Craig Watch Wind Farm

Technical Appendix 5.1: Outline Habitat Management Plan

November 2024

Craig Watch Wind Farm

Technical Appendix 5.1: Outline Habitat Management Plan

avianecology

CONTENTS

1 INTRODUCTION

1.1.1 This Technical Appendix presents any changes to the details of Technical Appendix 7.5: Outline Habitat Management Plan of the 2022 EIA Report. Where there is no change to the 2022 EIA Report (Technical Appendix 7.5: Outline Habitat Management Plan) this is stated.

1.1.2 The remainder of the Introduction is unchanged from 2022 EIA Report (Technical Appendix 7.5 Outline Habitat Management Plan).

1.2 Aims and Objectives

1.2.1 There are five proposed aims and related objectives of the Craig Watch Wind Farm HMP, to be achieved through the implementation of habitat management measures and habitat creation practices outlined herein. These are as follows:

- Aim 1: Enhancement of moorland/peatland habitats;
- Aim 2: Enhancement of fisheries habitats;
- Aim 3: Enhancement of Opportunities for black grouse;
- Aim 4: Enhancement opportunities for common gull; and
- Aim 5: Enhancement of opportunities for wildcat and otter.

1.2.2 The success of habitat management measures and habitat creation in achieving the aims and objectives of the HMP would be monitored, with the results reported, in accordance with timings and protocols to be agreed with NatureScot, MC, AC and other relevant stakeholders.

1.2.3 The HMP should be read in conjunction with **Technical Appendix 2.4: Outline Peat Management Plan** and **Technical Appendix 2.1: Forestry**. The combined aims of the three documents are to preserve and enhance notable habitats and forestry and provide compensatory woodland planting within the Site in a way which is sensitive to other Site-specific ecological and ornithological interests.

1.2.4 It is proposed that the aims, objectives and habitat management measures outlined herein would be further refined and prescribed in consultation with MC and AC (and other relevant stakeholders) following pre-construction baseline surveys (if required), and/ or Site investigation works as necessary.

1.2.5 The habitat management measures to be adopted are described with consideration given to NPF4 (2023) and particularly to ensure that habitat enhancement measures for the Proposed Development will contribute to enhancement of biodiversity, including restoring degraded habitats and building and strengthening nature networks and the connections between them.

1.3 Site Location

1.3.1 Unchanged from 2022 EIA Report (Technical Appendix 7.5: Outline Habitat Management Plan).

1.4 Current Site Conditions

1.4.1 Unchanged from 2022 EIA Report (Technical Appendix 7.5: Outline Habitat Management Plan).

1.5 Implementation

1.5.1 Unchanged from 2022 EIA Report (Technical Appendix 7.5: Outline Habitat Management Plan).

1.6 Steering Group and Review Committee

1.6.1 Unchanged from 2022 EIA Report (Technical Appendix 7.5: Outline Habitat Management Plan).

2 AIMS AND OBJECTIVES

2.1 Approach to HMP

2.1.1 Unchanged from 2022 EIA Report (Technical Appendix 7.5: Outline Habitat Management Plan).

2.2 Aim 1: Enhancement of Moorland Habitats

Objective 1: Promote Improved Structural Diversity of Wet Heath and Blanket Bog

2.2.1 Objective 1 would complement **Technical Appendix 2.4: Outline Peat Management Plan** and mitigation commitments made in Chapter 9: Hydrology, Hydrogeology and Geology in relation to using excavated soil and peat in Site restoration and rehabilitation at the end of the construction period. Vegetation cover would be re-established as quickly as possible on track and infrastructure verges and cut slopes by re-laying excavated peat acrotelm. This is intended to improve slope stability and provide erosion protection. Additional methods, including hydroseeding and/ or use of a biodegradable geotextile, would be considered if necessary in specific areas. For further details on habitat restoration after construction, see the 2022 EIA Report, **Technical Appendix 2.1: Outline Construction Environmental Management Plan (OCEMP).**

2.2.2 As detailed in the **Technical Appendix 2.4**: **Outline Peat Management Plan**, it is assumed that ditch backfilling and reinstatement of historic peat cutting, ploughed furrow and de-stumped areas could be subject to backfilling with peat, along with improvements to other areas of degraded or existing peatland as part of habitat management and restoration.

2.2.3 Opportunities for habitat improvement in proposed habitat enhancement areas to be considered include the following:

- reinstatement of peat turves and vegetated peat divots;
- use of mulches or heather brash or occasionally a biodegradable geotextile, like jute and re-seeding to protect areas of bare peat from further erosion;
- management of grazing by livestock in sensitive areas;
- re-profiling of peat hags, and hydroseeding if necessary and appropriate; and
- ditch-blocking to promote re-wetting where this is appropriate and does not interfere with operational activities of the Proposed Development or forestry operations.

2.2.4 It is anticipated that habitat restoration plans would result in the improvement of peat bog habitats covering an area likely to be in excess of those peat habitats to be directly lost as a result of the Proposed Development.

2.2.5 The success of the habitat improvement and peat restoration activities would be monitored on a regular basis for an ongoing period during the operational phase of the Proposed Development. The details would be included in the HMP to be agreed with the SGRC.

2.2.6 Areas identified for enhancement, particularly where drain blocking is proposed, would be subject to investigation survey and assessment by suitably qualified hydrologists and ecologists and agreed with

the landowner(s) and MC and AC (if required) to ensure water levels are not unexpectedly raised, or lowered, elsewhere within and outside the Site.

2.2.7 Areas suitable for peatland habitat improvement and restoration works have been identified as four distinct areas as shown (Areas 1, 3, 4, & 5) in **Figure 5.1**. Combined these areas constitute up to 104.2 ha, of blanket bog and dry modified bog habitat. Some of the bog/peatland habitats onsite were identified as being subject to unfavourable management including over-grazing, ditch creation and burning. Furthermore, areas of erosion and hagging within the M19 habitat were identified (see Technical Appendix 7.1: Habitats and Vegetation, which supported the 2022 EIA Report). It is therefore apparent that there is considerable peat restoration potential onsite given these unfavourable management activities and land features identified. As stated in the Chapter 5: Ecology, as a result of the Proposed Development there would be a loss of 2.74 ha potentially priority peatland habitat. In accordance with the current NatureScot guidance (2023[1]) this would require c. 27.4 ha compensatory peatland restoration and a further 8.7 ha for enhancement. The extent of the habitat improvement areas for peatland restoration works thus exceeds the amount required for compensation and enhancement by up to 68.1 ha. The peatland restoration works proposed will therefore compensate for the loss of potential priority peatland and will enhance the peatland habitats onsite adhering to current NatureScot guidance.

2.2.8 The Site is currently primarily grazed by sheep (and also cattle) and wild deer. It is proposed that livestock grazing within the Site and access for deer would continue throughout the operational lifetime of the Proposed Development and as such, habitat management principles to be further detailed and implemented would comprise a sensitive grazing regime (which would include maintaining the number of livestock at an optimal level for the habitat type, to avoid overgrazing and excessive poaching). Grazing densities would be managed within all management areas (see **Figure 5.1**), to prevent overgrazing and encourage and maintain a good overall Site condition.

2.2.9 Targeted deer management is not proposed as part of the HMP, and it is assumed that wild deer would be managed on-site as per the existing situation whilst the Proposed Development is operational. As part of the monitoring (see section 3) grazing levels would be checked over the course of the operation of the Proposed Development to ensure that grazing pressure is appropriate for the habitat enhancement goals. In the event that grazing pressure is considered to be too high, livestock levels (and deer management protocols) would be reviewed and discussed with the landowner(s) so that appropriate action is taken as necessary (this could include reducing stocking levels through limiting the number of livestock in sensitive areas and/ or increasing deer management measures).

Objective 2: Enhance Breeding and Foraging Habitat for Wetland Birds

2.2.10 The enhancement of moorland habitats and measures detailed above in Objective 1 would benefit ground-nesting species such as curlew and lapwing, and provide foraging opportunities for these species as well as waterfowl, such as teal.

2.3 Aim 2: Enhancement of Fisheries Habitats

2.3.1 Unchanged from 2022 EIA Report (Technical Appendix 7.5: Outline Habitat Management Plan).

2.4 Aim 3: Enhancement of Opportunities for Black Grouse

2.4.1 Unchanged from 2022 EIA Report (Technical Appendix 7.5: Outline Habitat Management Plan).

[1] NatureScot (2023). Advising on peatland, carbon-rich soil and priority peatland habitats in development management. November 2023.

2.5 Aim 4: Enhancement of Opportunities for Common Gull

2.5.1 Kelman Hill has been identified, during baseline surveys, as a heavily used area for foraging common gull *Larus canus* from the Tips of Corsemaul and Tom Mor Special Protection Area (SPA) and Site of Special Scientific Interest (SSSI).

2.5.2 All tree planting proposed (see Aim 2, and also compensatory planting proposed, see **Technical Appendix 2.1: Forestry**) has been sensitively located, so that tree cover is not likely to adversely affect foraging gulls using Kelman Hill.

Objective 1: Enhance Foraging Habitat

2.5.3 An objective to manage grassland/ heathland on Kelman Hill for foraging common gulls is proposed (Area 2 on **Figure 5.1**). This would include the adoption of a sensitive grazing regime to minimise overgrazing on the hill, while maximising the benefits that grazing brings[2]. Other management measures would also be considered including heather and scrub removal on Kelman Hill if establishment of these plants are deemed a threat to the integrity of the optimal foraging grassland habitat. The extent of the grassland/ heathland area for management is 74.8 ha.

Objective 2: Predator Control

2.5.4 Unchanged from 2022 EIA Report (Technical Appendix 7.5: Outline Habitat Management Plan).

Objective 3: Common Gull Monitoring

2.5.5 Unchanged from 2022 EIA Report (Technical Appendix 7.5: Outline Habitat Management Plan).

2.6 Aim 5: Enhancement of Opportunities for Wildcat and Otter

2.6.1 Unchanged from 2022 EIA Report (Technical Appendix 7.5: Outline Habitat Management Plan).

2.7 Restricted Operations within HMP Areas

2.7.1 Unchanged from 2022 EIA Report (Technical Appendix 7.5: Outline Habitat Management Plan).

3 MONITORING

3.1.1 Unchanged from 2022 EIA Report (Technical Appendix 7.5 Outline Habitat Management Plan).

4 PROPOSED HABITAT MANAGEMENT PLAN AREAS

4.1.1 The proposed habitat management plan areas which address the aims listed in Section 2 are as follows:

- Area 1 – peatland restoration and riparian planting. This could involve re-wetting/ possibly ditch blocking if appropriate. Sensitive grazing regime in place, reseeding bare areas to promote vegetation growth to protect and protect against erosion, reinstate/ re-profile peat. Riparian planting along watercourse flowing through Area 1 would consist of planting principally broad-leaved trees. Planting would be a mixture of continuous and discontinuous, to maximise benefits to wildlife. The extent of Area 1 is 76.4 ha.

- Area 2 – grassland/ heathland management (74.8 ha in extent). Important area for foraging common gull from SPA so manage to encourage continued use. Sensitive grazing regime, heather/ scrub removal (when required) to maintain a short grassy sward which is optimal for foraging gulls.

- Area 3, 4 & 5 – peatland restoration. This could involve re-wetting/ possibly ditch blocking. Sensitive grazing regime in place, reseeding bare areas to promote vegetation growth to protect versus erosion, reinstate/ re-profile peat. The combined area for Area 3, 4 and 5 identified for peatland restoration is 27.8 ha.

5 ACCORD WITH NPF4 (POLICY 3)

5.1.1 How the Proposed Development accords with NPF4 (2023), policy 3, is considered comprehensively in Chapter 6: Ecology, and the Planning Statement This section summarises how the habitat management measures to be adopted adheres to NPF4.

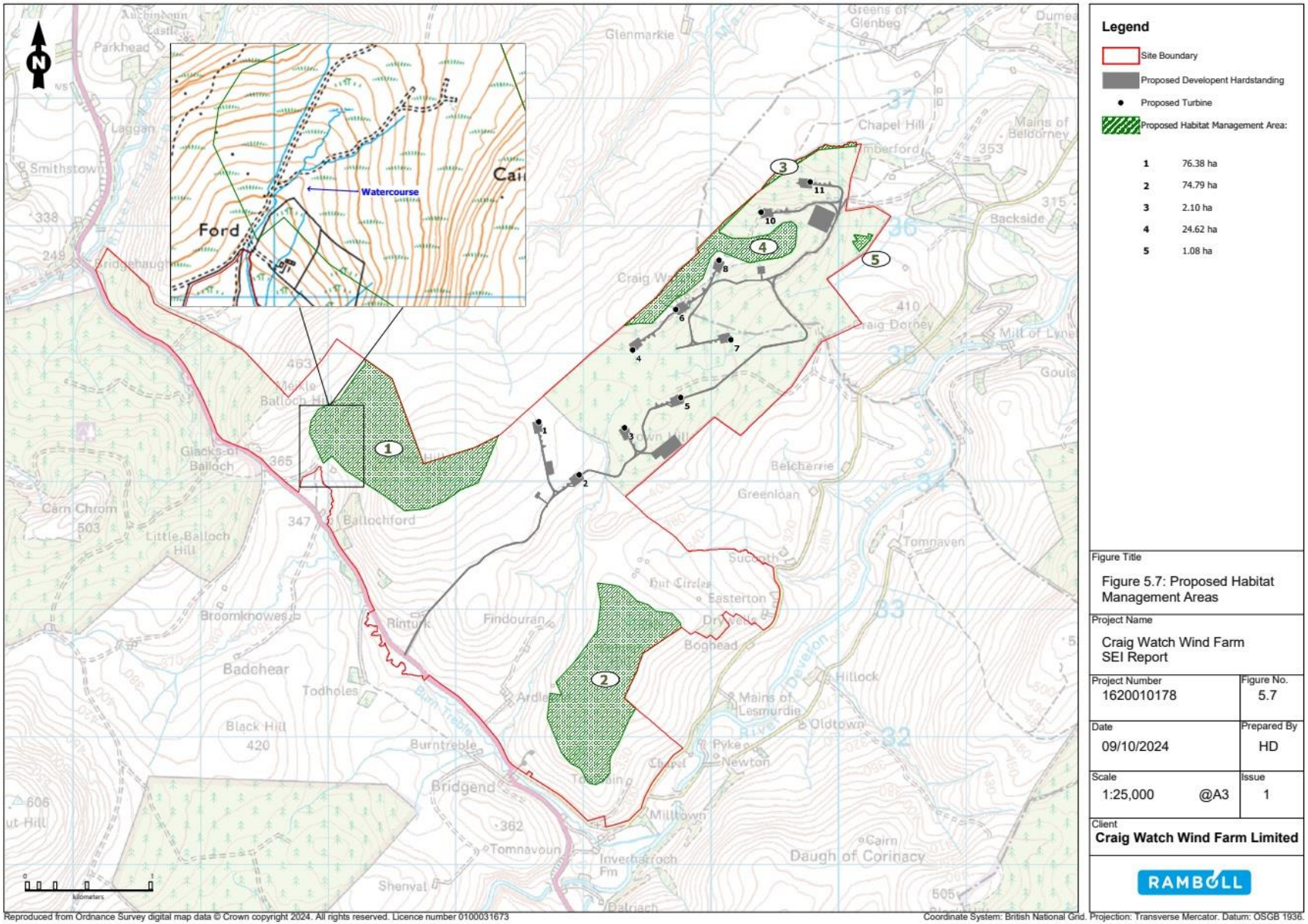
5.1.2 The proposed habitat management measures are considered extensive and ambitious, and will contribute to biodiversity enhancement, including restoring degraded peatland and strengthening ecological networks, through for example enhancing foraging opportunities in the wider area for SPA qualifying common gulls moving to and from the Tips of Corsemaul and Tom Mor SPA. Riparian tree planting will also improve connectivity through the Site (for example for foraging and commuting bats) and increase the resilience of watercourses to warming climate through shading and cooling water temperatures to benefit aquatic wildlife.

5.1.3 Habitat management measures have targeted species which are notable both nationally and locally, including black grouse, Scottish wildcat and ground-wading species, like curlew.

5.1.4 Peatland restoration is key for restoring function and increase the capabilities of carbon capture, particularly in those localities onsite where the peatland was identified as eroding and hagging.

5.1.5 Monitoring is fundamental for the measures proposed in this document, and this includes monitoring the success of habitat restoration areas, and the common gull population of the Tips of Corsemaul and Tom Mor SPA. This information will be used to identify any remedial actions required, and the monitoring results will be shared with relevant stakeholders.

FIGURE 5.1: SITE AND PROPOSED HABITAT ENHANCEMENT AREAS



Craig Watch Wind Farm

Technical Appendix 6.1: Collision Risk Model Analysis

November 2024

Contents

1. Introduction

1.1.1 This Technical Appendix presents any changes to the details and results of collision mortality risk calculations, completed to inform the impact assessment for the Proposed Development upon relevant ornithological features. Where there is no change to the 2022 EIA Report (Technical Appendix 8.2: Collision Risk Model Analysis) this is stated.

2. Methodology

2.1 Background

2.1.1 Unchanged from 2022 EIA Report (Technical Appendix 8.2: Collision Risk Model Analysis).

2.2 Wind Farm Parameters

2.2.1 The Proposed Development comprises 10 turbines, at 200 m maximum tip height, with a 118.5 m hub height, and 163 m maximum rotor diameter.

2.2.2 For the purposes of analysis, the flight risk volume (Vw) is based on a buffer constructed around the individual turbine locations with a radius of 290 m (area = 248.78 ha) and a height at least equal to the rotor diameter (163 m). The 290 m radius is in accordance with NatureScot guidance (SNH, 2009). The 290 m buffer radius used was to cover an area of 200 m plus at least the rotor radius.

2.2.3 Turbine parameters are summarised in **Table 2.1.** The indicative turbine model used for Collision Risk Model (CRM) Analysis is the 'Siemens Gamesa SG155'. Where there is a lack of available specification for a parameter for that turbine type, specification for a comparable candidate turbine is used. Where this is done, the parameter is footnoted in **Table 2.1** and a rationale provided.

Table 2.1 – Turbine Parameters

Parameter	Value	Unit
Size of Wind Farm *(290 m turbine buffer)*	248.78	ha
No. of rotors	10	-
No. of blades	3	-
Height to tip	200	metres
Rotor diameter	163	metres
Rotor radius	81.5	metres
Max chord	4.424	metres
Pitch	15	degrees
Rotation period	6.43[1]	seconds
Downtime	15	%

2.3 Viewsheds

2.3.1 Target species flight activity data for use in CRM Analysis calculations have been obtained from four VPs during VP flight activity surveys between March 2019 and February 2020, and two VPs between March and August 2020[2]. The number of VPs used was reduced from four to two because the initial four

[1] Based upon a maximum rotational speed of 11.20 r.p.m taken from a Siemens SWT-DD-142 3.5-4.1MW, with a conservative operating speed estimate derived as 20% of the maximum. Available at: https://www.siemensgamesa.com/en-int/-/media/siemensgamesa/downloads/en/products-and-services/archive/swt-dd-142.pdf [accessed 12/07/2024].
[2] Evolution of the Proposed Development layout meant that the four VP viewsheds used in Year 1 surveys covered an extended area outside the Site, and subsequently two VPs were considered appropriate in Year 2 surveys.

VPs covered excessive areas which were not considered appropriate for the updated Proposed Development layout.

2.3.2 Visible areas for each VP location have been calculated using an observer height of 1.5 m and a 10 m vertical offset above the ground. The extent of the visible area that could be seen from each VP location was confirmed during a reconnaissance visit. The viewshed radius for all VPs was 2 km.

2.3.3 **Tables 2.2, 2.3 and 2.4** present the visible areas of each viewshed and that which falls within the "Study Area" constructed using a 290 m buffer around the turbines for the purpose of analysis, during Year 1 (breeding and non-breeding seasons) and Year 2 (breeding season), and as shown in **Volume 2a**, **Figures 6.3a-c**[3]. In both survey years, VP viewshed coverage of the Study Area was maximised, in accordance with NatureScot guidance (SNH, 2017).

Table 2.2 – VP Locations and Viewshed Visible Areas – Year 1 (Breeding Season)

VP	Grid Reference	Visible Area (ha) Within 290 m Turbine Buffer
1	NJ 38321 32944	99.59
2	NJ 40410 35332	128.48
3	NJ 36952 34438	58.28
4	NJ 38923 36054	36.18

Table 2.3 – VP Locations and Viewshed Visible Areas – Year 1 (Non-Breeding Season)

VP	Grid Reference	Visible Area (ha) Within 290 m Turbine Buffer
1	NJ 38321 32944	99.59
2a	NJ 38653 35407	56.01
3	NJ 36952 34438	89.8
4	NJ 38923 36054	36.18

Table 2.4 – VP Locations and Viewshed Visible Areas – Year 2 (Breeding Season)

VP	Grid Reference	Visible Area (ha) Within 290 m Turbine Buffer
1	NJ 38321 32944	99.59
2b	NJ 38653 35407	154.46

2.4 VP Flight Activity Data

2.4.1 Unchanged from 2022 EIA Report (Technical Appendix 8.2: Collision Risk Model Analysis).

2.5 'At Risk' Flights

2.5.1 The flights of the following species were recorded as 'at risk'; common gull, hen harrier, goshawk, curlew, golden plover, pink-footed goose, peregrine, lapwing and greylag goose. 'At risk' was defined as those flights recorded within 290 m of the turbines and flying at collision risk height (i.e., between 37 - 200 m above ground level). Given the height bands used, this resulted in HT2-4 ('20 m' to '>180 m') being included as 'at risk', as a precaution.

2.5.2 CRM Analysis was only undertaken on those species with three, or more, at risk flights, over the 18 month survey period, and accordingly the flights of common gull, hen harrier, goshawk, curlew and golden plover were analysed. For ornithological features with less than three flights it can safely be assumed that there would be no signficant effect from collisions.

2.5.3 There are no designated sites with migratory geese (such as pink-footed goose) as qualifying species, within 20 km of the Site. Therefore the Site is outside the defined core foraging range of the species (SNH, 2016) from such designated sites. The pink-footed geese flights recorded are considered birds from outside designated site(s). Furthermore, the majoriry of pink-footed goose flights (132,110 seconds of the 139,310 seconds time 'at risk') were in HT4 (>180 m) and thus in reality were birds likely flying

[3] In Year 1 (breeding season) VP2 and VP3 were regularly undertaken simultaneously and due to some overlap (albeit relatively modest), as a precaution, the overlap area was included in VP2's viewshed and not VP3, so that there was no duplication of the survey of the overlap area.

over 'at risk' height. Accordingly, CRM Analysis was not undertaken on pink-footed geese recorded during surveys.

2.5.4 Details of VP flight activity of those target species flying 'at risk' are provided in **Annex 1**.

2.5.5 'At risk' flight activity recorded during the survey period for those species which were analysed using CRM is summarised in **Table 2.5**. Note, CRM Analysis was undertaken for common gull, goshawk and curlew during the breeding season in both Year 1 and Year 2, golden plover and hen harrier only during the breeding season in Year 1, and goshawk during the non-breeding season (Year 1).

Table 2.5 – 'At Collision Risk' Flight Activity Considered for CRM Analysis

Species	Total No. of Flights	Total No. of Birds	Total Flight Time (secs) at Collision Risk Height[4]
Golden plover[5]	3	27	3,729
Curlew	7	9	685
Common Gull	17	29	3,106
Goshawk	16	16	3,330
Hen harrier	5	6	958

2.6 Target Species Parameters

2.6.1 Unchanged from 2022 EIA Report (Technical Appendix 8.2: Collision Risk Model Analysis).

3. Collision Risk Analysis

3.1 Approach

3.1.1 Only those species with ≥3 flights at collision risk, over the 18 month survey period, were chosen for CRM Analysis, as flights below this number would be inconsequential at any population level (see also **Section 2.5**). As such, flights of common gull, hen harrier, goshawk, curlew and golden plover were subjected to CRM Analysis.

3.1.2 The following important information is used in the CRM Analysis:

- Wind farm 'Study Area' (out to 290 m, radius 248.78 ha);
- Assumed daylight flying hours (potential): 2738.6 hrs and 1750.3 hrs[6] respectively during the Breeding Bird Season and Non-Breeding Bird Seasons';
- Downtime: 15 %;
- Latitude for approximate centre of the Site: 57.404745; and
- Lifespan of wind farm is 33 years.

3.1.3 **Table 3.1** presents the output from the CRM Analysis for the assessed species, with details of results provided in **Annex 3**. Note, given the classification of at-risk flights (all flights in HT2-4, thus 20 – >180 m) but in reality the at-risk area is 37 – 200 m, these CRM Analysis results are considered to be precautionary (and represent a worst-case scenario). Results are provided for breeding seasons, unless otherwise stated. In **Table 3.1** '-' means that CRM Analysis was not undertaken, while '0' means that the collision mortality was considered to be inconsequential.

[4] Total flight time at risk height multiplied by the number of birds.
[5] Two additional golden plover flights were also recorded during the non-breeding season but given the low activity during the non-breeding survey period, only golden plover during the breeding season were subject to CRM Analysis.
[6] Potentially active hours have been calculated using latitude of 57.404745 as per Forsythe et al. (1995), for the breeding and non-breeding seasons. The daylight hours during the breeding season for curlew and golden plover was 1913.5 hrs given occupancies stated in Section 2.6.

Table 3.1 – CRM Analysis Results

Species	Avoidance Rate (%)	Annual Collision Mortality			33 year Collision Mortality		
		Year 1	Year 2	Average	Year 1	Year 2	Average
Common gull	99.2	0.051	0.072	0.062	1.668	2.381	2.025
Hen harrier	99	0.103	0	0.052	3.390	0	1.695
Goshawk *Breeding* *Non-breeding*[7]	 98 “	 0.663 0.069	 0.062 -	 0.363 -	 21.893 2.271	 2.059 -	 11.976 -
Curlew	98	0.014	0.088	0.051	0.469	2.897	1.683
Golden plover	98	0.173	0	0.087	5.707	0	2.854

4. References

Forsythe, W.C., Rykiel, Jr., E.J., Stahl, R.S., Wu, H. and Schoolfield, R.M. (1995). A Model Comparison for Daylength as a Function of Latitude and Day of the Year. *Ecological modelling*, 80, 87-95

SNH (2009). *Guidance on Methods for Monitoring Bird Populations at Onshore Wind Farms.* Guidance Note. January 2009.

SNH (2016). *Assessing connectivity with Special Protection Areas (SPAs).* Guidance. Version 3. June 2016, SNH, Inverness.

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

[7] Non-breeding surveys only undertaken in Year 1.

Annex 1 – 'At Risk' Flight Activity

Table A1-1 present 'at risk' flight activity for target species recorded during the survey period (March 2019 to August 2020); the number of birds, total flight duration and time spent at (HT2 – HT4) and below (HT1) collision risk height is presented. Note, of these, common gull, hen harrier, goshawk, curlew and golden plover were recorded in sufficient number 'at collision risk' height and considered appropriate for CRM Analysis to be carried out. 'Br' and 'Non-Br' in **Table A1-1** refers to 'Breeding' and 'Non-breeding', respectively.

Table A1-1 –Target species 'at risk' flight activity (Wind Farm 'Study Area': out to 290 m radius)

Survey Year	Season	Date	VP	Species	No. of Birds	Start Time (24hrs)	Flight Duration (secs)	Time spent (secs)			
								HT1	HT2	HT3	HT4
1	Br	27/03/2019	3	Hen harrier	1	13:43	135	0	135	0	0
1	Br	28/03/2019	1	Pink-footed goose	80	11:40	90	0	0	0	90
1	Br	28/03/2019	1	Pink-footed goose	180	08:46	90	0	0	0	90
1	Br	28/03/2019	1	Pink-footed goose	90	10:21	193	0	0	0	193
1	Br	28/03/2019	4	Common gull	1	10:53	160	0	30	130	0
1	Br	28/03/2019	4	Goshawk	1	12:32	190	0	0	60	130
1	Br	08/04/2019	1	Golden plover	25	14:19	145	0	0	145	0
1	Br	08/04/2019	1	Common gull	2	19:39	180	0	180	0	0
1	Br	08/04/2019	3	Hen harrier	1	16:20	163	88	75	0	0
1	Br	08/04/2019	4	Goshawk	1	16:55	138	0	78	60	0
1	Br	08/04/2019	4	Goshawk	1	17:01	38	8	30	0	0
1	Br	08/04/2019	4	Goshawk	1	16:48	247	0	67	135	45
1	Br	10/04/2019	2	Goshawk	1	11:45	60	0	45	15	0
1	Br	10/04/2019	2	Common gull	1	07:04	93	0	93	0	0
1	Br	10/04/2019	2	Common gull	3	08:43	90	0	0	90	0
1	Br	10/04/2019	2	Common gull	1	08:28	120	105	15	0	0
1	Br	10/04/2019	2	Goshawk	1	11:26	185	0	60	30	95

Survey Year	Season	Date	VP	Species	No. of Birds	Start Time (24hrs)	Flight Duration (secs)	Time spent (secs)			
								HT1	HT2	HT3	HT4
1	Br	10/04/2019	3	Hen harrier	2	11:49	255	0	30	105	120
1	Br	10/04/2019	3	Pink-footed goose	120	08:19	270	0	0	60	210
1	Br	10/04/2019	3	Goshawk	1	12:27	160	0	0	160	0
1	Br	15/04/2019	1	Goshawk	1	14:07	28	13	15	0	0
1	Br	15/04/2019	3	Golden plover	1	17:21	44	0	44	0	0
1	Br	15/04/2019	3	Hen harrier	1	16:11	178	15	163	0	0
1	Br	17/04/2019	2	Curlew	1	11:19	85	30	55	0	0
1	Br	17/04/2019	2	Goshawk	1	13:24	1544	0	90	195	1259
1	Br	15/05/2019	4	Curlew	1	10:27	40	10	30	0	0
1	Br	15/05/2019	4	Common gull	1	13:34	110	0	60	50	0
1	Br	24/05/2019	3	Curlew	1	17:43	47	17	30	0	0
1	Br	24/05/2019	3	Common gull	1	18:25	146	0	146	0	0
1	Br	25/05/2019	1	Hen harrier	1	08:13	89	14	75	0	0
1	Br	25/05/2019	1	Common gull	1	08:01	247	45	120	87	0
1	Br	17/06/2019	2	Common gull	1	13:11	65	0	65	0	0
1	Br	29/06/2019	1	Golden plover	1	09:14	60	0	0	60	0
1	Br	10/07/2019	2	Common gull	2	11:28	170	30	15	125	0
1	Non-Br	23/09/2019	1	Goshawk	1	14:29	120	0	15	105	0
1	Non-Br	22/10/2019	3	Goshawk	1	13:45	45	0	30	15	0
1	Non-Br	23/10/2019	1	Golden plover	60	10:19	120	0	75	45	0
1	Non-Br	28/11/2019	3	Peregrine	1	09:01	35	20	15	0	0
1	Non-Br	28/11/2019	3	Pink-footed goose	78	09:52	150	0	0	0	150

Survey Year	Season	Date	VP	Species	No. of Birds	Start Time (24hrs)	Flight Duration (secs)	Time spent (secs)			
								HT1	HT2	HT3	HT4
1	Non-Br	28/11/2019	3	Pink-footed goose	60	10:04	180	0	0	0	180
1	Non-Br	28/11/2019	3	Pink-footed goose	170	10:15	120	0	0	0	120
1	Non-Br	01/12/2019	2a	Pink-footed goose	85	08:35	160	0	0	0	160
1	Non-Br	18/12/2019	3	Golden plover	6	09:38	80	5	75	0	0
1	Non-Br	19/12/2019	1	Goshawk	1	12:50	50	0	50	0	0
1	Non-Br	31/01/2020	4	Pink-footed goose	84	10:57	90	0	0	0	90
1	Non-Br	31/01/2020	4	Pink-footed goose	32	10:22	65	0	0	0	65
1	Non-Br	18/02/2020	1	Goshawk	1	12:08	45	30	15	0	0
2	Br	20/04/2020	1	Curlew	1	16:24	94	19	75	0	0
2	Br	24/04/2020	2	Curlew	2	10:29	161	0	0	161	0
2	Br	24/04/2020	2	Goshawk	1	11:52	17	2	15	0	0
2	Br	24/04/2020	2	Goshawk	1	12:14	531	15	96	315	105
2	Br	14/05/2020	1	Lapwing	2	11:48	69	9	60	0	0
2	Br	19/05/2020	2	Common gull	1	11:38	42	0	42	0	0
2	Br	19/05/2020	2	Goshawk	1	12:04	35	5	30	0	0
2	Br	19/05/2020	2	Common gull	3	11:52	219	0	9	180	30
2	Br	21/05/2020	2	Curlew	1	17:16	23	0	0	0	23
2	Br	04/06/2020	1	Greylag goose	22	09:41	84	0	0	0	84
2	Br	04/06/2020	1	Greylag goose	22	09:47	117	0	0	0	117
2	Br	16/06/2020	1	Curlew	2	20:26	79	4	75	0	0
2	Br	17/06/2020	2	Common gull	2	19:47	65	0	45	20	0

Survey Year	Season	Date	VP	Species	No. of Birds	Start Time (24hrs)	Flight Duration (secs)	Time spent (secs)			
								HT1	HT2	HT3	HT4
2	Br	17/06/2020	2	Common gull	3	20:20	78	0	60	18	0
2	Br	18/06/2020	2	Common gull	3	05:44	63	0	45	18	0
2	Br	16/07/2020	2	Common gull	2	18:38	34	0	0	34	0
2	Br	16/07/2020	2	Common gull	1	20:16	95	15	45	35	0

Annex 2 – Collision Probability Calculations

Unchanged from Technical Appendix 8.2 of the 2022 EIA Report.

Annex 3 – Collision Risk Model Analysis

Common gull (Year 1 – breeding season)

VP	Watch data			Flying time (s)	Flying time hahr-1	Weighted flying time ha hr^-1	
	Area (ha)	Time (hrs)	HaHr	Risk height	Risk height	Weighting	Risk height
1	99.59	48.0	4780.32	264.81	0.0000153880	0.308777478	0.0000047515
2	128.48	48.0	6167.04	153.04	0.0000068932	0.398350541	0.0000027459
3	58.28	48.0	2797.44	38.70	0.0000038431	0.180696369	0.0000006944
4	36.18	48.0	1736.64	74.96	0.0000119899	0.112175612	0.0000013450
Totals	322.53	192.0	15481.44	531.52	0.0000381142	1.0000000000	0.0000095368

Mean activity hr^-1 in wind farm				WIND FARM DATA			
Risk height	0.00237	0.2373%		Wind farm area (ha)	248.78		
Daylight hours			2738.6				
Downtime			15	0.85		D	155.0
Vw =			385609000			L + d	4.834
Vr =			911674	No. of turbines	10	R	77.5
Vr/Vw =			0.0023642				
Speed			11.6				
Vw Occupancy =			6.497	23391.0			
Vr Occupancy =			0.015	55.3			
Transit time =			0.417				
Transits =			132.707				
Collision probability from NatureScot sheet			0.056				
Collisions with no avoidance			7.432				
Collisions with 99.2% avoidance			0.059				
Collisions with 99.2% avoidance & downtime			0.051				
33 year mortality			1.962				
33 year mortality with 15% downtime etc			1.668				

Years for 1 death	19.788				

Common gull (Year 2 – breeding season)

VP	Watch data			Flying time (s)	Flying time hahr-1	Weighted flying time ha hr^-1	
	Area (ha)	Time (hrs)	HaHr	Risk height	Risk height	Weighting	Risk height
1	99.59	48.0	4780.32	0.00	0.0000000000	0.392009447	0.0000000000
2b	154.46	48.0	7414.08	597.86	0.0000223996	0.607990553	0.0000136187
Totals	254.05	96.0	12194.40	597.86	0.0000223996	1.0000000000	0.0000136187

Mean activity hr^-1 in wind farm				**WIND FARM DATA**			
Risk height	0.00339	0.3388%		**Wind farm area (ha)**	242.78		
Daylight hours			2738.6				
Downtime			15	0.85		**D**	155.0
Vw =			385609000			**L + d**	4.834
Vr =			911674	**No. of turbines**	10	**R**	77.5
Vr/Vw =			0.0023642				
Speed			11.6				
Vw Occupancy =			9.279	33402.8			
Vr Occupancy =			0.022	79.0			
Transit time =			0.417				
Transits =			189.508				
Collision probability from NatureScot sheet			0.056				
Collisions with no avoidance			10.612				
Collisions with 99.2 % avoidance			0.085				
Collisions with 99.2 % avoidance & downtime			0.072				
33 year mortality			2.802				
33 year mortality with 15 % downtime etc			2.381				
Years for 1 death			13.857				

Curlew (Year 1 – breeding season)

VP	Watch data			Flying time (s)	Flying time hahr-1	Weighted flying time ha hr^-1	
	Area (ha)	Time (hrs)	HaHr	Risk height	Risk height	Weighting	Risk height
1	99.59	36.0	3585.24	0.00	0.0000000000	0.324432620	0.0000000000
2	128.48	33.0	4239.84	7.68	0.0000005033	0.383668151	0.0000001931
3	58.28	33.0	1923.24	44.88	0.0000064824	0.174036269	0.0000011282
4	36.18	36.0	1302.48	1.94	0.0000004130	0.117862960	0.0000000487
Totals	322.53	138.0	11050.80	54.50	0.0000073987	1.0000000000	0.0000013700

Mean activity hr^-1 in wind farm				WIND FARM DATA			
Risk height	0.00034	0.0341%		Wind farm area (ha)	248.78		
Daylight hours			1913.5				
Downtime			15	0.85		D	155.0
Vw =			385609000			L + d	4.974
Vr =			938078	No. of turbines	10	R	77.5
Vr/Vw =			0.0024327				
Speed			13				
Vw Occupancy =			0.652	2347.8			
Vr Occupancy =			0.002	5.7			
Transit time =			0.383				
Transits =			14.927				
Collision probability from NatureScot sheet			0.056				
Collisions with no avoidance			0.836				
Collisions with 98 % avoidance			0.017				
Collisions with 98 % avoidance & downtime			0.014				
33 year mortality			0.552				
33 year mortality with 15 % downtime etc			0.469				
Years for 1 death			70.368				

Curlew (Year 2 – breeding season)

VP	Watch data			Flying time (s)	Flying time hahr-1	Weighted flying time ha hr^-1	
	Area (ha)	Time (hrs)	HaHr	Risk height	Risk height	Weighting	Risk height
1	0.017	0.017	0.017	0.017	0.017	0.017	0.017
2b	0.014	0.014	0.014	0.014	0.014	0.014	0.014
Totals	254.05	72.0	9145.80	278.60	0.0000147573	1.0000000000	0.0000084615
Mean activity hr^-1 in wind farm				WIND FARM DATA			
Risk height	0.00211	0.2105%		Wind farm area (ha)	248.78		

Daylight hours	1913.5				
Downtime	15	0.85		D	155.0
Vw =	385609000			L + d	4.974
Vr =	938078	No. of turbines	10	R	77.5
Vr/Vw =	0.0024327				
Speed	13				
Vw Occupancy =	4.028	14500.9			
Vr Occupancy =	0.010	35.3			
Transit time =	0.383				
Transits =	92.199				
Collision probability from NatureScot sheet	0.056				
Collisions with no avoidance	5.163				
Collisions with 98 % avoidance	0.103				
Collisions with 98 % avoidance & downtime	0.088				
33 year mortality	3.408				
33 year mortality with 15 % downtime etc	2.897				
Years for 1 death	11.393				

Hen harrier (Year 1 – breeding season)

VP	Watch data			Flying time (s)	Flying time hahr-1	Weighted flying time ha hr^-1	
	Area (ha)	Time (hrs)	HaHr	Risk height	Risk height	Weighting	Risk height
1	99.59	48.0	4780.32	73.97	0.0000042984	0.308777478	0.0000013273
2	128.48	48.0	6167.04	0.00	0.0000000000	0.398350541	0.0000000000
3	58.28	48.0	2797.44	767.76	0.0000762362	0.180696369	0.0000137756
4	36.18	48.0	1736.64	0.00	0.0000000000	0.112175612	0.0000000000
Totals	322.53	192.0	15481.44	841.73	0.0000805346	1.0000000000	0.0000151028

Mean activity hr^-1 in wind farm				WIND FARM DATA			
Risk height	0.00376	0.3757%		Wind farm area (ha)	248.78		
Daylight hours			1913.5				
Downtime			15	0.85		D	155.0
Vw =			385609000			L + d	4.904
Vr =			924876	No. of turbines	10	R	77.5
Vr/Vw =			0.0023985				
Speed			11.5				
Vw Occupancy =			10.290	37042.9			
Vr Occupancy =			0.025	88.8			
Transit time =			0.426				
Transits =			208.348				
Collision probability from NatureScot sheet			**0.058**				
Collisions with no avoidance			12.084				
Collisions with 99 % avoidance			0.121				
Collisions with 99 % avoidance & downtime			0.103				
33 year mortality			3.988				
33 year mortality with 15 % downtime etc			3.390				
Years for 1 death			9.736				

Golden plover (Year 1 – breeding season)

VP	Watch data			Flying time (s)	Flying time hahr-1	Weighted flying time ha hr^-1	
	Area (ha)	Time (hrs)	HaHr	Risk height	Risk height	Weighting	Risk height
1	99.59	36.0	3585.24	684.79	0.0000530560	0.324432620	0.0000172131
2	128.48	33.0	4239.84	0.00	0.0000000000	0.383668151	0.0000000000
3	58.28	33.0	1923.24	64.96	0.0000093829	0.174036269	0.0000016330
4	36.18	36.0	1302.48	0.00	0.0000000000	0.117862960	0.0000000000
Totals	322.53	138.0	11050.80	749.75	0.0000624389	1.0000000000	0.0000188461

Mean activity hr^-1 in wind farm				WIND FARM DATA			
Risk height	0.00469	0.4689%		Wind farm area (ha)	248.78		
Daylight hours			1913.5				
Downtime			15	0.85		D	155.0
Vw =			385609000			L + d	4.704
Vr =			887157	No. of turbines	10	R	77.5
Vr/Vw =			0.0023007				
Speed			14				
Vw Occupancy =			8.971	32297.4			
Vr Occupancy =			0.021	74.3			
Transit time =			0.336				
Transits =			221.147				
Collision probability from NatureScot sheet			0.046				
Collisions with no avoidance			10.173				
Collisions with 98 % avoidance			0.203				
Collisions with 98 % avoidance & downtime			0.173				
33 year mortality			6.714				
33 year mortality with 15 % downtime etc			5.707				
Years for 1 death			5.782				

Goshawk (Year 1 – breeding season)

VP	Watch data			Flying time (s)	Flying time hahr-1	Weighted flying time ha hr^-1	
	Area (ha)	Time (hrs)	HaHr	Risk height	Risk height	Weighting	Risk height
1	99.59	48.0	4780.32	30.68	0.0000017830	0.308777478	0.0000005506
2	128.48	48.0	6167.04	2082.57	0.0000938038	0.398350541	0.0000373668
3	58.28	48.0	2797.44	212.01	0.0000210518	0.180696369	0.0000038040
4	36.18	48.0	1736.64	421.87	0.0000674792	0.112175612	0.0000075695
Totals	322.53	192.0	15481.44	2747.14	0.0001841179	1.0000000000	0.0000492909

Mean activity hr^-1 in wind farm				WIND FARM DATA			
Risk height	0.01226	1.2263%		Wind farm area (ha)	248.78		
Daylight hours			2738.6				
Downtime			15	0.85		D	155.0
Vw =			385609000			L + d	4.974
Vr =			938078	No. of turbines	10	R	77.5
Vr/Vw =			0.0024327				
Speed			10				
Vw Occupancy =			33.582	120896.3			
Vr Occupancy =			0.082	294.1			
Transit time =			0.497				
Transits =			591.288				
Collision probability from NatureScot sheet			0.066				
Collisions with no avoidance			39.025				
Collisions with 98 % avoidance			0.780				
Collisions with 98 % avoidance & downtime			0.663				
33 year mortality			25.756				
33 year mortality with 15% downtime etc			21.893				
Years for 1 death			1.507				

Goshawk (Year 2 – breeding season)

VP	Watch data			Flying time (s)	Flying time hahr-1	Weighted flying time ha hr^-1	
	Area (ha)	Time (hrs)	HaHr	Risk height	Risk height	Weighting	Risk height
1	99.59	48.0	4780.32	0.00	0.0000000000	0.392009447	0.0000000000
2b	154.46	48.0	7414.08	203.53	0.0000076255	0.607990553	0.0000046363
Totals	254.05	96.0	12194.40	203.53	0.0000076255	1.0000000000	0.0000046363

Mean activity hr^-1 in wind farm				WIND FARM DATA			
Risk height	0.00115	0.1153%		Wind farm area (ha)	248.78		
Daylight hours			2738.6				
Downtime			15	0.85		D	155.0
Vw =			385609000			L + d	4.974
Vr =			938078	No. of turbines	10	R	77.5
Vr/Vw =			0.0024327				
Speed			10				
Vw Occupancy =			3.159	11371.4			
Vr Occupancy =			0.008	27.7			
Transit time =			0.497				
Transits =			55.616				
Collision probability from NatureScot sheet			0.066				
Collisions with no avoidance			3.671				
Collisions with 98 % avoidance			0.073				
Collisions with 98 % avoidance & downtime			0.062				
33 year mortality			2.423				
33 year mortality with 15 % downtime etc			2.059				
Years for 1 death			16.025				

Goshawk (Year 1 – non-breeding season)

VP	Watch data			Flying time (s)	Flying time hahr-1	Weighted flying time ha hr^-1	
	Area (ha)	Time (hrs)	HaHr	Risk height	Risk height	Weighting	Risk height
1	99.59	36.0	3585.24	184.08	0.0000142625	0.353682790	0.0000050444
2a	56.01	36.0	2016.36	0.00	0.0000000000	0.198913275	0.0000000000
3	89.80	36.0	3232.80	107.80	0.0000092629	0.318914696	0.0000029541
4	36.18	36.0	1302.48	0.00	0.0000000000	0.128489239	0.0000000000
Totals	281.58	144.0	10136.88	291.89	0.0000235254	1.0000000000	0.0000079985

Mean activity hr^-1 in wind farm				WIND FARM DATA			
Risk height	0.00199	0.1990%		Wind farm area (ha)	248.78		
Daylight hours			1750.3				
Downtime			15	0.85		D	155.0
Vw =			385609000			L + d	4.974
Vr =			938078	No. of turbines	10	R	77.5
Vr/Vw =			0.0024327				
Speed			10				
Vw Occupancy =			3.483	12538.3			
Vr Occupancy =			0.008	30.5			
Transit time =			0.497				
Transits =			61.323				
Collision probability from NatureScot sheet			0.066				
Collisions with no avoidance			4.047				
Collisions with 98 % avoidance			0.081				
Collisions with 98 % avoidance & downtime			0.069				
33 year mortality			2.671				
33 year mortality with 15% downtime etc			2.271				
Years for 1 death			14.534				