Appendix 12I - Collision Risk Modelling Report

Appendix 12I
Collision Risk Modelling Report

Introduction

This Appendix documents the methodology and results of collision risk modelling based on data collected from Vantage Point ('VP') surveys undertaken from April 2016 to August 2018 in support of the Ecological Impact Assessment ('EcIA') for the Proposed Development.

Data obtained during VP surveys was used to determine the theoretical collision risk for a range of species by incorporation into a collision risk model ('CRM') (Band et al. 2007) and herein referred to as 'the Band model'. Goshawk was the only species taken forward for assessment.

Appendices 12B and 12D-E and **Confidential Appendices 12F-G** present figures of flight activity of species included in the CRM. **Annex A** of this Appendix contains the flight data used in the CRM, whilst **Annex B** presents CRM calculations.

CRM Methodology

Introduction

The risk of birds colliding with the turbine rotors has been assessed using a model developed by Band, which estimates the number of bird collisions with the turbine rotors during a specified time period (Band *et al*., 2007; NatureScot, 2000). The model requires input data based on species biometrics and flight characteristics, turbine specification and data on flights observed at the site. The amount of time that a species may be active within the survey area in any given season is also required for the model and must therefore be estimated.

The 'Band model' uses a two-stage approach, whereby the number of birds or flights passing through the air space swept by the rotors is determined at Stage 1 and the probability of a bird strike occurring is calculated at Stage 2. The product of Stage 1 and Stage 2 gives a theoretical annual collision mortality rate on the assumption that birds make no attempt to avoid collision.

However, it is widely accepted that many species are able to avoid turbine blades in a number of ways. Birds may exercise avoidance by detecting the wind farm or turbine and modifying their flight lines to avoid the structures or at close proximity, birds may see an oncoming blade and emergency avoidance action can be taken (NatureScot, 2000). As such, species specific avoidance rates were applied to the model to estimate the collision risk (NatureScot, 2017a).

The results of the model provides an estimate of the number of collisions that can be expected over a specific season, year, or for the lifetime of the wind farm.

Choice of Random or Regular Model

The Stage 1 calculation varies depending on whether flight activity follows a regular predictable pattern or is random. The second stage is identical for both methods.

The modelling method for birds with predictable (regular) flight activity is used for birds such as geese following a regular migration route or travelling from a winter roost to a regular feeding area.

The modelling method with irregular (or random) flight activity, such as raptors and waders, requires the calculation of the amount of time birds were observed flying per unit of area surveyed. This level of flight activity is then applied to the Proposed Development in subsequent calculations of the collision risk.

As goshawk was the only species taken forward for assessment, the random flight activity Stage 1 model was used.

Model Parameters

Turbines

The final candidate turbine for the Proposed Development will be chosen post consent and will be subject to a competitive tendering process.

For the purposes of CRM, it has been assumed that the turbine would have a hub height of 81.9 m and rotor diameter of 136 m, with the potential collision risk height ('PCH') of 13.9 – 149.9 m. The full set of parameters assumed for the Proposed Development is detailed in **Table 12I.1**

In addition, it has been assumed that turbines would be non-operational for 25 % of the time (e.g. during periods when wind speed is too low or too high to operate, or during maintenance).

Table 12I.1 – Turbine Technical Parameters

Parameter	2020 Application	Unit
Number of turbines	2	
Number of blades	3	
Approximate hub height	81.9	m
Approximate rotor diameter	136	m
Maximum height to blade tip	149.9	m
Minimum height to blade tip	13.9	m
PCH	13.9-149.9	m
Pitch	6	Degrees
Chord	4	m
Rotation period	4.6	rpm

Survey Effort, Available Hours Per Season and Observation Time

VP surveys commenced in April 2016 and continued through until the end of August 2018 at two VP locations (a total of four VP locations were used across the period but only ever two simultaneously). Changes in VP location were a result of changing access restrictions. A summary of survey effort is shown in **Table 12I.2**.

Table 12I.2 – VP survey effort

VP	Apr 16	May 16	Jun 16	Jul 16	Aug 16	Sep 16	Oct 16	Nov 16	Dec 16	Jan 17	Feb 17	Mar 17	Nov 17	Dec 17	Jan 18	Feb 18	Mar 18	Apr 18	May 18	Jun 18	Jul 18	Aug 18
A	3	15	9	9	6	6	6	6	4	8	6	6	7	8	4	3	14	9	9	9	9	6
B	6	12	9	9	6	6	6	6	4	8	6	6	-	-	-	-	-	-	-	-	-	-
1	-	-	-	-	-	-	-	-	-	-	-	-	7	8	4	3	14	-	-	-	-	-
3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	9	9	9	9	6

Available active hours was defined as the number of hours that a bird species may be potentially active in any given season (NatureScot, 2017b) (**Table 12I.3**). Available hours for flight activity were calculated to include daylight, one hour before sunrise and one hour after sunset for the only species taken forward for assessment, goshawk. Seasons are not defined using the baseline reports but rather the breeding and non-breeding seasons in relation to goshawk as defined within Hardey *et al*., (2013) and from experience of the area (breeding season, February to August; and non-breeding season, September to January).

Observation effort relates to the total number of survey hours undertaken at VP locations within the seasons in question.

Table 12I.3 – Available Hours and Observation Effort

Season	Available hours	Total observation effort (hours)
Breeding 2016 (Feb to Aug)	3,507:09	84 (42 hours at each VP) Surveys began in April 2016 and therefore missed the early part of the goshawk breeding season (February and March)
Non-breeding 2016/17 (Sep 16 to Jan 17)	1,725:12	60 (30 hours at each VP)
Breeding 2017 (Feb to Aug)	3,489:00	24 (12 hours at each VP) Surveys finished in March 2017 and therefore only include the early part of the goshawk breeding season
Non-breeding 2017/18 (Sep 17 to Jan 18)	1,724:13	38 (19 hours at each VP) Surveys began in late November and therefore missed the early part of the goshawk non-breeding season
Breeding 2018 (Feb to Aug)	3,496:00	118 (59 hours at VPA, 17 hours from VP1, 42 hours from VP3)

Random Model

Definition of terms

The **collision risk zone** ('CRZ') is defined as the wind farm polygon ('WFP'). This was taken as the perimeter of the Proposed Development plus a 500 m buffer and the proposed rotor length of 68 m (therefore a 568 m buffer around the proposed development). NatureScot guidance currently recommends a 500 m buffer to allow for observer inaccuracies when mapping flights during surveys (NatureScot, 2017b).

The **Vantage Point view-shed** is the survey area associated with each VP, calculated as a 180 degree arc of a 2km-radius applied around each VP location.

The **Flight risk area** ('FRA') is defined as the **area of visibility** of each viewshed at minimum collision-risk height, in this instance at 13.9 m, that falls within the CRZ, and was calculated using GIS (**Figures 12I.1a-e, Annex A,)**.

FRAw is an adjustment calculation that accounts for the difference between the height bands used for recording collision risk height flights and the length of the turbine blades. The flight activity surveys were carried out prior to turbine model selection and used three height bands that are not identical to the PCH of the final turbine dimensions, and therefore the overall bird activity is weighted to reflect that the swept area is smaller than the recording area, decreasing the overall bird activity (e.g. the 2016 breeding and 2016/17 non-breeding season used the height bands, 0-30 m, 30-130 m and >130 m; whereas the 2017/18 non-breeding and 2018 breeding season used height bands 0-30 m, 30-150 m and >150 m).

The **collision risk volume** is defined as the volume of the airspace between the minimum and maximum risk height band (13.9 m – 149.9 m) and is used in random models (NatureScot, 2000).

The **rotor-swept volume** is defined as the volume of air that would be swept by all of the rotors in the wind farm. For an individual rotor this is determined by the area swept (πr2) multiplied by the thickness of the rotor blades plus the length of the focal species (NatureScot, 2000).

Selection of flights

All flights that were observed at PCH falling within the CRZ were included. Those flights that extended beyond the CRZ were clipped to the CRZ boundary (i.e. only the time spent within the CRZ was included in the collision risk model). Where flights at PCH originated or ended outside of the CRZ, the amount of time for the clipped flight at PCH within CRZ was calculated as a proportion of the clipped flight length to the total flight length at PCH. Where a flight represented the activity of more than one bird, total flight time was calculated based on number of birds multiplied by the time at PCH within the CRZ.

Flights were apportioned to the breeding or non-breeding season identified in **Table 12I.3**. **Table 12I.4** shows the total flight times for all species where flight data indicated that the random CRM approach should be used.

Seasons that are absent from this table (e.g. breeding 2016, non-breeding 2016/17 and 2017/18) were omitted as no goshawk flight activity was recorded during these periods.

The clipped flights at PCH within the CRZ included in the modelling are shown in **Annex A**, **Figure 12I.2** (Confidential). **Annex A** provides details of all flights included in the random CRM (all flight data can be found in the **Confidential Appendices 12F-G**).

Table 12I.4 – Random Model: Goshawk flight time in seconds

Season	Total number of flights	Total seconds below PCH	Total seconds at PCH	Total seconds above PCH
Breeding 2017 (Feb to Aug)	2	5	171.07	0
Breeding 2018 (Feb to Aug)	3	4.74	0	77.55

Bird Parameters

Biometric measurements for bird species were taken from the BTO (https://www.bto.org/about-birds/birdfacts) with flight speeds from Alerstam *et al*., (2007) and are presented in **Table 12I.5**. Avoidance rates were taken from current guidance (NatureScot, 2017a).

Table 12I.5 – Bird Biometric Parameters

Species	Avoidance rate (%)	Length (m)	Wingspan (m)	Flight speed (m/s)	Flight style
Goshawk	98	0.55	1.10	11.3	Flapping

Results

A summary of the CRM results are shown in **Table 12I.6**, whilst details of model calculations are presented in **Annex B**.

Table 12I.6 – Goshawk Collision Rates

Season	Potential collisions	No avoidance	Avoidance (98%)
Breeding 2017 (Feb to Aug)	Per year 1 bird every *X* years Over 35 years	1.49 0.67 52.1	0.03 33.6 1.05
Breeding 2018 (Feb to Aug)	Per year 1 bird every *X* years Over 35 years	0.14 7.20 4.9	0.003 360 0.10

References

Alerstam T., Rosén M., Bäckman J., Ericson P.G.P. & Hellgren, O. (2007). Flight Speeds among Bird Species: Allometric and Phylogenetic Effects. *PLoS Biol* 5(8): e197. DOI:10.1371/journal.pbio.0050197.

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NatureScot. (2017a). *Avoidance Rates for the onshore NatureScot Wind Farm Collision Risk Model.* NatureScot guidance.

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New Cumnock: Sunrise, Sunset and Daylength. (2020). See: https://www.timeanddate.com/sun/@2641658 accessed on 08 April 2020.

Annex A – Flight data used in CRM

Table 12I.7 – Goshawk flight data used in CRM

Flight_Ref	VP	Date	Time	Seconds in height band	Original Length (m)	Clipped Length (m)	Clip Length %	Count	Height Band	Total Flight Time (secs)
MH_004_A	B	23/03/17	09:59	564	3,070.66	261.73	8.52	1	B	48.07
MH_004_B	B	23/03/17	10:08	53	335.76	0	0	1	A	0
MH_005_A	B	23/03/17	10:27	214	2743.36	0	0	1	B	0
MH_006_A	A	23/03/17	10:33	5	195.72	195.72	100	1	A	5
MH_006_B	A	23/03/17	10:33	123	1,646.28	1,646.28	100	1	B	123
MH_008	A	27/02/18	12:53	5	134.14	0	0	1	A	0
MH_009_a	A	27/02/18	13:29	360	662.30	0	0	2	B	0
MH_009_b	A	27/02/18	13:29	30	109.81	0	0	2	A	0
MH_010	A	26/03/18	12:17	120	2086.27	1348.26	64.63	1	C	77.55
MH_012_a	A	29/03/18	12:43	15	1153.11	0	0	1	B	0
MH_012_b	A	29/03/18	12:43	10	301.02	0	0	1	A	0
MH_013	1	29/03/18	13:47	6	782.99	33.20	4.24	1	A	0.25
MH_014_a	A	29/03/18	14:49	115	1346.50	0	0	1	B	0
MH_014_b	A	29/03/18	14:49	10	384.11	0	0	1	A	0
MR_015_a	3	22/05/18	13:34	42	1357.90	145.28	10.70	1	A	4.49

Flight_Ref	VP	Date	Time	Seconds in height band	Original Length (m)	Clipped Length (m)	Clip Length %	Count	Height Band	Total Flight Time (secs)
MR_015_b	3	22/05/18	13:34	41	1016.38	0	0	1	B	0
MR_016	A	22/05/18	15:21	7	588.06	0	0	1	B	0

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256000 257000 258000 259000 260000 261000

609000 608000 607000 606000 605000

Key

- Site boundary
- Vantage point location
- 2km viewing arc
- VP1 viewshed visibility 13.9m above ground level
- VP3 viewshed visibility 13.9m above ground level
- VPA viewshed visibility 13.9m above ground level
- VPB viewshed visibility 13.9m above ground level

VP1 VP3 VPA VPB

Rigg Hill Sheepfold Knockburn Crodtradlie Burn Trough Burn Straid Burn Connelburn Rig Ashmark Hill Corby Knowes McCool's Craig Quarries (disused) Quarry (dis) Lamb Hill Benty Cowan Hill Chang Hill Littlechang Hill Littlechang Burn Castlock Burn Ewe Hill Polga Burn Connel Burn Barcow Burn Auchincally Burn Glenshalloch Burn Meikle Hill Barbeys Hill High Chang Hill Enoch Hill 569 Craig of Bahoun Monquhill Strandlud Hill Blackstone Hill Auchincally Hill Black Loch Waterfall Cairn Saddle Hags Glenhastel Craigs Jock's Hags Auchintoly Hill McCowans Knowe Milray Hill Hillend Hill Strathwiggan Burn Hen Craig West Strand Dun Hill Moss Finglandfoot Back Moss Glenlee Gallow Rig Moss Sandy Syke Quarry (dis) Reeve Craigs Craignane Back Strand Finland Burn

07 08 09

0 250 500 750 1,000 m

Scale at A3: 1:20,000

Client

RWE

Enoch Hill 2 Wind Farm
Environmental Impact Assessment Report

Annex A Figure 12I.1A
Viewshed analyses - overview

wsp

July 2023

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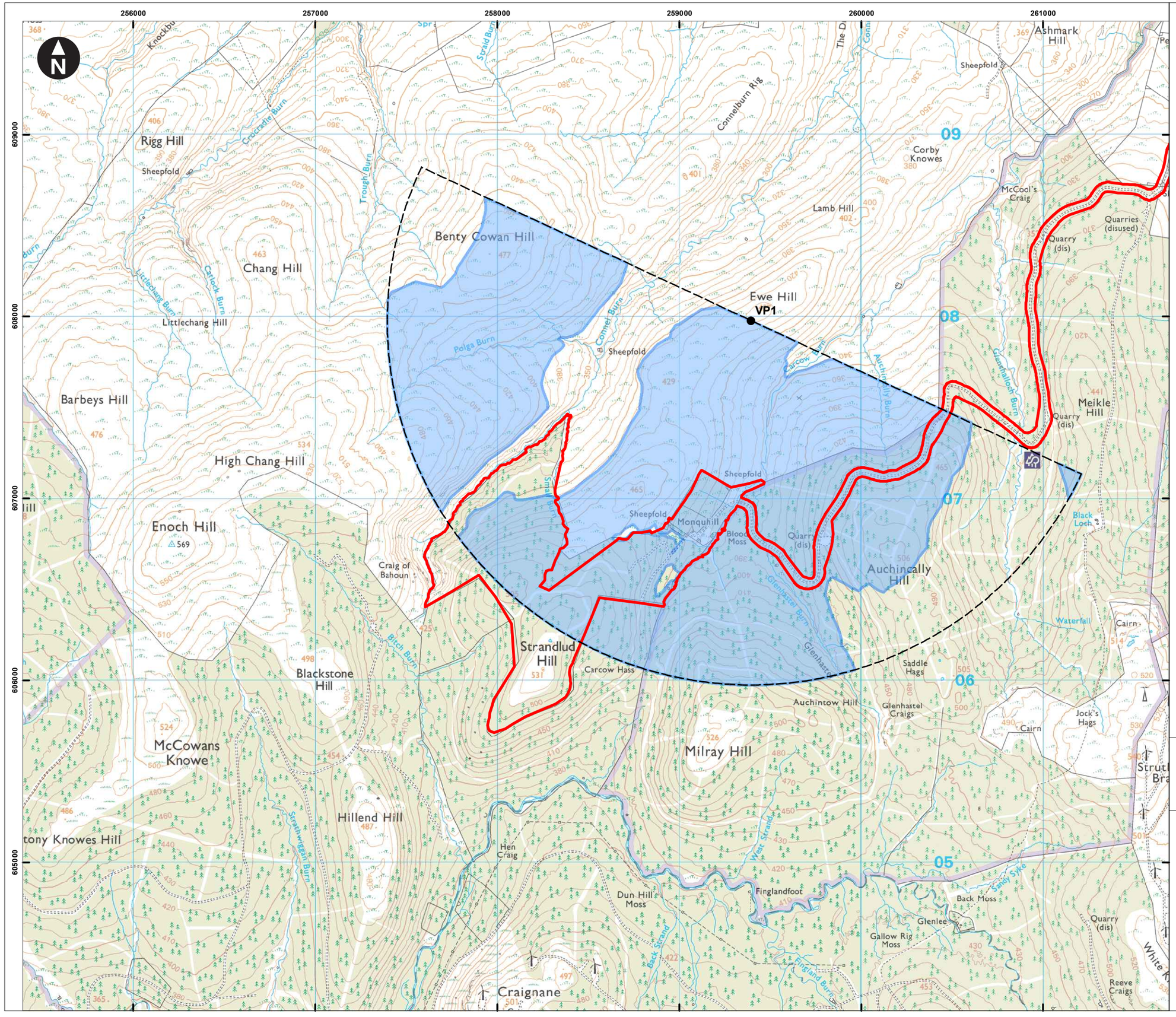


Key

- Site boundary
- Vantage point location
- 2km viewing arc
- VP1 viewshed visibility 13.9m above ground level

0 250 500 750 1,000 m

Scale at A3: 1:20,000

Client

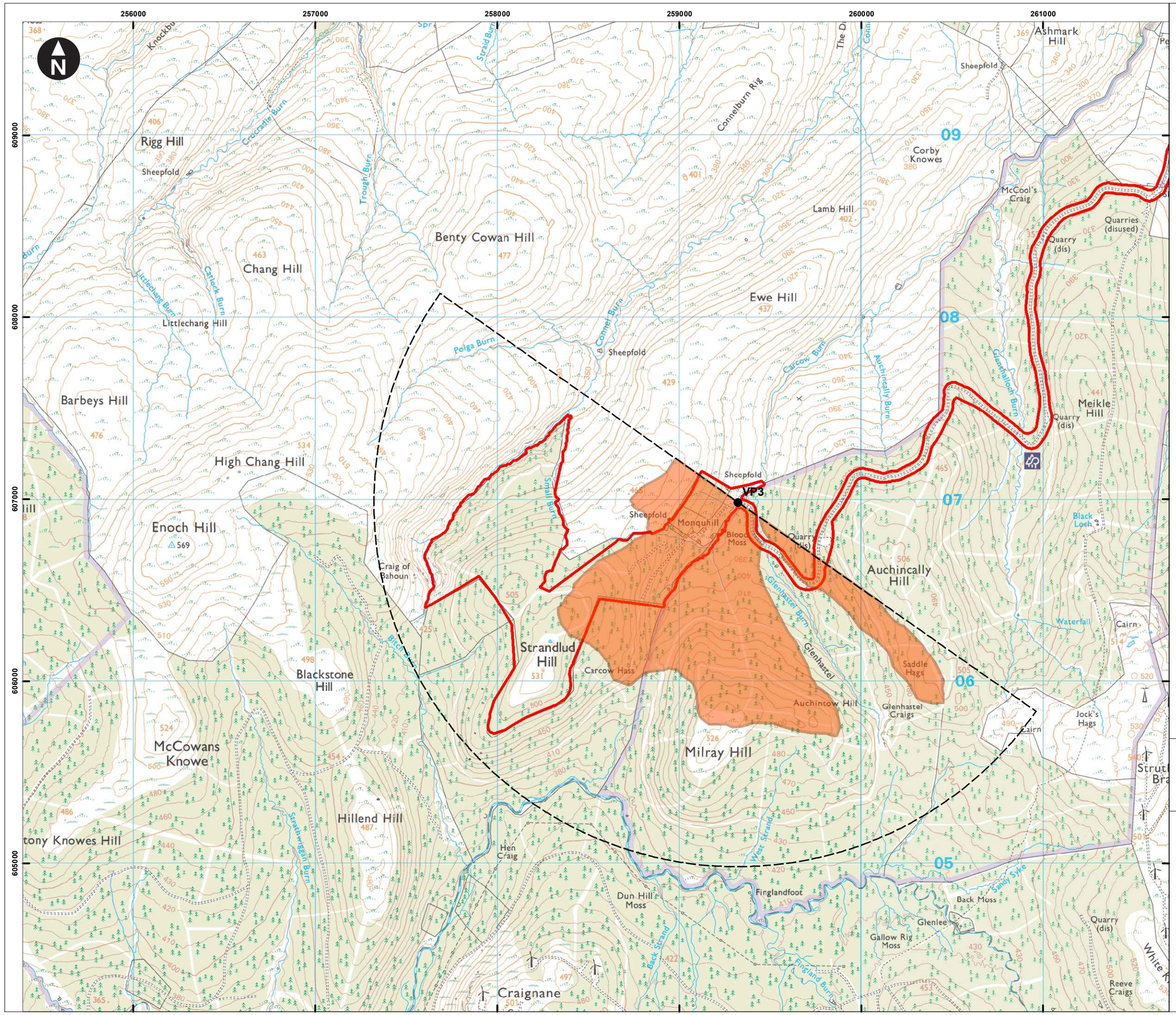
RWE

Enoch Hill 2 Wind Farm
Environmental Impact Assessment Report

Annex A Figure 12I.1B
Viewshed analyses - VP1

wsp

July 2023



Key

- Site boundary
- Vantage point location
- 2km viewing arc
- VP3 viewshed visibility 13.9m above ground level

0 250 500 750 1,000 m

Scale at A3: 1:20,000

Client

RWE

Enoch Hill 2 Wind Farm
Environmental Impact Assessment Report

Annex A Figure 12I.1C
Viewshed analyses - VP3

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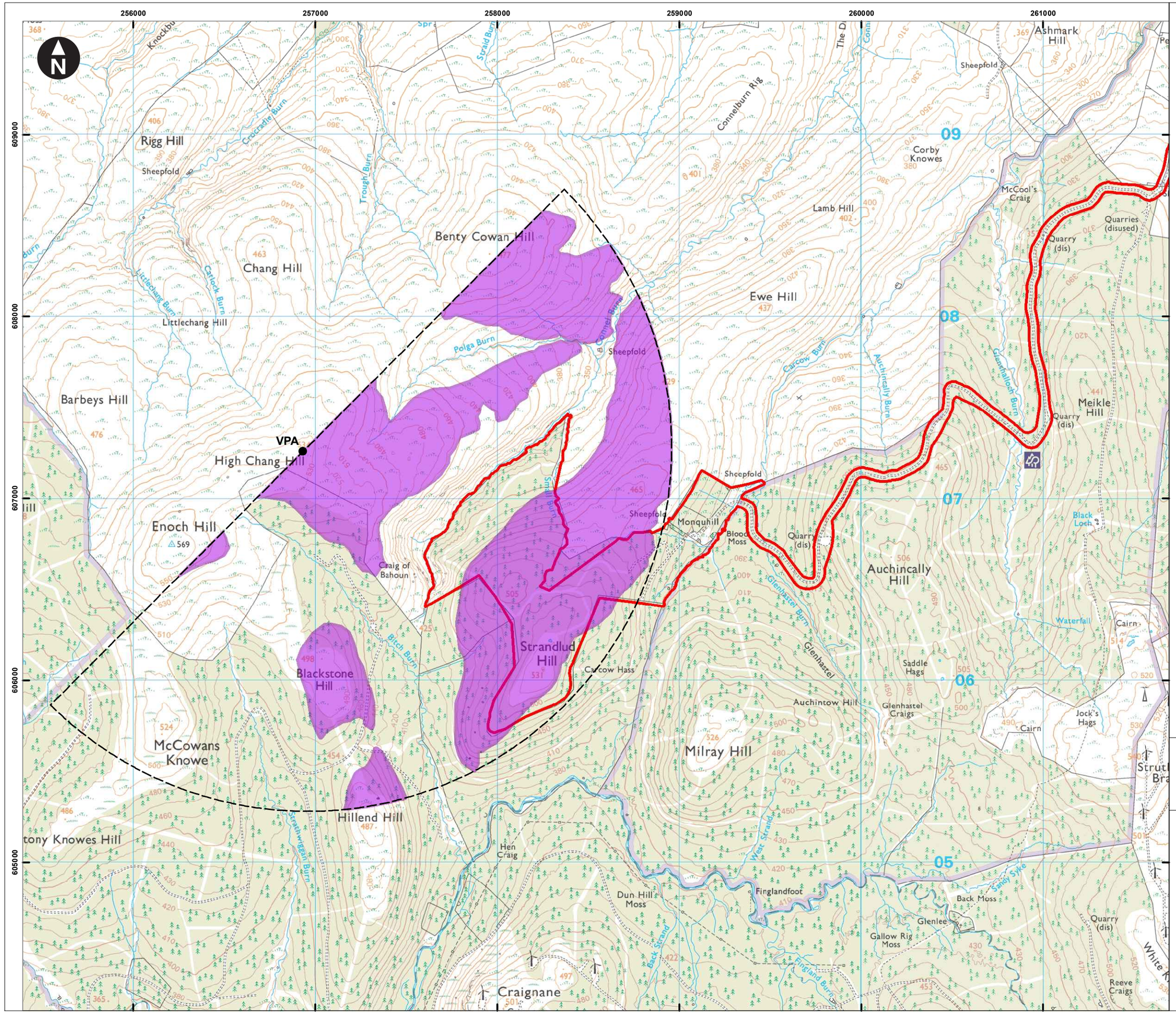

Key

- Site boundary
- Vantage point location
- 2km viewing arc
- VPA viewshed visibility 13.9m above ground level

0 250 500 750 1,000 m

Scale at A3: 1:20,000

Client

RWE

Enoch Hill 2 Wind Farm
Environmental Impact Assessment Report

Annex A Figure 12I.1D
Viewshed analyses - VPA

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609000 608000 607000 606000 605000

N

Rigg Hill
Sheepfold
Knockbu
Crudcradle Burn
Trough Burn
Straid Burn
Connelburn Rig
Ashmark Hill
Sheepfold
Corby Knowes
McCool's Craig
Lamb Hill
Quarries (disused)
Quarry (dis)
Benty Cowan Hill
Chang Hill
Littlechang Burn
Castlock Burn
Littlechang Hill
Ewe Hill
Polga Burn
Connel Burn
Sheepfold
Carcow Burn
Auchincally Burn
Glenshalloch Burn
Meikle Hill
Quarry (dis)
Barbeys Hill
High Chang Hill
Small Burn
Sheepfold
Sheepfold
Monquhill
Blood Moss
Quarry (dis)
VPB
Black Loch
Enoch Hill
569
Craig of Bahoun
Auchincally Hill
Glenhastel Burn
Waterfall
Cairn
Strandlud Hill
Carcow Hass
Birch Burn
Blackstone Hill
Saddle Hags
Glenhastel Craigs
Auchintow Hill
Jock's Hags
Cairn
McCowans Knowe
Milray Hill
Hillend Hill
Strathwiggan Burn
Hen Craig
West Strand
Finglandfoot
Dun Hill Moss
Back Strand
Back Moss
Glenlee
Gallow Rig Moss
Finland Burn
Sandy Syke
Quarry (dis)
Reeve Craigs
Craignane

09 08 07 06 05

Key

- Site boundary
- Vantage point location
- 2km viewing arc
- VPB viewshed visibility 13.9m above ground level

0 250 500 750 1,000 m

Scale at A3: 1:20,000

Client

RWE

Enoch Hill 2 Wind Farm
Environmental Impact Assessment Report

Annex A Figure 12I.1E
Viewshed analyses - VPB

July 2023

258000

259000

607000

606000

N

Craig of Bahoun

Small Burn

Sheepfold

Monquhill

Blood Moss

Strandlud Hill

Carcow Hass

Milray Hill

Hillend Hill

Bitch Burn

MH_006_A

MH_006_B

MH_015_a

MH_013

MH_010

MH_004_A

1

2

465

425

505

531

500

450

410

380

390

400

490

460

440

420

454

487

526

Key

Site boundary

Turbine location

New turbine buffer

Clipped flights within buffer

0 100 200 300 400 m

Scale at A3: 1:7,500

Client

RWE

Enoch Hill 2 Wind Farm
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Annex A Figure 12I.2 (Confidential)
CRM clipped flight data

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Annex B – CRM calculations

Band Model (Stage 1) - Random Flights

Species: Goshawk

Season: Breeding season 2017 (February - August)

Wind Farm Parameters	
WFP (ha)	178.61
Number turbines	2
Rotor diameter	136
Hub height (m)	81.9
Max chord (m)	4
Rotor depth	4.2
Pitch (degrees)	6
Rotation period (secs)	4.6
Turbine operation time 75%	0.75
Avoidance Rate 98%	0.02
Rotor radius^2	4624.00
Combined rotor swept area	29053.44
Collision Risk volume 'Vw' (m^3)	242,909,600
Rotor swept volume 'V_r' (m^3)	138,004

Bird Parameters	
length (m)	0.55
wingspan (m)	1.1
flapping (0) or gliding (1)	0
Assumed flight speed (m/s)	11.3
Number daylight hours available	3507
Maximum recording height (m)	130
Minimum recording height (m)	30

Survey Data								
VP	A	B						
FRA (ha)	265	318						
Observation Time (hours)	12	12						
Time at height band A	5.00	0.00						
Time at height band B	123.00	48.07						
Time at height band C	0.00	0.00						
Total Time at PCH	128.00	48.07						

Flight activity per unit time and area		1	2							Total
Observation effort	Obsevation time (seconds) * hectare	11448000	13737600							25185600.0
Flying time at risk height	Effort at each VP / FRA	1.12E-05	3.50E-06							1.47E-05
Weighted by observation effort										
Weighted obs effort	Effort at each VP / sum of all effort at all VP's	4.55E-01	5.45E-01							1.0
Adjusted time at risk height	Weighted obs effort * flying time at risk height	5.08E-06	1.91E-06							6.99E-06
Occupancy Rate										
Summed Occupancy rate	Sum of weighted average flight activity per visible ha	0.000006991								
Estimated bird time 'b' in risk area	Summed Occupancy rate*windfarm polygon*hours active	4.38								
FRAw	Estimated bird time*(rotor diameter/recording height band)	5.96								
Rotor Transits										
Bird occupancy of rotor swept volume ('b')	Estimated bird time * (rotor swept volume / collision risk volume)*3600	12.18								
Bird transit time (t)	(rotor depth+bird length)/flight speed(m/s)	0.42								
Number of transits 'ntr'	'n'/'t'	28.98								
CALCULATION OF COLLISION RISK FOR BIRD PASSING THROUGH ROTOR AREA										
Probability of collision		0.068								

Calculation of number collisions	No avoidance	Avoidance 98%
Collisions per year	1.49	0.03
Equivalent to 1 bird every *x* (years)	0.67	33.6
Over 35 years	52.1	1.05

Band Model (Stage 1) - Random Flights

Species: Goshawk

Season: Breeding season 2018 (February - August)

Wind Farm Parameters	
WFP (ha)	178.61
Number turbines	2
Rotor diameter	136
Hub height (m)	81.9
Max chord (m)	4
Rotor depth	4.2
Pitch (degrees)	6
Rotation period (secs)	4.6
Turbine operation time 75%	0.75
Avoidance Rate 98%	0.02
Rotor radius^2	4624.00
Combined rotor swept area	29053.44
Collision Risk volume 'Vw' (m^3)	242,909,600
Rotor swept volume 'V_r' (m^3)	138,004

Bird Parameters	
length (m)	0.55
wingspan (m)	1.1
flapping (0) or gliding (1)	0
Assumed flight speed (m/s)	11.3
Number daylight hours available	3507
Maximum recording height (m)	150
Minimum recording height (m)	30

Survey Data							
VP	A	1	3				
FRA (ha)	265	457	138				
Observation Time (hours)	59	17	42				
Time at height band A	0.00	0.25	4.49				
Time at height band B	0.00	0.00	0.00				
Time at height band C	77.55	0.00	0.00				
Total Time at PCH	77.55	0.25	4.49				

Flight activity per unit time and area		1	2	3					Total
Observation effort	Obsevation time (seconds) * hectare	56286000	27968400	20865600					105120000.0
Flying time at risk height	Effort at each VP / FRA	1.38E-06	8.94E-09	2.15E-07					1.60E-06
Weighted by observation effort									
Weighted obs effort	Effort at each VP / sum of all effort at all VP's	5.35E-01	2.66E-01	1.98E-01					1.0
Adjusted time at risk height	Weighted obs effort * flying time at risk height	7.38E-07	2.38E-09	4.27E-08					7.83E-07
Occupancy Rate									
Summed Occupancy rate	Sum of weighted average flight activity per visible ha	0.000000783							
Estimated bird time 'b' in risk area	Summed Occupancy rate*windfarm polygon*hours active	0.49							
FRAw	Estimated bird time*(rotor diameter/recording height band)	0.56							
Rotor Transits									
Bird occupancy of rotor swept volume ('b')	Estimated bird time * (rotor swept volume / collision risk volume)*3600	1.14							
Bird transit time (t)	(rotor depth+bird length)/flight speed(m/s)	0.42							
Number of transits 'ntr'	'n'/'t'	2.70							
E									
Probability of collision		0.068							

Calculation of number collisions	No avoidance	Avoidance 98%
Collisions per year	0.14	0.003
Equivalent to 1 bird every *x* (years)	7.20	360.2
Over 35 years	4.9	0.10

Stage 2 - CALCULATION OF COLLISION RISK FOR BIRD PASSING THROUGH ROTOR AREA

Only enter input parameters in green cells

K: [1D or [3D] (0 or 1)	**1**	
NoBlades	**3**	
MaxChord	**4**	m
Pitch (degrees)	**6**	
BirdLength	**0.55**	m
Wingspan	**1.1**	m
F: Flapping (0) or gliding (+1)	**0**	
Bird speed	**11.3**	m/sec
RotorDiam	**136**	m
RotationPeriod	**4.60**	sec
Bird aspect ratioo: β	0.50	

Calculation of alpha and p(collision) as a function of radius

				Upwind:			Downwind:		
r/R	c/C	α	collide		contribution	collide		contribution
radius	chord	alpha	length	p(collision)	from radius r	length	p(collision)	from radius r
0.025	0.575	4.87	16.72	0.97	0.00121	16.24	0.94	0.00117
0.075	0.575	1.62	5.74	0.33	0.00248	5.25	0.30	0.00227
0.125	0.702	0.97	4.08	0.24	0.00294	3.49	0.20	0.00252
0.175	0.860	0.70	3.50	0.20	0.00354	2.78	0.16	0.00281
0.225	0.994	0.54	3.15	0.18	0.00409	2.32	0.13	0.00301
0.275	0.947	0.44	2.61	0.15	0.00415	1.82	0.11	0.00289
0.325	0.899	0.37	2.26	0.13	0.00425	1.51	0.09	0.00284
0.375	0.851	0.32	2.00	0.12	0.00434	1.29	0.07	0.00280
0.425	0.804	0.29	1.80	0.10	0.00442	1.13	0.07	0.00277
0.475	0.756	0.26	1.64	0.09	0.00449	1.00	0.06	0.00275
0.525	0.708	0.23	1.50	0.09	0.00454	0.91	0.05	0.00275
0.575	0.660	0.21	1.38	0.08	0.00459	0.83	0.05	0.00275
0.625	0.613	0.19	1.28	0.07	0.00462	0.77	0.04	0.00277
0.675	0.565	0.18	1.19	0.07	0.00464	0.72	0.04	0.00280
0.725	0.517	0.17	1.11	0.06	0.00465	0.68	0.04	0.00284
0.775	0.470	0.16	1.04	0.06	0.00465	0.65	0.04	0.00289
0.825	0.422	0.15	0.97	0.06	0.00464	0.62	0.04	0.00296
0.875	0.374	0.14	0.91	0.05	0.00461	0.60	0.03	0.00303
0.925	0.327	0.13	0.86	0.05	0.00458	0.58	0.03	0.00312
0.975	0.279	0.12	0.81	0.05	0.00453	0.57	0.03	0.00322

Overall p(collision) = Upwind 8.2% Downwind 5.5%

Average 6.8%