2019.

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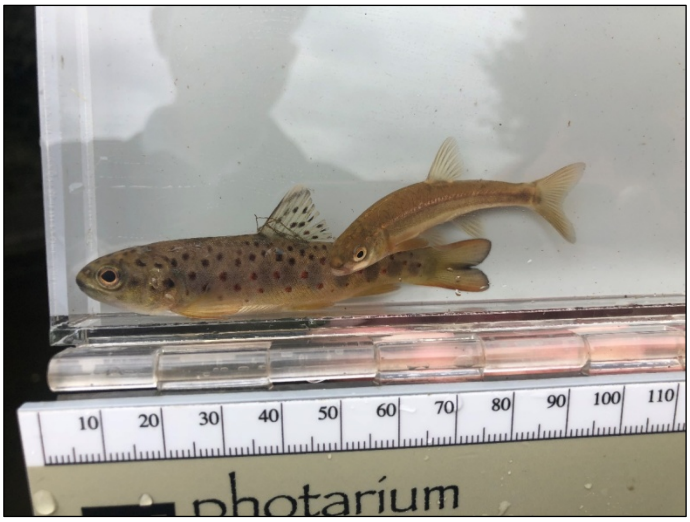

Plate 7 Brown trout and Minnow from the Clonygowan Stream during September 2019.

Plate 8 Three-spined sticklebacks from Site 2 on the Clonygowan Stream.

Plate 9 Site 3 on the Cottoners Brook during September 2019.

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Plate 10 Rubbish dumping at Site 3 on the Cottoners Brook during September 2019.

Plate 11 Site 4 on the Cottoners Brook during September 2019.

Plate 12 Heavy siltation on the Cottoners Brook during September 2019.

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Plate 13 Additional dip net survey on the Cottoners Brook just upstream of the River barrow confluence, September 2019.

Plate 14 Three-spined sticklebacks from the lower reaches of the Cottoners Brook.

Plate 15 *Gammarus* spp. were the most common macroinvertebrate recorded.

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Plate 16 The confluence of the Cottoners Brook and River Barrow during September 2019.

Plate 17 Extensive erosion was recorded on the River Barrow immediately upstream of the confluence of the Cottoners Brook.

Plate 18 River Barrow at Borness (upstream of Cottoners Brook confluence). Extensive impacts from agricultural activities were apparent.

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Plate 19 River Barrow at Site 5 during September 2019.

Plate 20 Juvenile Atlantic salmon from the River Barrow at Site 5.

Plate 21 Stone Loach were common at Site 10.

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Plate 22 Eutrophication apparent at Site 1 on the River Barrow during September 2019.

Plate 23 Damselfly larvae were common at the River Barrow sites.

Plate 24 Site 6 on the White Hill (E) Stream – dry at the time of the September 2019 survey.

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Plate 25 Site 7 on the White Hill (E) Stream, September 2019.

Plate 26 Site 8 on the Forest_Upper stream, September 2019.

Plate 27 Site 9 on the Forest_Upper stream, September 2019.

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Plate 28 Electrical fishing survey on the River Barrow at Site 10, September 2019.

Plate 29 Dip net survey on the River Barrow at Site 10, September 2019.

Plate 29 Brown trout from the River Barrow at Site 10, September 2019. Salmon were also present at this site.

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Plate 30 Minnows were common in the River Barrow at Site 10.

Plate 31 Heavy siltation on the River Barrow at Site 10, September 2019.

Plate 32 Site 11 on the White Hill (W) Stream, September 2019.

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APPENDIX 1 CONSULTATION

Dr. Elaine Bennett
Fehily Timoney & Company
Core House
Pouladuff Road
Cork T12 D773
18.07.2019
Re. Proposed Windfarm at Dernacart, Co. Laois

Dear Sir/Madam,

Thank you for your email dated July 5th requesting consultation from IFI on the proposed Windfarm at Dernacart, Co. Laois.

Please find below our initial concerns and recommendations in relation to this development:

1. All watercourses that will receive drainage from the construction sites of the turbines or the access roads must be assessed in terms of aquatic biodiversity with particular emphasis on fish, the food of fish, spawning grounds and fish habitat in general. In this regard changes to river morphology should be avoided.

2. The aquatic habitat and physical nature of any watercourse affected by the development must be fully described in detail. This includes areas of open water, pool riffle glide sequences, density and types of aquatic vegetation, description of riparian zones to distance of at least 10 metres on either bank etc. The extent of the surveys should be sufficiently long so as to be representative of the habitat contained in that watercourse. There should be a particular focus on sections upstream and downstream of any point where an impact on the watercourse is likely to arise. It may be appropriate to survey a tributary stream and the larger, more important streams it joins, and assess the effect the discharge might further have on biodiversity and fisheries in the larger streams. Surveys of un-impacted (control) streams should also be included in the EIAR.

3. Electrofishing surveys will be required for all waters. Quantitative data in relation to all fish species should be compiled. The presence of salmonid species, crayfish and lamprey species will be of particular concern. In undertaking the electrofishing survey only experienced personnel should be employed. Appropriate permits for electrofishing must be obtained from the Department of Communications, Energy and Natural Resources. Authorised personnel must ensure that they comply with all the conditions contained in the permit.

4. We are concerned about soils, their structure and types around all turbines, turbine pads, associated access roads and site development. In particular we have concerns about the stability of the soils and the impact that works on both the turbines and access roads will have either directly or by vibration on the stability of the soils.

5. IFI strongly recommends that specialist personnel are employed to assess soil strength and suitability of the ground at each site and along any proposed access road. This is particularly important in relation to the peat soils in the area. IFI may have difficulties with development on peat soils where the peat depth exceeds one metre. The potential for soil movement and landslides should be assessed fully within the EIAR.

6. Particular attention should be paid to the hydrology of any site where excavations including excavations for road construction are being undertaken. It is important that natural flow paths are not interrupted or diverted in such a manner as to give rise to erosion or instability of soils caused by an alteration in water movement either above or below ground.

7. Attention should be paid to drainage during both the construction phase and the operational phase. This includes waters being pumped from foundations or other excavations. It is

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particularly important during the construction phase that sufficient retention time in the settlement pond is available to ensure no deleterious matter is discharged to any waters. We strongly recommend that settlement ponds are maintained, where appropriate, during the operational phase to allow for the adequate settlement of suspended solids and sediments and prevent any deleterious matter from discharging into any natural waters. In constructing and designing silt traps, particular attention should be paid to rainfall levels and intensity. The silt traps should be designed to minimise the movement of silt especially during intense precipitation events where the trap maybe hydraulically overloaded. It is essential that they are located with good access to facilitate monitoring sampling and maintenance. A license to discharge to waters may be required from the local authority.

8. IFI are also concerned about the construction of roads as these will tend to provide preferential flow paths for surface waters. Considerable detail must be provided in relation to the interception of surface water flows. Normal flows paths should be maintained both during and after construction. Situations can arise where water transportation is significantly increased in certain watercourses thereby putting additional pressures on watercourses and interfering with the sustained flow of water particularly during dry weather. This should be avoided. The use of sedimentary rocks, such as shale, in road construction should be avoided. This type of material has poor tensile strength and is liable to be crushed by heavy vehicles thereby releasing fine sediment materials into the drainage system which are difficult to precipitate and may give rise to water pollution. We recommend that specialist expertise should advise on the type of material required for road construction bearing in mind the pressures that will arise during the construction phase and the necessity to avoid pollution due to fines washing out into the roadside drainage.

9. Attention should be paid to material stockpiles and their location. Drainage from disturbed and stockpiled soils will have to be considered in advance. It may be necessary to stockpile in confined areas only. Consideration must be given to runoff from any stockpiles. It should be noted that cement leachate, hydrocarbon oils and other toxic poisonous materials will require full containment and should not be permitted to discharge to any waters

10. IFI should be consulted advance in relation to crossings of watercourses or the use of any temporary diversions, with final design to be approved by IFI. When designing crossings, the length, the slope and width of any instream structure will be important. Clear span bridges are the preferred option for crossings especially in upland areas.

11. Please also note that any instream works or other works which may impact directly on a watercourse should only be carried out during the open season which is from 1 st July to 30 th of September in each year (so as to avoid impacting on the aquatic habitat during the spawning season.) It would be important that appropriate scheduling of works is allowed for.

12. Following a site inspection, a number of drains were noted that while currently dry have a hydrological connection to the River Barrow. These should be included in any drainage assessment.

13. The proposed methodology for and locations of the cable route watercourse crossings should also be examined in detail. This is particularly important for the proposed Barrow crossing SW of Portarlington and for the crossing of Cottoner's Brook.

Given the proposal is preliminary in nature, the above comments and observations are generic and the specific requirements may change with the final development design. Should you require any further information or clarification from IFI, please do not hesitate to contact me.

Yours sincerely,
Jane Gilleran
Fisheries Environmental Officer
Inland Fisheries Ireland - Clonmel

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APPENDIX 2 RESULTS

Table A2.1 Summary results of the electrical fishing surveys undertaken at the 10 survey sites during September 2019. Each site was fished for 5 minutes and an additional 3 minutes was spent surveying for juvenile lampreys.

Site	Watercourse Name	Atlantic salmon	Brown Trout	Brook Lamprey	Minnow	Three-spined stickleback	Stone Loach	Dace	Roach
1	Barrow	***	***	*	**		**	*	
2	Clonygowan		*			*			
3	Cottoners Brook								
4	Cottoners Brook				**	**			
5	Barrow	***	**		***		*		**
6	White Hill (E) Stream								
7	White Hill (E) Stream								
8	Forest_Upper								
9	Forest_Upper								
10	Barrow	**	**		*	**	***	*	*
11	White Hill (W) Stream								

*Present, **Small Numbers, ***Common, ****Numerous

Table A2.2 Results of the 5-minute electrical fishing surveys at the 10 survey sites (CPUE catch/min).

Site	Watercourse Name	Atlantic salmon	Brown Trout	Minnow	Three-spined stickleback	Stone Loach	Dace	Roach
1	Barrow	0.8	1.2	3.2	0	1	0.2	0
2	Clonygowan	0	0.2	0	2	0	0	0
3	Cottoners Brook	0	0	0	0	0	0	0
4	Cottoners Brook	0	0	2	2.4	0	0	0
5	Barrow	1.6	2.4	5	0	1	0	1.4
6	White Hill (E) Stream	0	0	0	0	0	0	0
7	White Hill (E) Stream	0	0	0	0	0	0	0
8	Forest_Upper	0	0	0	0	0	0	0
9	Forest_Upper	0	0	0	0	0	0	0
10	Barrow	0.4	1.2	5.4	4	1.4	0.8	0.4
11	White Hill (W) Stream	0	0	0	0	0	0	0

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Table A2.3 Results of the lamprey surveys at the 10 survey sites.

Site	Watercourse Name	Potential lamprey habitat present (Y/N)	Brook Lamprey
1	Barrow	Y	1
2	Clonygowan	N	
3	Cottoners Brook	N	
4	Cottoners Brook	N	
5	Barrow	Y	0
6	White Hill (E) Stream	N	
7	White Hill (E) Stream	N	
8	Forest_Upper	N	
9	Forest_Upper	N	
10	Barrow	Y	0
11	White Hill (W) Stream	N	

Table A2.4 Macroinvertebrates recorded at the 11 sites surveyed during September 2019.

	Pollution sensitivity group	Site Number (2019 survey)										
		1	2	3	4	5	6	7	8	9	10	11
MAYFLIES (Uniramia, Ephemeroptera)												
Family Heptagenidae												
Ecdyonurus sp.	A	*				*						
Family Ephemeridae												
Ephemera danica	A	*									*	
Family Caenidae												
Caenis rivulorum	C											
Family Ephemerellidae												
Serratella ignita	C	**	**			**						
Family Baetidae												
Baetis rhodani	C	***	*			***		**			******	
STONEFLIES (Order Plecoptera)												
Family Nemouridae												
Nemoura cinerea	A											
Family Leuctridae												
Leuctra spp.	B											
CASED CADDIS FLIES (Tricoptera)												
Family Limnephilidae												
Limnephilus spp.	B	*				*						
Potamophylax spp.	B					*					*	
Family Glossosomatidae												
Agapetus fuscipes	B											
Family Sericostomatidae												
Sericostoma personatum	B	**				**						
Family Phryganeidae	B											
Family Goeridae	B					*						
CASELESS CADDIS FLIES (Trichoptera)												
Family Hydropsychidae												
Hydropsyche spp.	C	**				**					***	
Family Rhyacophilidae												
Rhyacophila dorsalis	C	*										
Family Polycentopodidae												
Plectronemia spp.	C											
Polycentropus spp.	C											
DAMSELFLIES (Odonata, Zygoptera)												
Family Calopterygidae	B	*				*					**	**
Family Coenagrionidae	B		***			**						
DRAGONFLIES (Odonata, Anisoptera)												
Family Aeshnidae	B										*	
TRUE FLIES (Diptera)												
Family Simulidae	C											
Similium sp.		***				*****					******	
Family Tipulidae	C											
Dicronata sp.	C										*	
Family Chironomidae												
Chironomous sp.	E							***				

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	Pollution sensitivity group	Site Number (2019 survey) 1	2	3	4	5	6	7	8	9	10	11
Green chironomid	C	***				***		**			**	**
Family Thaumaleidae												
Thaumaleius sp.	C											
BEETLES (Coleoptera)												
Family Gyrinidae	C											
Gyrinus sp.	C	***	*	**	***	***			*	*		
Family Dytiscidae	D	***	***									
Family Haliplidae	C		*									
Family Elmidae	C											
Family Helophoridae	C		*			*						
Family Hydrophillidae	D				*							
SNAILS (Mollusca, Gastropoda)												
Family Lymnaeidae	D	*	*		*	*			**			
Family Planorbiidae		****	*		*	*					*	
Family Hydrobiidae	C											
Bithynia spp.	C											
Jenkin's spire shell *Potamopyrgus jenkinsi*	C	****				***						
Family Physidae												
Bladder Snail *Physa fontinalis*	D											
Family Ancylidae												
River limpet *Ancylus fluviatilis*	C											
Ancylus lacustrus	C											
MUSSELS (Mollucsa, Lamellibranchiata)												
Orb/Pea Mussels (Sphaeridae)	D	***				***					**	
Unioniodae												
Anodonta anatina	C	*									*	
CRUSTACEANS (Crustacea)												
Amphipods (Amphipoda, Gammaridae)												
Gammarus duebeni	C	*****	**	**	****	*****		**	**		**	******
Isopods, Asellidae												
Asellus aquaticus	D	**				***					***	
Family Astacidae												
Austropotamobius pallipes	C										**	
LEECHES (Hirudinae)												
Family Erpobdellidae												
Family Piscicolidae												
Family Glossiphonidae												
BUGS (Hemiptera)												
Family Veliidae	C	***		****	***	*		*****	*****	*		*
Family Nepidae	C	*									*	
Greater water boatman (Notonectidae)	C											
Family Corixidae	C	*									*	
Family Aphelocheiridae	C											
Aphelocheirus aestivalis	B	*										
Family Hydrometridae												
Hydrometra stagnorum	C	*			*	*					**	
Family Gerridae												
Gerris sp.	C	**			**	**			*	*	*	*
WATER MITE (Order Hydracarina)	C										*	*
SEGMENTED WORMS (Annelida, Clitellata)												
Family Lumbriculidae	D	*						*				

*Present (1 or 2 individuals), **Scarce/Few (<1%), ***Small Numbers (<5%), ****Fair Numbers (5-10%), *****Common (10-20%), ******Numerous (25-50%), *******Dominant (50-75%), ********Excessive (>75%).

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Table A2.5 Results of the Biological Water Quality Assessments at the 10 survey sites (2019).

Site	Watercourse Name	Macroinvertebrate Family Diversity	Q-rating	Water quality status
1	Barrow	27	Q4	Good
2	Clonygowan	10	Q3	Moderate
3	Cottoners Brook	8	n/a	Poor
4	Cottoners Brook	3	n/a	Bad
5	Barrow	23	Q3-4	Moderate
6	White Hill (E) Stream	Dry	n/a	n/a
7	White Hill (E) Stream	6	n/a	n/a
8	Forest_Upper	5	n/a	n/a
9	Forest_Upper	3	n/a	n/a
10	Barrow	20	Q3-4	Moderate
11	White Hill (W) Stream	5	n/a	n/a

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Appendix 12.7

Collision Risk Modelling Report

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FEHILY TIMONEY
30 YEARS

CONSULTANTS IN ENGINEERING, ENVIRONMENTAL SCIENCE & PLANNING

DELIVERABLE REPORT

Collision Risk Modelling Calculations for target species at the proposed Dernacart Wind Farm (Start of Summer 2018 to end of Summer 2019)

Prepared for: Statkraft

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1. INTRODUCTION

This report presents the results of the collision risk modelling for the proposed Dernacart wind farm, Co. Laois. This modelling used data from vantage point (VP) surveys carried out in the summer of 2018 and 2019 and winter of 2018/2019. VP surveys were SNH (Scottish Natural Heritage) compliant (SNH 2017a). Fourteen target species were recorded in flight within the study area during survey work. One of the target species (Jack Snipe) recorded was present during the winter only and one of the target species (Black-Headed Gull) was present during the summer only, while the remaining 12 were resident bird species (Curlew, Golden Plover, Grey Heron, Herring Gull, Kestrel, Lapwing, Lesser Black-Backed Gull, Merlin, Peregrine, Sparrowhawk, Snipe and Woodcock). Not all target species were recorded at the site in both years of survey work.

The modelling was carried out using the Scottish Natural Heritage Collision Risk Model (Scottish Natural Heritage 2000; Band *et al.,* 2007). The bird occupancy method (SNH 2000) was used to calculate the number of bird transits through the rotors, and the spreadsheet accompanying the SNH report was used to calculate collision probabilities for birds transiting the rotors.

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2. DATA SOURCES

The following data and information were provided for this assessment:

- Spreadsheet data listing all observations of flight activity recorded during the VP surveys.
- GIS mapping of flight lines recorded during the summer 2018, summer 2019 and winter 2018/2019 VP surveys.
- Mapping of the VP locations.
- Mapping of the constructed turbine locations.
- Technical specifications for the constructed and permitted turbines.
- Various clarifications about the survey methodology.

All the data and information used in this assessment about the VP surveys and constructed wind farm was provided by Natural Power. All statements made in this report about the VP survey methodology are based on information provided by Natural Power, and/or review of data supplied by Natural Power.

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3. REVIEW AND ANALYSIS OF THE VP SURVEY COVERAGE AND RESULTS

VP locations

Six VPs were initially used for the surveys from April 2018 until November 2018: VP1, VP2, VP3, VP4, VP5 and VP6 (Table 3.1). An additional VP (VP7) was added in December 2018, bringing the total to seven VPs for the period December 2018 to September 2019. The locations of these VPs were selected to ensure complete viewshed coverage of the 500 m buffer around turbine locations, as recommended by SNH (2017a) guidance. There were no changes in VP positions during the surveys in 2018 and 2019. Ninety-seven percent of the total survey area was visible from the seven VP locations and 94% was visible from the six VP locations. A correction factor was applied to the resulting collision risk probabilities to account for this based on the visibility from six VP locations (worst-case scenario).

Table 3.1: VPs Used for Avian Surveys

VP Number	Grid Reference (ITM)
1	643664, 711651
2	643903, 711226
3	643628, 710551
4	644337, 709846
5	644882, 710674
6	645023, 711574
7	642744, 711950

VP survey effort

VP surveys were carried out at the site monthly from April 2018 to September 2019 inclusive. Winter was defined as from October 2018 to March 2019 inclusive (six months) and summer from April to September inclusive (six months) for both 2018 and 2019. Therefore, over the entire survey period two summer surveys were completed and one winter survey. Watches were 2 * 3 hours = 6 hours per VP per month. Thus, the following survey effort was completed for the following seasons:

- Summer 2018. 6 VPs * 6 hours / VP / month * 6 months = 216 hours or 777,600 seconds.
- Winter 2018/2019. 6 VPs * 6 hours / VP / month * 2 months = 72 hours or 259,200 seconds. 7 VPs * 6 hours / VP / month * 4 months = 168 hours or 604,800 seconds. Total = 72 hours + 168 hours = 240 hours or 864,000 seconds. Note that for VP7, only 24 hours of winter surveys were conducted instead of the 36 hours for the rest of the VPs.
- Summer 2019. 7 VPs * 6 hours / VP / month * 6 months = 252 hours or 907,200 seconds.

Total survey effort over the entire period was 708 hours or 2,548,800 seconds.

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VP survey protocol

The VP surveys recorded flight activity of all target species within fixed visual envelopes. Flight durations were recorded separately for the following vertical distance bands: <20 m, 20-40 m, 40-140 m and >140 m. Flight durations were not classified in the field as inside and outside of the 500 m buffer boundary surrounding the turbines.

Selection of target species for the collision risk model

The following 14 raptor, wader and waterbird species were recorded inside and outside the 500 m buffer boundary during the VP surveys across 2018 and 2019:

- Black-headed gull (*Chroicocephalus ridibundus*);
- Curlew (*Numenius arquata*);
- Golden plover (*Pluvialis apricaria*);
- Grey heron (*Ardea cinerea*);
- Herring gull (*Larus argentatus*);
- Jack snipe (*Lymnocryptes minimus*);
- Kestrel (*Falco tinninculus*);
- Lapwing (*Vanellus vanellus*);
- Lesser black-backed gull (*Larus fuscus*);
- Merlin (*Falco columbarius*);
- Peregrine (*Falco peregrinus*);
- Sparrowhawk (*Accipiter nisus*);
- Snipe (*Gallinago gallinago*); and
- Woodcock (*Scolopax rusticola*).

Post-hoc manipulation of flight activity data

To ensure alignment with SNH (2017a) guidance for collision risk modelling (CRM), flight durations were retrospectively classified as inside and outside of the 500 m buffer boundary (the zone where birds are at risk of collision with turbines, also known as 'at-risk' flights) using QGIS to calculate flight line lengths and thus, the proportion of the flight line inside or outside of the 500 m buffer boundary. For example, if a flight line was 500 m in length, but 250 m was inside of the 500 m boundary and 250 m was outside, then 50% of the recorded flight durations were classed as inside the buffer (this was repeated for flight durations for each individual height band). This assumes that birds are travelling at a constant speed.

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As the height bands did not distinguish between above and below rotor swept height, all flight duration data were assumed to be within the rotor swept height. This is a conservative approach and will overestimate the number and duration of 'at-risk' flights.

Flight times

Calculations were carried out using the flight times recorded in the 'at-risk' 500 m buffer zone area for a watch time of 1.5 years, as there were two summer seasons and one winter season in our study period. The calculation process accounted for this fact, allowing a probability of collision risk per year instead of 1.5 years to be provided (see example calculation for Kestrel).

The total flight times for each species inside the 500 m buffer at rotor swept height across 1.5 years are shown in Table 3.2 below.

Table 3.2: Total Flight Times (Summer 2018, Winter 2018/19 and Summer 2019)

Species	Total flight times in rotor swept height band (seconds)
Black-headed gull	395
Curlew	1,818
Golden plover	20,987
Grey heron	1,991
Herring gull	162
Jack snipe	30
Kestrel	20,098
Lapwing	27,063
Lesser black-backed gull	1,544
Merlin	585
Peregrine	151
Sparrowhawk	3,085
Snipe	936
Woodcock	602

The biometrics and flight speed values used in the calculations for each of the target species is shown in Table 3.3 below. The bird body lengths and wingspans were sourced from the BTO bird facts website (https://www.bto.org/understanding-birds/birdfacts/find-a-species; accessed 25th October 2019). The flight speeds used come from Alerstam *et al.*, 2007. As no flight speeds were available for Golden Plover, those for Grey Plover were used. Similarly, no speeds were available for Jack Snipe or Woodcock, so values for Snipe were used for these two species. Finally, no speeds were available for Merlin, so the speed for Hobby was used. Using flight speeds of closely-related species is an acceptable substitute when no data is available (SNH 2017a).

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Birds are assumed to be active for 8 hours a day in winter and 12 hours a day in summer (except for Golden Plover and Lapwing with 12 hours a day in winter and 15 hours a day in summer to account for crepuscular and nocturnal activity; Snipe was also assumed to be active for 15 hours a day in summer to account for crepuscular/nocturnal display flights).

Table 3.3: Avian Biometric Data and Avoidance Rates

Species	Length (m)	Wingspan (m)	Average speed (m/s)	Avoidance rates[1] (%)
Black-headed gull	0.36	1.05	11.9	98
Curlew	0.55	0.9	16.3	98
Golden plover	0.28	0.72	17.9	98
Grey heron	0.94	1.85	12.5	98
Herring gull	0.6	1.44	12.8	98
Jack snipe	0.18	0.4	17.1	98
Kestrel	0.34	0.76	10.1	95
Lapwing	0.3	0.84	12.8	98
Lesser black-backed gull	0.58	1.42	13.1	98
Merlin	0.28	0.56	11.3	98
Peregrine	0.42	1.02	12.1	98
Sparrowhawk	0.33	0.62	11.3	98
Snipe	0.26	0.46	17.1	98
Woodcock	0.34	0.58	17.1	98

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[1] Avoidance rates refer to the frequency at which birds may avoid a wind farm. SNH (2018) guidance states that this may be due to displacement from the area, avoidance of turbines or evasive action to prevent a collision. Avoidance rates may be different for different bird species and SNH (2018) guidance provides a list of recommended avoidance rates that should be applied to raw collision risk probabilities.

4. MODEL DETAILS

Collision risk calculations have been performed using a random flight model as detailed by Band *et al.,* (2007).

The planned turbine model for the 8 no. turbines of the proposed development has not been decided yet. To provide a conservative estimate of collision risk, the Siemens Gamesa SG 6.0 – 170 model was used. Details of the turbine parameters are show in Table 4.1 (below). Data on operational time, blade pitch angle and mean rotational speed were collected from Statkraft.

Table 4.1: Wind Farm and Wind Turbine Parameters

Parameter	Permitted	Notes
Hub height (m)	100	Calculated
Blade diameter (m)	170	Information provided by client
Blade radius (m)	85	Calculated
Maximum swept height (m)	185	Information provided by client
Minimum swept height (m)	15	Calculated
Number of blades	3	Taken from Developer Package SG 6.0-170
Maximum blade chord length (m)	4.5	Taken from Developer Package SG 6.0-170
Average blade depth (m)	2.6	Taken from Developer Package SG 6.0-170
Fastest rotational speed (r.p.m)	11.5	No information in Developer Package SG 6.0-170, so used values from Siemens Gamesa SWT-DD-142
Fastest rotation period (s)	5.2	Calculated
Blade pitch (degrees)	30	Taken from Band *et al.,* (2007) as maximum of typical range
Number of turbines with these dimensions proposed	8	Information provided by client
Wind farm operation (%)	97.7	Conservative estimate of turbine operating time

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5. EXAMPLE CALCULATION OF THE COLLISON RISK FOR KESTRAL (*FALCO TINNUNCULUS)*

An example of a collision risk calculation used for Kestrel is provided below.

Kestrel is a resident species in the area around the proposed Wind Farm site. A total of 20,098 seconds of Kestrel flight time within the rotor swept height was observed from the VP watches in the summer of 2018, winter of 2018/2019 and the summer of 2019.

The total watch time across two summers and one winter was a total of 708 hours or 2,548,800 seconds. This accounts for the change in the number of VP locations from six to seven from December 2018 onwards.

(i) To calculate the probability of a bird flying through the rotor swept area:

In order to account for the overlap in the areas that were viewed from the different VPs, the size of the field of view for each VP was estimated by mapping in the field and the areas for the seven VPs were summed to give a cumulative area. This was then clipped to the 500 m buffer zone to provide a final cumulative area (Accumulative).

Accumulative = 1,734 hectares

Proportion of total observation time during which Kestrels were recorded in flight at heights between 0 m and > 140 m:

(1) t = 20,098 / 2,548,800 = 0.00788524 (proportion)

The proportion of flight activity per hectare of visible area, F = t/Accumulative.

(2) F = 0.007982098 / 1,734 = 4.54743E-06 (proportion per hectare)

The Flight Risk Area of the proposed wind farm (calculated in QGIS as the area of a minimum convex polygon based on the locations of all proposed turbines, surrounded by an additional buffer corresponding to the 85 m rotor radius) = 230 hectares.

Therefore, the proportion of flight time spent in flight between 0 m and > 140 m in the wind farm area is:

(3) t2 = F X Flight Risk Area = 4.54743E-06 * 230 = 0.001045908 (proportion)

This value must be adjusted to take account of the height of the actual turbine rotors. The value t2 is multiplied by the upper turbine tip height (UT) minus the lower turbine tip height (LT), divided by the upper height of the used flight observations height band (UBH) minus the lower height of the same band (LBH), thus: t2 X ((UT – LT)/(UBH – LBH)).

(4) t% = 0.001045908 X ((185 – 15) / (140 - 0)) = 0.001270032 (or 0.1270032 % of total flight time spent in flight between 0 m and >140 m adjusted to account for the height of the actual turbine rotors)

In order to account for Kestrel occupancy over the summer survey period, birds have been assumed to be present between April to September inclusive (183 days). As there were two summers in the study period, this value has been multiplied by two to give 366 days. An assumption is made that the birds are active for 12 hours per day during summer. For winter, birds have been assumed to be present between October to March inclusive (182 days) and have been assumed to be active for 8 hours per day.

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Note: Golden Plover and Lapwing are assumed to be active for 15 hours a day in summer and 12 hours a day in winter to account for nocturnal and crepuscular activity. Snipe was also assumed to be active for 15 hours a day in summer to account for crepuscular/nocturnal display flights

(5) Occupancy, n = ((182 X 8) + (366 X 12)) X t% = 5,848 hours X 0.001270032 = 7.427145119 hours per 1.5 years.

The flight risk volume, Vw = flight risk area X diameter of rotors

(6) Vw = 230 hectares X 10,000 X 170 metres = 391,000,000 m^3

Volume swept by the rotors, Vr = number of turbines X πr^2 X (d+l), where d is the average depth of the rotors, l is the average length of the birds and r is the radius of the rotors (85 m).

(7) Vr = 8 X 22,698 X (2.6 + 0.34) = 533,857.1228 m^3.

The bird occupancy of swept volume, b = n X (Vr/Vw), where n is the bird occupancy for the year, from (5) above.

(8) b = 7.427145119 X 533,857.1228 / 1,263,100,000) = 0.010140753 hours (36.51 seconds) per 1.5 years.

Time taken for a bird to fly through rotors of one turbine, t3 = (d+l)/v, where v is the average velocity of the birds.

(9) t3 = 2.94 / 10.1 = 0.291089109 seconds.

Therefore, number of bird transits through the rotors is:

(10) b / t3 = 36.51 / 0.291089109 = 125.4255102 bird transits per 1.5 years. To obtain an estimate per year, the number of transits was divided by 1.5 = 125.4255102 / 1.5 = 83.60947163 transits per year.

(ii) To calculate the probability of the birds colliding with the turbine rotors:

The probability of a bird actually colliding with the turbine blades when making a transit through a rotor depends on a number of factors that are imperfectly known and at present have to be estimated. Not least of these is the avoidance factor that is used to approximate the ability of birds to take evasive action when coming close to wind turbine blades. The method of Band *et al.,* (2007) makes a number of assumptions: birds are assumed to be of a simple cruciform shape, turbine blades are assumed to have width and pitch angle, but no thickness, birds fly through turbines in straight lines and their flight is not affected by the slipstream of the turbine blade etc. In the calculations the length of a Kestrel is taken to be 0.34 metres and the wingspan 0.76 metres (these figures are the means of published ranges taken from the BTO website on 22/07/2019). The flight velocity of the Kestrel is assumed to be 10.7 metres per second. The maximum chord of the blades is taken to be 4.5 metres, pitch is assumed to be 30 degrees and the rotation cycle at maximum operating speed (11.5 rpm) is taken to be 5.2 seconds per rotation.

A probability, ρ (r, ϕ), of collision for a bird at radius r from the hub and at a position along a radial line that is at angle ϕ from the vertical is calculated. This probability is then integrated over the entire rotor disc, assuming that the bird transit may be anywhere at random within the area of the disc.

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Scottish Natural Heritage have made available a spreadsheet to aid the calculation of these probabilities (http://www.snh.gov.uk/planning-and-development/renewable-energy/onshore-wind/bird-collisionrisks-guidance/). For a full explanation of the calculation methods see Band *et al.,* (2007).

Assuming the worst-case scenario (i.e. shortest rotation time and bird flapping rather than gliding), the average of the upwind and downwind probabilities of collision is 9.3%.

So, the product of the number of bird transits per year and the probability of collision is:

(11) 83.60947163 X 0.093323898 = 7.802761826 collisions per year, without any avoidance of the turbine blades by the birds.

The SNH (SNH, 2018) recommended avoidance rate for Kestrel is 95%.

Therefore, the predicted number of Kestrel collisions per year with 95% avoidance is:

(12) 7.802761826 X 0.05 = 0.390138091 collisions per year.

Using a (conservative) figure of 97% for turbine operating time (i.e. downtime or non-rotational time of only 3%) and the fact that only 94% of the 500 m buffer zone was covered by viewsheds (for 6 VPs – a worst-case scenario), a final figure of:

(13) 0.390138091 X 0.97 X (100/94) = **0.402589307** collisions per year is reached.

This is equivalent to one collision approximately every 2 years using the flight data recorded between 0 and > 140 metres.

The calculations detailed for Kestrel above were also carried out for each of the other target species.

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6. RESULTS

The results of the collision risk calculations for all target species, for different data sets, for different spatial areas and using different turbine dimensions are shown in Table 6.1 below. The avoidance rate factors used are as recommended by Scottish Natural Heritage (SNH, 2010; SNH 2018). Note that it should be cautioned that VP surveys are not a recommended method of recording Snipe flight activity, as a significant proportion of display and other flight activity is crepuscular and unlikely to be meaningfully recorded. To account for this, Snipe were assumed to be active for 15 hours a day in the collision risk calculations.

For all target species, the probabilities of collision with turbines were all < 1 per year. There are three target species with higher collision risk probabilities than the rest: Golden Plover (one predicted collision every 4 years or 6.91 collisions every 30 years), Kestrel (one predicted collision every 2 years or 12.08 collisions every 30 years) and Lapwing (one predicted collision every 4 years or 8.55 collisions every 30 years). For all other target species, not a single collision is predicted within the 30-year nominal lifespan of the proposed wind farm.

For Golden Plover, Kestrel and Lapwing, the population-level consequences of predicted collision risk were calculated. This was assessed by considering the additional mortality that would be caused (assuming that the collision risk is additive) relative to background mortality rates in the population, with a threshold of a 1% increase in annual mortality used to determine whether the impact is potentially significant (Percival, 2003). Estimates of the potential increase in annual mortality rates for the national and local populations are shown in Table 6.2. No estimates of the local population of Golden Plover were available for the three I-WeBS sites nearest to the proposed wind farm development or from local BirdWatch Ireland groups. The same was also true for Kestrel. Consequently, only national populations were assessed for these two bird species.

The results show that the increase in annual mortality to national populations of Golden Plover, Kestrel and Lapwing is negligible. The same is also true for the local population of Lapwing.

Table 6.1: Collison Risk Modelling Results

Species	Number of predicted collisions per year[2]	One predicted collision every x years	Number of predicted collisions in 30-year nominal lifespan of wind farm
Black-headed gull	0.0033	305	0.10
Curlew	0.0172	58	0.52
Golden plover	0.2304	4	6.91
Grey heron	0.0223	45	0.67
Herring gull	0.0015	647	0.05
Jack snipe	0.0003	3,659	0.01
Kestrel	0.4026	2	12.08
Lapwing	0.2851	4	8.55
Lesser black-backed gull	0.0147	68	0.44

[2] With correction factors applied for the following: avoidance rates, operating time and fact that 94% and not 100% of the study area was visible for the first 8 months of surveys (a conservative approach was taken, as 97% was visible for the other 11 months of surveys).

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Species	Number of predicted collisions per year[2]	One predicted collision every x years	Number of predicted collisions in 30-year nominal lifespan of wind farm
Merlin	0.0045	220	0.14
Peregrine	0.0013	771	0.04
Sparrowhawk	0.0247	40	0.74
Snipe	0.0089	112	0.27
Woodcock	0.0051	196	0.15

Table 6.2: Calculations of Potential increases in Annual Mortality due to Predicted Collison Mortality Rates for Golden Plover, Lapwing and Kestrel

Parameter	Description	Source / Calculation	National Population			Local Population		
			Golden Plover	Lapwing	Kestrel	Golden Plover	Lapwing	Kestrel
pop	Population size	**National** (all-Ireland): wintering estimates of Golden Plover and Lapwing = Burke *et al.,* (2018); year-round estimates of Kestrel = Crowe *et al.,* (2014). **Local**: Lapwing = sum of mean counts from the following three I-WeBS sites between 2006-2016 (River Barrow: Mountmellick (Clonterry) in Co. Laois; Raheen Lough in Co. Offaly; and River Barrow (Monasterevin – Portarlington) in Co. Kildare).	92,060	84,690	19,970	N/A	212	N/A
surv	Annual survival rate	Adult survival rates from www.bto.org/understanding-birds/birdfacts accessed 03/10/2019	0.73	0.705	0.69	0.73	0.705	0.69
mort(back)	Annual background mortality	pop*(1-surv)	24,856.2	24,986.55	6190.7	N/A	62.54	N/A
mort(coll)	Predicted annual collision mortality	Predicted collision rates from Table 6.1.	0.23	0.29	0.40	0.23	0.29	0.40
Δmort	Percentage increase in annual mortality rate due to collisions	(mort(coll)/mort(back))*100	+0.0009 %	+0.001%	+0.007 %	N/A	+0.46%	N/A

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7. DISCUSSION

From the collision risk probabilities calculated, it can be concluded that the proposed Dernacart wind farm will have a negligible effect on collision risk for the populations of 14 target bird species. No collisions are predicted for 11 out of 14 target species (Black-Headed Gull, Curlew, Grey Heron, Herring Gull, Jack Snipe, Lesser Black-Backed Gull, Merlin, Peregrine, Sparrowhawk, Snipe and Woodcock) in the 30-year nominal lifespan of the wind farm. While the collision risk for the other three bird species (Golden Plover, Kestrel and Lapwing) is slightly higher, the population-level consequences on national and local populations was also calculated to be negligible.

The Band CRM model involves making a number of assumptions. The amount of time that a species may be active within the site is also required for the model and must be estimated with respect to the bird species' known behaviour and observations of its occurrence at the study area.

The model assumes that no action is taken by a bird to avoid collision, so that the unadjusted collision risk figures derived are purely theoretical and represent worst case estimates. In reality, birds are able to perceive potential obstacles while in flight and actively take avoiding action. Given the general absence of empirically derived avoidance estimates for individual species, additional assumptions about likely levels of active avoidance on the part of birds are generally made in order to draw conclusions. Available evidence to date (SNH, 2010; SNH, 2017; Fernley *et al*., 2006; Whitfield & Madders, 2006; Whitfield, 2009; Whitfield & Urquhart, 2015) suggests that avoidance rates are well in excess of 95%. Accordingly, outputs from collision risk analysis where precautionary avoidance rates are used must be interpreted with care.

The Band model favoured by SNH has been the subject of academic study regarding its relevance and usefulness (Chamberlain *et al*., 2005; Chamberlain *et al*., 2006) and the conclusions have been that the model can be considered to be mathematically robust. However, the main influence on the final result of collision risk analysis is the avoidance rate that is applied to the model; and without accurate avoidance rates, the usefulness of the model as a predictor of impact can be badly impaired. The avoidance rate factors used are those that are currently recommended by SNH (SNH, 2010; SNH, 2018). These avoidance rates are widely considered to be highly precautionary in nature. It should be remembered that the difference between an avoidance factor of 98% and 99% will have the effect of doubling the calculated annual collision rate. In many cases where collision mortality has been monitored for operating wind farms, observed mortality has been below that which was predicted by modelling pre-construction bird survey data.

In the case of the calculations for the proposed Dernacart wind farm site, a conservative approach was taken in the choice of which bird flights to include in the collision risk calculations. In addition, a worst-case scenario i.e. shortest rotation time (top turbine rotating speed) and birds flapping rather than gliding has been used. Other studies use the mean of the worst-case scenario and best-case scenario (longest rotation period and bird gliding rather than flapping) probabilities. Finally, the calculations have used the very conservative downtime estimate (3%, or turbines rotating 97% of the time), where other studies often include a greater proportion of turbine downtime. A conservative correction factor was also applied to the final collision risk probabilities based on the assumption that 94% of the 500 m buffer area was visible from 6 VP locations for the first 8 months of surveys. This is even though 97% of the buffer area was visible when an additional VP was added, increasing visibility for 11 out of 19 months of surveys. Therefore, the likely empirical collision mortality figures should be lower than those presented here.

In conclusion, the results show that the proposed Dernacart wind farm will likely have negligible impacts on populations of the 14 target bird species present.

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