HAVERIGG II WIND FARM LIFETIME EXTENSION

Report to Inform a Habitats Regulations Assessment

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Ecology Consulting

Client: **Thrive Renewables (Haverigg II) Ltd**

Table of Contents

Executive Summary

Thrive Renewables (Haverigg II) Ltd is proposing to extend the lifetime of the existing 4-turbine Haverigg II wind farm in south Cumbria for a further 10 years beyond their current planning consent (which expires in 2022) until 2032, plus a further 12 months to allow for decommissioning and restoration works to take place.

Following consultation with Natural England (and agreement over the scope of the surveys required), this report has been produced to address the increased collision risk that would result from the Haverigg II wind farm lifetime extension, in relation to the Habitats Regulations, specifically the Morecambe Bay and Duddon Estuary SPA) and Ramsar sites. The baseline data used in this report included:

- Vantage point (VP) surveys during 2014 and 2019 breeding seasons, and the 2014-15 autumn/winter;
- Nocturnal surveys during the 2014-15 autumn/winter;
- Collision victim searches during 2014 and 2019 breeding seasons, and the 2014-15 autumn/winter.

Natural England has advised that it considers that a Likely Significant Effect cannot be ruled out for the Haverigg II Lifetime Extension for four species: lesser black-backed gull, herring gull, golden plover and curlew. As a result, this assessment provides the information required to inform an Appropriate Assessment.

Collision modelling was carried out for all the SPA species recorded over-flying the collision risk zone and at rotor height in sufficient numbers to possibly be at risk of a significant impact; : golden plover, curlew, lesser black-backed gull and herring gull. As well as applying a range of theoretical avoidance rates, the collision search data were used in combination with the modelling to determine empirical site-specific avoidance rates for the two main groups at risk, gulls (99.2%) and waders (99.6%).

Collision risks (applying the empirical site-specific avoidance rates) were of negligible magnitude for golden plover and curlew, and for lesser black-backed gull and herring gull in winter, for the Haverigg II wind farm alone. No adverse effects on integrity under the Habitats Regulations were identified for these species at these times of year.

Collision risks for lesser black-backed gull and herring gull in the breeding season, however, were predicted to be of low magnitude. It was, though, concluded that there would be no adverse effect on integrity to the SPA herring gull and lesser black-backed gull breeding populations due to collision risk, for the following reasons:

- Only a very low amount of additional mortality was predicted from the collision risk modelling, and this was even lower when the actual observed collision rates were taken into account;
- Previous population analyses for offshore wind farms have shown that a much higher level of mortality could be sustained by the populations (Dept of Energy and Climate Change 2014) albeit based on higher population estimates than in the latest data;
- The risk from the Haverigg II wind farm is trivial in comparison with previous (including recent) gull culling schemes.

Cumulative collision risks were also concluded to have no adverse effect on integrity, for the same reasons.

Notwithstanding the conclusions reached above, Natural England has advised that it considers, on the basis of a precautionary approach, that mitigation measures are required in order to avoid the possibility of any adverse effect on the integrity of the SPA breeding lesser black-backed and herring gull populations. These measures would comprise provision of funding for the construction of predator-proof fencing at the main SPA breeding colony at South Walney.

In conclusion, the proposed Haverigg II lifetime extension would not adversely affect the ecological integrity of the Morecambe Bay and Duddon Estuary SPA/Ramsar, either alone or in combination with any other plan or project, and therefore authorisation for the project may be granted.

Introduction

1. Thrive Renewables is proposing to extend the lifetime of the existing 4-turbine Haverigg II wind farm in south Cumbria for a further 10 years beyond their current planning consent (which expires in 2022) until 2032, plus a further 12 months to allow for decommissioning and restoration works to take place. The proposed lifetime extension would not involve replacement of turbines or changes to the existing infrastructure, so potential construction effects have been scoped out from this report. The decommissioning would not be changed from that which has already been consented as part of the original wind farm applications, so it too has been scoped out from this report.

2. The Haverigg II Wind Farm (Haverigg II), comprises four Wind World W4200 wind turbines with a blade tip height of 62.5m and supporting infrastructure (including access tracks and switchgear). The total generating capacity of Haverigg II is 2.4 MW. Planning permission was granted for Haverigg II in 1995 (planning ref: 4/95/0553/0) and it was constructed in 1998.

3. Following the production of an EIA Screening Report for the scheme and subsequent consultation, Natural England has advised that a Habitats Regulations Assessment should be undertaken, as the proposed lifetime extension site lies in proximity to the Morecambe Bay and Duddon Estuary Special Protection Area (SPA)/Ramsar site. Natural England's main ornithological concern is in relation to birds from the SPA/Ramsar site that may over-fly the wind farm and hence be at risk of collision.

4. This report addresses the increased collision risk that would result from the Haverigg II wind farm lifetime extension, in relation to the Habitats Regulations. The report provides information on the existing baseline populations for the species for which the Duddon Estuary and Morecambe Bay SPA and Ramsar site have been designated (and that could be affected by the proposed development). It includes an assessment of the collision risk of the proposed development on those populations alone and in combination with other operational, consented and proposed wind farms and other relevant projects in the area.

5. The information presented in this report draws on all of the available information (including from the EIA screening report and its appendices and from previous surveys of the site) on the key species that are SPA qualifying features that could possibly be significantly affected by the wind farm, in order to provide the information required to inform the Habitats Regulations Assessment.

Special Protection Areas Considered in this Report

6. There is one SPA in the 20km search area around the proposed wind farm site which is considered in this report, the Morecambe Bay and Duddon Estuary SPA. Sections of the SPA are also designated as Ramsar sites, (a) the Duddon Estuary Ramsar site and (b) the Morecambe Bay Ramsar site.

7. The SPA lies 370m south from the nearest Haverigg II wind turbine at its closest point. It comprises extensive inter-tidal habitats with an internationally important wintering waterfowl community. Most species would be restricted to the inter-tidal habitats but some (including pink-footed goose, golden plover, curlew, lesser black-backed gull and herring gull) are likely to range more widely over adjacent farmland.

8. The qualifying features of the SPA are summarised in Table 1, and further details are given in the SPA citation in Appendix 1. The site qualifies under Article 4.1 of the Directive (2009/147/EC) as it is used regularly by 1% or more of the Great Britain populations of nine species listed in Annex I in any season. It qualifies under Article 4.2 of the Directive (79/409/EEC) as it is used regularly by 1% or more of the biogeographical populations of the 15 regularly occurring migratory species

(other than those listed in Annex I) in any season. The wintering waterbird and seabird assemblages are additional qualifying features under Article 4.2.

9. The information sheets for the two Ramsar sites are given in Appendix 2. The Morecambe Bay Ramsar site is designated for several additional nationally important wintering waterbird populations that are not designated features of the SPA, including wigeon, goldeneye, red-breasted merganser, eider, great crested grebe, cormorant and lapwing (all are, though noted on the citation as SPA assemblage species). The only additional designated species for the Duddon Estuary Ramsar site is red-breasted merganser (again a SPA assemblage species).

10. No other SPAs/Ramsar site would be affected by the proposed lifetime extension.

Table 1. Citation species for the Morecambe Bay and Duddon Estuary SPA.

Species	Time of Year	Population	Importance
Article 4.1 qualifying features			
Whooper swan	Non-breeding	113 individuals (2009/10 – 2013/14)	1.0% of GB population
Little egret	Non-breeding	134 individuals (2009/10 – 2013/14)	3.0% of GB population
Golden plover	Non-breeding	1,900 individuals (Morecambe Bay SPA citation value 1991)	1.0% of GB population (1991)
Bar-tailed godwit	Non-breeding	3,046 individuals (2009/10 – 2013/14)	8.0% of GB population
Ruff	Non-breeding	8 individuals (2009/10– 2013/14)	1.0% of GB population
Mediterranean gull	Non-breeding	18 individuals (2009/10– 2013/14)	1.0% of GB population
Little tern	Breeding	84 individuals (2010 –2014)	2.2% of GB population
Sandwich tern	Breeding	1,608 individuals (1988- 1992)	5.7% of GB population (1992)
Common tern	Breeding	570 individuals (Morecambe Bay SPA citation value 1991)	2.0% of GB population (1991)
Article 4.2 qualifying features			
Pink-footed goose	Non-breeding	15,648 individuals (2009/10 – 2013/14)	4.5% of biogeographic population
Shelduck	Non-breeding	5,878 individuals (2009/10 – 2013/14)	2.0% of biogeographic population
Pintail	Non-breeding	2,498 individuals (2009/10 – 2013/14)	4.2% of biogeographic population
Oystercatcher	Non-breeding	55,888 individuals (2009/10 – 2013/14)	6.8% of biogeographic population
Grey plover	Non-breeding	2,000 individuals (Morecambe Bay SPA citation value 1991)	1.0% of biogeographic population (1991)
Ringed plover	Non-breeding	1,049 individuals (2009/10 – 2013/14)	1.4% of biogeographic population
Curlew	Non-breeding	12,209 individuals (2009/10 – 2013/14)	1.5% of biogeographic population
Black-tailed godwit	Non-breeding	2,413 individuals (2009/10 – 2013/14)	4.0% of biogeographic population
Turnstone	Non-breeding	1,359 individuals (2009/10 – 2013/14)	1.0% of biogeographic population
Knot	Non-breeding	32,739 individuals (2009/10 – 2013/14)	7.3% of biogeographic population

Species	Time of Year	Population	Importance
Sanderling	Non-breeding	3,600 individuals (Morecambe Bay SPA citation value 1991)	3.0% of biogeographic population (1991)
Dunlin	Non-breeding	26,982 individuals (2009/10 – 2013/14)	2.0% of biogeographic population
Redshank	Non-breeding	11,133 individuals (2009/10 – 2013/14)	4.6% of biogeographic population
Lesser black-backed gull	Non-breeding	9,450 individuals (2009/10 – 2013/14)	1.7% of biogeographic population
Lesser black-backed gull	Breeding	9,720 individuals (2011-2015)	2.7% of biogeographic population
Herring gull	Breeding	20,000 individuals (Morecambe Bay SPA citation value 1991)	1.0% of biogeographic population (1991)
Wintering waterfowl community >20,000 individuals †	Wintering	266,751 individuals (2009/10 – 2013/14)	>20,000 individuals
Wintering seabird community	Wintering	40,672 individuals (Morecambe Bay SPA citation value 1997)	>20,000 individuals

† includes above waterfowl plus red-breasted merganser great crested grebe, black-tailed godwit, cormorant, wigeon, teal, mallard, eider, goldeneye, red-breasted merganser, lapwing and whimbrel.

11. Ecological links between the proposed wind farm lifetime extension site and this SPA (and Ramsar sites) are considered in this report. The main concern in relation to the SPA would be if there were sufficient numbers of any qualifying bird species over-flying the site at collision height to be at significant risk of collision.

Legislative Framework

12. Under the Conservation of Habitats and Species Regulations 2017 which translates the Birds and Habitats Directives into English Law (hereafter termed the Habitats Regulations), a development that is likely to have a significant effect on a SPA requires Appropriate Assessment. On the advice of Natural England, this development has been considered in the context of those Regulations.

13. The first test under the Habitats Regulations is whether the development is likely to have a significant effect on any of the populations of importance for which the site has been designated. If it is (as determined by the Competent Authority, in this case Copeland Borough Council), then an Appropriate Assessment needs to be carried out by the Competent Authority to determine whether the development could threaten the ecological integrity of the SPA (European Commission 2018). In this context ecological integrity is defined in “Managing Natura 2000 Sites” as:

> *”the coherence of the site’s ecological structure and function, across its whole area, or the habitats, complex of habitats and/or populations of species for which the site is or will be classified”*

14. The Conservation Objectives for the Morecambe Bay and Duddon Estuary SPA (as published on the Natural England web site[1]) apply to the site and the individual species and/or assemblage of species for which the site has been classified (the "Qualifying features" listed above).

> *"The objectives are to ensure that, subject to natural change, the integrity of the site is maintained or restored as appropriate, and that the site contributes to achieving the aims of the Wild Birds Directive, by maintaining or restoring:*
>
> *Subject to natural change, to maintain or restore:*
>
> - *The extent and distribution of the habitats of the qualifying features;*
> - *The structure and function of the habitats of the qualifying features;*
> - *The supporting processes on which the habitats of the qualifying features rely;*
> - *The populations of the qualifying features;*
> - *The distribution of the qualifying features within the site."*

Scope of this report

15. The scope of this report to inform the Habitats Regulations Assessment is as follows:

- Desk study of the available ornithological data on the site (including review of existing reports and data);
- Collision risk modelling for Herring Gull and Lesser Black-backed Gull;
- Collision risk modelling for wintering waterbirds;
- Assess Nocturnal Flight Paths - use best available information (including local night surveys carried out during August 2014-March 2015) to determine the appropriate nocturnal activity values to include in the collision risk modelling;
- Cumulative impact assessment - cumulative and 'in combination' effects have been considered in relation to other operational, consented or proposed wind turbine developments that could affect these SPA species.

Key Ornithological Interests: Baseline Conditions

16. The data available for this assessment include field data obtained from detailed year-round baseline studies carried out during the 2014 breeding season, the 2014/15 autumn/winter period and the 2019 breeding season. Further details are provided in the EIA Screening Report (Arcus Consultancy Services 2019). Data used for this report included:

- April-July 2014 vantage point (VP) surveys - 36 hours' surveys from a single VP (Percival et al. 2014).
- August 2014-March 2015 VP surveys - 72 hours' surveys from a single VP (Percival et al. 2015).

[1] https://designatedsites.naturalengland.org.uk/Marine/MarineSiteDetail.aspx?SiteCode=UK9020326&HasCA=1&NumMarineSeasonality=25&SiteNameDisplay=Morecambe%20Bay%20and%20Duddon%20Estuary%20SPA#hlco. Accessed 9/12/19.

- May-July 2019 VP surveys - 36 hours' surveys from a single VP (Arcus Consultancy Services 2019).
- Nocturnal surveys August 2014-March 2015 - eight surveys using an image intensifier (Percival et al. 2015), using an infra-red lamp to assist viewing without disturbing the birds (Gillings et al. 2005).
- Collision victim searches from April-June 2014 (Percival et al. 2014), April-August 2019 and September 2018-February 2019 (Arcus Consultancy Services 2019).

Baseline Flight Activity

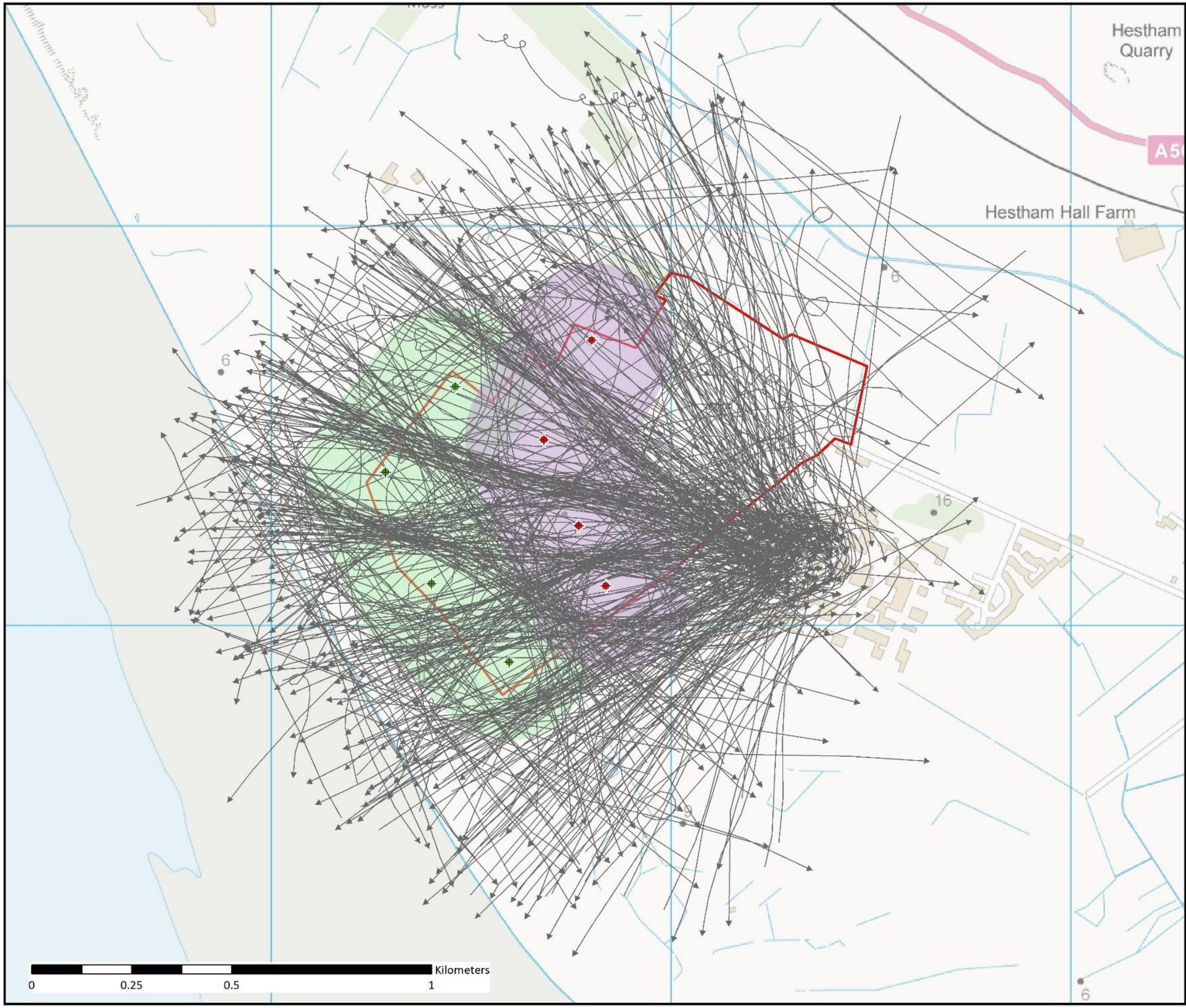
17. The rates of bird flight movement observed across the survey area during the 2014-15 autumn/winter vantage point surveys are summarised in Table 2. This gives the mean over-flying rate per hour for each key species during the autumn (August-November) and winter (December-March) surveys. This includes all the observations of the target species flying over the proposed lifetime extension site and its surrounds.

18. Table 2 also gives the percentage of flights of each species that were recorded at the rotor height of the existing turbines. The existing turbines rotor blades are 20.5-62.5m above the ground (Haverigg II) and 24-76m above the ground (Haverigg III).

Table 2. SPA species (qualifying and assemblage) flight rates recorded over the survey area during the August 2014 – March 2015 vantage point surveys (36 hours autumn Aug-Nov, 36 hours winter Dec-Mar).

Species	Autumn flight rate (no/hr)	Winter flight rate (no/hr)	Autumn total number of flights	Winter total number of flights	% flights at rotor height	
					Haverigg II (20.5-62.5m)	Haverigg III (24-76m)
Qualifying Species:						
Whooper Swan	0.3	0.0	10	0	0%	0%
Pink-footed Goose	26.1	17.8	940	641	8%	13%
Shelduck	0.0	0.1	0	3	100%	100%
Little Egret	0.1	0.0	4	0	0%	0%
Oystercatcher	0.1	0.0	2	1	0%	0%
Ringed Plover	0.1	0.0	4	0	0%	0%
Golden Plover	19.0	51.2	684	1842	71%	76%
Curlew	3.9	54.0	141	1944	44%	39%
Lesser Black-backed Gull	12.3	5.3	442	190	37%	36%
Herring Gull	62.4	109.5	2245	3943	39%	37%
Sandwich Tern	0.0	0.0	1	0	0%	0%
Assemblage Species:						
Teal	0.0	0.0	0	1	0%	0%
Mallard	0.0	0.3	1	10	50%	50%
Cormorant	0.9	1.2	31	44	47%	47%
Lapwing	4.0	5.1	144	185	73%	82%

19. Much the most frequently recorded SPA species was herring gull. Their flight lines are shown in Figure 1. Other SPA species seen over-flying the wind farm site included pink-footed goose (Figure 2), golden plover (Figure 3), curlew (Figure) and lesser black-backed gull (Figure 5).



THRIVE RENEWABLES

Haverigg II Wind Farm Lifetime Extension

FIGURE 1

Vantage Point Survey 2014-15 Flight Lines: Herring Gull

KEY:

- Haverigg II turbines
- Haverigg III turbines
- Flight lines 2014-15
- Haverigg III Collision Zone (200m)
- Haverigg II Collision Zone (200m)
- Wind farm site boundary

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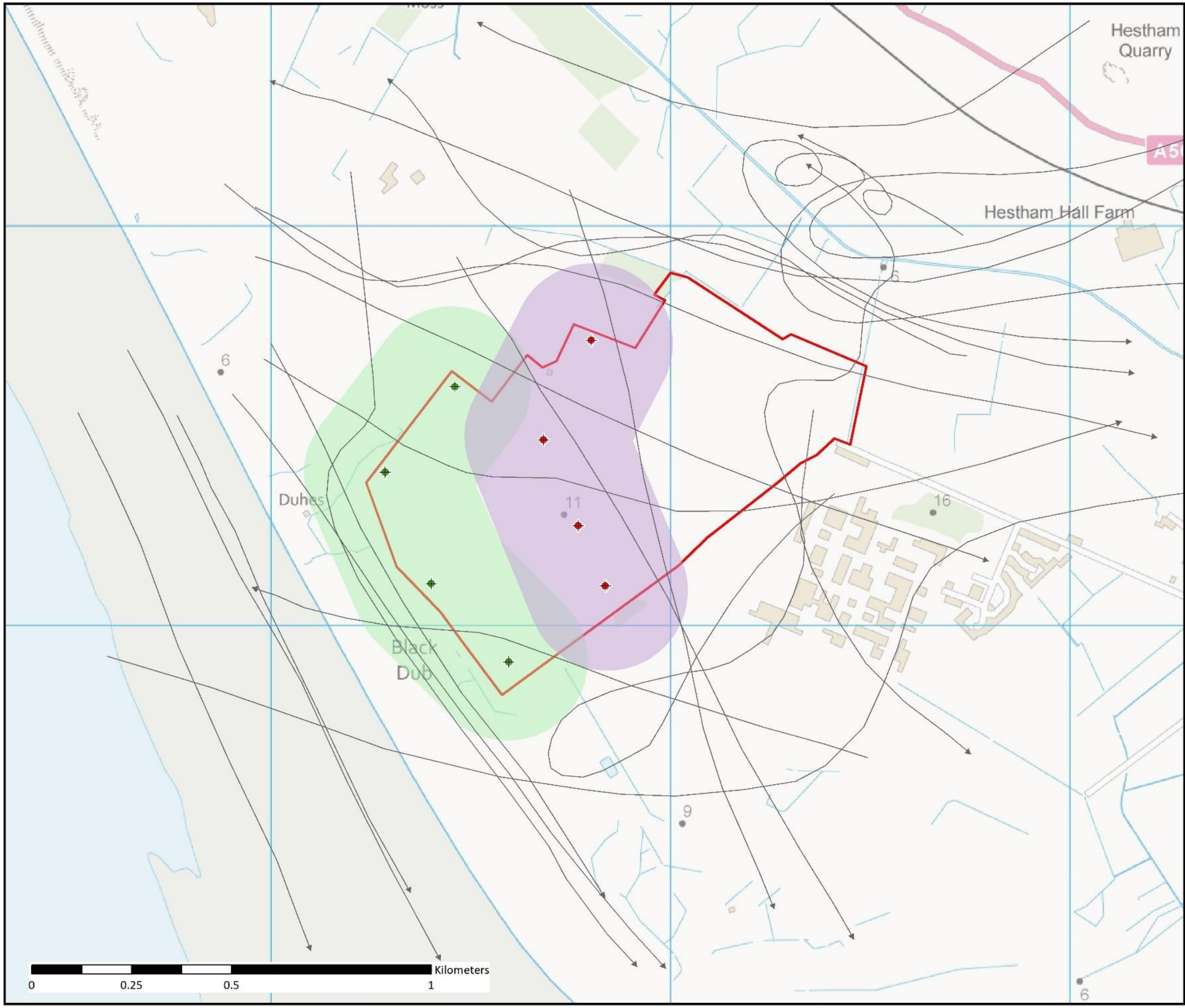
HAVERIGG LIFETIME EXTENSION



THRIVE RENEWABLES

Haverigg II Wind Farm Lifetime Extension

FIGURE 2

Vantage Point Survey 2014-15 Flight Lines: Pink-footed Goose

KEY:

- Haverigg II turbines
- Haverigg III turbines
- Flight lines 2014-15
- Haverigg III Collision Zone (200m)
- Haverigg II Collision Zone (200m)
- Wind farm site boundary

Ecology Consulting

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LAYOUT DWG N/A	T-LAYOUT NO. N/A
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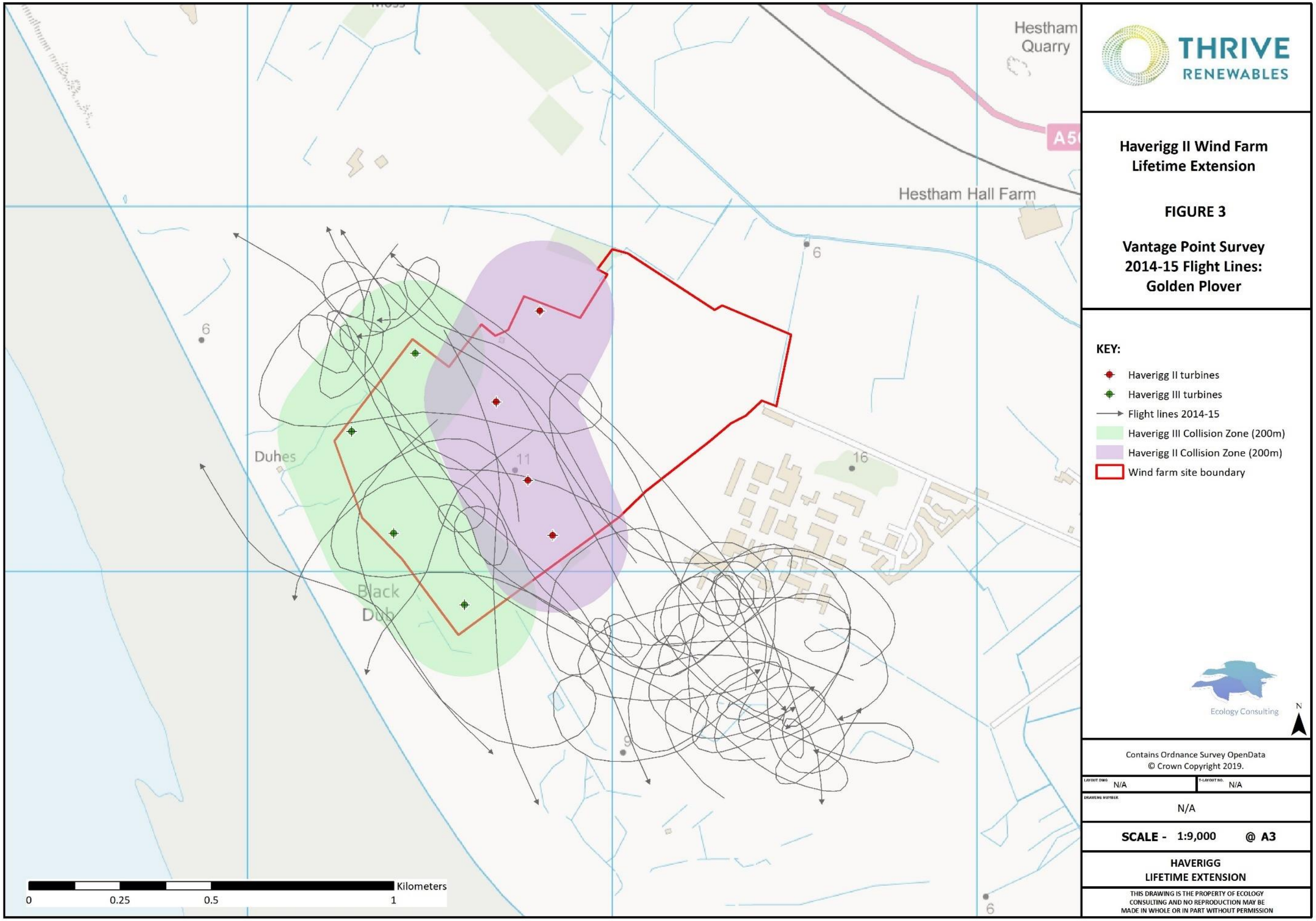
HAVERIGG LIFETIME EXTENSION



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THRIVE RENEWABLES
Haverigg II Wind Farm Lifetime Extension
FIGURE 3
Vantage Point Survey 2014-15 Flight Lines: Golden Plover
KEY:
Haverigg II turbines
Haverigg III turbines
Flight lines 2014-15
Haverigg III Collision Zone (200m)
Haverigg II Collision Zone (200m)
Wind farm site boundary
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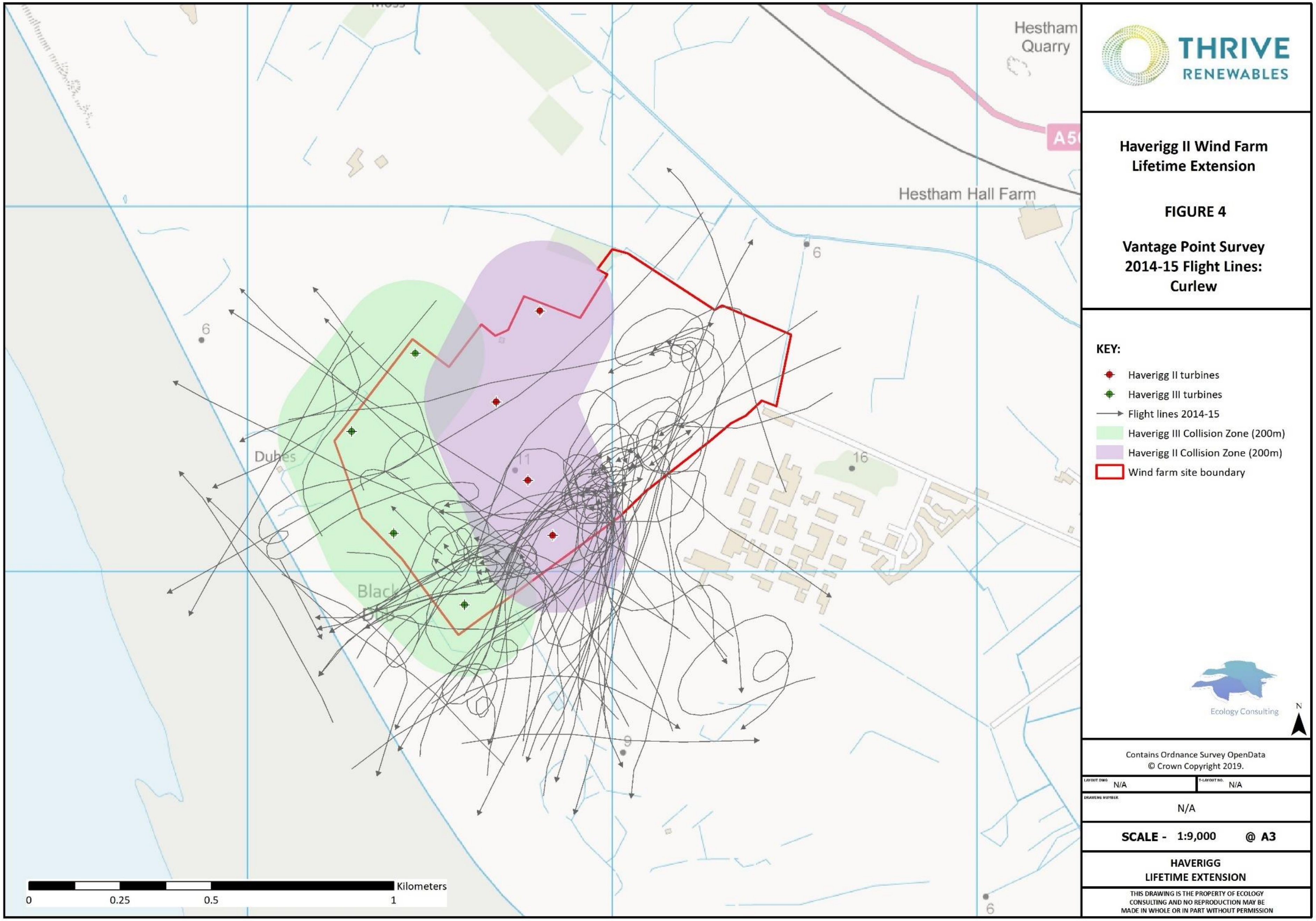
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THRIVE RENEWABLES
Haverigg II Wind Farm Lifetime Extension
FIGURE 4
Vantage Point Survey 2014-15 Flight Lines: Curlew
KEY:
Haverigg II turbines
Haverigg III turbines
Flight lines 2014-15
Haverigg III Collision Zone (200m)
Haverigg II Collision Zone (200m)
Wind farm site boundary
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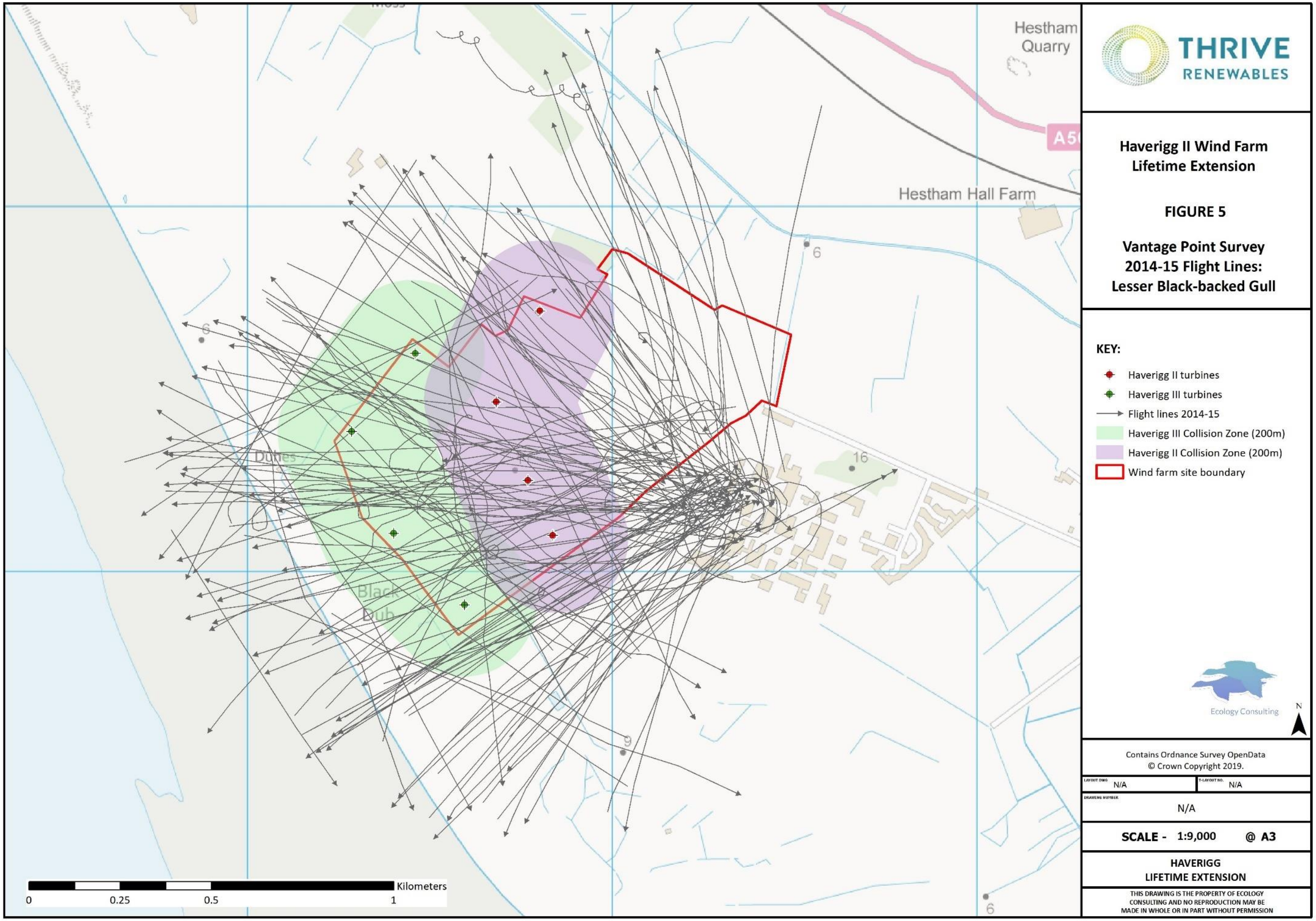
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THRIVE RENEWABLES
Haverigg II Wind Farm Lifetime Extension
FIGURE 5
Vantage Point Survey 2014-15 Flight Lines: Lesser Black-backed Gull
KEY:
Haverigg II turbines
Haverigg III turbines
Flight lines 2014-15
Haverigg III Collision Zone (200m)
Haverigg II Collision Zone (200m)
Wind farm site boundary
Ecology Consulting
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HAVERIGG LIFETIME EXTENSION
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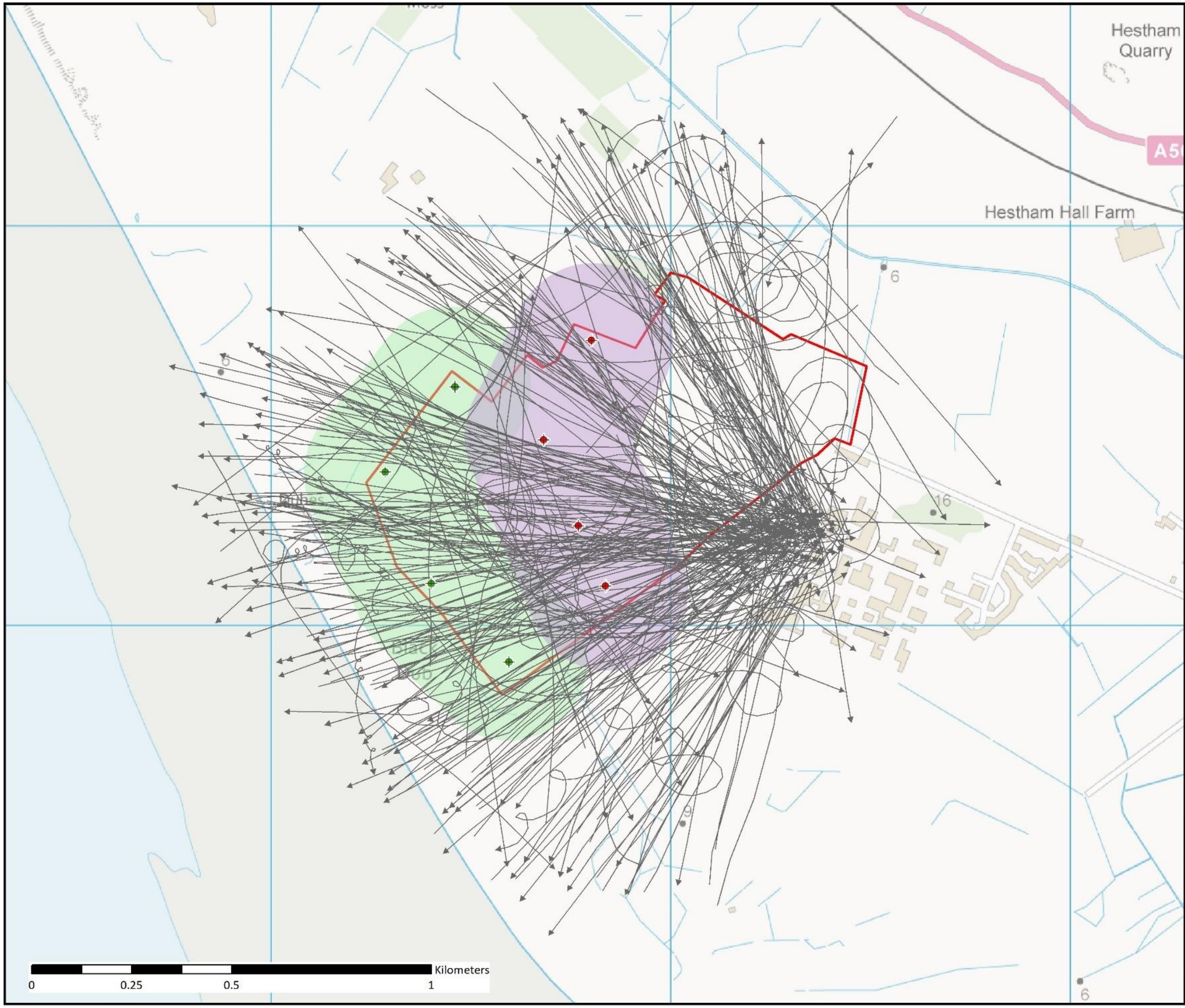
20. The rates of bird flight movement observed across the survey area during the 2014 breeding season vantage point surveys are summarised in Table 3. This gives the mean over-flying rate per hour for each key species over the study period. This includes all the observations of the target species flying over the proposed lifetime extension site and its surrounds.

21. Table 3 also gives the percentage of flights of each species that were recorded at the rotor height of the existing turbines.

Table 3. SPA species (qualifying and assemblage) flight rates recorded over the breeding bird survey area during the April-July 2014 vantage point surveys (36 hours).

Species	Flight Rate (no/hr)	Total number of flights	% flights at rotor height	
			Haverigg II (20.5-62.5m)	Haverigg III (24-76m)
Qualifying Species:				
Shelduck	0.11	4	0%	0%
Oystercatcher	1.14	41	32%	29%
Golden Plover	0.53	19	0%	0%
Curlew	5.58	201	50%	50%
Lesser Black-backed Gull	39.2	1,411	36%	34%
Herring Gull	90.9	3,273	26%	24%
Assemblage Species:				
Mallard	0.22	8	100%	100%
Cormorant	0.11	4	50%	100%
Lapwing	0.64	23	50%	42%
Whimbrel	0.14	5	0%	100%

22. Much the most frequently recorded SPA species were herring gull and lesser black-backed gull, with most records being of birds moving to/from their breeding colonies on the HMP Haverigg prison, which is located adjacent to the eastern boundary of the proposed lifetime extension site. Their flight lines are shown in Figures 6 and 7. Flight lines of the only other SPA species recorded in higher numbers during these surveys, curlew, are shown in Figure 8.



THRIVE RENEWABLES

Haverigg II Wind Farm Lifetime Extension

FIGURE 6

Vantage Point Survey Apr-Jul 2014 Flight Lines: Herring Gull

KEY:

- Haverigg II turbines
- Haverigg III turbines
- Flight Lines Apr-July 2014
- Haverigg III Collision Zone (200m)
- Haverigg II Collision Zone (200m)
- Wind farm site boundary

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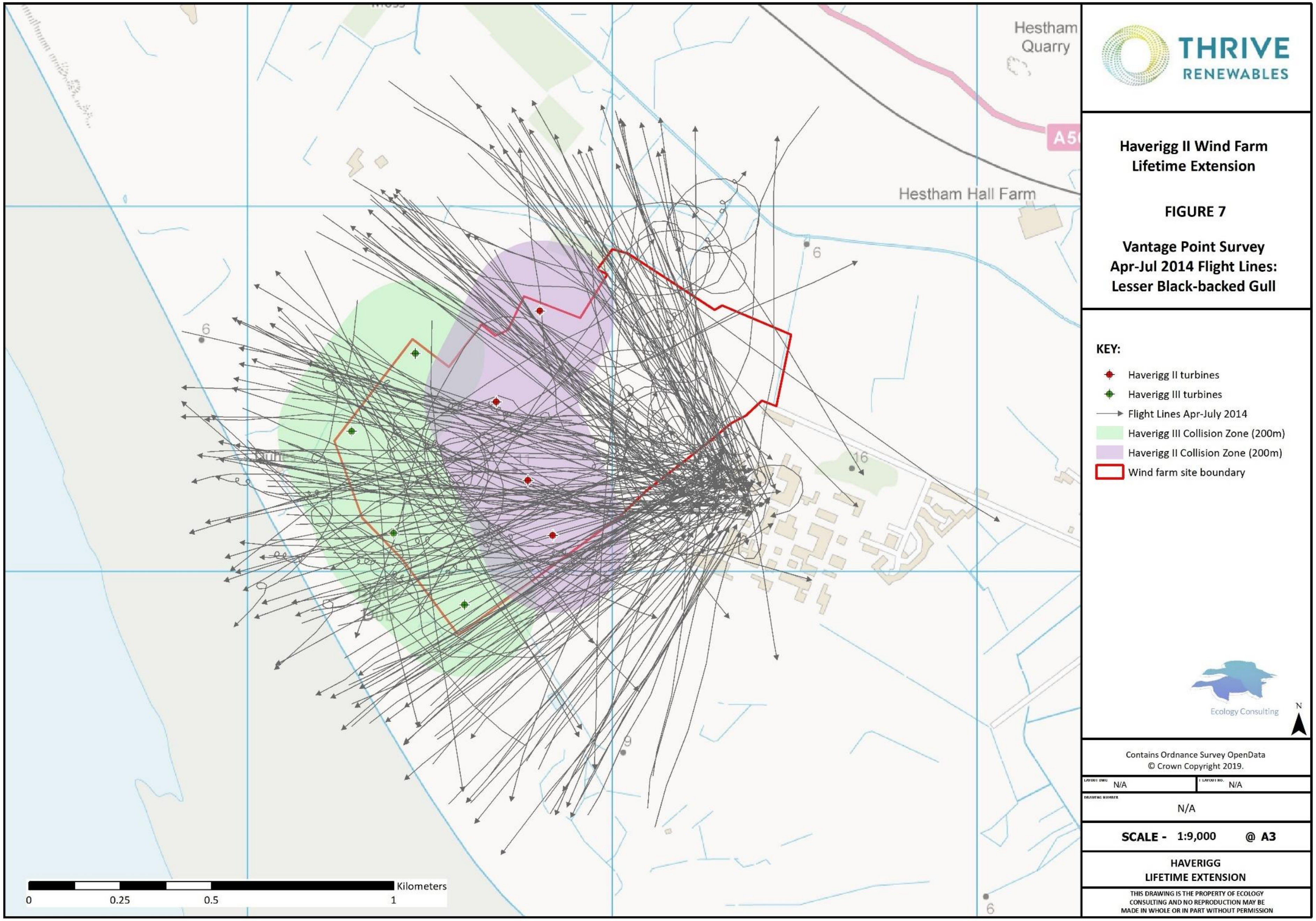
HAVERIGG LIFETIME EXTENSION



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Kilometers
THRIVE RENEWABLES
Haverigg II Wind Farm
Lifetime Extension
FIGURE 7
Vantage Point Survey
Apr-Jul 2014 Flight Lines:
Lesser Black-backed Gull
KEY:
Haverigg II turbines
Haverigg III turbines
Flight Lines Apr-July 2014
Haverigg III Collision Zone (200m)
Haverigg II Collision Zone (200m)
Wind farm site boundary
Ecology Consulting
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LIFETIME EXTENSION
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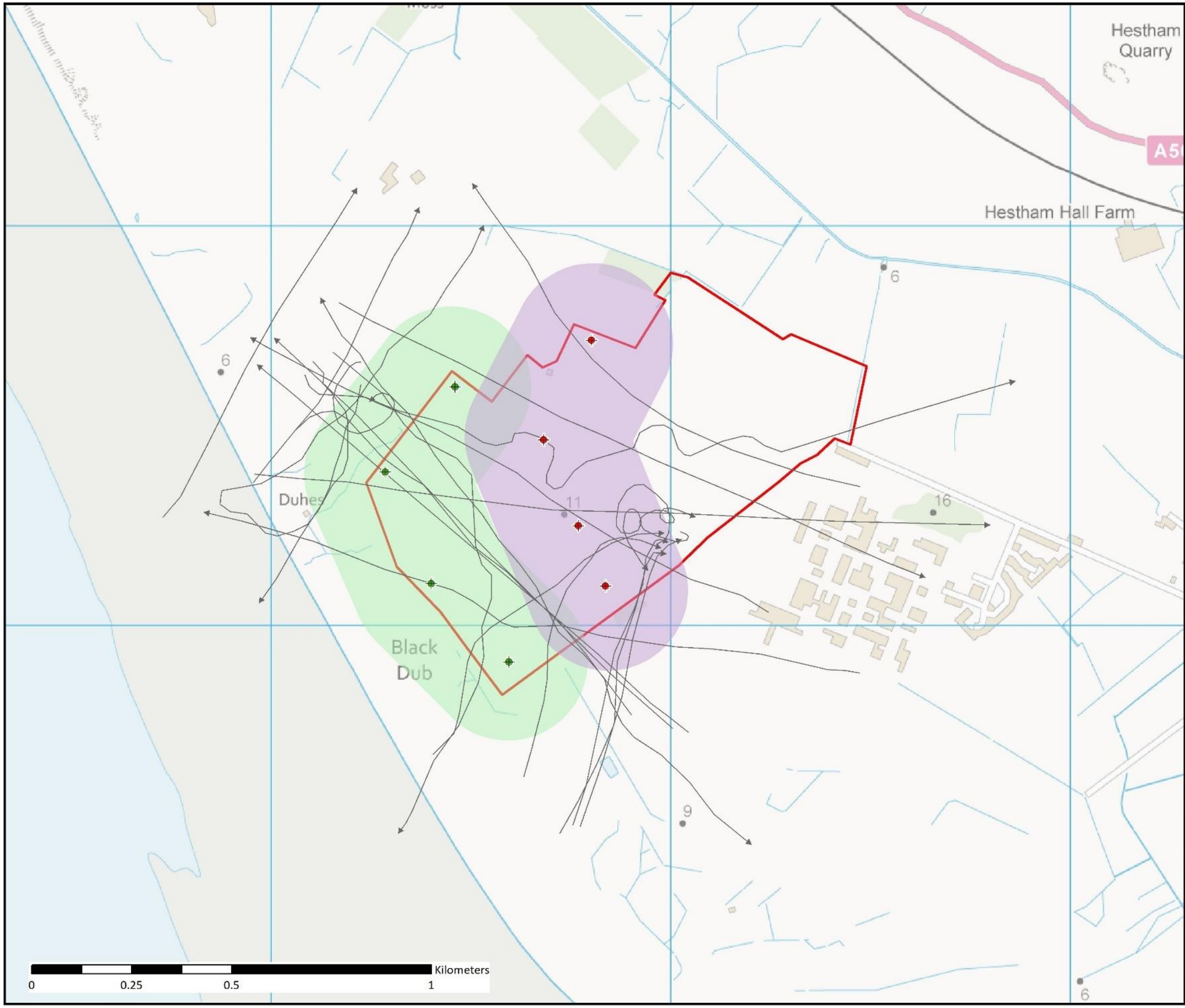

THRIVE RENEWABLES

Haverigg II Wind Farm Lifetime Extension

FIGURE 8

Vantage Point Survey Apr-Jul 2014 Flight Lines: Curlew

KEY:

- Haverigg II turbines
- Haverigg III turbines
- Flight Lines Apr-July 2014
- Haverigg III Collision Zone (200m)
- Haverigg II Collision Zone (200m)
- Wind farm site boundary

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HAVERIGG LIFETIME EXTENSION

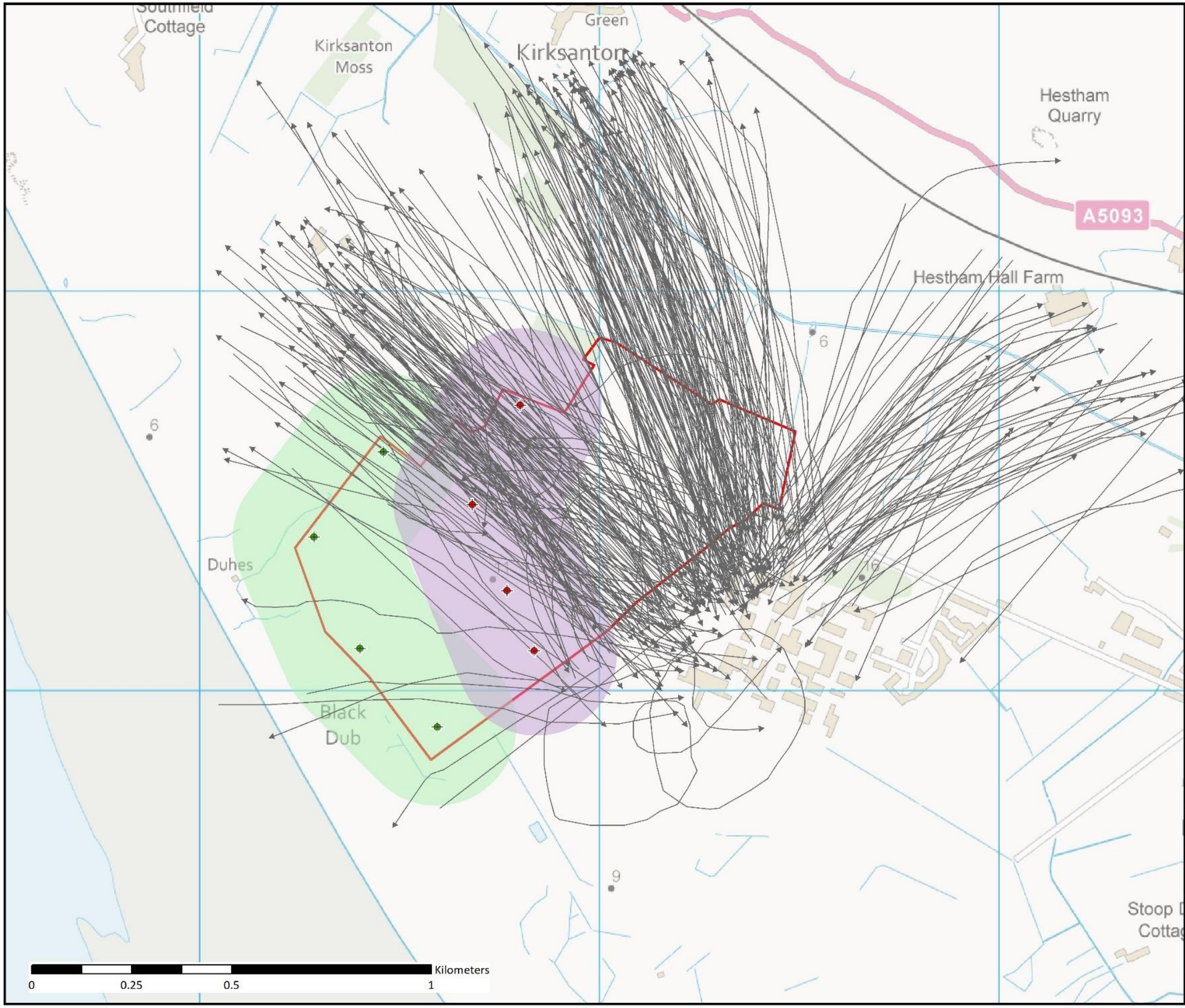
23. The rates of bird flight movement observed across the survey area during the 2019 breeding season vantage point surveys are summarised in Table 4. This gives the mean over-flying rate per hour for each key species over the study period. This includes all the observations of the target species flying over the proposed lifetime extension site and its surrounds.

24. Table 4 also gives the percentage of flights of each species that were recorded at the rotor height of the existing turbines. Flight heights were recorded to broad bands in the 2019 surveys, so it was not possible to estimate the percentage at rotor height for Haverigg II and III separately.

Table 4. SPA species (qualifying and assemblage) flight rates recorded over the survey area during the May-July 2019 vantage point surveys (36 hours).

Species	**Flight Rate (no/hr)**	**Total number of flights**	**Approximate % flights at rotor ht**
Qualifying Species:			
Little Egret	0.11	4	67%
Oystercatcher	3.69	133	26%
Black-tailed Godwit	0.08	3	50%
Curlew	6.42	231	60%
Lesser Black-backed Gull	28.2	1,016	89%
Herring Gull	48.8	1,757	89%
Assemblage Species:			
Mallard	0.28	10	54%
Lapwing	1.53	55	47%
Whimbrel	1.11	40	54%

25. As in 2014, the most frequently recorded SPA species were herring gull and lesser black-backed gull, with most records being of birds moving to/from their breeding colonies on the prison. Their flight lines are shown in Figures 9 and 10. Flight lines of the only other SPA species recorded in higher numbers during these surveys, curlew, are shown in Figure 11.



THRIVE RENEWABLES

Haverigg II Wind Farm Lifetime Extension

FIGURE 9

Vantage Point Survey May-Jul 2019 Flight Lines: Herring Gull

KEY:

- Haverigg II turbines
- Haverigg III turbines
- Flight lines May-July 2019
- Haverigg III Collision Zone (200m)
- Haverigg II Collision Zone (200m)
- Wind farm site boundary

Ecology Consulting

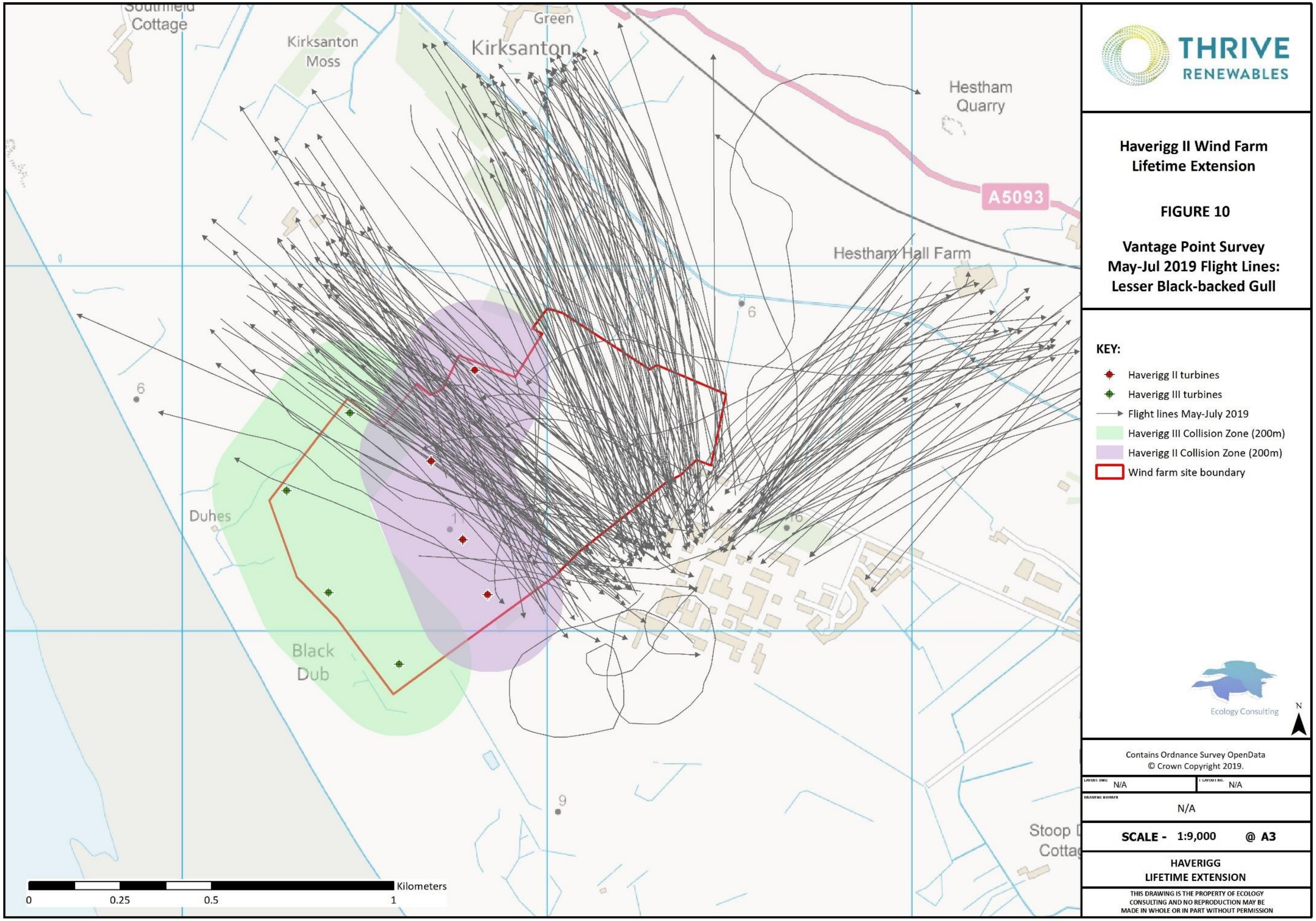
N

N/A	N/A

N/A

SCALE - 1:9,000 @ A3

HAVERIGG LIFETIME EXTENSION



Cottage
Kirksanton Moss
Kirksanton
Green
Hestham Quarry
A5093
Hestham Hall Farm
Duhes
Black Dub
Kilometers
0
0.25
0.5
1
THRIVE RENEWABLES
Haverigg II Wind Farm Lifetime Extension
FIGURE 10
Vantage Point Survey May-Jul 2019 Flight Lines: Lesser Black-backed Gull
KEY:
Haverigg II turbines
Haverigg III turbines
Flight lines May-July 2019
Haverigg III Collision Zone (200m)
Haverigg II Collision Zone (200m)
Wind farm site boundary
Ecology Consulting
N
Contains Ordnance Survey OpenData © Crown Copyright 2019.
N/A
N/A
N/A
SCALE - 1:9,000 @ A3
HAVERIGG LIFETIME EXTENSION
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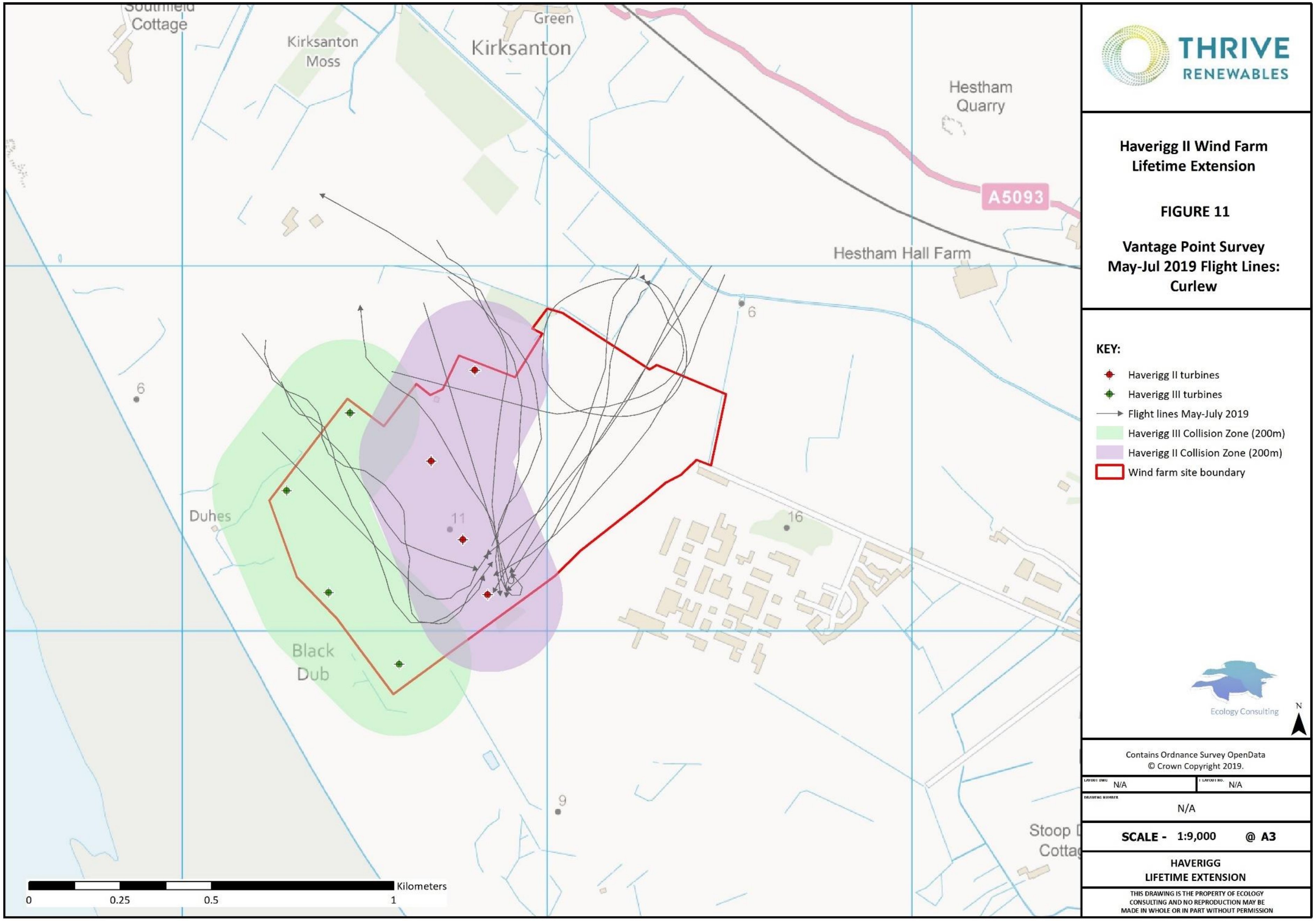

Southfield
Cottage
Kirksanton
Moss
Green
Kirksanton
Hestham
Quarry
A5093
Hestham Hall Farm
6
6
Duhes
11
16
Black
Dub
9
Stoop
Cottag
Kilometers
0
0.25
0.5
1
THRIVE
RENEWABLES
Haverigg II Wind Farm
Lifetime Extension
FIGURE 11
Vantage Point Survey
May-Jul 2019 Flight Lines:
Curlew
KEY:
Haverigg II turbines
Haverigg III turbines
Flight lines May-July 2019
Haverigg III Collision Zone (200m)
Haverigg II Collision Zone (200m)
Wind farm site boundary
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Nocturnal Activity

26. The peak counts and total numbers of SPA species recorded during the nocturnal surveys are summarised in Table 5. The Table also shows the percentage of birds that were recorded feeding and flying at night.

Table 5. SPA species (qualifying and assemblage) nocturnal activity during the 2014-15 surveys (8 surveys).

Species	Peak count in survey area at night	Total counted at night	% feeding	% flying
Qualifying Species:				
Oystercatcher	3	7	0%	43%
Ringed Plover	28	29	76%	14%
Golden Plover	38	136	81%	15%
Curlew	24	30	80%	7%
Herring Gull	35	97	0%	15%
Unidentified herring/lesser black-backed gulls	200	200	0%	0%
Assemblage Species:				
Lapwing	3	5	0%	40%

27. The results of the SPA species' activity at night were used to determine appropriate values to account for nocturnal activity (Band 2012). A value of 50% of daylight activity was used for waders, and 10% for gulls (the collision modelling uses only broad categories to take nocturnal activity into account given the difficulty in obtaining accurate flight data at night). The collision modelling has therefore assumed that wader flight activity at night is at a level of 50% of that during the day, and gull activity 10% (as this taxonomic group was clearly less active at night).

Collision Searches

28. A total of four SPA birds were found under the Haverigg II turbines during the April-July 2014 collision searches; three herring gulls and one lesser black-backed gull. An additional lesser black-backed gull was found under one of the Haverigg III turbines.

29. In 2019 herring gull and lesser black-backed gull were again the only SPA species found dead under the turbines. A total of four confirmed herring gulls and one unidentified large gull (assumed to be a herring gull as the most likely species given numbers present and as a worst case for the assessment) were located under the Haverigg II turbines during the surveys, and one lesser black-backed gull at Haverigg III. As in 2014, no other SPA species were recorded as collision victims.

30. The 2018-19 winter collision searches located one probable golden plover, another unidentified probable wader (assumed to be another golden plover as a worst case for this assessment) and two herring gulls under the Haverigg II turbines, and one herring gull at Haverigg III.

31. Further details of the collisions are given in the EIA screening report.

32. The search efficiency trials showed a very high rate of collision detectability over all of the surveys combined, with overall 93% of trials located (as would be expected given the ground conditions at the site, dominated by short grassland).

33. Field trials and monitoring of the collisions over time indicated that some carcasses were removed quickly but most left feather traces that were detectable over longer periods. Pooling all of the available data on carcass persistence, the overall mean time to disappearance was 54 days (±8.1SE). With a mean daily persistence rate of 98.67% (i.e. on average 100% - 98.67% = 1.33% of carcasses disappeared each day)

this gave a probability of 12% that carcasses disappeared before being found in the 2014 surveys (which were more frequent, about every 10 days) and 33% for the 2018-19 surveys (which were carried out on approximately a monthly visit frequency).

34. Taking into account the search efficiency and carcass removal for all of the available data from both Haverigg II and III, the five gull carcasses found in 2014 would equate to:

5 x 1.07 x 1.12 = 6.0 gulls

35. This value needs though to be adjusted further to take into account that these surveys only covered part (43%) of the breeding season (taken as April-July), so the overall total gull collision estimate was 14.1.

36. For the 2019 breeding season, the six gulls located would equate to 7.5 actual collisions.

6 x 1.07 x 1.33 = 7.5 gulls

37. For the 2018-19 winter, applying the same correction factors, the three herring gulls and two waders would equate to 7.5 gulls and 5 wader collisions in total.

Habitats Regulation Tests

38. This section provides an overview of the tests that need to be applied under the Habitats Regulations, drawing on the 'Managing Natura 2000 sites' document produced by the European Communities (European Commission 2018). After an initial discussion of the tests to be applied, the information relevant to each species is presented. The process for applying these tests, as summarised in Annex III of 'Managing Natura 2000 sites', is included in Appendix 3.

Test 1: Likely Significant Effect

39. The initial test that has to be considered is whether the development may result in a Likely Significant Effect. This "significance" differs from its definition under the EIA Regulations. In the context of the Habitats Regulations, it is usually used as a coarse filter to identify projects that require further assessment.

40. The potential effects need to be judged in relation to the features for which the European sites (SPAs) have been designated, and their nature conservation objectives.

41. A significant effect can result from off-site projects as well as those within the European site, so could potentially occur at Haverigg II even though the proposed wind farm is not located within any SPA. No part of the Proposed Development would directly affect any SPA.

42. Following PINS (2017) guidance, the sections below:

- identify the potential hazards to the SPA interests that may result from the proposed wind farm;
- provide information on the probability that those effects will affect the SPA populations and nature conservation objectives; and
- assess the likely magnitude of those potential effects.

43. These effects could potentially occur through the lifetime extension of the wind farm (10 years), after which it would be decommissioned and removed from the site (and hence would not be a permanent feature of the site).

44. Natural England has advised that it considers that a **Likely Significant Effect** cannot be ruled out for the Haverigg II Lifetime Extension for four species: lesser black-backed gull, herring gull, golden plover and curlew. These were the species identified from the surveys as interacting with the windfarm. Other species were screened out at this stage because there was no evidence of them being at risk from the development. As a result, this assessment provides the information required to inform an Appropriate Assessment.

Test 2: Threat to Ecological Integrity

45. The Competent Authority will be required to decide whether the plan or project would adversely affect the integrity of the site(s), in the light of the relevant Conservation Objectives. Ecological integrity in this context has been defined as:

    "the coherence of the site's ecological structure and function, across its whole area, or the habitats, complex of habitats and/or populations of species for which the site is or will be classified".

46. An adverse effect on integrity is one that is likely to prevent the site from making the same contribution to favourable conservation status for the relevant feature as it did at the time of its designation.

47. The Conservation Objectives for the Morecambe Bay and Duddon Estuary SPA/pSPA[2] are as follows:

    "Ensure that the integrity of the site is maintained or restored as appropriate, and ensure that the site contributes to achieving the aims of the Wild Birds Directive, by maintaining or restoring;

    - *The extent and distribution of the habitats of the qualifying features*
    - *The structure and function of the habitats of the qualifying features*
    - *The supporting processes on which the habitats of the qualifying features rely*
    - *The population of each of the qualifying features, and,*
    - *The distribution of the qualifying features within the site."*

48. The site-specific objectives for the qualifying SPA species that could be affected by the proposed development, redshank, have also been considered in this assessment. On the advice of Natural England this includes those for the Lesser Black-backed Gull and Herring Gull populations, both of which have been classed as 'unfavourable declining', and are well below the target population for the 'restore' objective (10,000 pairs). Although the source colonies for these species that is interacting with the windfarm site is outside the SPA boundary, Natural England advised that these colonies adjacent to the SPA should be treated as part of the functional meta-population, and assessed in this context.

Assessment of Ornithological Effects

49. There are three ways in which a proposed wind farm lifetime extension might have an adverse effect on bird species: collision risk leading to increased mortality rate, loss of habitat through disturbance and disruption to flight lines through a barrier effect. Following consultation with Natural England, this report focusses on collision risk to lesser black-backed gull, herring gull, golden plover and curlew as the key issue at this site for the lifetime extension. There would not be any direct loss of habitat as a result of the proposed lifetime extension.

Collision Risk

50. This potential effect will occur during the operational phase of the wind farm. There have been a number of wind farms that have caused bird mortalities through collision, but the characteristics of the development and the affected species are very different to those at the Haverigg site. Most notably, at Altamont Pass in California and Tarifa in southern Spain, large numbers of raptors have been killed (Orloff and Flannery 1992, Janss 1998, Thelander et al. 2003). Such problems have occurred where large numbers of sensitive species occur in close proximity to very large numbers (hundreds/thousands) of turbines, and usually also where the wind farm area provides a particularly attractive feeding resource. In wind farm sites in the UK collision rates have generally been very low and are not considered to be

[2] http://publications.naturalengland.org.uk/publication/6242841537806336

significant (Meek et al. 1993, Tyler 1995, Dulas 1995, EAS 1997, Bioscan 2001, Percival et al. 2008, Percival et al. 2009a, Percival et al. 2013).

51. In order to further inform the determination of the likelihood of adverse effects occurring, collision modelling has been carried out for all the SPA species recorded over-flying the collision risk zone and at rotor height in sufficient numbers (applying professional judgement) to possibly be at risk of a significant impact; golden plover, curlew, lesser black-backed gull and herring gull.

52. The collision risk model used in this assessment is the one developed by SNH and BWEA (Percival et al., 1999; Band, 2001; Band et al., 2007). Details of the model are given in these publications. The model runs as a two-stage process. Firstly, the risk is calculated making the assumption that flight patterns are unaffected by the presence of the wind turbines, i.e. that no avoidance action is taken. This is essentially a mechanistic calculation, with the collision risk calculated as the product of (i) the probability of a bird flying through the rotor swept area, and (ii) the probability of a bird colliding if it does so. This probability is then multiplied by the estimated numbers of bird movements through the wind farm rotors at the risk height (i.e. the height of the rotating rotor blades) in order to estimate the theoretical numbers at risk of collision if they take no avoiding action.

53. The second stage then incorporates the probability that the birds, rather than flying blindly into the turbines, will actually take a degree of avoiding action, as has been shown to occur in all studies of birds at existing wind farms. SNH has recommended a precautionary approach in the use of avoidance rates, using a value of 98% as a general default rate, but higher rates where there is evidence available from field studies. Higher recommended rates include 99% for several larger raptors, 99.8% for geese and 99.5% for gulls (SNH 2017b, Furness 2019). This precautionary approach is useful as an initial filter to identify sites where collision risk is clearly not an issue, but does not necessarily provide a realistic estimate of actual likely collision rates when compared with data from existing wind farms.

54. The field studies of collision rates and flight activity at Haverigg have enabled site-specific avoidance rates to be calculated, using the collision model to compare predictions with actual collision rates. Avoidance rates were calculated as the proportionate difference between the actual number of collisions (taking into account observation detection and scavenger removal rates) and the predicted risk in the absence of any avoidance behaviour (see Appendix 4). Using this approach, avoidance rates of 99.2% were derived for gulls and 99.6% for waders. This is based only on post-construction data from the wind farm site itself, so this does not include macro-avoidance of the site itself (Cook et al. 2014), which may increase the rates further. They do though provide an appropriate precautionary rate for this assessment that has an empirical basis and is based on evidence from this specific site.

55. Details of the input data and the collision risk calculations are given in Appendix 4. Body sizes and baseline mortality rates were taken from Robinson (2005), and flight speeds from Alerstam et al. (2007), as detailed in Appendix 4.

56. The flight rates of each of the key species though the collision risk zone are summarised in Table 6. This risk zone was defined as the wind farm plus a 200m buffer. These zones are shown in Figures 1-11. A 200m buffer was used as it was possible to map flights more accurately given the presence of the wind turbines at the site. Extending the buffer to cover a wider area would include other habitats that would be unrepresentative of the actual wind farm site.

Table 6. Flight rates of SPA species recorded through the collision risk zone at rotor height during the baseline vantage point surveys during the baseline surveys.

Species	Winter 2014-15	Breeding 2014	Breeding 2019
Golden Plover	7.0	0	0
Curlew	7.9	1.6	3.3
Lesser Black-backed Gull	2.0	8.5	11.3
Herring Gull	15.3	13.5	21.0

57. The magnitude of the potential population impact of the collision risk has been determined as a percentage increase in the existing baseline mortality (to put the potential wind farm mortality into the ecological context of the birds' population dynamics). Any more than a 1% increase (the upper threshold

for a negligible magnitude effect, e.g. Percival 2007) in the background mortality rate would be considered as a potential adverse effect on the integrity of any SPA population, though professional judgement was also applied in the assessment to examine the ecological context of that additional mortality.

Collision Risk Modelling Results

58. Table 7 summarises the collision risk analysis for each of the SPA species modelled. The Table gives the number of collisions predicted per year, applying a range of avoidance rates (from the collision risk model), the percentage increase that this would represent over the baseline mortality and whether such an impact would result in any adverse effect on integrity under the Habitats Regulations. The avoidance rates used in the further assessment, based on the empirical data from the Haverigg VP survey and collision searches (and with reference to other published values), are shown in bold (99.2% for gulls and 99.6% for waders). The results are presented separately for each season.

59. The baseline populations used to calculate the percentage increase in mortality were derived from the most recently published BTO Wetland Bird Survey five-year mean peak count for the SPA for the autumn/wintering populations (for golden plover, curlew and for non-breeding lesser black-backed gull and herring gulls), and (for breeding lesser black-backed and herring gulls) , and data provided by Natural England during consultation from the Seabird Monitoring Programme[3]. Separate assessments have been made for the breeding and non-breeding seasons. Natural England requested that the assessment be made (on a precautionary basis) for breeding lesser black-backed and herring gulls against the most recent breeding gull populations from the SPA, i.e. those from 2019 (856 pairs of lesser black-backed gulls and 1,568 pairs of herring gulls). If the five-year means were used, this would result in a reduced increase over the baseline mortality. These five-year means were approximately five-fold higher than in 2019 for lesser black-backed gull and 20% higher for herring gull (the South Walney colony had a major drop in lesser black-backed gull numbers in 2019 in comparison with previous years).

Table 7: Collision risk modelling predictions for the Haverigg II Wind Farm lifetime extension for SPA species.

Species	**Estimated actual number of collisions**	**Predicted number of collisions per year applying the following avoidance rates:**					**Percentage increase in annual baseline mortality at empirical avoidance rate**	**Magnitude of impact**	**Potential adverse effect on integrity?**
		98%	**99%**	**99.2%**	**99.5%**	**99.6%**			
Golden Plover									
Breeding 2014	0	0	0	0	0	**0**	**0%**	Negligible	No
Breeding 2019	0	0	0	0	0	**0**	**0%**	Negligible	No
Winter 2014-15	5.0	5.96	2.98	2.38	1.49	**1.19**	**0.10%**	Negligible	No
Lesser Black-backed Gull									
Breeding 2014	0	5.37	2.68	**2.15**	1.34	1.07	**3.21%**	Low	No
Breeding 2019	2.8	7.02	3.51	**2.81**	1.76	1.40	**4.20%**	Low	No
Winter 2014-15	0	2.02	1.01	**0.81**	0.51	0.40	**0.16%**	Negligible	No
Herring Gull									

[3] http://archive.jncc.gov.uk/default.aspx?page=1550

Species	Estimated actual number of collisions	Predicted number of collisions per year applying the following avoidance rates:					Percentage increase in annual baseline mortality at empirical avoidance rate	Magnitude of impact	Potential adverse effect on integrity?
		98%	99%	99.2%	99.5%	99.6%			
Breeding 2014	8.4	8.67	4.33	**3.47**	2.17	1.73	**2.17%**	Low	No
Breeding 2019	6.3	14.11	7.06	**5.65**	3.53	2.82	**3.54%**	Low	No
Winter 2014-15	5.0	13.38	6.69	**5.35**	3.35	2.68	**0.33%**	Negligible	No
Curlew									
Breeding 2014	0	1.01	0.51	0.41	0.25	**0.20**	**0.01%**	Negligible	No
Breeding 2019	0	1.57	0.78	0.63	0.39	**0.31**	**0.02%**	Negligible	No
Winter 2014-15	0	7.82	3.91	3.13	1.95	**1.56**	**0.04%**	Negligible	No

Note: bold indicates collision risk for each species used in further population analysis, based on empirical data from Haverigg. Seasonal impacts considered as additive apart from lesser black-backed gulls, as the large majority of the local breeding birds of that species move away in the winter period and any birds in the winter period are more likely to be migrant or wintering from elsewhere

60. The predicted collision risks for the Haverigg II wind farm lifetime extension were negligible magnitude, apart from the two gull species during the breeding season, which were low magnitude impacts in both 2014 and 2019. Looking at the ecological context of this additional mortality, whilst a LSE was identified, it was concluded that the low magnitude impacts predicted would result in **no adverse effect on integrity** in relation to collision risk from the proposed Haverigg II lifetime extension, for the following reasons:

- Only a very low amount of additional mortality was predicted from the collision modelling, and the actual observed collision rates (lesser black-backed gull 2.5 predicted per breeding season, 2.0 observed - taking into account search efficiency and scavenger removal; herring gull 4.6 predicted, 4.2 observed);
- Previous population analyses for offshore wind farms have shown that a much higher level of mortality could be sustained by the populations (90 herring gull collisions and 300 lesser black-backed gull collisions, Dept of Energy and Climate Change 2014), albeit based on higher population estimates than in the latest data.

61. Notwithstanding the conclusion reached above, Natural England has advised that it considers that mitigation measures are required in order to ensure that there is no adverse effect on the integrity of the SPA breeding lesser black-backed and herring gull populations as a result of Haverigg II wind farm. These mitigation measures are set out below.

Barrier Effect

62. A further potential effect of the proposed wind farm could be disruption to important flight lines (barrier effect). Birds may see the wind farm and change their route to fly around (rather than through) it. This would reduce the risk of collision but could possibly have other effects, for example potentially making important feeding areas less attractive (by acting as a barrier to the birds reaching them) and (if diversions were of a sufficient scale) resulting in increased energy consumption.

63. The distance needed to divert around the wind farm would be only small and would not be expected to act as a major barrier to movements. The flight lines plotted during the vantage point surveys (Figures 1-11) do not suggest that any of the SPA species exhibited any evidence of a significant barrier effect of the

wind farm, with many flights continuing through and in close proximity to the wind farm (though largely avoiding the rotor swept area). Barrier effects would result in **no adverse effect on integrity.**

Cumulative Effects

64. The cumulative assessment of the ornithological effects of the proposed Haverigg II lifetime extension has been undertaken sequentially, in order to address issues with gaps in the assessment of other projects.

65. The first step was to consider cumulative assessment of Haverigg II lifetime extension with that also being proposed for Haverigg III, as directly comparable data are available for the two schemes (as the same baseline surveys have covered both). Table 8 shows the predicted collision risks for the four SPA species considered for Haverigg II, in combination with the Haverigg III scheme.

Table 8: In-combination collision risk modelling predictions for the Haverigg II and III Wind Farm lifetime extension for SPA species.

Species	Estimated actual number of collisions	Predicted number of collisions per year applying the following avoidance rates:					Percentage increase in annual baseline mortality at empirical avoidance rate	Magnitude of impact	Potential adverse effect on integrity?
		98%	99%	99.2%	99.5%	99.6%			
Golden Plover									
Breeding 2014	0	0	0	0	0	0	**0%**	Negligible	No
Breeding 2019	0	0	0	0	0	0	**0%**	Negligible	No
Winter 2014-15	5.0	13.3	6.6	5.3	3.3	2.7	**0.34%**	Negligible	No
Lesser Black-backed Gull									
Breeding 2014	2.8	7.7	3.9	**3.1**	1.9	1.5	**4.63%**	Low	No
Breeding 2019	1.3	9.7	4.8	**3.9**	2.4	1.9	**5.77%**	Low	No
Winter 2014-15	0	2.7	1.4	**1.1**	0.7	0.5	**0.33%**	Negligible	No
Herring Gull									
Breeding 2014	11.3	11.3	5.7	**4.5**	2.8	2.3	**2.85%**	Low	No
Breeding 2019	6.3	21.0	10.5	**8.4**	5.3	4.2	**5.27%**	Low	No
Winter 2014-15	7.5	19.6	9.8	**7.8**	4.9	3.9	**0.72%**	Negligible	No
Curlew									
Breeding 2014	0	1.9	0.9	0.7	0.5	**0.4**	**0.03%**	Negligible	No
Breeding 2019	0	2.1	1.0	0.8	0.5	**0.4**	**0.03%**	Negligible	No
Winter 2014-15	0	12.6	6.3	5.0	3.1	**2.5**	**0.09%**	Negligible	No

Note: bold indicates collision risk for each species used in further population analysis, based on empirical data from Haverigg. Possible adverse effects on site integrity are considered further in the main text.

66. The predicted collision risks for the lifetime extensions of the two schemes in combination for golden plover and curlew were still of negligible magnitude, so would result in **no adverse effect on integrity** in relation to collision risk from the proposed Haverigg II and III lifetime extensions for these species. The same conclusion was reached for lesser black-backed gull and herring gull outside the breeding season. The cumulative risks from the two wind farms for these two gull species in the breeding season were predicted to be of low magnitude, so further consideration has been given to these impacts below.

67. For the second step of the cumulative assessment, consideration has been given to the potential cumulative impacts of other onshore wind farm schemes within 20km of Haverigg II, and within the same buffer distance of the Morecambe Bay and Duddon Estuary SPA, as shown in Table 9. Reference was also made to the RSPB bird sensitivity mapping for wind farms for Cumbria and Lancashire (Youngs and Shackleton 2007, and Youngs and White 2008).

Table 9. Onshore wind farm developments and proposals in planning within a 20km buffer of the proposed lifetime extension, and the Morecambe Bay and Duddon Estuary SPA.

Wind Energy Development	Status	Distance from Haverigg II (km)	County	No. of turbines	Turbine capacity (MW)
Haverigg III	Operational	0.04	Cumbria	4	0.85
HMP Haverigg	Consented	0.3	Cumbria	5	3
Askam	Operational	10	Cumbria	7	0.66
Furness (Harlock Hill Repowering)	Operational	11	Cumbria	5	2.3
Kirkby Moor	Operational (lifetime extension consented)	13	Cumbria	12	0.4
Fanny House Farm	Operational	35	Lancashire	1	1.5
Heysham	Operational	35	Lancashire	1	2
Heysham South	Operational	35	Lancashire	3	2.5
Lancaster University	Operational	42	Lancashire	1	2
Armistead	Operational	45	Cumbria	6	2
Orchard End	Operational	45	Lancashire	2	2
Caton Moor Repowering	Operational	46	Lancashire	8	2
Lambrigg	Operational	47	Cumbria	5	1.3
Dewlay Cheese	Operational	50	Lancashire	1	2

68. Given the very low collision risk from the Haverigg II lifetime extension for golden plover and curlew (in terms of both absolute numbers and change to the baseline mortality), it is not likely to contribute materially to any significant cumulative risk. The HMP Haverigg wind farm (which has been consented but not built) did predict a similar negligible magnitude level of collision mortality for that scheme too (2.1 golden plover collisions per year, and 0.1 curlew collisions per year). The available evidence indicates that there would be **no adverse effect on integrity** in relation to cumulative collision risk for either golden plover or curlew. Lack of quantitative assessment of collision risk for herring gull and for lesser black-backed gull at many of these schemes means that it is not possible to carry out a quantitative cumulative assessment. Gulls have often been overlooked in baseline surveys. The HMP Haverigg wind farm baseline surveys, for example, only treated gulls as a secondary species, so flight lines were not mapped, and no collision modelling was undertaken (despite that site being adjacent to a breeding colony).

69. None of the projects listed in Table 9 predicted any significant ornithological effects, either alone or in combination.

70. In the third and final step of the cumulative assessment, consideration has been given to the offshore wind farms and other plans and projects that could affect the Morecambe Bay and Duddon Estuary SPA/Ramsar populations of the two gull species under consideration, including recent/ongoing management measures. During the consultation process Natural England requested that this include the annual licensing applications to manage large gulls in the region.

71. The offshore wind farms within 20km of the site/SPA are shown in Table 10. The most recent cumulative assessment for these sites (Walney Extension) concluded that a Likely Significant Effect of collision mortality on the Morecambe Bay and Duddon Estuary herring gull and lesser black-backed gull

populations could not be ruled out, so an Appropriate Assessment was carried out. This concluded, with a predicted annual collision risk of 36 herring gulls and 17 lesser black-backed gulls from the Walney Extension site on its own (and a cumulative risk of 111 for lesser black-backed gull - no reliable cumulative value could be derived for herring gull) would not result in any adverse effect on site integrity. Population modelling carried out to inform the assessment indicated that 90 herring gull collisions and 300 lesser black-backed gull collisions could be sustainably removed annually from the population (Dept of Energy and Climate Change 2014). It should though be noted that, at that time, the Conservation Objectives for the site had not identified the 'restore' objective currently afforded to this feature.

72. These offshore collision risks were calculated applying a precautionary 98% avoidance rate. Subsequent studies have shown this to be any overly precautionary number, and a higher value of 99.5% is currently recommended (Cook et al. 2014, JNCC et al. 2014, Furness 2019). This would result in a 75% reduction in collision risk from these offshore sites, substantially increasing the gap between the predicted risk and the level at which a non-sustainable population impact might occur.

73. Both herring gull and lesser black-backed gulls have been culled in large numbers in this region and nationally over the last 50 years (Ross-Smith et al 2014, Coulson 2015). This has included a major cull of the Haverigg colony adjacent to the Haverigg II site. That colony had reached a peak of 1,700 breeding pairs of lesser black-backed gulls and 900 breeding pairs of herring gulls in 2007. Two years later, after a major control programme, those number were reduced to only 52 pairs of lesser black-backed gulls and 117 pairs of herring gulls (and numbers have remained low since that time, JNCC Seabird Monitoring Programme[4]). Nationally in the UK, there is now clear evidence that culling has been a major contributor to large gull population declines (Coulson 2015). The effect of the Haverigg II wind farm, is clearly trivial in comparison with this Natural England-approved management, and makes only a very small contribution to the cumulative impact.

74. Overall, even though the predicted cumulative mortality exceeded a 1% increase over the baseline mortality, it was concluded that the Haverigg II lifetime extension would result in no **adverse effect on integrity** for cumulative collision risk to the SPA herring gull and lesser black-backed gull breeding populations, for the following reasons:

- Only a very low amount of additional mortality was predicted from the collision modelling, and the actual observed collision rates (lesser black-backed gull 3.5 predicted per year, 2.0 observed; herring gull 6.5 predicted, 8.8 observed);
- Previous population analyses for offshore wind farms have shown that a much higher level of mortality could be sustained by the populations (90 herring gull collisions and 300 lesser black-backed gull collisions, Dept of Energy and Climate Change 2014) albeit based on higher population estimates than in the latest data;
- The contribution of the Haverigg II wind farm to the cumulative impact is trivial in comparison with previous and recent gull culling schemes (including removal of about 1,650 pairs of lesser black-backed gulls and 800 herring gulls between 2007 and 2009, as documented in the JNCC Seabird Monitoring Programme[4]) and it is the population declines as a result of other factors such as these which has led to the prediction of a LSE based on the mortality caused by Haverigg II wind farm.

75. Notwithstanding the conclusion reached above, Natural England has advised that it considers that mitigation measures are required in order to avoid the possibility of any adverse effect on the integrity of the SPA breeding lesser black-backed and herring gull populations. These mitigation measures are set out below. The implementation of these measures, to which the applicant has committed, means that the outcome will be the same whether a conclusion of adverse effect on integrity is reached or not by the determining authority. The mitigation measures will ensure that there is not any adverse effect on SPA integrity.

[4] http://archive.jncc.gov.uk/page-4460. Accessed 18/12/19.

Table 10. Offshore wind farm developments and proposals in planning within a 20km buffer of the proposed lifetime extension, and the Morecambe Bay and Duddon Estuary SPA.

Wind Energy Development	Status	Distance from Haverigg II (km)	County	No. of turbines	Turbine capacity (MW)
Ormonde Offshore	Operational	15	Cumbria	30	5
Walney 1	Operational	22	Cumbria	51	3.6
Walney 2	Operational	23	Cumbria	51	3.6
Barrow	Operational	24	Cumbria	30	3
West of Duddon Sands	Operational	26	Cumbria	108	3.6
Walney Extension (Walney 3)	Operational	30	Cumbria	110	6

Mitigation Measures

76. Natural England has advised that it considers mitigation should be implemented as a precautionary measure to ensure that the Haverigg II lifetime extension has no adverse effect on the integrity of the Morecambe Bay and Duddon Estuary SPA breeding lesser black-backed gull and herring gull populations.

77. Natural England advised that it considers "*an appropriate intervention would be to increase the number of birds that are able to safely breed at South Walney. Appropriate methods to predator fence seabird colonies are now well established. To be fully compliant with Habitat Regulations provision any predator fencing at South Walney should be additional to that already installed*." Natural England has recommended that this should provide for protection of at least 10 lesser black-backed gull nests and 25 herring gull nests for the Haverigg II and III lifetime extensions in combination, and that an area of 1 ha. should be sufficient (i.e. 500 m of new fencing).

78. Therefore, in order to mitigate possible effects of the Haverigg II lifetime extension, Thrive Renewables will fund the installation of 375 m of new predator-proof fencing, sufficient to protect 0.7 ha. of the gull colony (Haverigg II constitutes about 75% of the combined collision risk, so this value represents 75% of the total).

79. This increased protection of the breeding colony would be expected to reduce the reliance of breeding lesser black-backed and herring gulls on sites such as Haverigg Prison, and would be expected to increase the productivity of the local gull populations to offset mortality associated with the development.

80. Thrive Renewables will work with Cumbria Wildlife Trust (CWT) to ensure that the mitigation is in place prior to the first breeding season after the life extension period comes into force in 2025. Payment for these mitigation works will be secured prior to determination of the lifetime extension.

Conclusions

81. This report has provided baseline data and analysis to inform the Habitats Regulations Assessment required for the proposed lifetime extension.

82. Summarising the Habitats Regulations Assessment, potential effects the Morecambe Bay and Duddon Estuary SPA/Ramsar sites that are considered within this report are provided in Table 11 below. Effects have been grouped where appropriate for ease of presentation. On the advice of Natural England, Likely Significant Effects were identified for four species that are qualifying features of the Morecambe Bay and Duddon Estuary SPA; lesser black-backed gull, herring gull, golden plover and curlew.

Table 11. Impacts considered within the Habitats Regulations Assessment for the Haverigg II wind farm lifetime extension

Designation	Potential Effects	Likely Significant Effect of Lifetime Extension
Morecambe Bay and Duddon Estuary SPA/Ramsar	• Disturbance and displacement of birds during the operation of the wind farm.	• No
	• Mortality through collision with the wind turbines during operation.	• Possible
	• Barrier effect of the wind farm on bird flight lines during operation.	• No

83. There would be no direct loss of any SPA habitat or risk of environmental contamination within any SPA.

84. Table 12 summarises all of the potential impacts considered in this report relating to the Morecambe Bay and Duddon Estuary SPA/Ramsar sites.

Table 12. Summary of the potential effects of the Haverigg II wind farm lifetime extension on the Morecambe Bay and Duddon Estuary SPA/Ramsar sites

Name of European site/Ramsar: Morecambe Bay and Duddon Estuary SPA/Ramsar												
Distance to Haverigg II wind farm: 0.3 km												
European site features	**Likely Effects of wind farm**											
	Disturbance			***Collision Risk***			***Barrier Effect***			***In-combination effects***		
	C	***O***	***D***	***C***	***O***	***D***	***C***	***O***	***D***	***C***	***O***	***D***
Breeding:												
Lesser black-backed gull	×[a]	×[a]	×[a]		✓		×[e]	×[e]	×[e]	×[c]	✓	×[c]
Herring gull	×[a]	×[a]	×[a]		✓		×[e]	×[e]	×[e]	×[c]	✓	×[c]
Little tern	×[a]	×[a]	×[a]		×[b]		×[b]	×[b]	×[b]	×[c]	×[c]	×[c]
Sandwich tern	×[a]	×[a]	×[a]		×[b]		×[b]	×[b]	×[b]	×[c]	×[c]	×[c]
Common tern	×[a]	×[a]	×[a]		×[b]		×[b]	×[b]	×[b]	×[c]	×[c]	×[c]
Winter/passage												
Whooper swan	×[a]	×[a]	×[a]		×[b]		×[b]	×[b]	×[b]	×[c]	×[c]	×[c]
Pink-footed Goose	×[a]	×[a]	×[a]		×[b]		×[b]	×[b]	×[b]	×[c]	×[c]	×[c]
Shelduck	×[a]	×[a]	×[a]		×[b]		×[b]	×[b]	×[b]	×[c]	×[c]	×[c]
Pintail	×[a]	×[a]	×[a]		×[b]		×[b]	×[b]	×[b]	×[c]	×[c]	×[c]
Little egret	×[a]	×[a]	×[a]		×[b]		×[b]	×[b]	×[b]	×[c]	×[c]	×[c]
Oystercatcher	×[a]	×[a]	×[a]		×[f]		×[e]	×[e]	×[e]	×[c]	×[c]	×[c]
Ringed plover	×[a]	×[a]	×[a]		×[b]		×[b]	×[b]	×[b]	×[c]	×[c]	×[c]
Golden plover	×[a]	×[a]	×[a]		✓		×[e]	×[e]	×[e]	×[c]	✓	×[c]
Grey plover	×[a]	×[a]	×[a]		×[b]		×[b]	×[b]	×[b]	×[c]	×[c]	×[c]
Knot	×[a]	×[a]	×[a]		×[b]		×[b]	×[b]	×[b]	×[c]	×[c]	×[c]
Sanderling	×[a]	×[a]	×[a]		×[b]		×[b]	×[b]	×[b]	×[c]	×[c]	×[c]
Dunlin	×[a]	×[a]	×[a]		×[b]		×[b]	×[b]	×[b]	×[c]	×[c]	×[c]
Ruff	×[a]	×[a]	×[a]		×[b]		×[b]	×[b]	×[b]	×[c]	×[c]	×[c]
Bar-tailed godwit	×[a]	×[a]	×[a]		×[b]		×[b]	×[b]	×[b]	×[c]	×[c]	×[c]

Name of European site/Ramsar: Morecambe Bay and Duddon Estuary SPA/Ramsar												
Distance to Haverigg II wind farm: 0.3 km												
European site features	**Likely Effects of wind farm**											
	Disturbance			***Collision Risk***			***Barrier Effect***			***In-combination effects***		
	C	***O***	***D***	***C***	***O***	***D***	***C***	***O***	***D***	***C***	***O***	***D***
Black-tailed godwit	✕[a]	✕[a]	✕[a]		✕[f]		✕[e]	✕[e]	✕[e]	✕[c]	✕[c]	✕[c]
Curlew	✕[a]	✕[a]	✕[a]		✓		✕[e]	✕[e]	✕[e]	✕[c]	✓	✕[c]
Redshank	✕[a]	✕[a]	✕[a]		✕[b]		✕[b]	✕[b]	✕[b]	✕[c]	✕[c]	✕[c]
Turnstone	✕[a]	✕[a]	✕[a]		✕[b]		✕[b]	✕[b]	✕[b]	✕[c]	✕[c]	✕[c]
Mediterranean gull	✕[a]	✕[a]	✕[a]		✕[b]		✕[e]	✕[e]	✕[e]	✕[c]	✕[c]	✕[c]
Wintering waterfowl assemblage	✕[d]	✕[d]	✕[d]		✕[f]		✕[e]	✕[e]	✕[e]	✕[c]	✕[c]	✕[c]

Table Key:

✓ = Potential for likely significant effect **cannot** be excluded
✕ = Potential for likely significant effect **can** be excluded
C= construction
O = operation
D = decommissioning

- Where an impact is not considered relevant for a feature of the European site, the cell in the Table is shaded grey.
- There would be no collision risk for any species during construction or decommissioning as the turbine blades would not be rotating, so this would not be a relevant impact.
- There would be no disturbance risk for species that have no habitat available within the potential impact zone of wind farm, so this would not be a relevant impact.

Evidence supporting conclusions

- **a.** Disturbance effects of lifetime extension scoped out as possible Likely Significant Effect.
- **b.** Species not recorded within the potential collision risk zone of the wind farm flying at rotor height during baseline surveys.
- **c.** Impacts alone so low that could not possibly make any significant contribution to an in-combination risk.
- **d.** Collision modelling demonstrated negligible collision risk; Table 7.
- **e.** Barrier effect would not result in either reduced utilisation of an ecological resource (through birds no longer being able to reach it through the barrier) or significantly increased energy expenditure by the birds in flying around the barrier, so no LSE.
- **f.** Use of collision risk zone at rotor height so low that collision risk negligible.

85. Given that Likely Significant Effects could not be ruled out for lesser black-backed gull, herring gull, golden plover and curlew, this report has provided analysis to inform the assessment process should the Competent Authority determine that an Appropriate Assessment is required (as was concluded in this report).

86. The SPA Conservation Objectives (as set out above) against which this assessment needs to be made seek to maintain the habitats of the qualifying species in favourable condition.

87. The predicted effects of the Project on the relevant SPA qualifying and assemblage species in the context of the Habitats Regulations have been assessed above, and primarily related to collision risk from the operational wind turbines. The predicted effects of the Haverigg II lifetime extension have been assessed against the SPA Conservation Objectives, to determine whether there would be any adverse effect of the development on the ecological integrity of the Morecambe Bay and Duddon Estuary SPA/Ramsar site.

88. Though some very minor (negligible magnitude) effects may occur on the SPA golden plover and curlew populations, and on non-breeding populations of lesser black-backed gull and herring gull, none of these effects would have an adverse effect on the ecological integrity of the SPA.

89. Low magnitude collision risks were identified for breeding lesser black-backed gull and for breeding herring gull populations. On the advice of Natural England, mitigation measures will be implemented on a precautionary basis in order to ensure that there would be adverse effect on the integrity of either of these populations.

90. In summarising the likely effects on the qualifying bird populations for the SPA, the assessment process illustrated in the flow diagram in the IPC 10th Advice Note is undertaken as follows:

- "*Is the proposal directly connected with or necessary to site management for nature conservation?*" No.
- "*Is the project likely to have a significant effect on the internationally important interest features of the site, alone or in combination with other plans and projects?"*
  - For four qualifying species, lesser black-backed gull, herring gull, golden plover and curlew, this cannot, under the definition of likely significant effect under the Habitats Regulations, be ruled out, so the next stage is:
- "*Assess the implications of the effects of the proposal for the site's conservation objectives. Can it be ascertained that the proposal will not affect integrity of the site*?"
  - No qualifying or assemblage species has been identified as being significantly affected by the project either alone or in combination (with the agreed precautionary mitigation measures in place). In terms of the relevant tests under the Habitat Regulations, it can be safely concluded that the proposed lifetime extension would not threaten the ecological integrity of the Morecambe Bay and Duddon Estuary SPA/Ramsar site. Hence the end result is that "*consent may be granted*."

91. In conclusion, therefore, the proposed Haverigg II lifetime extension would not adversely affect the ecological integrity of the Morecambe Bay and Duddon Estuary SPA/Ramsar, either alone or in combination with any other plan or project, and therefore authorisation for the project may be granted.

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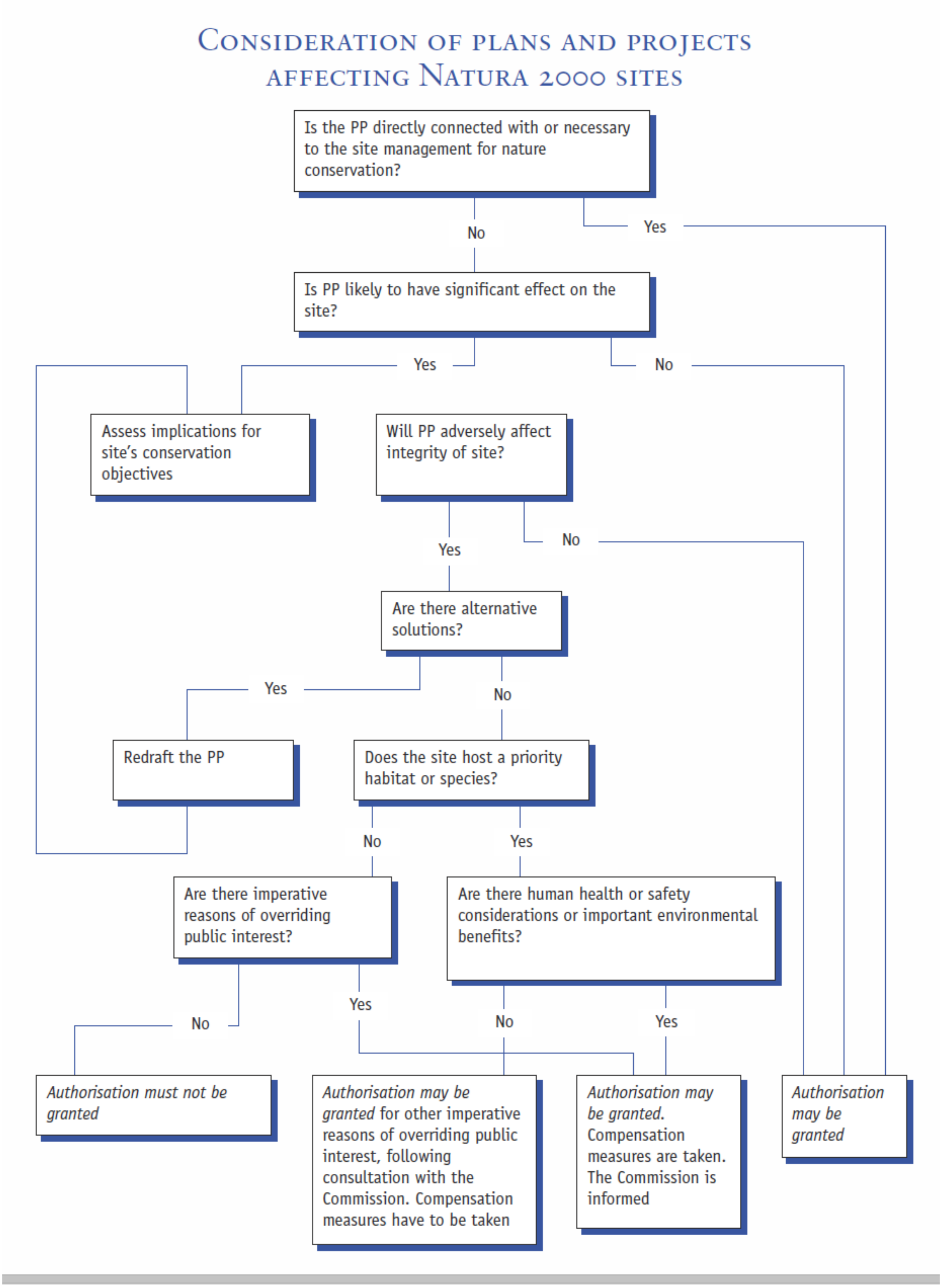
APPENDIX 1: Morecambe Bay and Duddon Estuary SPA Citation

[Add in pdf]

APPENDIX 2: Ramsar Citations for Morecambe Bay and the Duddon Estuary

[Add in pdf]

APPENDIX 3: Managing Natura 2000 Sites Annex III



APPENDIX 4. CALCULATION OF EMPIRICAL AVOIDANCE RATES

The collision searches, taking into account the search efficiency and carcass removal using all of the available data from both Haverigg II and III, gave estimates of the actual number of collisions with the Haverigg II and II wind turbines as follows (from paragraphs 28-37 of the main report):

- Breeding season 2014: 14.1 gull collisions
- Breeding season 2019: 7.5 gull collisions.
- Winter 2018-19 winter: 7.5 gull collisions and 5.0 wader collisions.

Empirical avoidance rates were calculated as the proportionate difference between the actual number of collisions (taking into account observation detection and scavenger removal rates) and the predicted risk in the absence of any avoidance behaviour using the Band collision model (Band et al. 2007). The model was run combining all of the available data to generate an overall annual risk without avoidance:

Number of collisions predicted in the absence of any avoiding behaviour = 2,360 gulls, 1,390 waders

Number of actual collisions recorded per year (taking into account the search efficiency and carcass removal) =

Average breeding season values + winter

For gulls = (14.1 + 7.5)/2 + 7.5 = 18.3

For waders = 5.0

Avoidance rate for gulls (herring gull and lesser black-backed gull combined) = 1 - (Actual number of collisions/Predicted number of collisions)

= 1 - (18.3 / 2,360) = 99.2%

Avoidance rate for waders (golden plover and curlew combined)

= 1 - (5.0 / 1,390) = 99.6%

Thus, using this approach, avoidance rates of 99.2% were derived for gulls and 99.6% for waders.

APPENDIX 5. COLLISON RISK MODELLING

This Appendix sets out the collision risk modelling that has been undertaken to support the ornithological assessment of the proposed Haverigg II wind farm lifetime extension.

Firstly, the standard Band model spreadsheets are presented for each species modelled in turn. These provide the information used to calculate the risk that individuals of each species would face if they flew through the Haverigg II wind farm rotor swept area. For the first species, for example, golden plover, this gives an overall 9.8% chance of collision.

CALCULATION OF COLLISION RISK FOR BIRD PASSING THROUGH ROTOR AREA											
Golden Plover											
Only enter input parameters in blue											
K: [1D or [3D] (0 or 1)	1		**Calculation of alpha and p(collision) as a function of radius**								
NoBlades	3						Upwind:			Downwind:	
MaxChord	2.2	m	r/R	c/C	a	collide		contribution	collide		contribution
Pitch (degrees)	15		radius	chord	alpha	length	p(collision)	from radius	length	p(collision)	from radius
BirdLength	0.28	m	0.025	0.575	8.84	17.49	1.00	0.00125	16.83	1.00	0.00125
Wingspan	0.72	m	0.075	0.575	2.95	6.05	0.62	0.00467	5.39	0.55	0.00416
F: Flapping (0) or gliding (-	0		0.125	0.702	1.77	4.31	0.44	0.00554	3.51	0.36	0.00451
			0.175	0.860	1.26	3.71	0.38	0.00667	2.73	0.28	0.00491
Bird speed	13.7	m/sec	0.225	0.994	0.98	3.35	0.34	0.00775	2.22	0.23	0.00513
RotorDiam	42	m	0.275	0.947	0.80	2.73	0.28	0.00774	1.66	0.17	0.00469
RotationPeriod	2.13	sec	0.325	0.899	0.68	2.30	0.24	0.00769	1.28	0.13	0.00427
			0.375	0.851	0.59	1.97	0.20	0.00762	1.01	0.10	0.00388
			0.425	0.804	0.52	1.72	0.18	0.00752	0.80	0.08	0.00352
			0.475	0.756	0.47	1.51	0.16	0.00739	0.65	0.07	0.00318
Bird aspect ratio: b	0.39		0.525	0.708	0.42	1.34	0.14	0.00724	0.53	0.05	0.00288
			0.575	0.660	0.38	1.20	0.12	0.00707	0.44	0.05	0.00262
			0.625	0.613	0.35	1.09	0.11	0.00701	0.39	0.04	0.00252
			0.675	0.565	0.33	0.99	0.10	0.00691	0.35	0.04	0.00244
			0.725	0.517	0.30	0.91	0.09	0.00679	0.32	0.03	0.00239
			0.775	0.470	0.29	0.83	0.09	0.00664	0.30	0.03	0.00237
			0.825	0.422	0.27	0.76	0.08	0.00646	0.28	0.03	0.00238
			0.875	0.374	0.25	0.69	0.07	0.00625	0.29	0.03	0.00263
			0.925	0.327	0.24	0.63	0.07	0.00601	0.30	0.03	0.00286
			0.975	0.279	0.23	0.57	0.06	0.00575	0.30	0.03	0.00306
				Overall p(collision) =			**Upwind**	**13.0%**		**Downwind**	**6.6%**
								Average	**9.8%**		

CALCULATION OF COLLISION RISK FOR BIRD PASSING THROUGH ROTOR AREA											
Herring Gull											
Only enter input parameters in blue											
K: [1D or [3D] (0 or 1)	1		**Calculation of alpha and p(collision) as a function of radius**								
NoBlades	3						Upwind:			Downwind:	
MaxChord	2.2	m	r/R	c/C	a	collide		contribution	collide		contribution
Pitch (degrees)	15		radius	chord	alpha	length	p(collision)	from radius	length	p(collision)	from radius
BirdLength	0.6	m	0.025	0.575	8.26	22.30	1.00	0.00125	21.65	1.00	0.00125
Wingspan	1.44	m	0.075	0.575	2.75	7.65	0.84	0.00632	7.00	0.77	0.00578
F: Flapping (0) or gliding (-	0		0.125	0.702	1.65	5.24	0.58	0.00721	4.44	0.49	0.00611
			0.175	0.860	1.18	4.34	0.48	0.00837	3.36	0.37	0.00649
Bird speed	12.8	m/sec	0.225	0.994	0.92	3.83	0.42	0.00948	2.69	0.30	0.00668
RotorDiam	42	m	0.275	0.947	0.75	3.13	0.34	0.00948	2.05	0.23	0.00621
RotationPeriod	2.13	sec	0.325	0.899	0.64	2.64	0.29	0.00945	1.62	0.18	0.00578
			0.375	0.851	0.55	2.27	0.25	0.00939	1.30	0.14	0.00538
			0.425	0.804	0.49	1.99	0.22	0.00930	1.07	0.12	0.00501
			0.475	0.756	0.43	1.75	0.19	0.00918	0.89	0.10	0.00467
Bird aspect ratio: b	0.42		0.525	0.708	0.39	1.59	0.18	0.00922	0.79	0.09	0.00456
			0.575	0.660	0.36	1.48	0.16	0.00937	0.73	0.08	0.00461
			0.625	0.613	0.33	1.38	0.15	0.00949	0.68	0.08	0.00469
			0.675	0.565	0.31	1.29	0.14	0.00958	0.65	0.07	0.00480
			0.725	0.517	0.28	1.21	0.13	0.00964	0.62	0.07	0.00494
			0.775	0.470	0.27	1.13	0.12	0.00967	0.60	0.07	0.00514
			0.825	0.422	0.25	1.06	0.12	0.00967	0.62	0.07	0.00560
			0.875	0.374	0.24	1.00	0.11	0.00965	0.63	0.07	0.00603
			0.925	0.327	0.22	0.94	0.10	0.00959	0.63	0.07	0.00643
			0.975	0.279	0.21	0.88	0.10	0.00950	0.63	0.07	0.00680
				Overall p(collision) =			**Upwind**	**17.5%**		**Downwind**	**10.7%**
								Average	**14.1%**		

CALCULATION OF COLLISION RISK FOR BIRD PASSING THROUGH ROTOR AREA											
Lesser Black-backed Gull											
Only enter input parameters in blue											
K: [1D or [3D] (0 or 1)	1		**Calculation of alpha and p(collision) as a function of radius**								
NoBlades	3						Upwind:			Downwind:	
MaxChord	2.2	m	r/R	c/C	a	collide		contribution	collide		contribution
Pitch (degrees)	15		radius	chord	alpha	length	p(collision)	from radius	length	p(collision)	from radius
BirdLength	0.58	m	0.025	0.575	8.45	22.65	1.00	0.00125	22.00	1.00	0.00125
Wingspan	1.42	m	0.075	0.575	2.82	7.77	0.84	0.00627	7.11	0.77	0.00574
F: Flapping (0) or gliding (-	0		0.125	0.702	1.69	5.32	0.57	0.00716	4.52	0.49	0.00608
			0.175	0.860	1.21	4.41	0.47	0.00831	3.43	0.37	0.00646
Bird speed	13.1	m/sec	0.225	0.994	0.94	3.88	0.42	0.00940	2.75	0.30	0.00666
RotorDiam	42	m	0.275	0.947	0.77	3.18	0.34	0.00940	2.10	0.23	0.00621
RotationPeriod	2.13	sec	0.325	0.899	0.65	2.68	0.29	0.00936	1.65	0.18	0.00578
			0.375	0.851	0.56	2.30	0.25	0.00930	1.33	0.14	0.00539
			0.425	0.804	0.50	2.01	0.22	0.00920	1.10	0.12	0.00502
			0.475	0.756	0.44	1.78	0.19	0.00908	0.92	0.10	0.00468
Bird aspect ratio: b	0.41		0.525	0.708	0.40	1.59	0.17	0.00898	0.78	0.08	0.00442
			0.575	0.660	0.37	1.47	0.16	0.00911	0.72	0.08	0.00445
			0.625	0.613	0.34	1.37	0.15	0.00921	0.67	0.07	0.00452
			0.675	0.565	0.31	1.28	0.14	0.00928	0.63	0.07	0.00461
			0.725	0.517	0.29	1.19	0.13	0.00932	0.61	0.07	0.00473
			0.775	0.470	0.27	1.12	0.12	0.00934	0.58	0.06	0.00488
			0.825	0.422	0.26	1.05	0.11	0.00932	0.59	0.06	0.00525
			0.875	0.374	0.24	0.99	0.11	0.00928	0.60	0.06	0.00566
			0.925	0.327	0.23	0.92	0.10	0.00920	0.61	0.07	0.00605
			0.975	0.279	0.22	0.87	0.09	0.00910	0.61	0.07	0.00641
				Overall p(collision) =			**Upwind**	**17.1%**		**Downwind**	**10.4%**
								Average	**13.8%**		

CALCULATION OF COLLISION RISK FOR BIRD PASSING THROUGH ROTOR AREA											
Curlew											
Only enter input parameters in blue											
K: [1D or [3D] (0 or 1)	1		**Calculation of alpha and p(collision) as a function of radius**								
NoBlades	3						Upwind:			Downwind:	
MaxChord	2.2	m	r/R	c/C	a	collide		contribution	collide		contribution
Pitch (degrees)	15		radius	chord	alpha	length	p(collision)	from radius	length	p(collision)	from radius
BirdLength	0.55	m	0.025	0.575	10.51	22.64	1.00	0.00125	21.98	1.00	0.00125
Wingspan	0.9	m	0.075	0.575	3.50	7.76	0.67	0.00504	7.11	0.61	0.00461
F: Flapping (0) or gliding (+1)	0		0.125	0.702	2.10	5.43	0.47	0.00587	4.63	0.40	0.00500
			0.175	0.860	1.50	4.59	0.40	0.00694	3.61	0.31	0.00546
Bird speed	16.3	m/sec	0.225	0.994	1.17	4.09	0.35	0.00795	2.95	0.26	0.00575
RotorDiam	42	m	0.275	0.947	0.96	3.32	0.29	0.00790	2.24	0.19	0.00534
RotationPeriod	2.13	sec	0.325	0.899	0.81	2.78	0.24	0.00783	1.76	0.15	0.00495
			0.375	0.851	0.70	2.38	0.21	0.00773	1.41	0.12	0.00459
			0.425	0.804	0.62	2.07	0.18	0.00761	1.16	0.10	0.00425
			0.475	0.756	0.55	1.87	0.16	0.00768	1.01	0.09	0.00414
Bird aspect ratio: b	0.61		0.525	0.708	0.50	1.71	0.15	0.00775	0.90	0.08	0.00409
			0.575	0.660	0.46	1.57	0.14	0.00780	0.82	0.07	0.00406
			0.625	0.613	0.42	1.45	0.13	0.00782	0.75	0.06	0.00405
			0.675	0.565	0.39	1.34	0.12	0.00782	0.70	0.06	0.00406
			0.725	0.517	0.36	1.24	0.11	0.00780	0.65	0.06	0.00410
			0.775	0.470	0.34	1.16	0.10	0.00775	0.62	0.05	0.00416
			0.825	0.422	0.32	1.08	0.09	0.00768	0.60	0.05	0.00425
			0.875	0.374	0.30	1.00	0.09	0.00758	0.58	0.05	0.00436
			0.925	0.327	0.28	0.93	0.08	0.00747	0.56	0.05	0.00449
			0.975	0.279	0.27	0.87	0.08	0.00733	0.55	0.05	0.00465
				Overall p(collision) =			**Upwind**	**14.3%**		**Downwind**	**8.8%**
								Average	**11.5%**		

The second section of this Appendix provides details of the calculations that have been made of the key species flight activity within the collision risk zone.

The first part of the Table below gives the survey effort (number of hours observation) from the single VP for each month in each survey year.

All of the key species (golden plover, lesser black-backed gull, herring gull and curlew) followed predictable direct routes so that variant of the model was used for those species (which required the number of flights through the collision risk zone as their bird activity input).

The numbers of flights observed through the collision risk zone in Section 2. These are converted into flight rates through the wind farm in section 3. The hours of activity per month are summarised in Section 4 (with daylight hours calculated using Band 2012), and the calculations of the overall numbers of flights per month through the collision risk zone are given in Section 5 (which feed into the following section of the modelling).

HAVERIGG II COLLISION RISK MODELLING DATA INPUT: BIRD USAGE																
1. Hours observation																
			Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec		
	2014					8	9	10	9	4.5	13.5	9	9	7.5		
	2015		10.5	9	9											
	2019						12	12	12							
2. Bird flights observed through collision risk zone (number of individuals)																
			Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec		
Golden Plover		2014				0	0	0	0	0	0	119	0	215		
		2015	23	110	0											
		2019					0	0	0							
Herring Gull		2014				125	79	145	137	29	145	25	190	71		
		2015	121	181	360											
		2019					265	333	158							
Lesser Black-backed Gull		2014				66	51	70	118	20	57	4	1	0		
		2015	0	20	41											
		2019					185	128	96							
Curlew		2014				0	0	2	55	0	3	29	11	0		
		2015	481	112	2											
		2019					0	0	117							
3. Bird flights/hr through collision risk zone																
			Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Breeding	NB
Golden Plover		2014				0	0	0	0	0	0	13.222	0	28.667	0.0	7.0
		2015	2.1905	12.222	0											
		2019					0	0	0						0.0	
Herring Gull		2014				15.625	8.7778	14.5	15.222	6.4444	10.741	2.7778	21.111	9.4667	13.5	15.3
		2015	11.524	20.111	40											
		2019					22.052	27.764	13.184						21.0	
Lesser Black-backed Gull		2014				8.25	5.6667	7	13.111	4.4444	4.2222	0.4444	0.1111	0	8.5	2.0
		2015	0	2.2222	4.5556											
		2019					15.388	10.668	7.9716						11.3	
Curlew		2014				0	0	0.2	6.1111	0	0.2222	3.2222	1.2222	0	1.6	7.9
		2015	45.81	12.444	0.2222											
		2019					0	0	9.75						3.3	
4. Number of hours for which birds were assumed to be potentially active over the time period that they were present																
			Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Breeding	NB
Mean daylight hrs			7.7	9.5	11.8	14.2	16.3	17.5	17.0	15.1	12.8	10.5	8.3	7.1	16.2	11.1
Mean nocturnal hours			16.3	14.5	12.2	9.8	7.7	6.5	7.0	8.9	11.2	13.5	15.7	16.9		
No days birds present			31	28	31	30	31	30	31	31	30	31	30	31	122	243
Total hours day			237.7	266.9	365.6	424.5	504.7	524.9	526.2	468.1	384.7	325.1	249.9	219.5		
Total hours night			506	405	378	295	239	195	218	276	335	419	470	525		
5. Bird flights/month															TOTAL FLIGHTS	
			Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Breeding	NB
Golden Plover		2014				0	0	0	0	0	0	7068	0	13810	0	27,691
Nocturnal 50%	50%	2015	1075	5738	0											
		2019				0	0	0	0						0	
Herring Gull		2014				7095	4640	7894	8341	3195	4492	1019	6269	2574	27,971	43,190
Nocturnal 10%	10%	2015	3322	6182	16136											
		2019				11554	11657	15116	7224						45,552	
Lesser Black-backed Gull		2014				3746	2996	3811	7185	2203	1766	163	33	0	17,737	6,686
Nocturnal 10%	10%	2015	0	683	1838											
		2019				4903	8135	5808	4368						23,214	
Curlew		2014				0	0	124	3881	0	123	1722	593	0	4,006	30,888
Nocturnal 50%	50%	2015	22485	5842	123											
		2019				0	0	0	6192						6,192	

The next part of the Appendix shows the details of the collision risk modelling for each season for which each species was observed within the collision risk zone at rotor height, giving the predicted risk based on each period's survey data, and an overall best estimate of the annual risk (the winter risk added to the average breeding season risk).

HAVERIGG II WIND FARM							
BAND ET AL 2007 COLLISION MODEL (DIRECT FLIGHTS)							
	Golden Plover				**Herring Gull**		
	Winter 2014-15	**Breeding 2014**	**Breeding 2019**		**Winter 2014-15**	**Breeding 2014**	**Breeding 2019**
Collision risk height	42	42	42		42	42	42
Risk corridor Width	1,080	1,080	1,080		1,080	1,080	1,080
Risk corridor Area	45,360	45,360	45,360		45,360	45,360	45,360
Annual number of flights through collision zone	27,691	0	0		43,190	27,971	45,552
% at rotor height	100%	100%	100%		100%	100%	100%
Annual number flying through risk window	27,691	0	0		43,190	27,971	45,552
No turbines	4	4	4		4	4	4
Rotor diameter	42	42	42		42	42	42
Rotor swept area	1385	1385	1385		1385	1385	1385
Allowance for overlap	0%	0%	0%		0%	0%	0%
Proportion of risk window occupied by rotors	12%	12%	12%		12%	12%	12%
Annual no bird rotor passes	3383	0	0		5277	3417	5565
Band individual collision risk	9.8%	9.8%	9.8%		14.1%	14.1%	14.1%
Turbine downtime	10%	10%	10%		10%	10%	10%
Non-avoidance collisions	298	0	0		669	433	706
Avoidance rate	98.0%	98.0%	98.0%		98.0%	98.0%	98.0%
Predicted collisions per year	**5.96**	**0.00**	**0.00**		**13.38**	**8.67**	**14.11**
Total annual collision risk	Winter	**2014-15**	**5.96**		Winter	**2014-15**	**13.38**
	Breeding	**2014**	**0.00**		Breeding	**2014**	**8.67**
		2019	**0.00**			**2019**	**14.11**
		Overall	***5.96***			***Overall***	***24.77***

HAVERIGG II WIND FARM							
BAND ET AL 2007 COLLISION MODEL (DIRECT FLIGHTS)							
	LBB Gull				**Curlew**		
	Winter 2014-15	**Breeding 2014**	**Breeding 2019**		**Winter 2014-15**	**Breeding 2014**	**Breeding 2019**
Collision risk height	42	42	42		42	42	42
Risk corridor Width	1,080	1,080	1,080		1,080	1,080	1,080
Risk corridor Area	45,360	45,360	45,360		45,360	45,360	45,360
Annual number of flights through collision zone	6,686	17,737	23,214		30,888	4,006	6,192
% at rotor height	100%	100%	100%		100%	100%	100%
Annual number flying through risk window	6,686	17,737	23,214		30,888	4,006	6,192
No turbines	4	4	4		4	4	4
Rotor diameter	42	42	42		42	42	42
Rotor swept area	1385	1385	1385		1385	1385	1385
Allowance for overlap	0%	0%	0%		0%	0%	0%
Proportion of risk window occupied by rotors	12%	12%	12%		12%	12%	12%
Annual no bird rotor passes	817	2167	2836		3774	489	757
Band individual collision risk	13.8%	13.8%	13.8%		11.5%	11.5%	11.5%
Turbine downtime	10%	10%	10%		10%	10%	10%
Non-avoidance collisions	101	268	351		391	51	78
Avoidance rate	98.0%	98.0%	98.0%		98.0%	98.0%	98.0%
Predicted collisions per year	**2.02**	**5.37**	**7.02**		**7.82**	**1.01**	**1.57**
Total annual collision risk	Winter	**2014-15**	**2.02**		Winter	**2014-15**	**7.82**
	Breeding	**2014**	**5.37**		Breeding	**2014**	**1.01**
		2019	**7.02**			**2019**	**1.57**
		Overall	***8.22***			***Overall***	***9.11***