Hinterland Survey Data Summer 2021

Date	Site	Common Name	Quantity
19/04/2021	Gearagh	Moorhen	3
19/04/2021	Gearagh	Mute Swan	18
19/04/2021	Gearagh	Whooper Swan	2
19/04/2021	Gearagh	Great Crested Grebe	17
19/04/2021	Gearagh	Teal	1
19/04/2021	Gearagh	Mallard	3
19/04/2021	Gearagh	Lesser Black-backed Gull	47
19/04/2021	Gearagh	Whimbrel	36
19/04/2021	Gearagh	Cormorant	4
19/04/2021	Gearagh	Yellow Legged Gull	1
19/04/2021	Gearagh	Sand Martin	100
19/04/2021	Lee Valley	Dipper with nest	
19/04/2021	Lee Valley	Mallard	10
19/04/2021	Lee Valley	Grey Wagtail	2
19/04/2021	Inchigeelagh	Grey wagtail	1
19/04/2021	Inchigeelagh	Mallard	2
19/04/2021	Lough Allua	Mute Swan	2
19/04/2021	Lough Allua	Grey Heron	1
19/04/2021	Lough Allua	Lesser Black-backed Gul	2
19/04/2021	Lough Allua	Cormorant	6
17/04/2021	Ballyvourney North	Raven	5
17/04/2021	Ballyvourney North	Hooded Crow	7
18/04/2021	Sillahertane	Meadow Pipit	5
18/04/2021	Sillahertane	Stonechat	1
18/04/2021	Sillahertane	Hooded Crow	6
18/04/2021	Lough Nabuddoga	Willow Warbler	6
18/04/2021	Lough Nabuddoga	Raven	3
18/04/2021	Lough Nabuddoga	Siskin	4
18/04/2021	Lough Nabuddoga	Chaffinch	6
18/04/2021	Lough Nabuddoga	Blackcap	4
18/04/2021	Lough Nabuddoga	Meadow Pipit	4
18/04/2021	Lough Nabuddoga	Skylark	3
18/04/2021	Lough Nabuddoga	Swallow	3
18/04/2021	Lough Nabuddoga	Sand Martin	2
18/04/2021	Grousemount hinterland	Willow Warbler	4
18/04/2021	Grousemount hinterland	Blackbird	2
18/04/2021	Grousemount hinterland	Blackcap	3

Date	Site	Common Name	Quantity
18/04/2021	Grousemount hinterland	Song Thrush	2
18/04/2021	Grousemount hinterland	Chiffchaff	1
18/04/2021	Grousemount hinterland	Pied Wagtail	2
18/04/2021	Grousemount hinterland	Dunnock	2
18/04/2021	Grousemount hinterland	Wren	3
18/04/2021	Grousemount hinterland	Robin	3
22/05/2021	Gearagh	Great Crested Grebe	23
22/05/2021	Gearagh	Mallard	7
22/05/2021	Gearagh	Mute Swan	21
22/05/2021	Gearagh	Whooper Swan	2
22/05/2021	Gearagh	Lesser Black-backed Gull	1
22/05/2021	Gearagh	Grey wagtail	1
22/05/2021	Lee Valley	Mallard	2
22/05/2021	Lee Valley	Willow Warbler	2
22/05/2021	Lough Allua	Mute Swan	2
22/05/2021	Lough Allua	Cormorant	3
22/05/2021	Lough Allua	Mallard	2
22/05/2021	Lough Allua	Grey Heron	1
22/05/2021	Lough Allua	Lesser Black-backed Gul	1
22/05/2021	Lough Allua	Moorhen	3
22/05/2021	Inchigeelagh	Dipper	2
22/05/2021	Inchigeelagh	Willow Warbler	2
22/05/2021	Inchigeelagh	House Sparrow	3
29/05/2021	Ballyvourney North	Raven	2
29/05/2021	Ballyvourney North	Hooded Crow	3
29/05/2021	Ballyvourney North	Magpie	2
29/05/2021	Ballyvourney North	Pied Wagtail	2
30/05/2021	Grousemount hinterland	Woodpigeon	4
30/05/2021	Grousemount hinterland	Blackcap	2
30/05/2021	Grousemount hinterland	Swallow	4
30/05/2021	Grousemount hinterland	Wren	2
30/05/2021	Grousemount hinterland	Blackbird	3
30/05/2021	Grousemount hinterland	Willow Warbler	4
30/05/2021	Sillahertane hinterland	Chaffinch	4
30/05/2021	Sillahertane hinterland	Pheasant	2
30/05/2021	Sillahertane hinterland	Hooded Crow	8
30/05/2021	Sillahertane hinterland	Robin	2
30/05/2021	Sillahertane hinterland	Meadow Pipit	4

Date	Site	Common Name	Quantity
30/05/2021	Sillahertane hinterland	Reed Bunting	1
30/05/2021	Sillahertane hinterland	Siskin	4
30/05/2021	Sillahertane hinterland	Raven	2
30/05/2021	Lough Nabuddoga	Wren	6
30/05/2021	Lough Nabuddoga	Willow Warbler	8
30/05/2021	Lough Nabuddoga	Hooded Crow	3
30/05/2021	Lough Nabuddoga	Chaffinch	4
30/05/2021	Lough Nabuddoga	Goldcrest	2
30/05/2021	Lough Nabuddoga	Siskin	4
30/05/2021	Lough Nabuddoga	Woodpigeon	2
30/05/2021	Lough Nabuddoga	Skylark	3
30/05/2021	Lough Nabuddoga	Meadow Pipit	4
30/05/2021	Lough Nabuddoga	Redpoll	2
30/05/2021	Lough Nabuddoga	Mistle Thrush	1

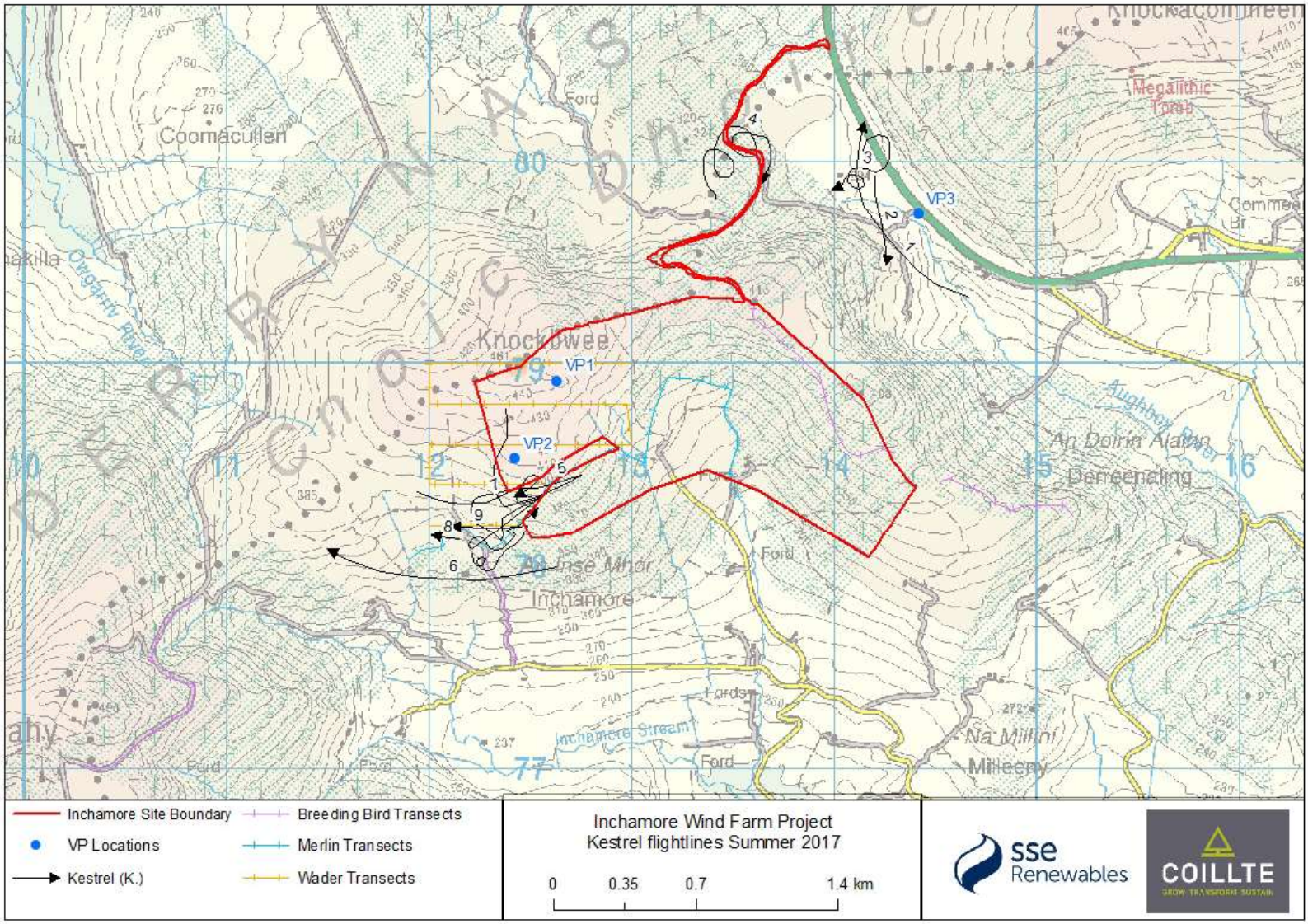
Common name (BTO code)	Scientific name	*BoCCI status	**Annex I status
Blackbird (B.)	*Turdus merula*	Green	No
Blackcap (BC)	*Sylvia atricapilla*	Green	No
Blue tit (BT)	*Cyanistes caeruleus*	Green	No
Bluethroat (BU)	*Luscinia svecica*	Green	No
Buzzard (BZ)	*Buteo buteo*	Green	No
Chaffinch (CH)	*Fringilla coelebs*	Green	No
Chiffchaff (CC)	*Phylloscopus collybita*	Green	No
Coal tit (CT)	*Periparus ater*	Green	No
Dunnock (D.)	*Prunella modularis*	Green	No
Fieldfare (FF)	*Turdus pilaris*	Green	No
Goldcrest (GC)	*Regulus regulus*	Amber	No
Goldfinch (GO)	*Carduelis carduelis*	Green	No
Great Black Backed Gull (GB)	*Larus marinus*	Amber	No
Great tit (GT)	*Parus major*	Green	No
Grey heron (H.)	*Ardea cinerea*	Green	No
Grey wagtail (GW)	*Motacilla cinerea*	Red	No
Golden Plover (GP)	***Pluvialis apricaria***	**Red**	**Yes**
Hen harrier (HH)	***Circus cyanaeus***	**Amber**	**Yes**
Hooded crow (HC)	*Corvus cornix*	Green	No
House martin (HM)	*Delichon urbicum*	Amber	No
Jackdaw (JD)	*Coloeus monedula*	Green	No
Jay (J.)	*Garrulus glandarius*	Green	No
Kestrel (K.)	*Falco tinnunculus*	Red	No
Lesser black-backed gull (LB)	*Larus fuscus*	Amber	No
Linnet (LI)	*Linaria cannabina*	Amber	No
Long-tailed tit (LT)	*Aegithalos caudatus*	Green	No
Magpie (MG)	*Pica pica*	Green	No
Meadow pipit (MP)	*Anthus pratensis*	Red	No
Merlin (ML)	***Falco columbarius***	**Amber**	**Yes**
Mistle thrush (M.)	*Turdus viscivorus*	Green	No
Pheasant (PH)	*Phasianus colchicus*	Green	No
Peregrine (PE)	***Falco peregrinus***	**Green**	**Yes**

Common name (BTO code)	Scientific name	*BoCCI status	**Annex I status
Pied wagtail (PW)	*Motacilla alba*	Green	No
Raven (RN)	*Corvus corax*	Green	No
Redpoll (LR)	*Acanthis flammea*	Green	No
Redwing (RE)	*Turdus iliacus*	Red	No
Red Grouse (RG)	*Lagopus lagopus*	Red	No
Reed Warbler (RW)	*Acrocephalus scirpaceus*	Amber	No
Robin (R.)	*Erithacus rubecula*	Green	No
Rook (RO)	*Corvus frugilegus*	Green	No
Siskin (SK)	*Spinus spinus*	Green	No
Skylark (S.)	*Alauda arvensis*	Amber	No
Snipe (SN)	*Gallinago gallinago*	Red	No
Song thrush (ST)	*Turdus philomelos*	Green	No
Sparrowhawk (SH)	*Accipiter nisus*	Green	No
Starling (SG)	*Sturnus vulgaris*	Amber	No
Stonechat (SC)	*Saxicola rubicola*	Green	No
Swallow (SL)	*Hirundo rustica*	Amber	No
Wheatear (W.)	*Oenanthe oenanthe*	Amber	No
White-tailed Eagle (WE)	***Haliaeetus albicilla***	**Red**	**Yes**
Willow warbler (WW)	*Phylloscopus trochilus*	Amber	No
Woodpigeon (WP)	*Columba palumbus*	Green	No
Wren (WR)	*Troglodytes troglodytes*	Green	No

* refers to the conservation status of the species according to Birds of Conservation Concern in Ireland.

**refers to species listed on Annex I of the EU Birds Directive; shown in bold.

Summer 2017



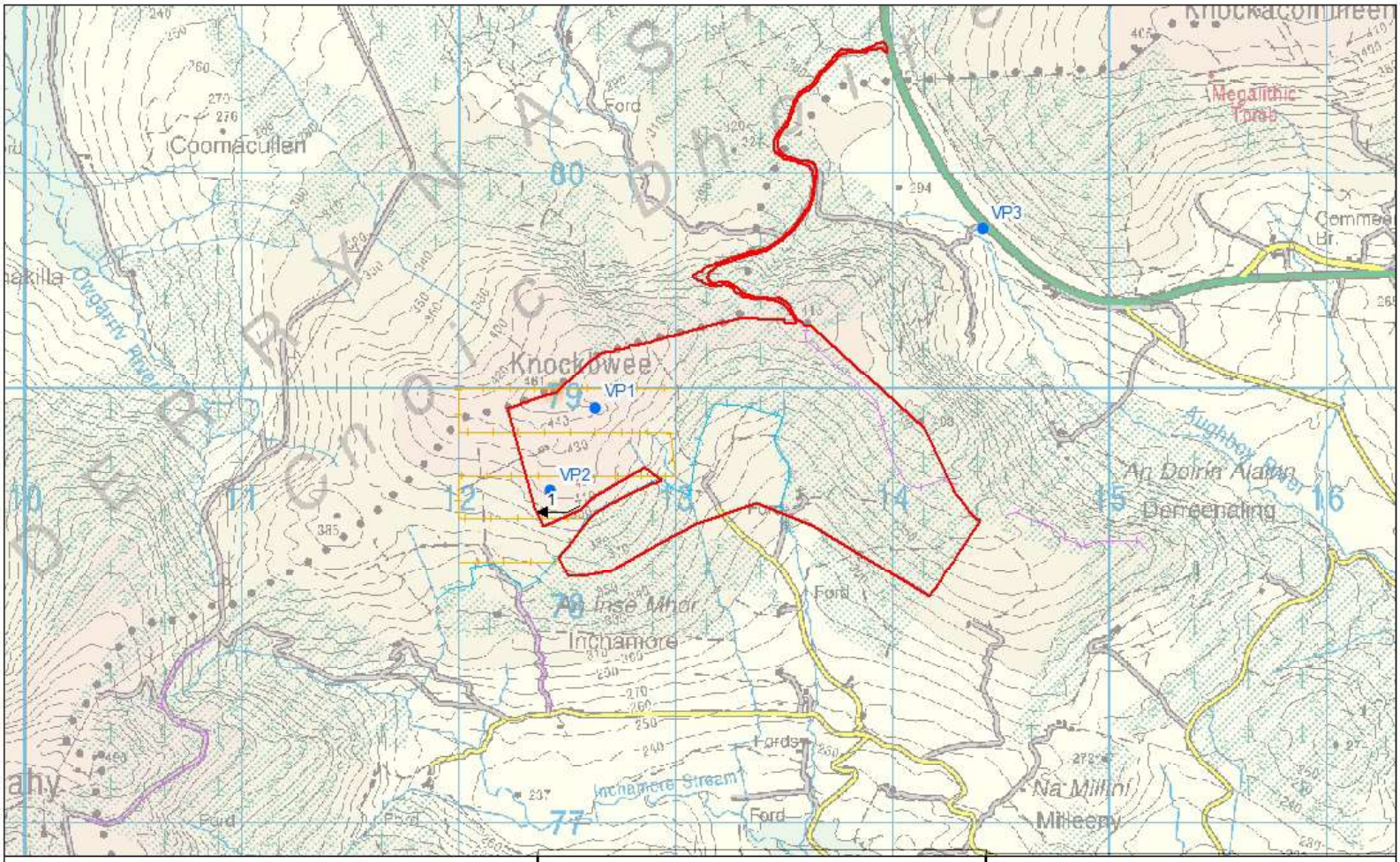
Inchamore Site Boundary
VP Locations
Kestrel (K.)
Breeding Bird Transects
Merlin Transects
Wader Transects

Inchamore Wind Farm Project
Kestrel flightlines Summer 2017

0 0.35 0.7 1.4 km

sse Renewables

COILLTE
GROW · TRANSFORM · SUSTAIN



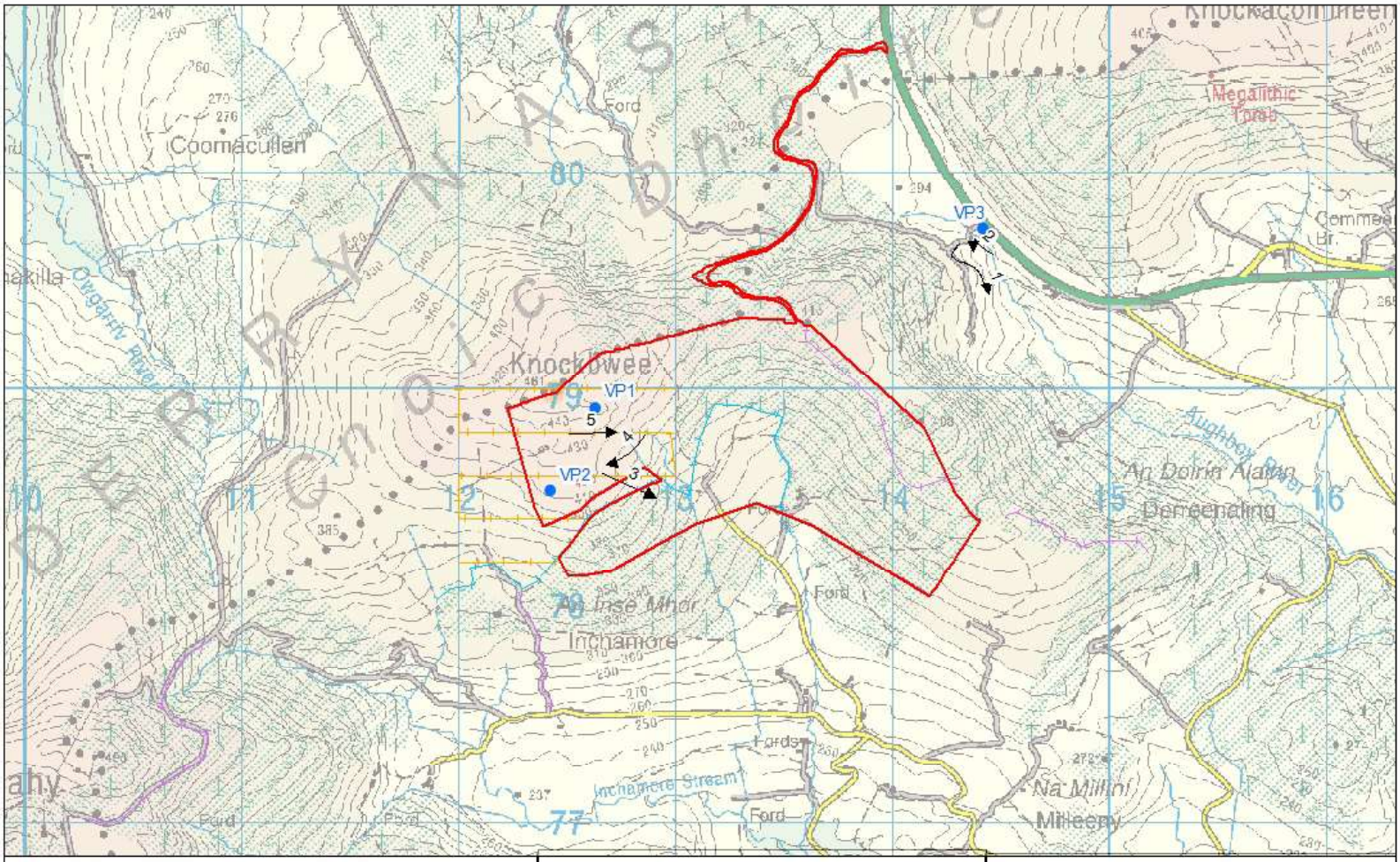
Inchamore Site Boundary
VP Locations
Peregrine (PE)
Breeding Bird Transects
Merlin Transects
Wader Transects

Inchamore Wind Farm Project
Peregrine flightlines Summer 2017

0 0.35 0.7 1.4 km

sse Renewables

COILLTE
GROW · TRANSFORM · SUSTAIN



Inchamore Site Boundary
VP Locations
Sparrowhawk (SH)
Breeding Bird Transects
Merlin Transects
Wader Transects

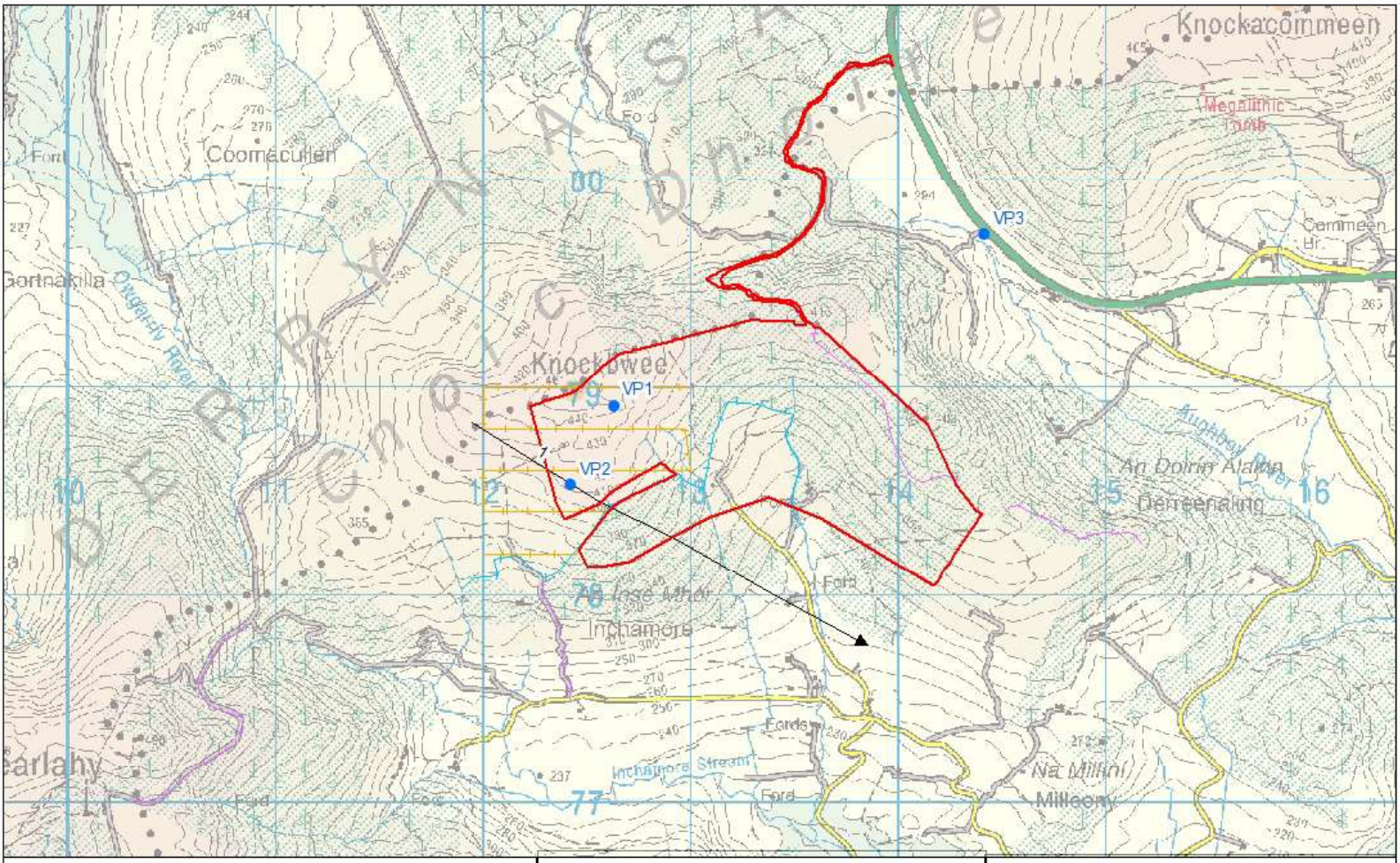
Inchamore Wind Farm Project
Sparrowhawk flightlines Summer 2017

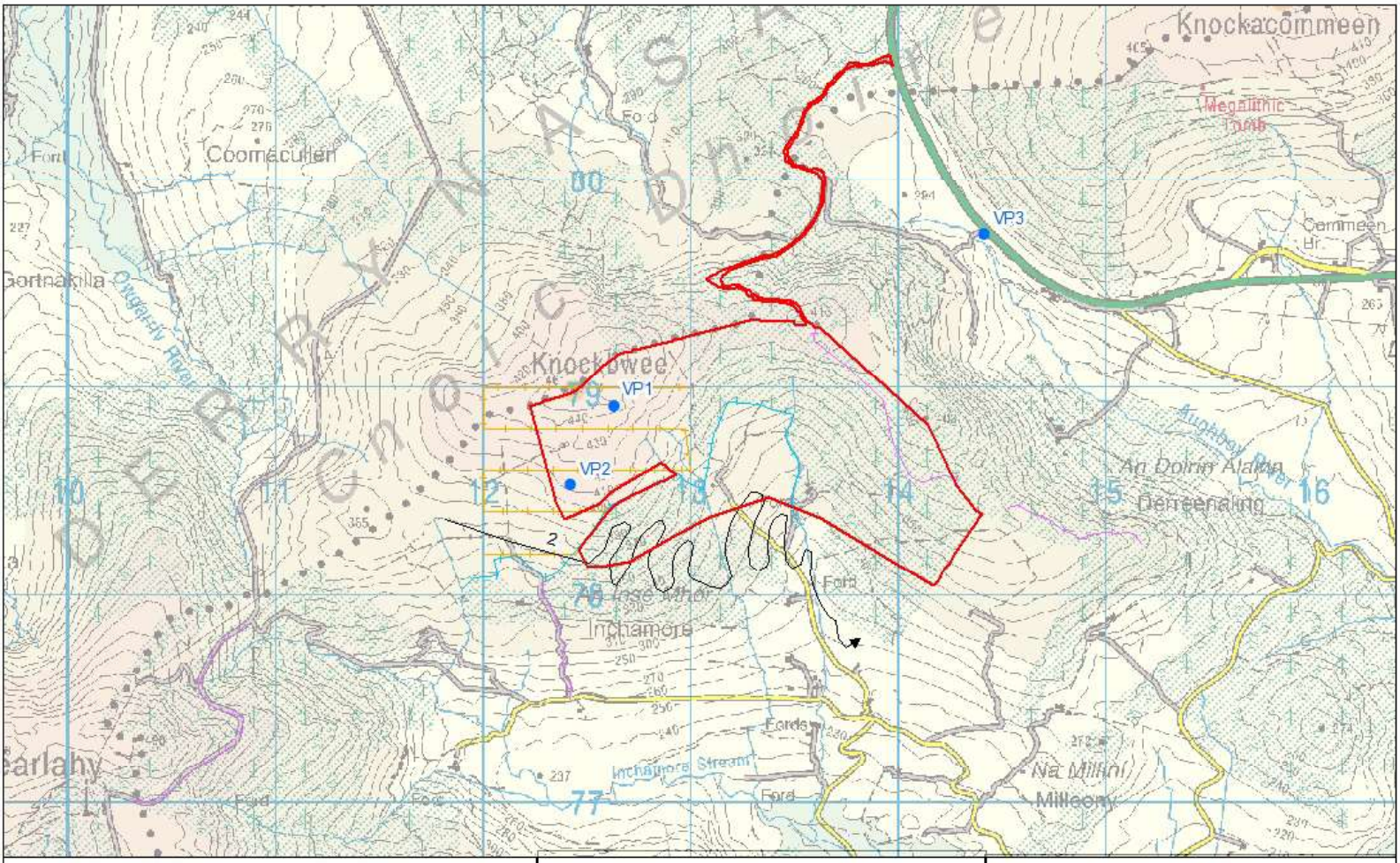
0 0.35 0.7 1.4 km

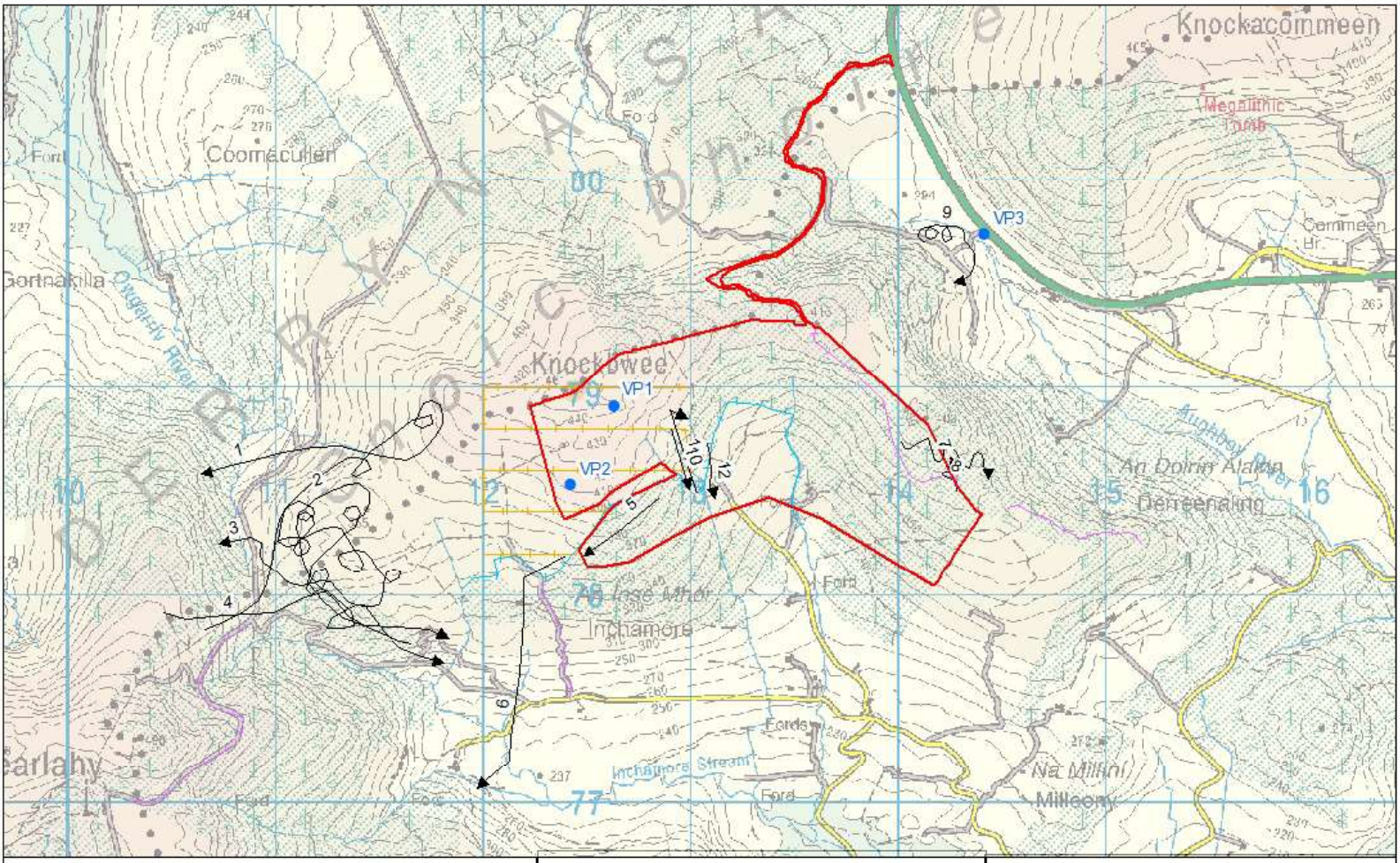
sse Renewables

COILLTE
GROW · TRANSFORM · SUSTAIN

Summer 2018


Knockacommeen
Megalithic Tomb
Coomaculleen
VP3
Cnmmeen Hr.
Gortnakilla
Knockowee
VP1
VP2
An Doirin Alainn
Derreenalinq
Inchamore
Fords
Inchamore Stream
Na Milinn
Milleeny
Ford
Inchamore Site Boundary
VP Locations
Buzzard (BZ)
Breeding Bird Transects
Merlin Transects
Wader Transects
Inchamore Wind Farm Project
Buzzard flightlines Summer 2018
0
0.35
0.7
1.4 km
sse Renewables
COILLTE


Knockacommeen
Megalithic Tomb
Coomaculleen
VP3
Cummeen Hr.
Gortnakilla
Knockowee
VP1
VP2
An Doirín Alainn
Derreenalinn
Inchamore
Fords
Inchamore Stream
Na Milíní
Milleeny
Inchamore Site Boundary
VP Locations
Hen Harrier (HH)
Breeding Bird Transects
Merlin Transects
Wader Transects
Inchamore Wind Farm Project
Hen Harrier flightlines Summer 2018
0
0.35
0.7
1.4 km
sse Renewables
COILLTE



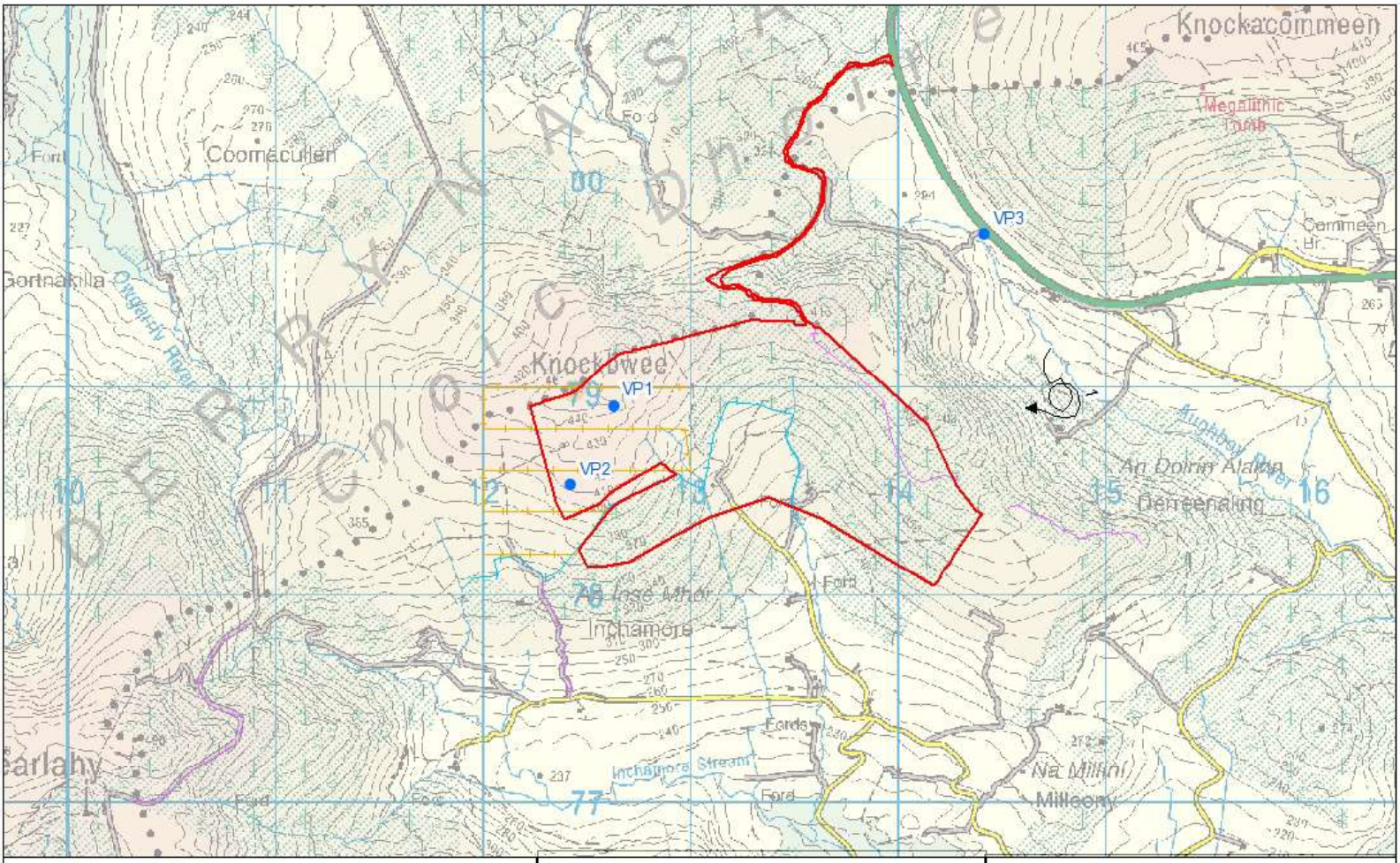
Inchamore Site Boundary
VP Locations
Kestrel (K.)
Breeding Bird Transects
Merlin Transects
Wader Transects

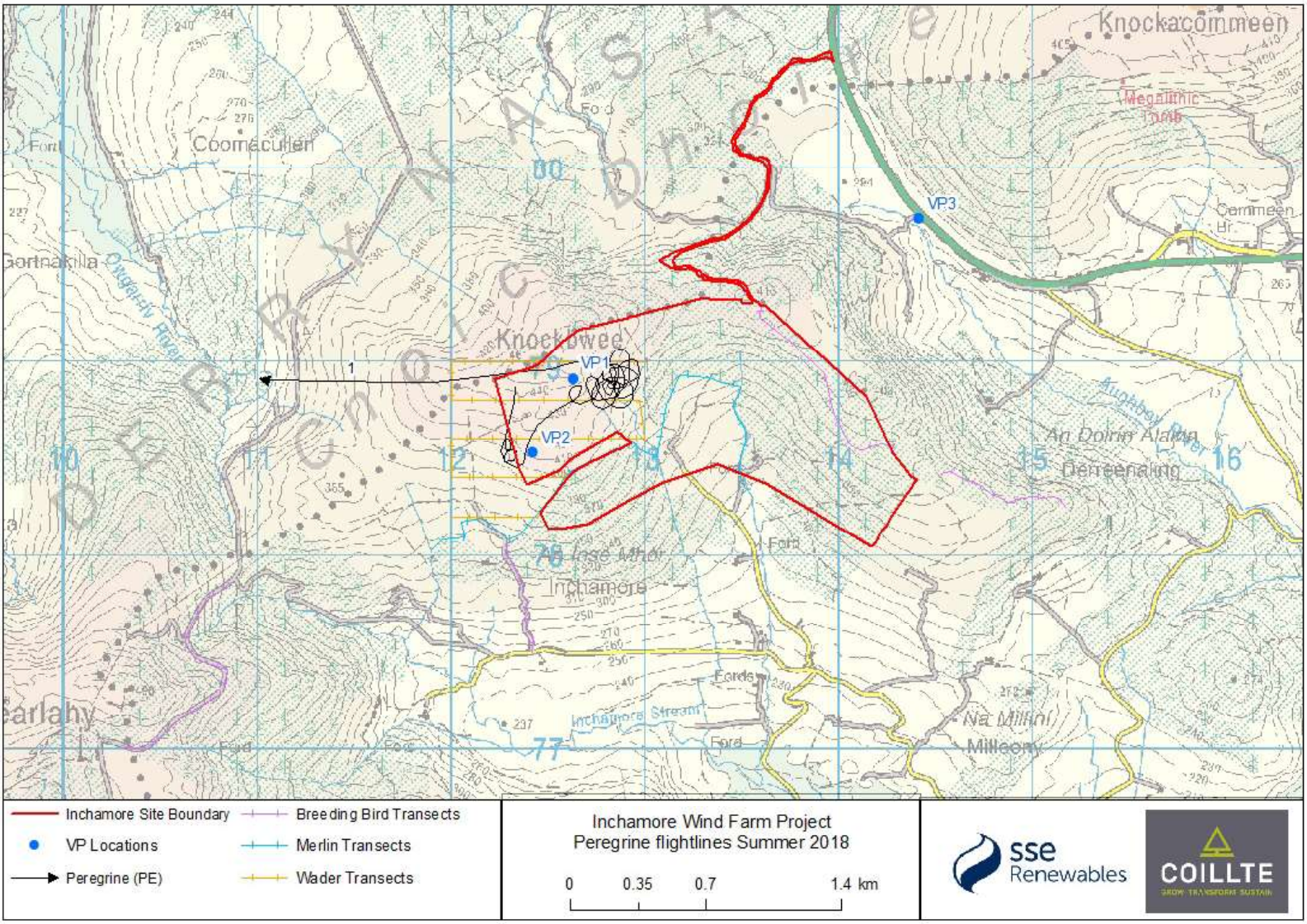
Inchamore Wind Farm Project
Kestrel flightlines Summer 2018

0 0.35 0.7 1.4 km

sse Renewables

COILLTE
GROW. TRANSFORM. SUSTAIN.


Knockacommeen
Megalithic Tomb
Coomaculleen
VP3
Cnmmeen Hr.
Gortnakilla
Knockowee
VP1
VP2
An Doirin Alainn
Derreenaling
Inchamore
Fords
Inchamore Stream
Na Milloni
Milleeny
Inchamore Site Boundary
VP Locations
Merlin (ML)
Breeding Bird Transects
Merlin Transects
Wader Transects
Inchamore Wind Farm Project
Merlin flightlines Summer 2018
0
0.35
0.7
1.4 km
sse Renewables
COILLTE



Inchamore Site Boundary
VP Locations
Peregrine (PE)
Breeding Bird Transects
Merlin Transects
Wader Transects

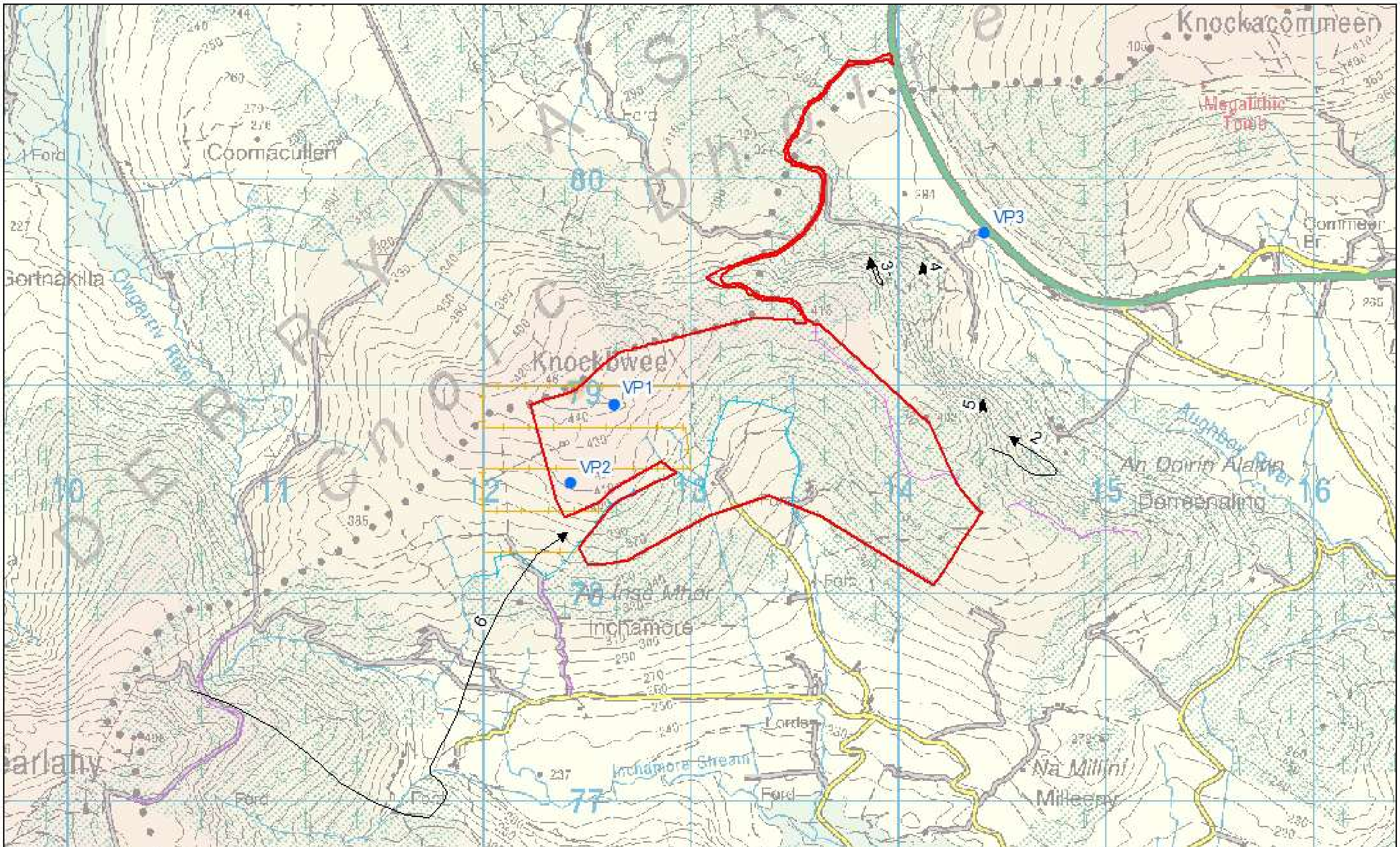
Inchamore Wind Farm Project
Peregrine flightlines Summer 2018

0 0.35 0.7 1.4 km

sse Renewables

COILLTE
GROW · TRANSFORM · SUSTAIN

Summer 2020



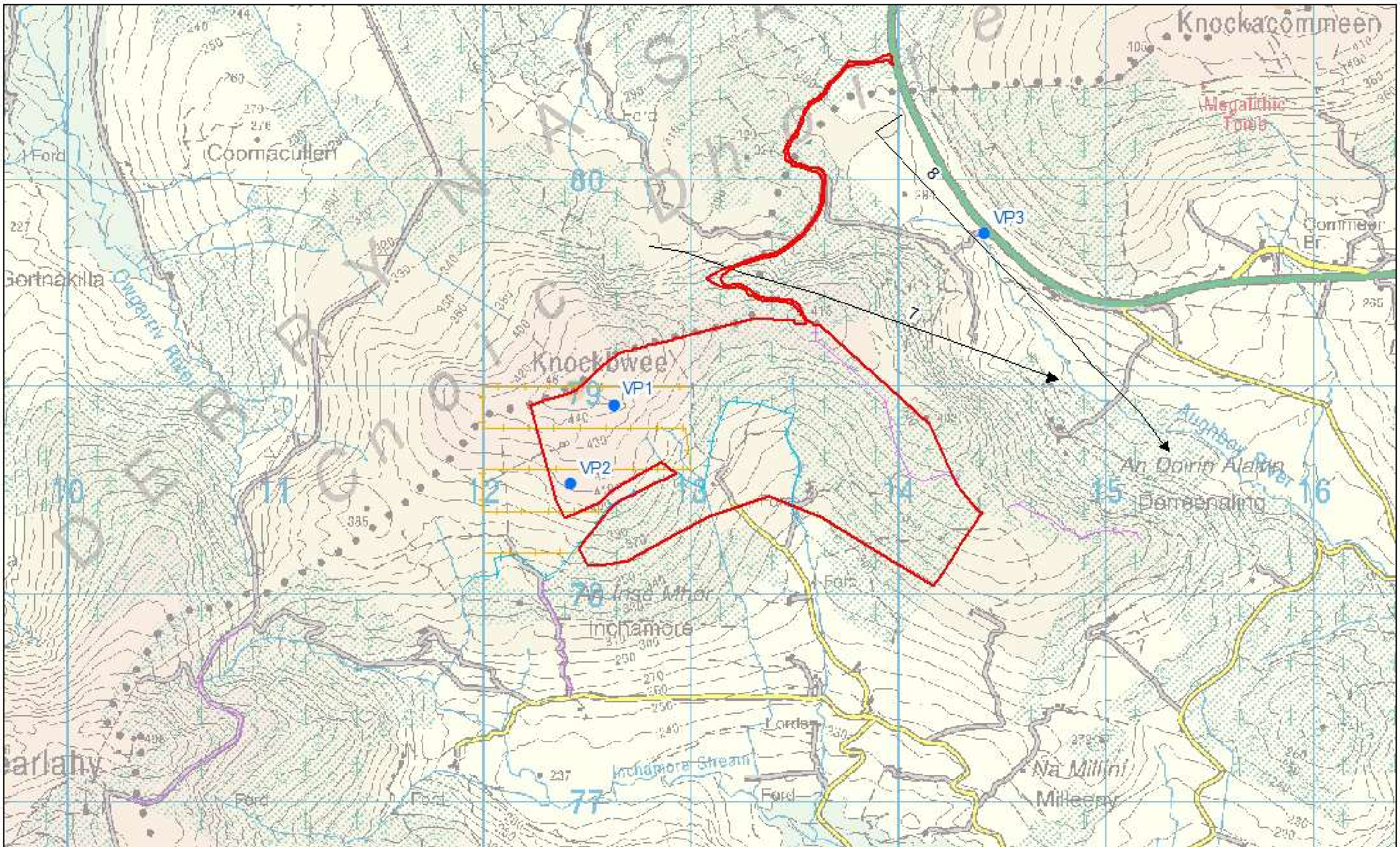
Inchamore Site Boundary
VP Locations
Kestrel (K.)
Breeding Bird Transects
Merlin Transects
Wader Transects

Inchamore Wind Farm Project
Kestrel flightlines Summer 2020

0 0.35 0.7 1.4 km

sse Renewables

COILLTE
GROW TRANSFORM SUSTAIN



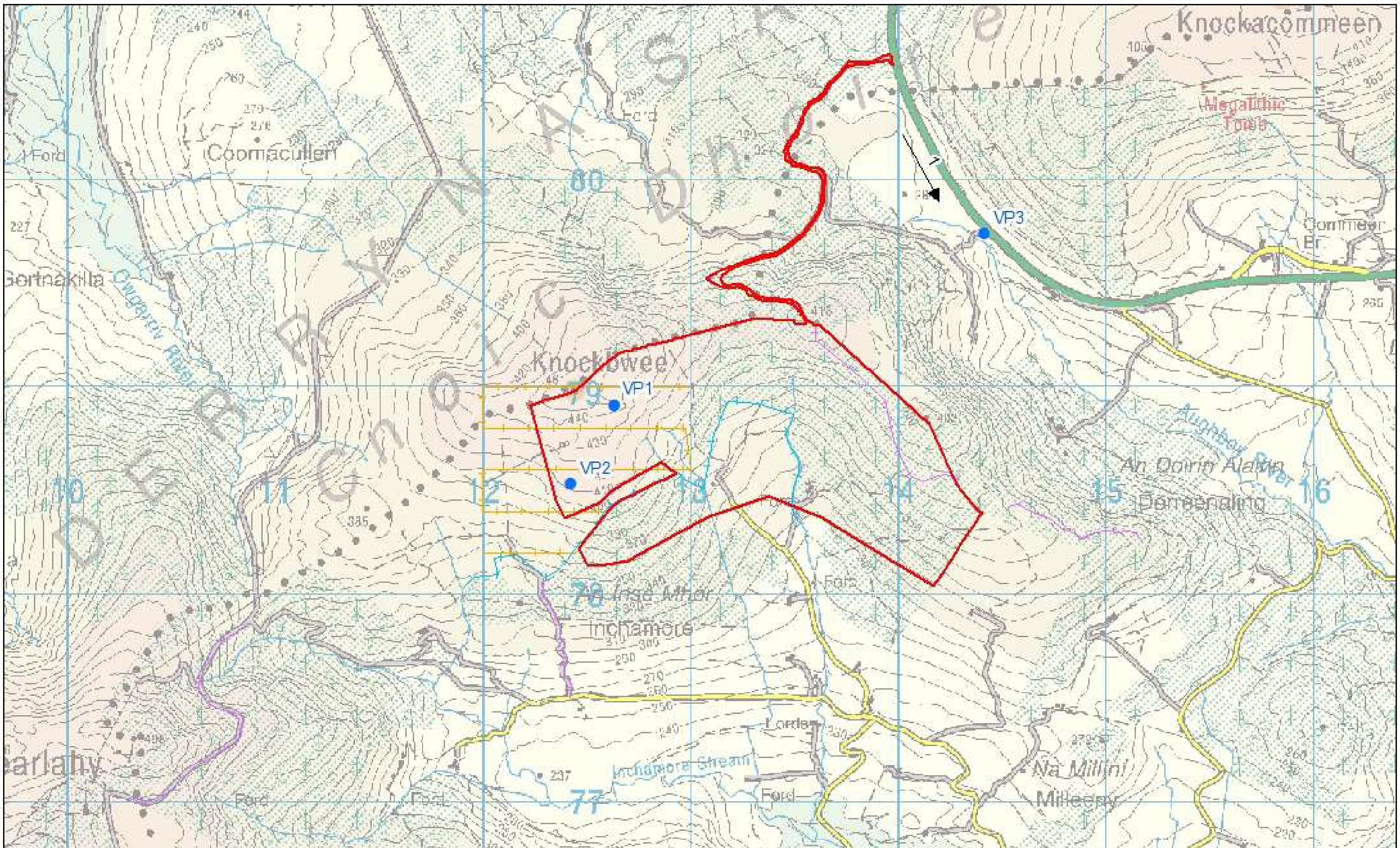
Inchamore Site Boundary	Breeding Bird Transects
VP Locations	Merlin Transects
Lesser Black-backed Gull (LB)	Wader Transects

Inchamore Wind Farm Project
Lesser Black-backed Gull flightlines Summer 2020

0 0.35 0.7 1.4 km

sse Renewables

COILLTE
GROW TRANSFORM SUSTAIN



Inchamore Site Boundary
VP Locations
Sparrowhawk (SH)
Breeding Bird Transects
Merlin Transects
Wader Transects

Inchamore Wind Farm Project
Sparrowhawk flightlines Summer 2020

0 0.35 0.7 1.4 km

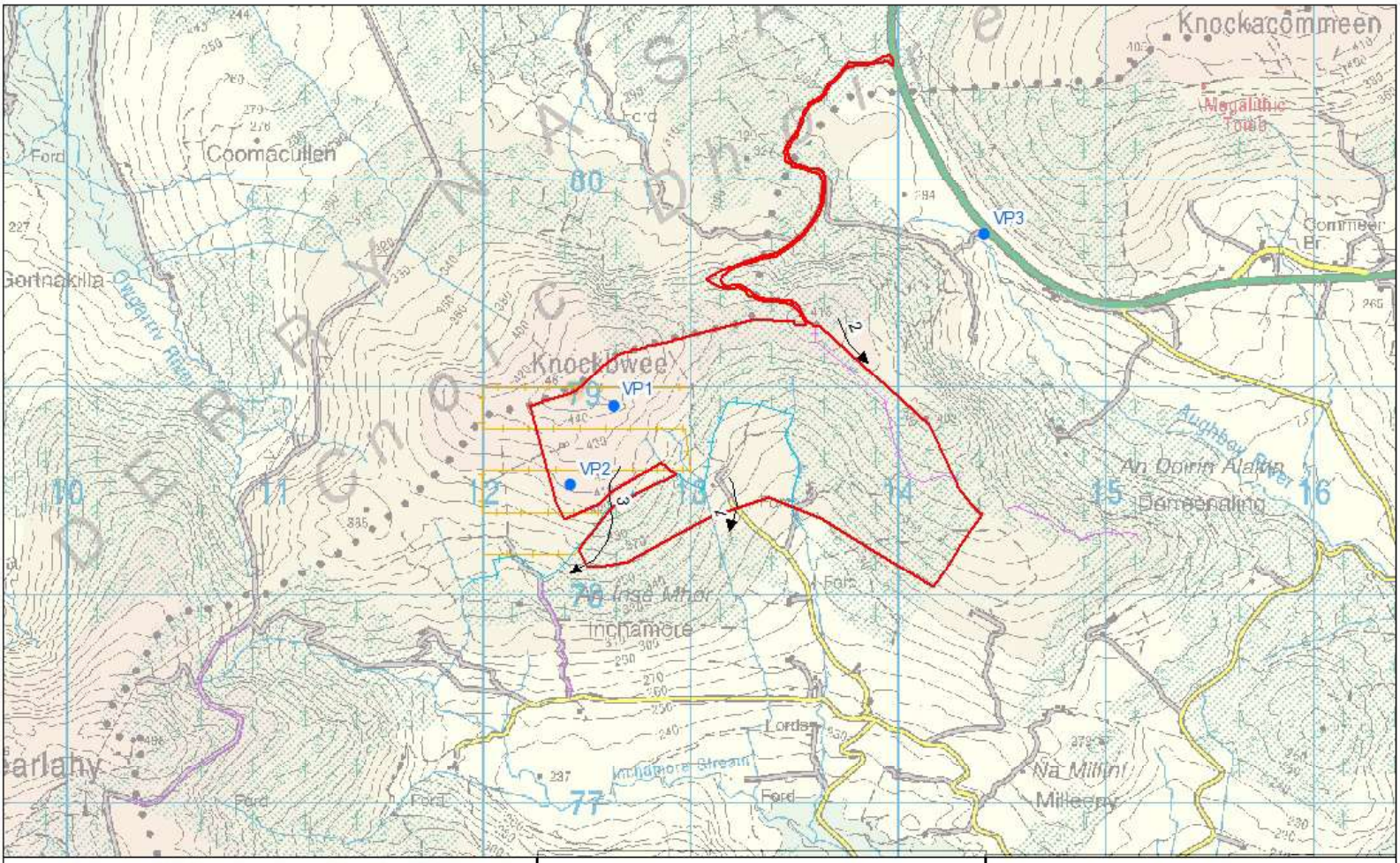
sse Renewables

COILLTE
GROW · TRANSFORM · SUSTAIN

FID	id	VP	ΓO_co	Date	Time	Flightline
0	0	2	K.	2020-08-29	11:22	6
1	0	1	LB	2020-08-30	12:12	7
2	0	1	LB	2020-08-30	13:42	8
3	0	3	K.	2020-08-07	13:03	3
4	0	3	K.	2020-08-07	13:50	4
5	0	3	K.	2020-08-07	14:08	5
6	0	3	SH	2020-05-28	13:40	1
7	0	3	K.	2020-05-28	17:19	2

BTO_name
Kestrel
Lesser Black-backed Gull
Lesser Black-backed Gull
Kestrel
Kestrel
Kestrel
Sparrowhawk
Kestrel

Summer 2022



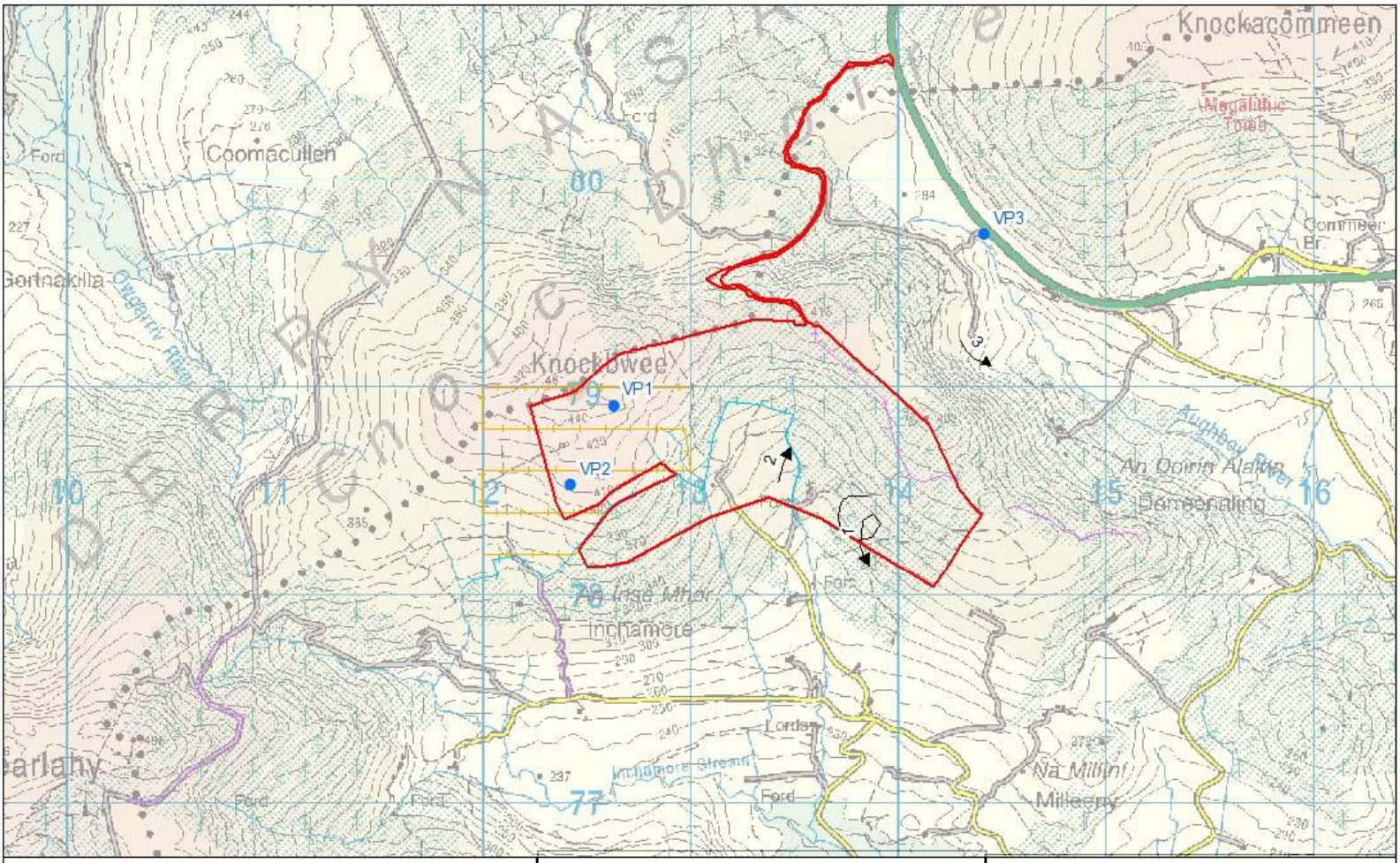
Inchamore Site Boundary
VP Locations
Kestrel (K.)
Breeding Bird Transects
Merlin Transects
Wader Transects

Inchamore Wind Farm Project
Kestrel flightlines Summer 2022

0 0.35 0.7 1.4 km

sse Renewables

COILLTE
GROW · TRANSFORM · SUSTAIN



Inchamore Site Boundary
VP Locations
Sparrowhawk (SH)
Breeding Bird Transects
Merlin Transects
Wader Transects

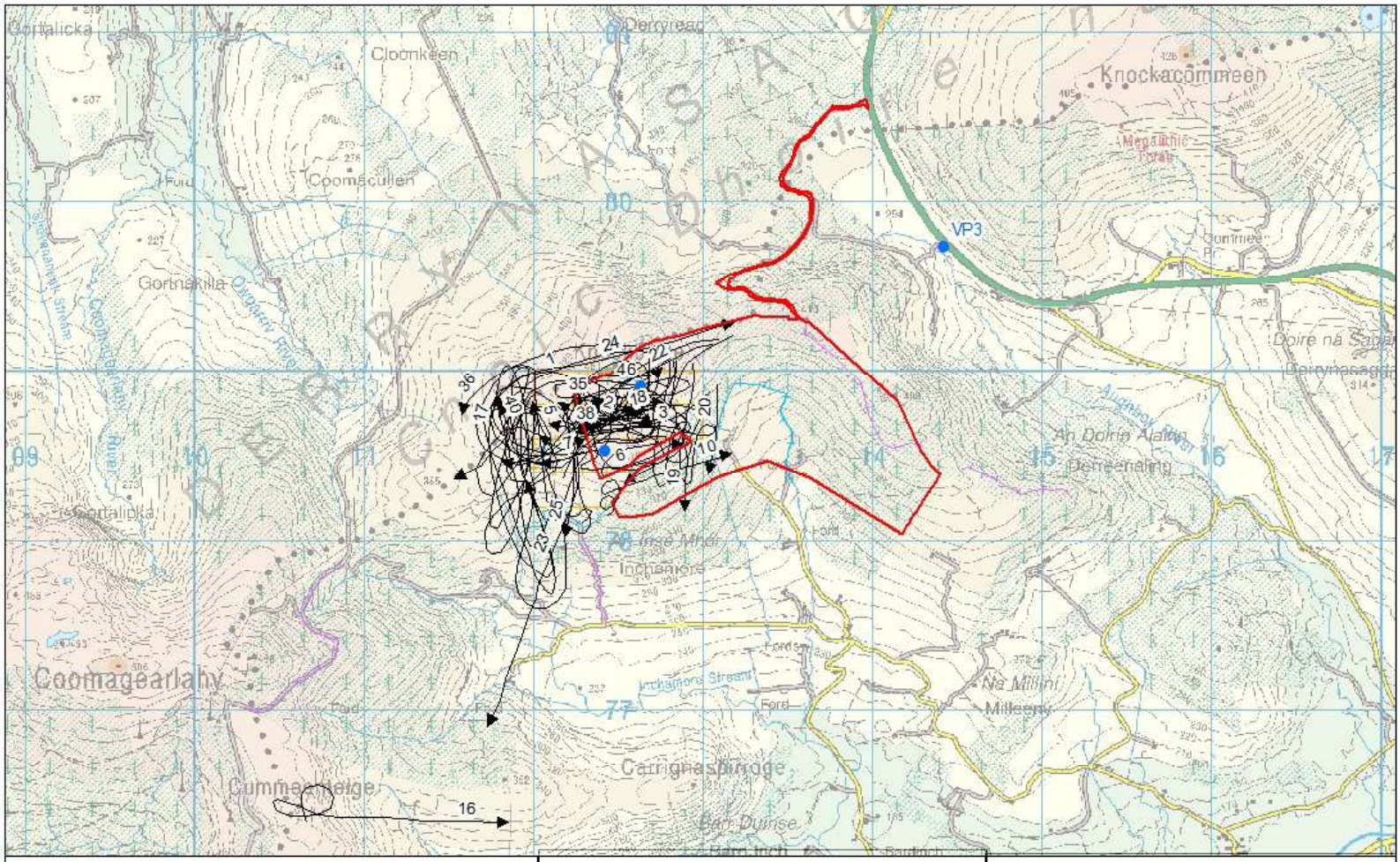
Inchamore Wind Farm Project
Sparrowhawk flightlines Summer 2022

0 0.35 0.7 1.4 km

sse Renewables

COILLTE
GROW · TRANSFORM · SUSTAIN

Winter 2017-2018



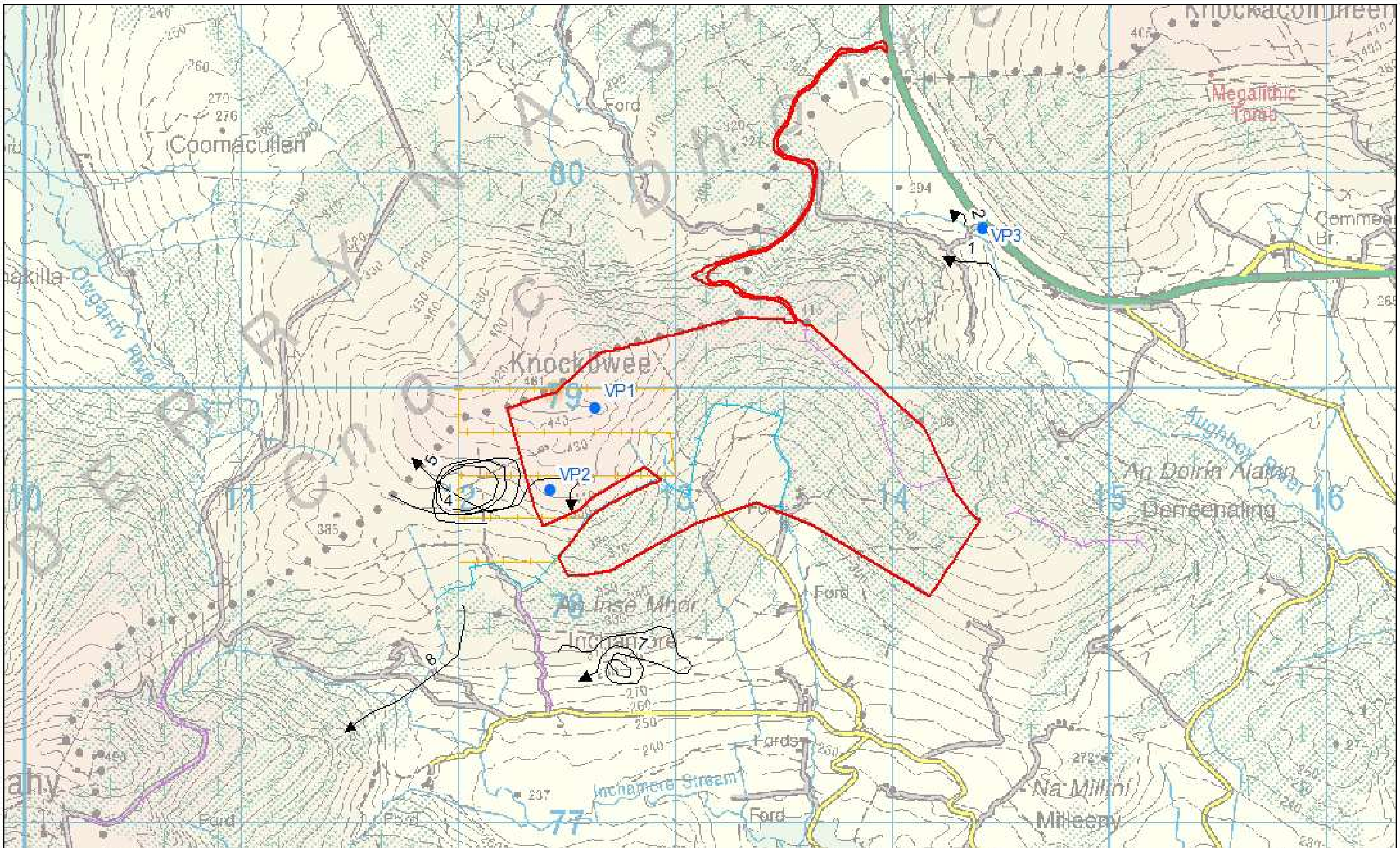
Inchamore Site Boundary
VP Locations
Golden Plover (GP)
Breeding Bird Transects
Merlin Transects
Wader Transects

Inchamore Wind Farm Project
Golden Plover flightlines Winter 2017-2018

0 0.45 0.9 1.8 km

sse Renewables

COILLTE
GROW · TRANSFORM · SUSTAIN

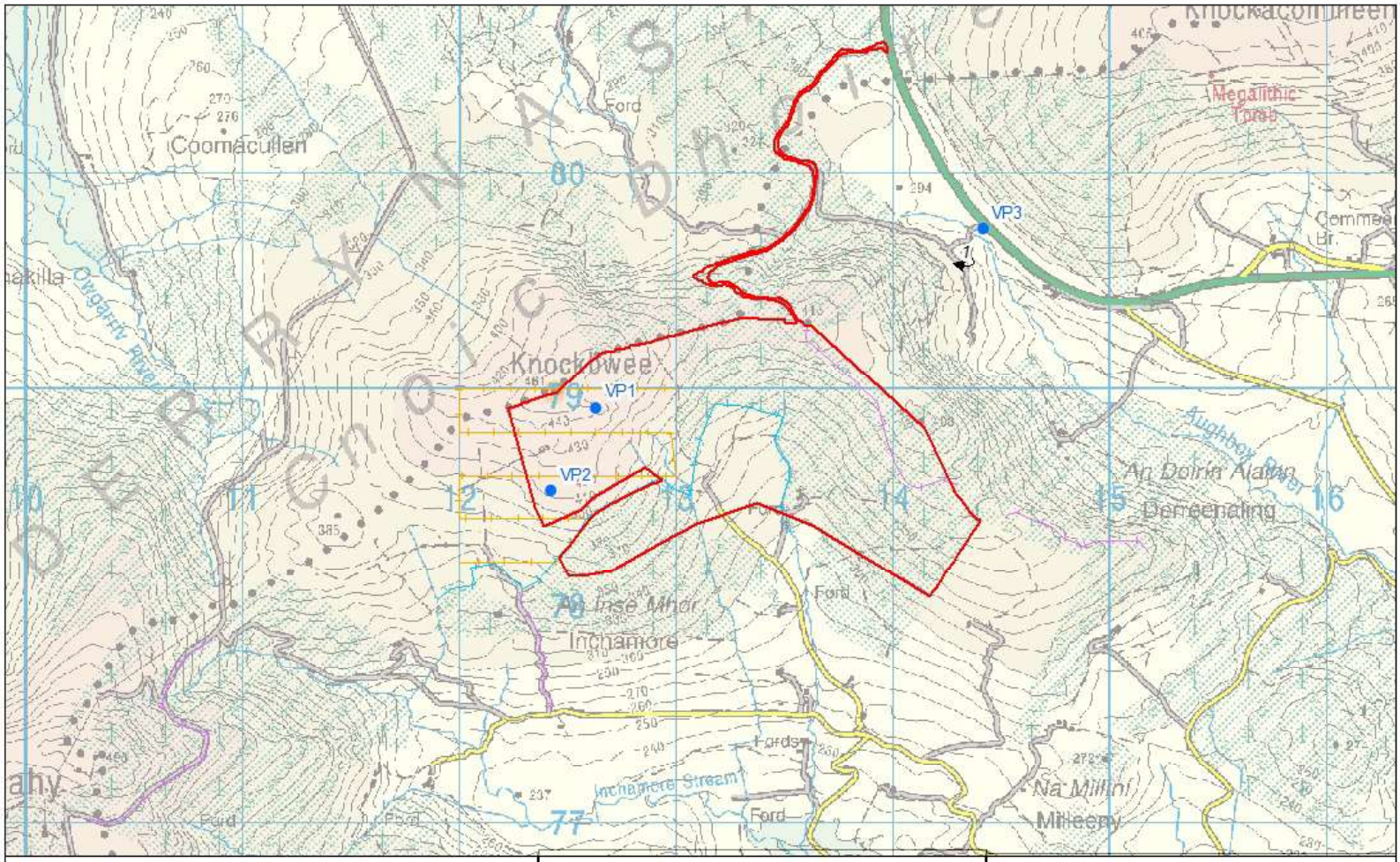


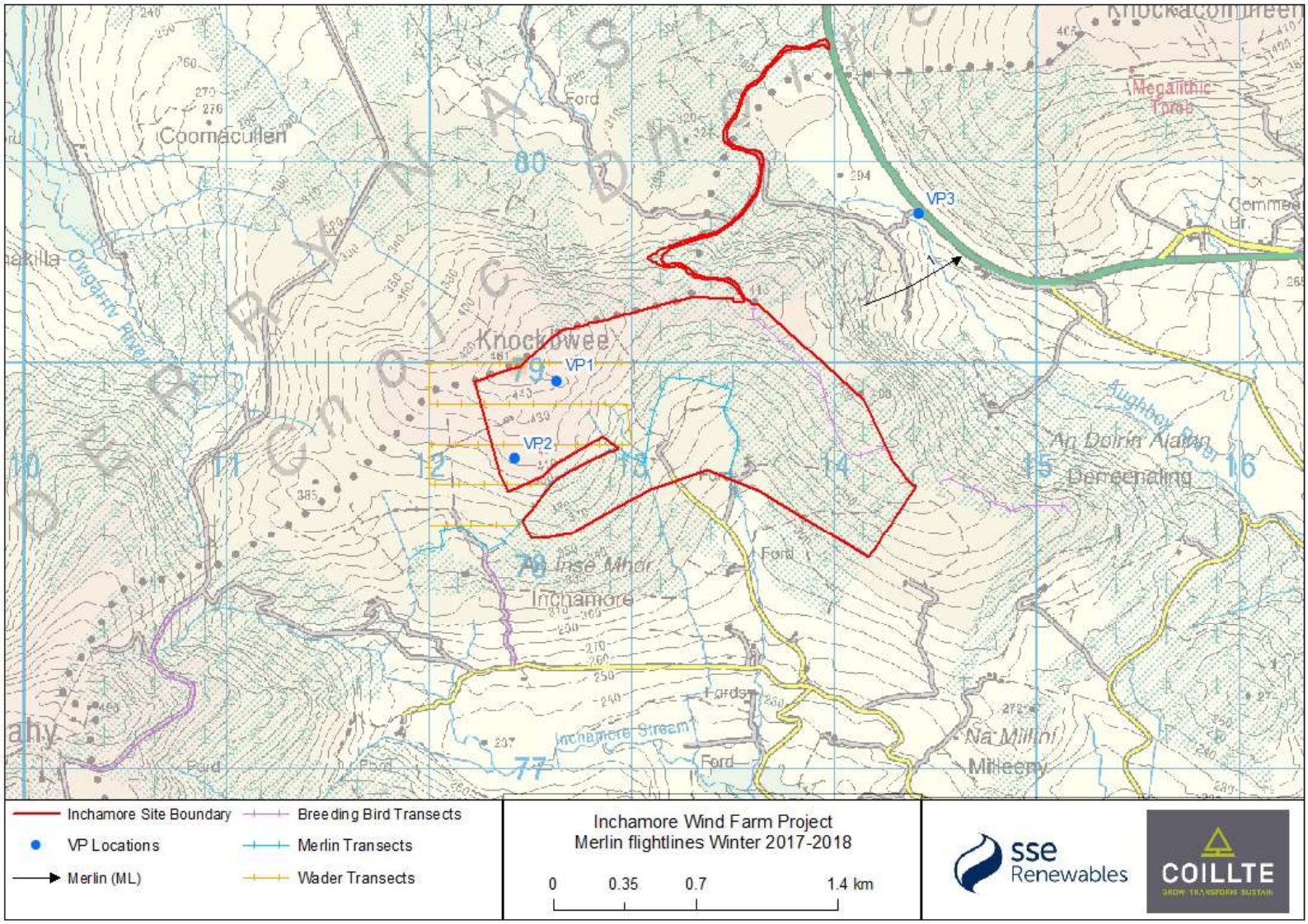
Inchamore Site Boundary
VP Locations
Hen Harrier (HH)
Breeding Bird Transects
Merlin Transects
Wader Transects

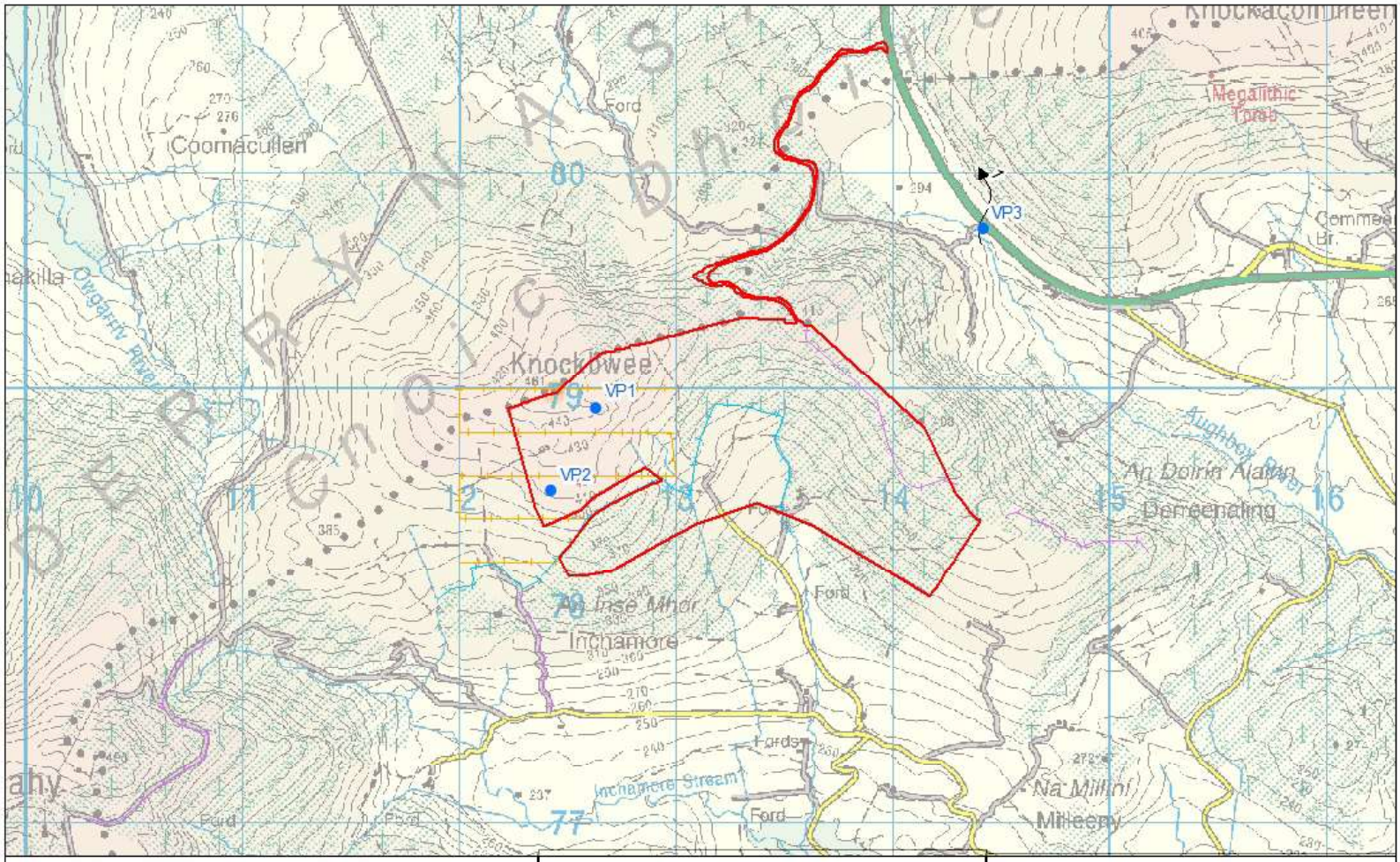
Inchamore Wind Farm Project
Hen Harrier flightlines Winter 2017-2018

0 0.35 0.7 1.4 km

sse Renewables
COILLTE


Coomaculleen
Knockacommeen
Megalithic Tomb
Ford
VP3
Knockowee
VP1
VP2
An Doirín Alainn
Derreenaling
Inse Mhór
Inchamore
Inchamore Stream
Na Millíní
Milleeny
Aughboy River
Inchamore Site Boundary
VP Locations
Kestrel (K.)
Breeding Bird Transects
Merlin Transects
Wader Transects
Inchamore Wind Farm Project
Kestrel flightlines Winter 2017-2018
0
0.35
0.7
1.4 km
sse Renewables
COILLTE


Coomaculleen
Knockacommeen
Megalithic Tomb
Ford
VP3
VP1
VP2
Knockowee
An Doirín Alainn
Derreenaling
Inse Mhór
Inchamore
Inchamore Stream
Na Millíní
Milleeny
Aughboy River
Inchamore Site Boundary
VP Locations
Merlin (ML)
Breeding Bird Transects
Merlin Transects
Wader Transects
Inchamore Wind Farm Project
Merlin flightlines Winter 2017-2018
0
0.35
0.7
1.4 km
sse Renewables
COILLTE



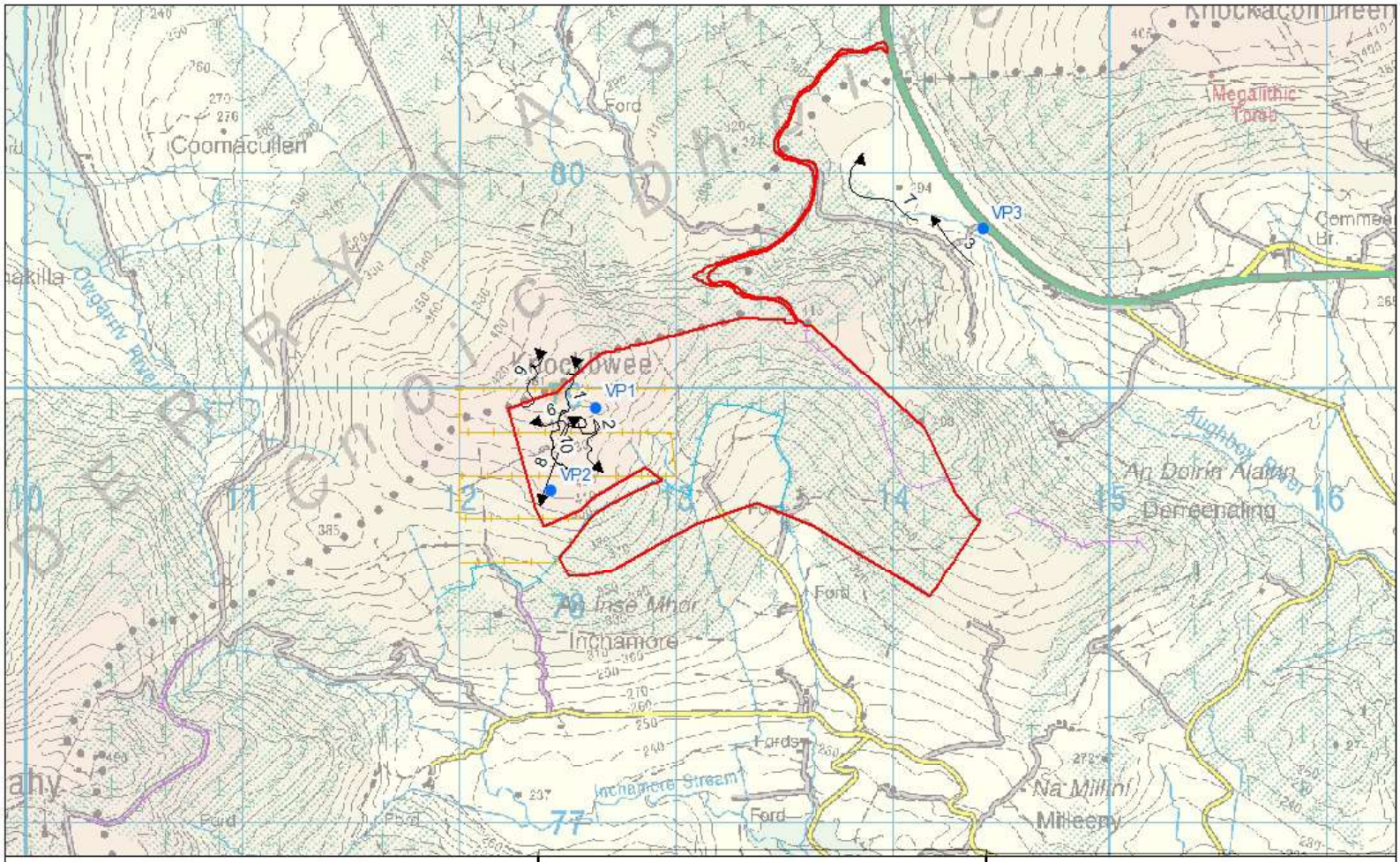
Inchamore Site Boundary
VP Locations
Sparrowhawk (SH)
Breeding Bird Transects
Merlin Transects
Wader Transects

Inchamore Wind Farm Project
Sparrowhawk flightlines Winter 2017-2018

0 0.35 0.7 1.4 km

sse Renewables

COILLTE
GROW · TRANSFORM · SUSTAIN



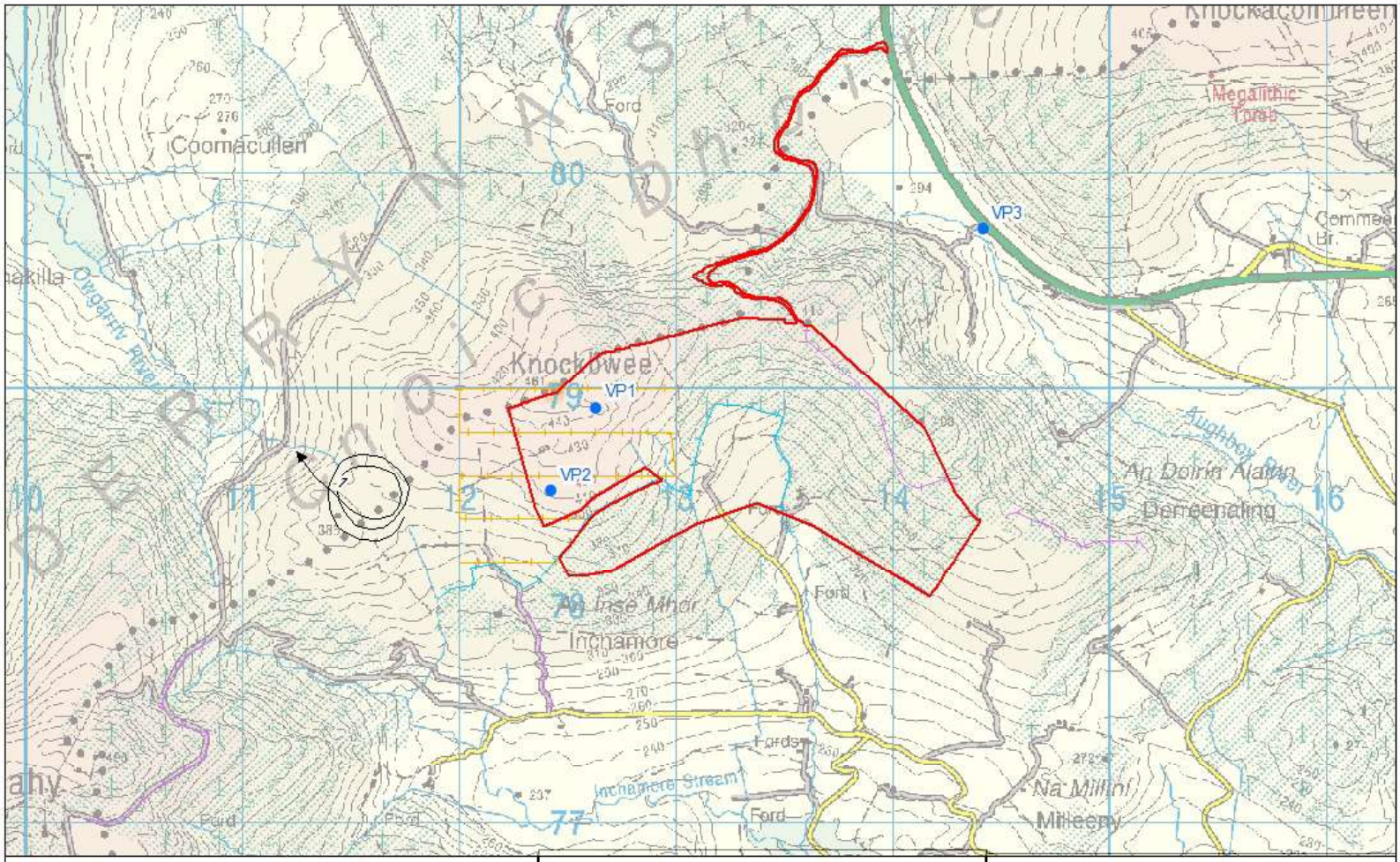
Inchamore Site Boundary
VP Locations
Snipe (SN)
Breeding Bird Transects
Merlin Transects
Wader Transects

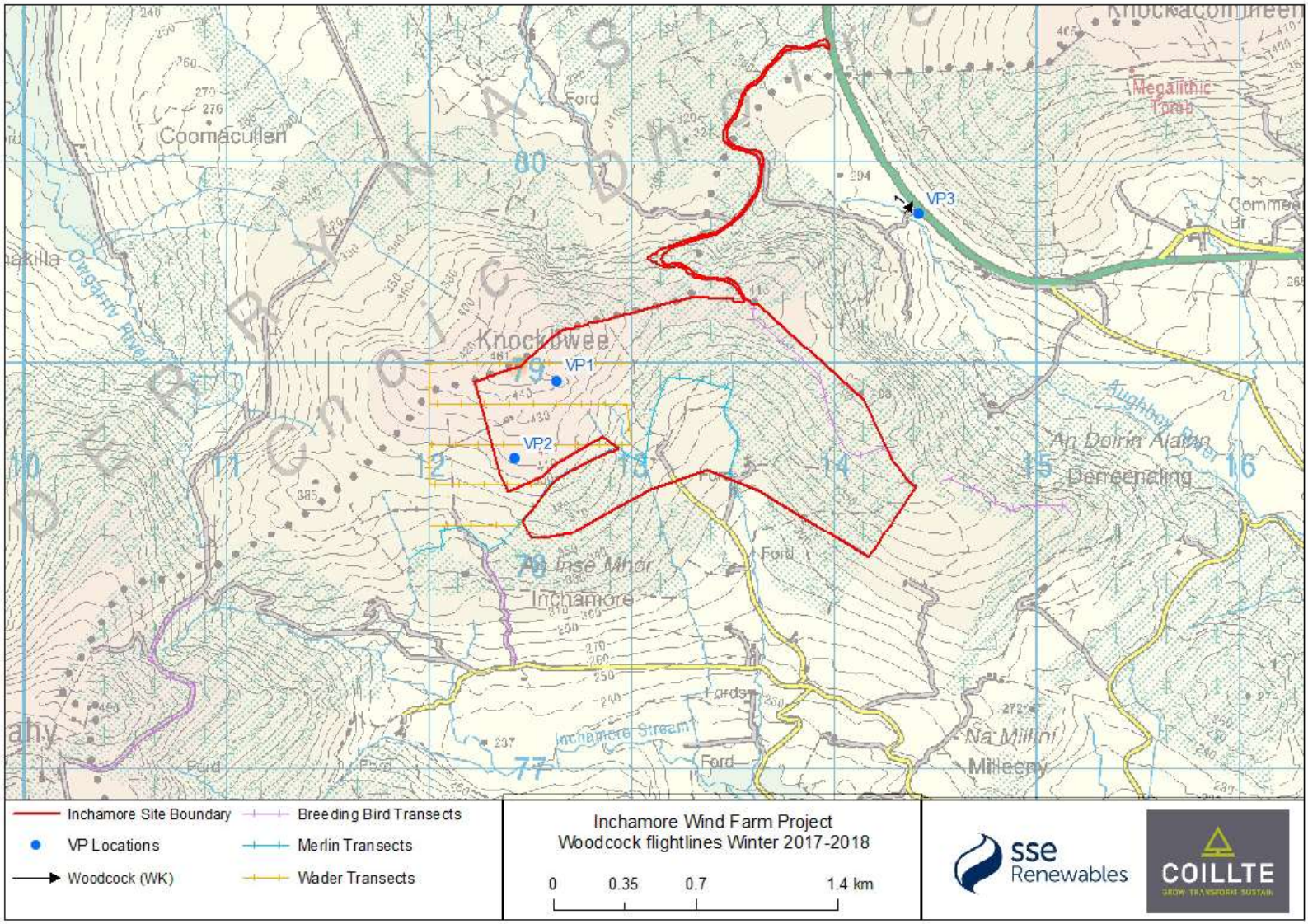
Inchamore Wind Farm Project
Snipe flightlines Winter 2017-2018

0 0.35 0.7 1.4 km

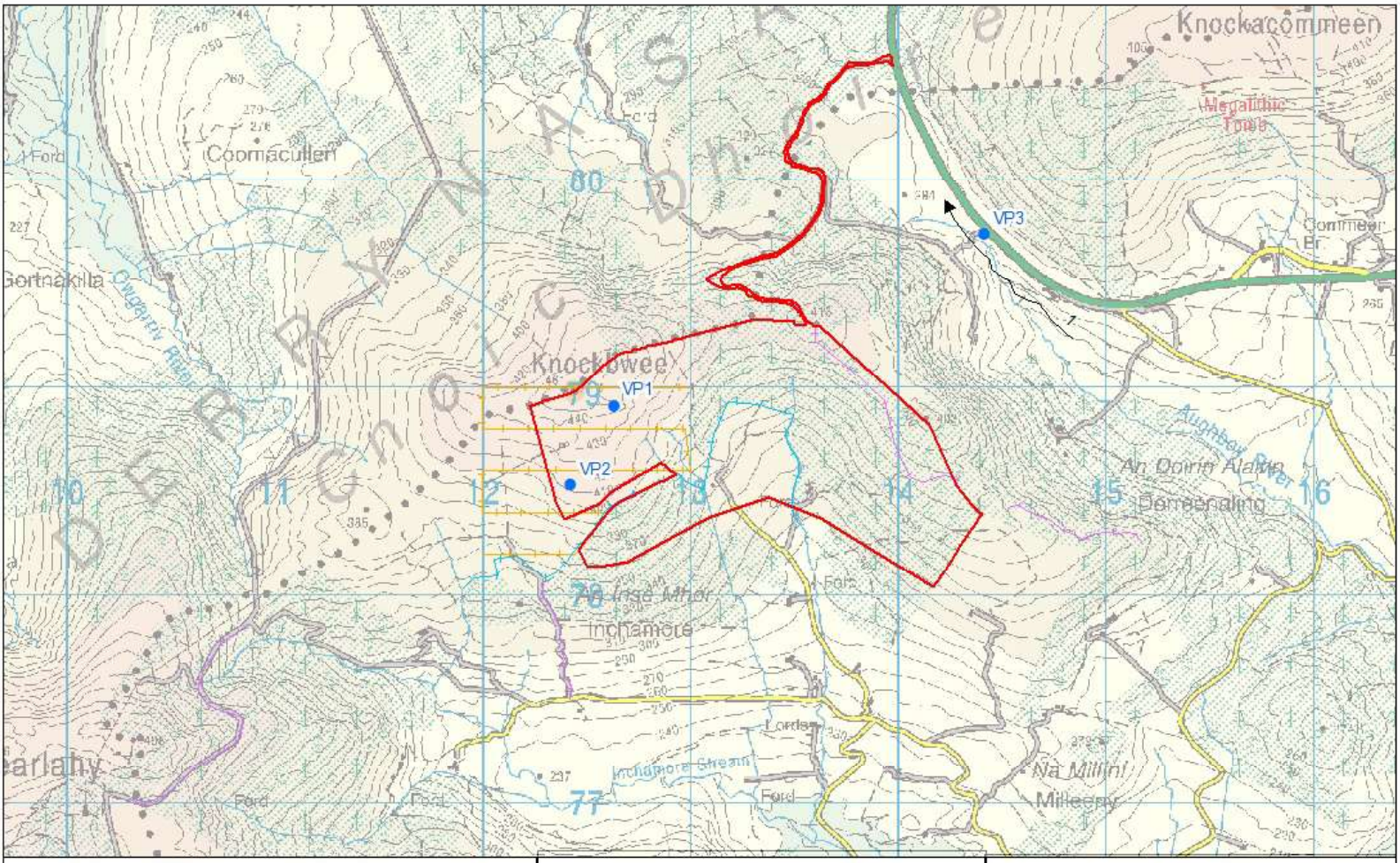
sse Renewables

COILLTE
GROW · TRANSFORM · SUSTAIN


Coomacullen
Knockowee
VP1
VP2
VP3
Megalithic Tomb
An Doirín Alainn
Derreenaling
Inse Mhór
Inchamore
Inchamore Stream
Na Millíní
Milleeny
Ford
Fords
Aughboy River
Inchamore Site Boundary
VP Locations
White-tailed Eagle (WE)
Breeding Bird Transects
Merlin Transects
Wader Transects
Inchamore Wind Farm Project
White-tailed Eagle flightlines Winter 2017-2018
0
0.35
0.7
1.4 km
sse Renewables
COILLTE


Coomaculleen
Knockacommeen
Megalithic Tomb
Knockowee
VP1
VP2
VP3
An Doirín Alainn
Derreenaling
Inse Mhór
Inchamore
Inchamore Stream
Na Millíní
Milleeny
Ford
Fords
Aughboy River
Inchamore Site Boundary
VP Locations
Woodcock (WK)
Breeding Bird Transects
Merlin Transects
Wader Transects
Inchamore Wind Farm Project
Woodcock flightlines Winter 2017-2018
0
0.35
0.7
1.4 km
sse Renewables
COILLTE

Winter 2018 - 2019



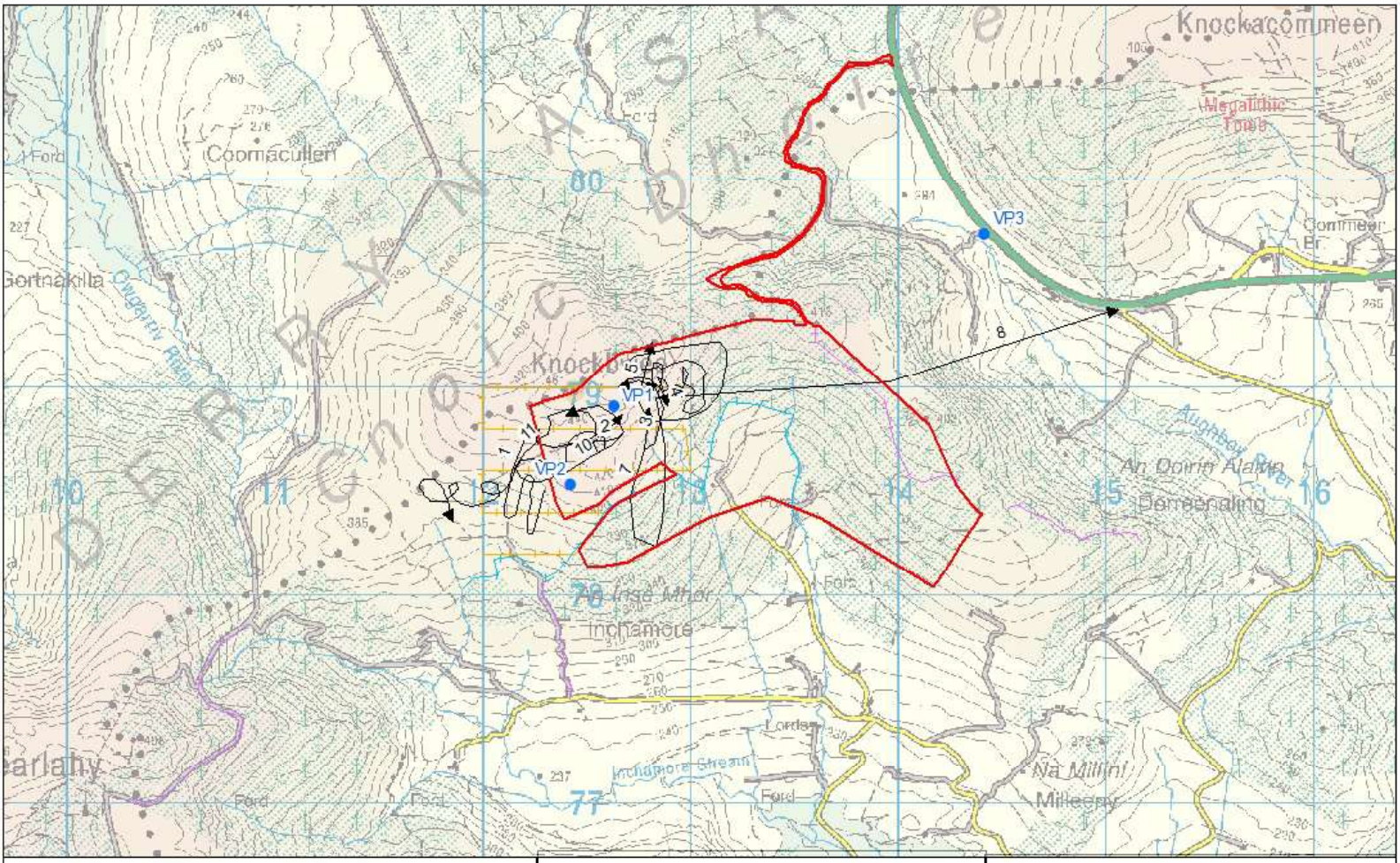
Inchamore Site Boundary
VP Locations
Common Gull (CM)
Breeding Bird Transects
Merlin Transects
Wader Transects

Inchamore Wind Farm Project
Common Gull flightlines Winter 2018-2019

0 0.35 0.7 1.4 km

sse Renewables

COILLTE
GROW · TRANSFORM · SUSTAIN



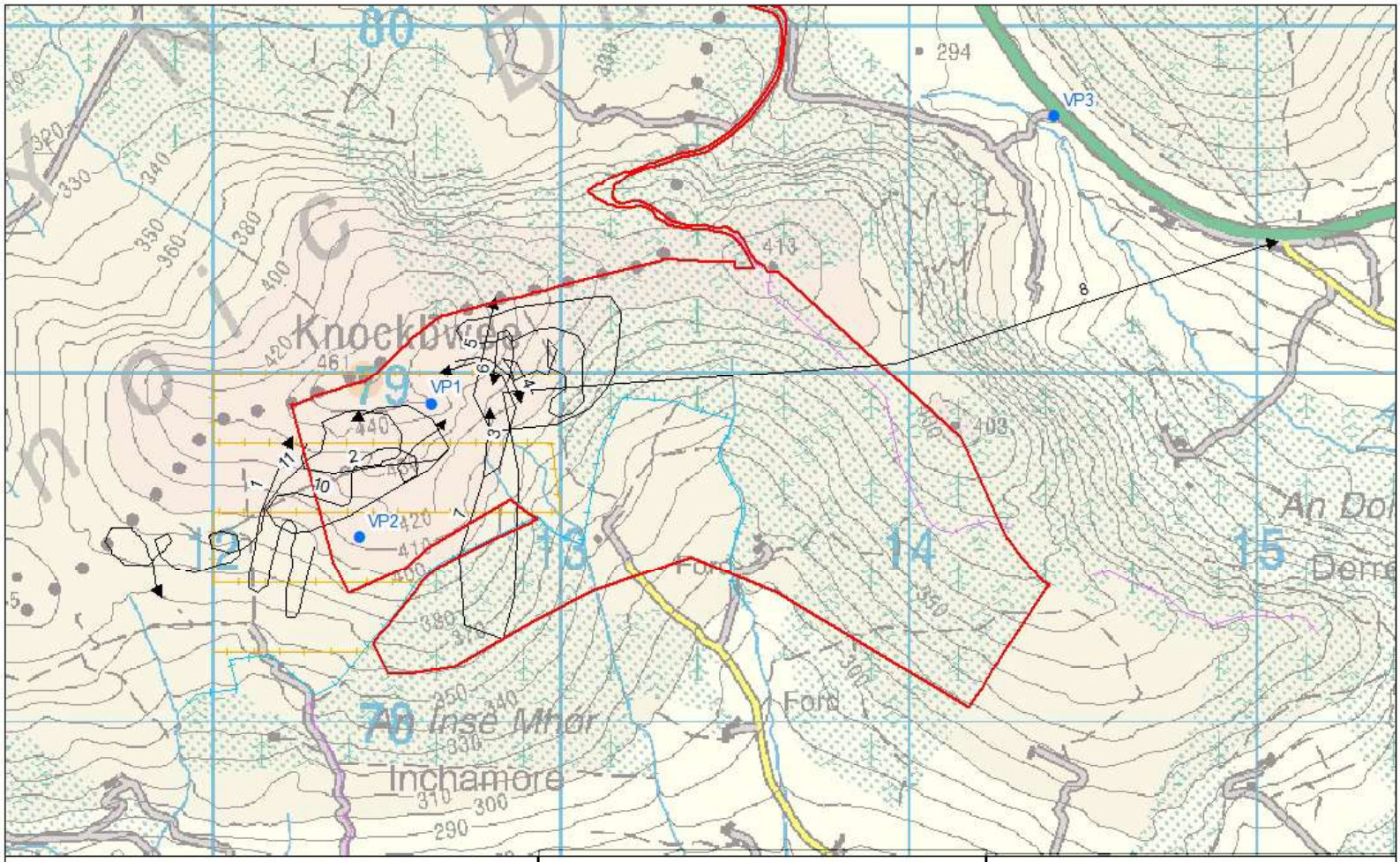
Inchamore Site Boundary
VP Locations
Golden Plover (GP)
Breeding Bird Transects
Merlin Transects
Wader Transects

Inchamore Wind Farm Project
Golden Plover flightlines Winter 2018-2019

0 0.35 0.7 1.4 km

sse Renewables

COILLTE
GROW · TRANSFORM · SUSTAIN



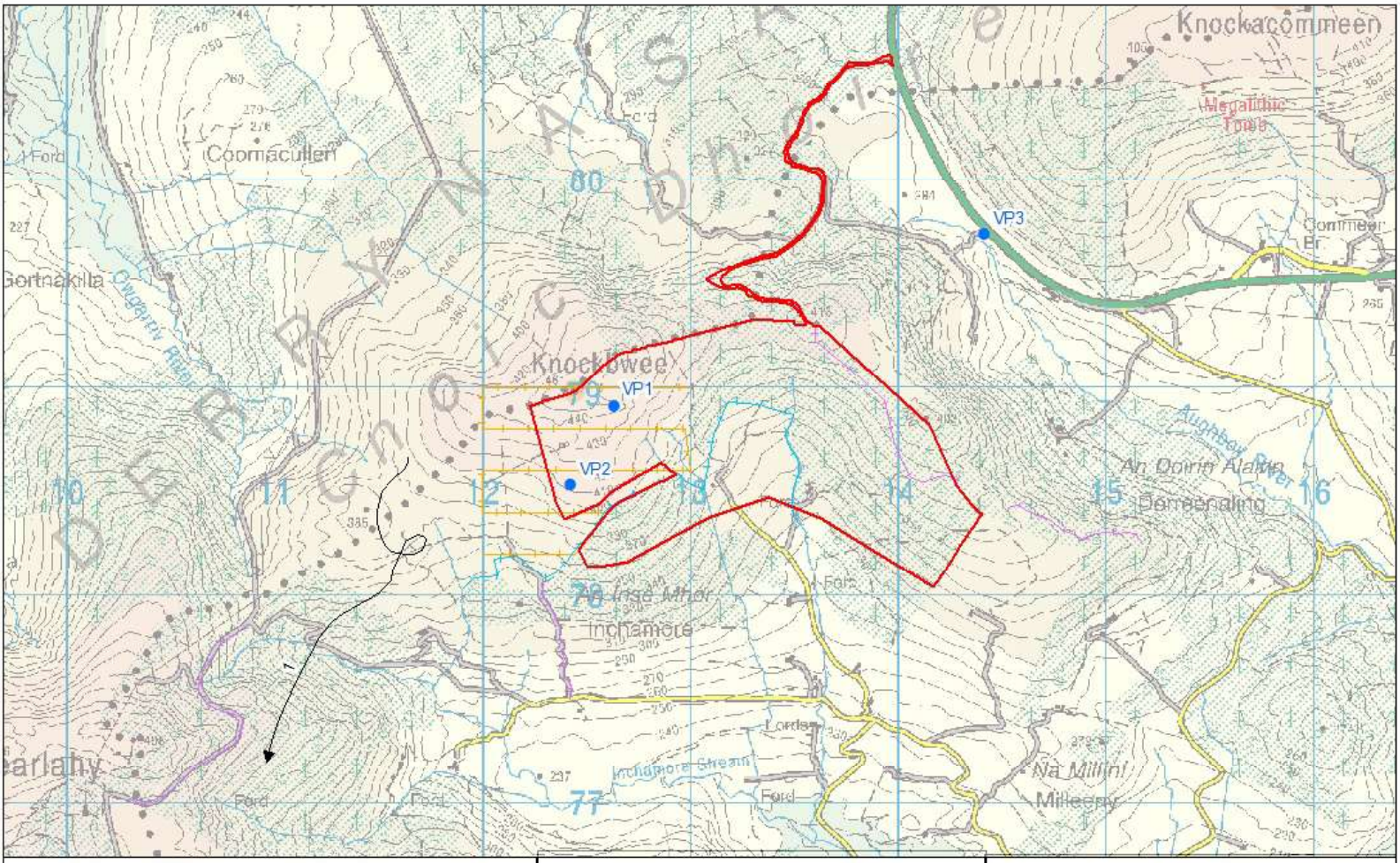
Inchamore Site Boundary
VP Locations
Golden Plover (GP)
Breeding Bird Transects
Merlin Transects
Wader Transects

Inchamore Wind Farm Project
Golden Plover flightlines Winter 2018-2019

0 0.2 0.4 0.8 km

sse Renewables

COILLTE
GROW · TRANSFORM · SUSTAIN



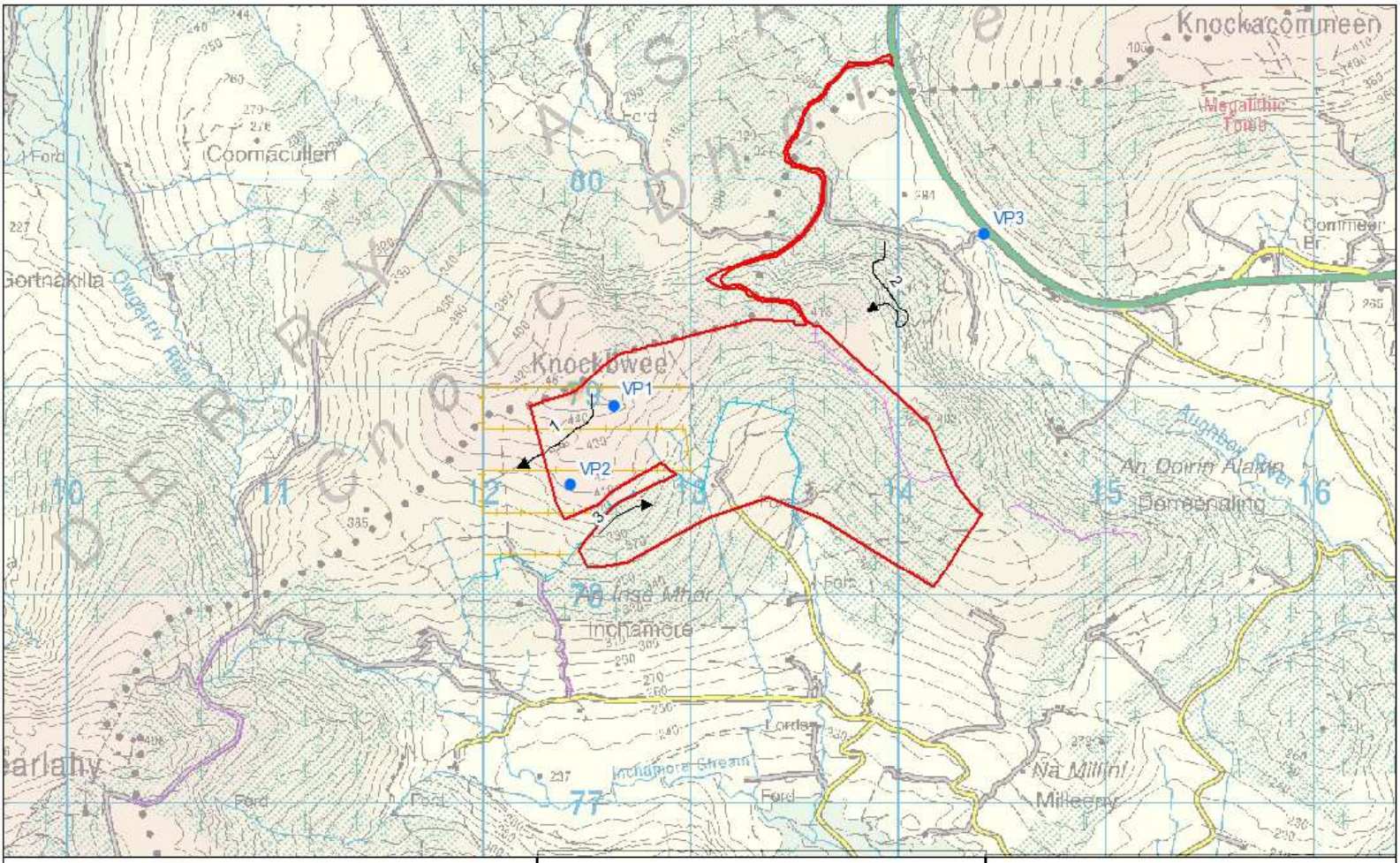
Inchamore Site Boundary
VP Locations
Grey Plover (GV)
Breeding Bird Transects
Merlin Transects
Wader Transects

Inchamore Wind Farm Project
Grey Plover flightlines Winter 2018-2019

0 0.35 0.7 1.4 km

sse Renewables

COILLTE
GROW · TRANSFORM · SUSTAIN



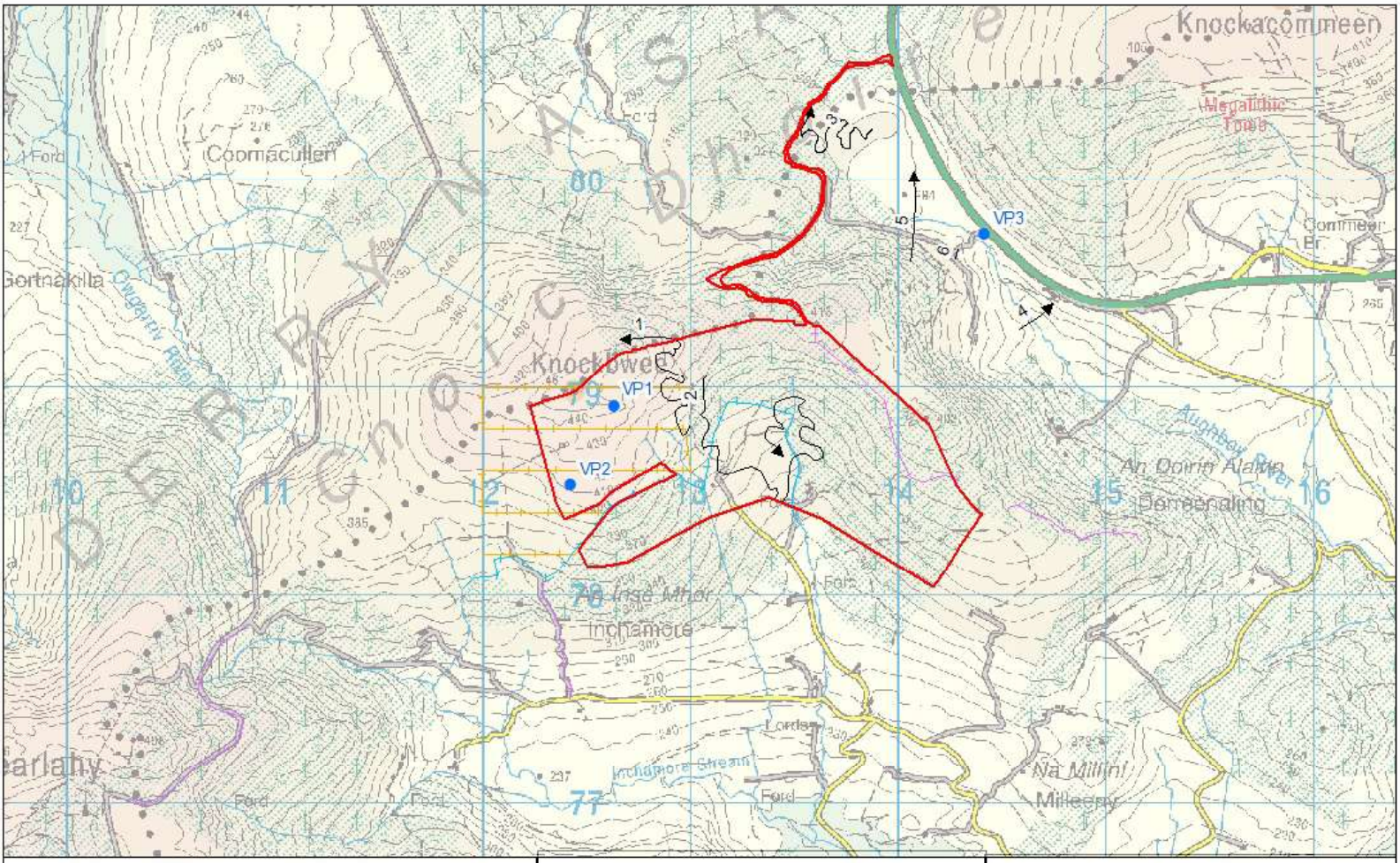
Inchamore Site Boundary
VP Locations
Hen Harrier (HH)
Breeding Bird Transects
Merlin Transects
Wader Transects

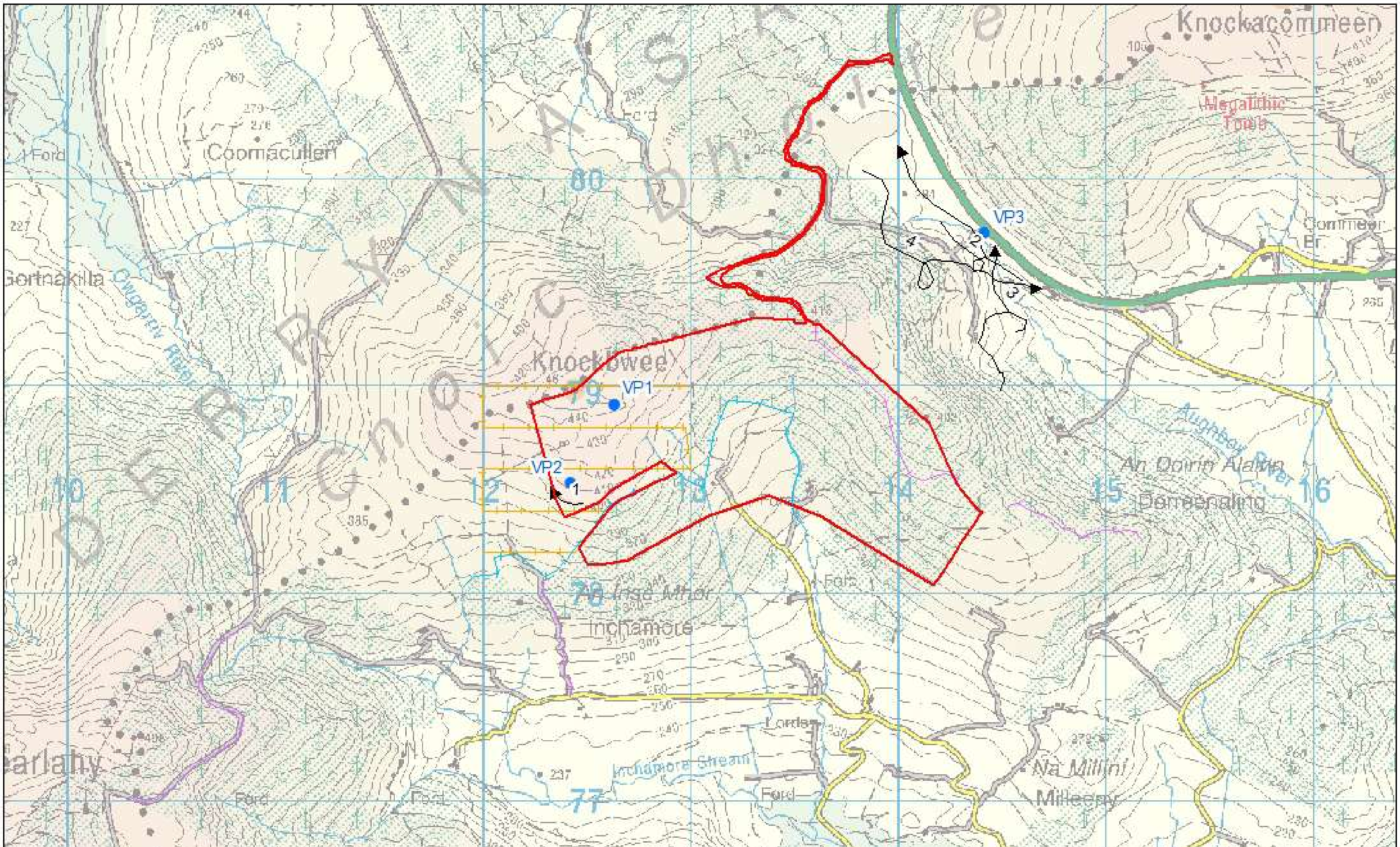
Inchamore Wind Farm Project
Hen Harrier flightlines Winter 2018-2019

0 0.35 0.7 1.4 km

sse Renewables

COILLTE
GROW. TRANSFORM. SUSTAIN.


Knockacommeen
Megalithic Tomb
Coomaculleen
Gortnakilla
Knocklowen
VP1
VP2
VP3
Inchamore
Inchamore Stream
An Doirin Alainn
Domeenalinn
Na Millini
Milleeny
Ford
Inchamore Site Boundary
VP Locations
Kestrel (K.)
Breeding Bird Transects
Merlin Transects
Wader Transects
Inchamore Wind Farm Project
Kestrel flightlines Winter 2018-2019
0
0.35
0.7
1.4 km
sse Renewables
COILLTE



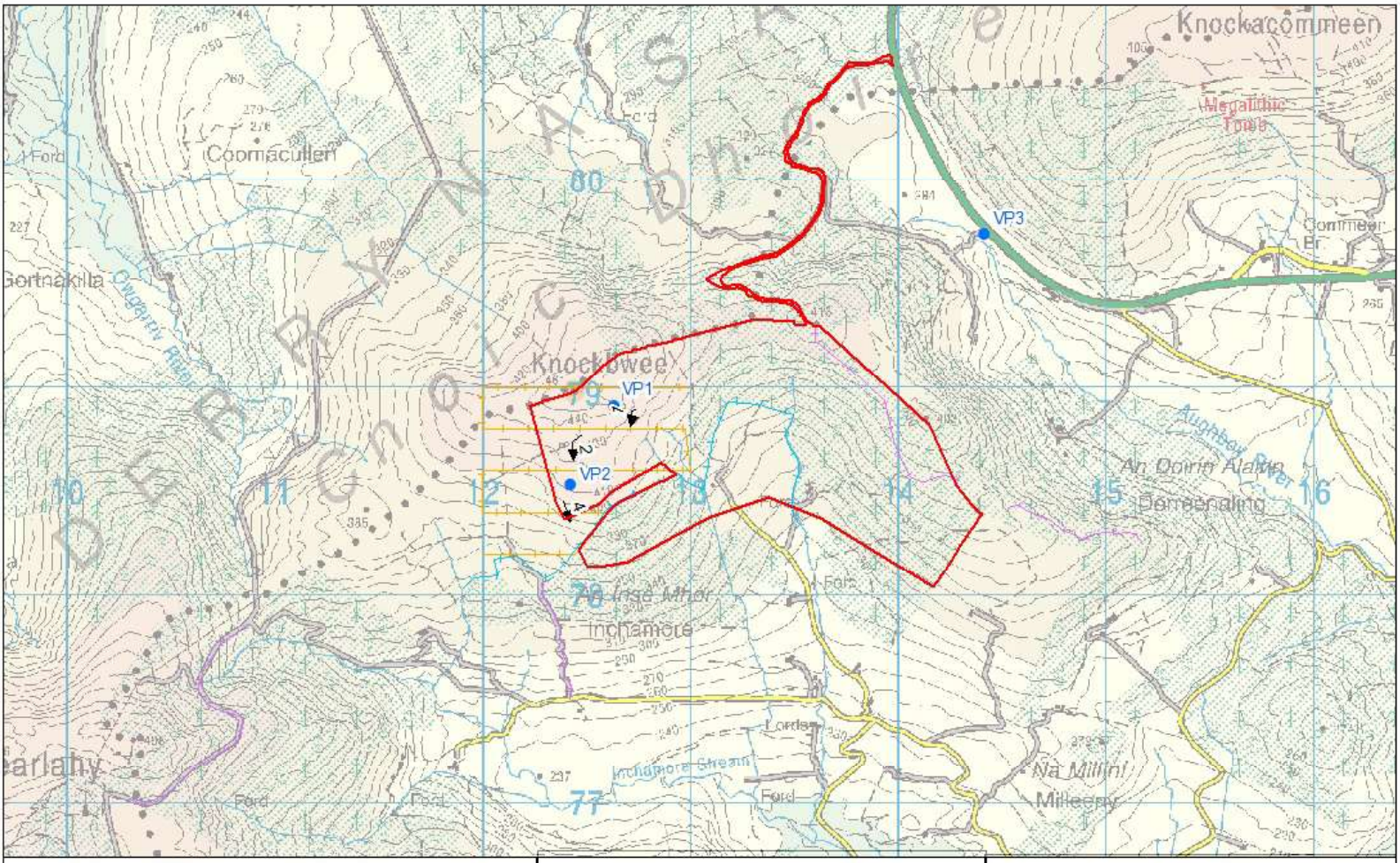
Inchamore Site Boundary	Breeding Bird Transects
VP Locations	Merlin Transects
Meadow Pipet (MP)	Wader Transects

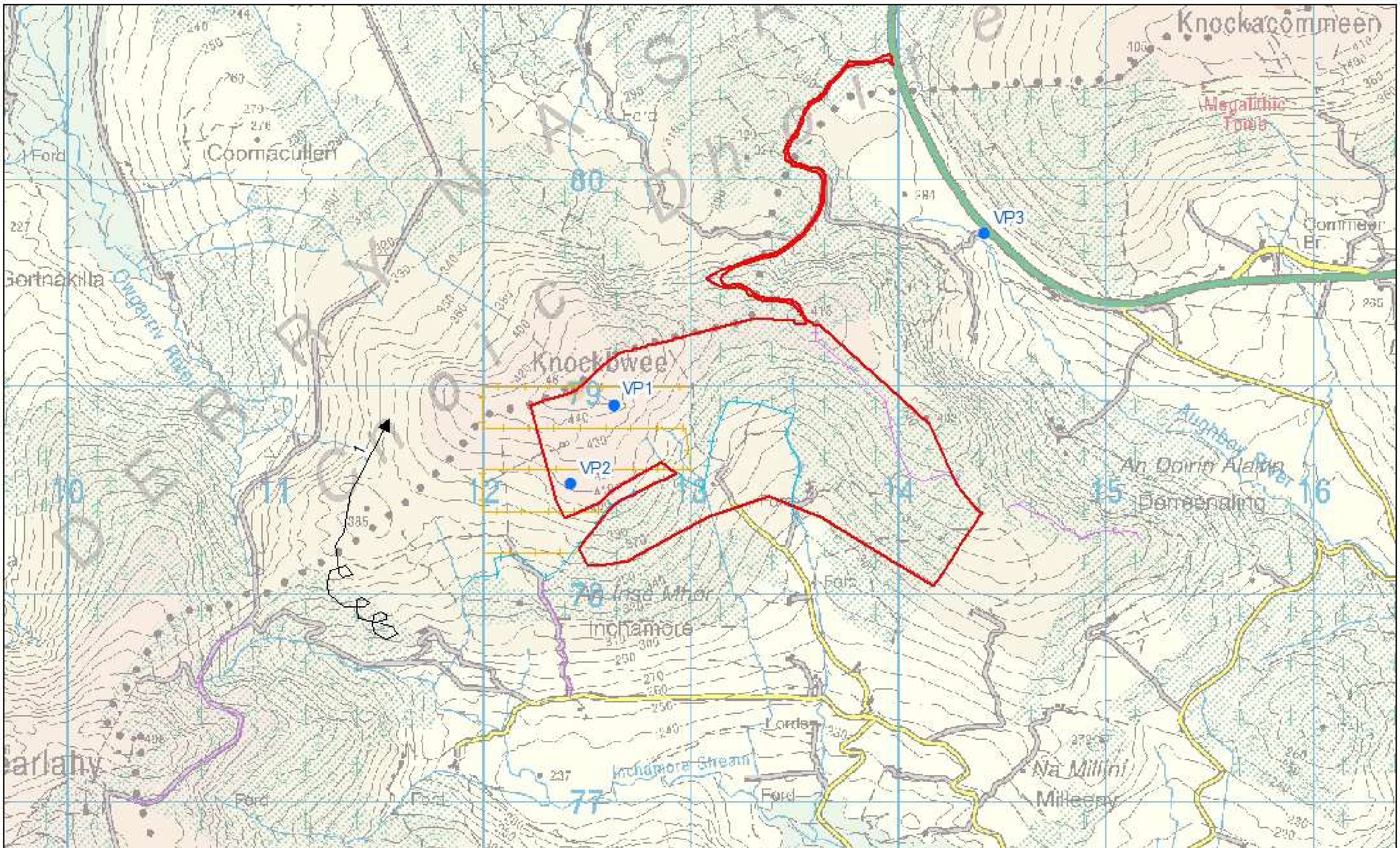
Inchamore Wind Farm Project
Meadow Pipet flightlines Winter 2018-2019

0 0.35 0.7 1.4 km

sse Renewables

COILLTE
GROW TRANSFORM SUSTAIN


Knockacommeen
Megalithic Tomb
Coomaculleen
Gortnakilla
Knockowee
VP1
VP2
VP3
Inchamore
Inchamore Stream
An Doirin Alainn
Domeenalina
Na Millini
Milleeny
Ford
Inchamore Site Boundary
VP Locations
Snipe (SN)
Breeding Bird Transects
Merlin Transects
Wader Transects
Inchamore Wind Farm Project
Snipe flightlines Winter 2018-2019
0
0.35
0.7
1.4 km
sse Renewables
COILLTE

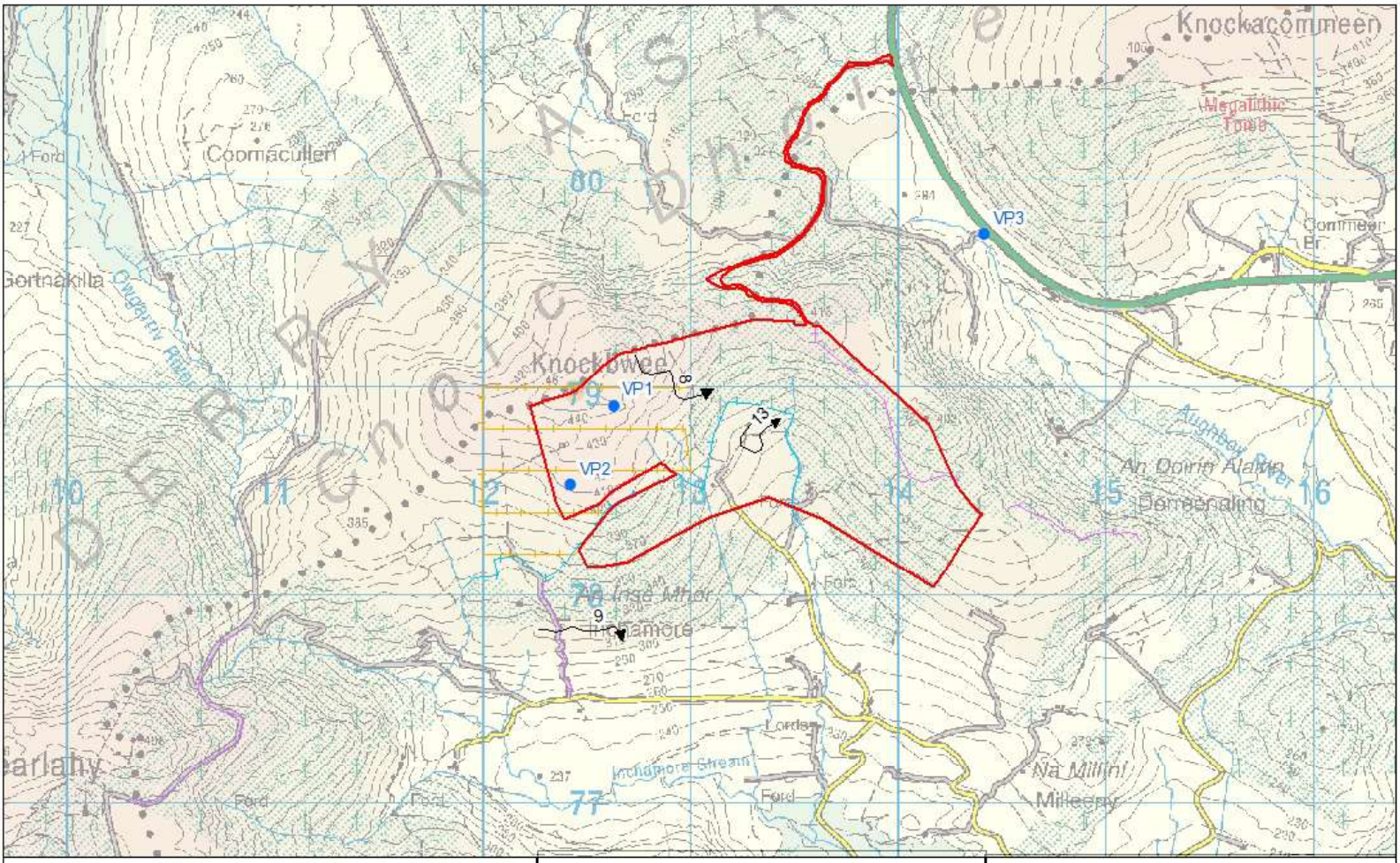


Inchamore Site Boundary
VP Locations
White-tailed Eagle (WE)
Breeding Bird Transects
Merlin Transects
Wader Transects

Inchamore Wind Farm Project
White-tailed Eagle flightlines Winter 2018-2019

0 0.35 0.7 1.4 km

Winter 2020 - 2021



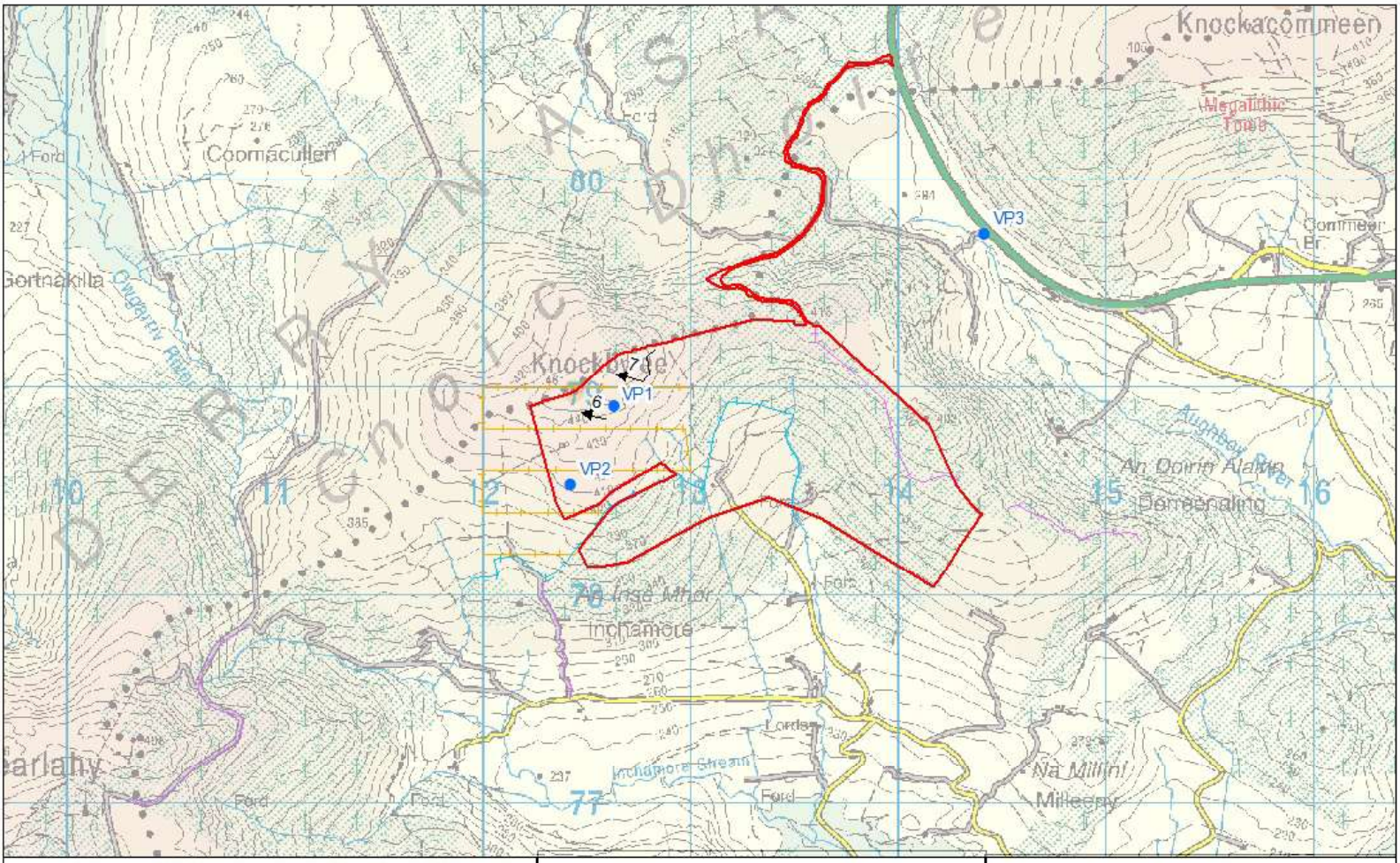
Inchamore Site Boundary
VP Locations
Buzzard (BZ)
Breeding Bird Transects
Merlin Transects
Wader Transects

Inchamore Wind Farm Project
Buzzard flightlines Winter 2020-2021

0 0.35 0.7 1.4 km

sse Renewables

COILLTE
GROW · TRANSFORM · SUSTAIN



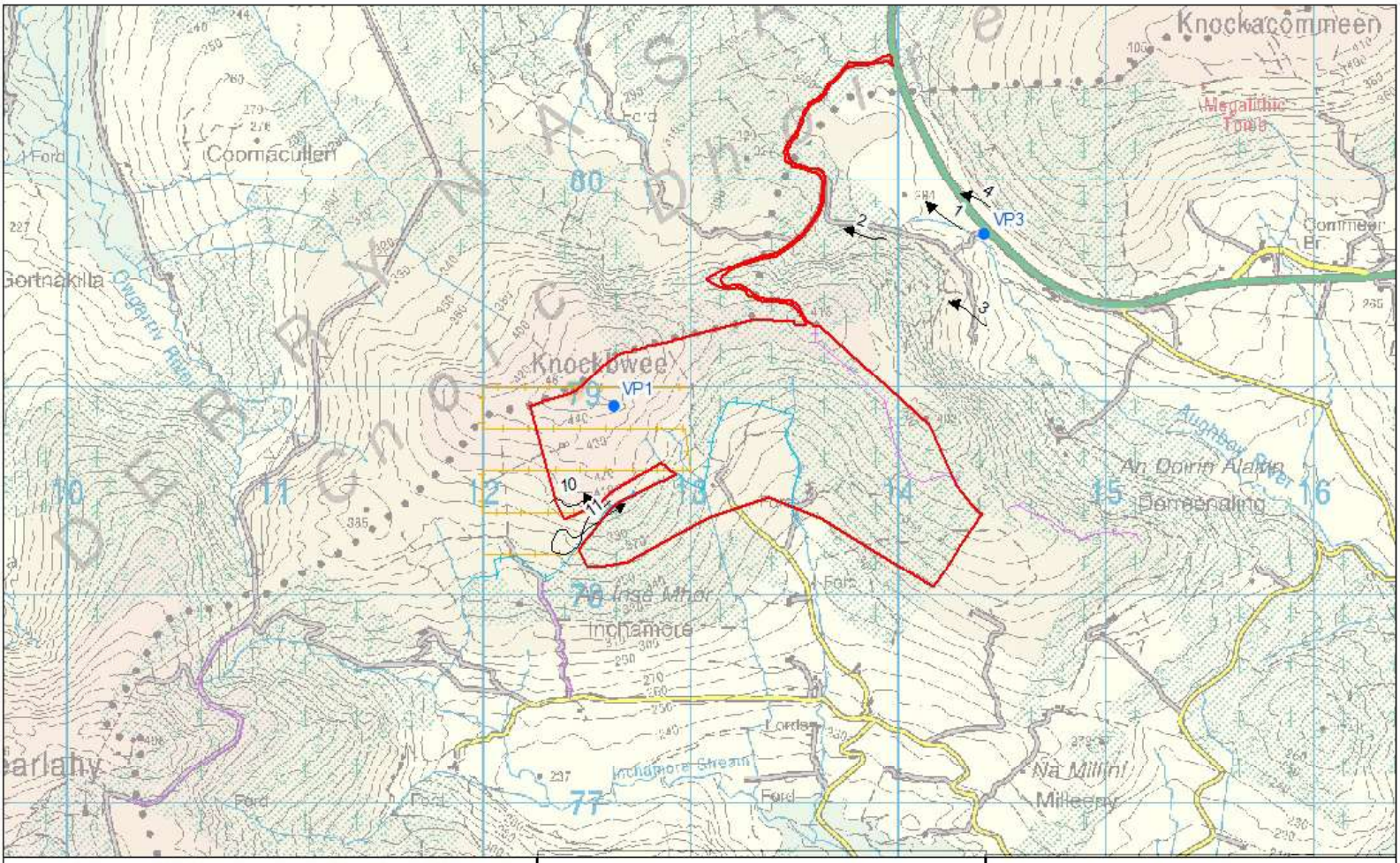
Inchamore Site Boundary
VP Locations
Golden Plover (GP)
Breeding Bird Transects
Merlin Transects
Wader Transects

Inchamore Wind Farm Project
Golden Plover flightlines Winter 2020-2021

0 0.35 0.7 1.4 km

sse Renewables

COILLTE
GROW · TRANSFORM · SUSTAIN



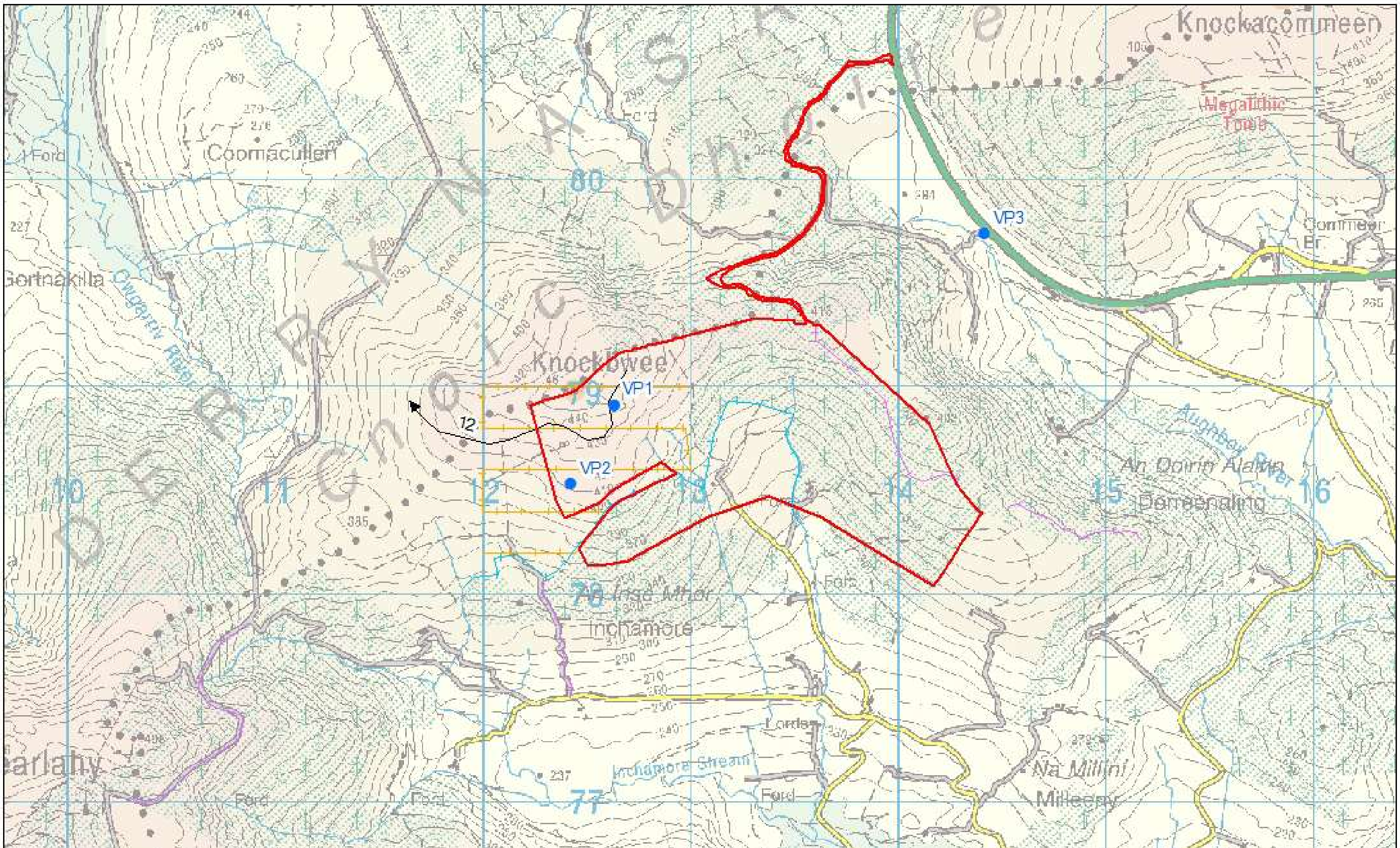
Inchamore Site Boundary
VP Locations
Kestrel (K.)
Breeding Bird Transects
Merlin Transects
Wader Transects

Inchamore Wind Farm Project
Kestrel flightlines Winter 2020-2021

0 0.35 0.7 1.4 km

sse Renewables

COILLTE
GROW · TRANSFORM · SUSTAIN



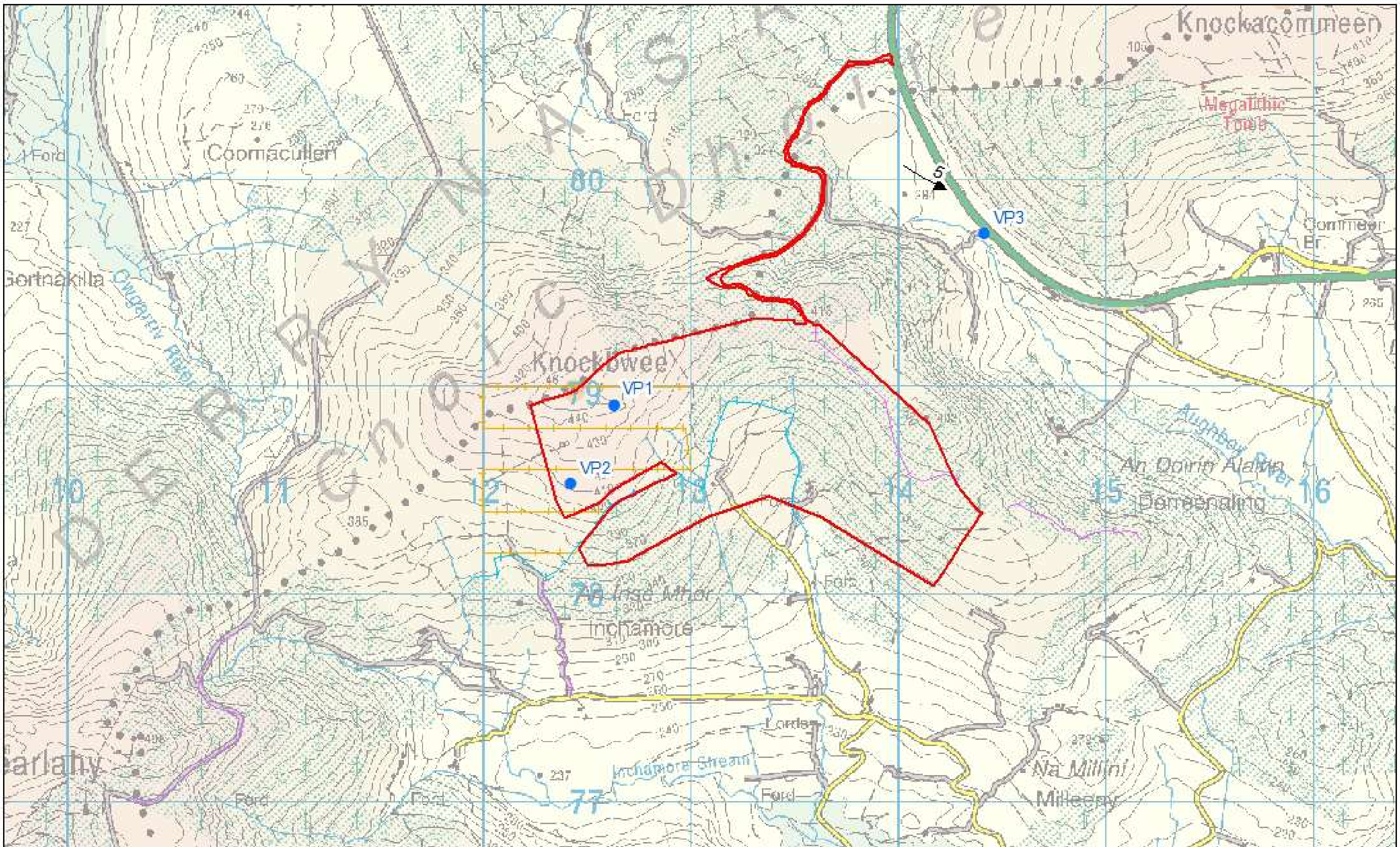
Inchamore Site Boundary	Breeding Bird Transects
VP Locations	Merlin Transects
Peregrine (PE)	Wader Transects

Inchamore Wind Farm Project
Peregrine flightlines Winter 2020-2021

0 0.35 0.7 1.4 km

sse Renewables

COILLTE
GROW TRANSFORM SUSTAIN



Inchamore Site Boundary
VP Locations
Sparrowhawk (SH)
Breeding Bird Transects
Merlin Transects
Wader Transects

Inchamore Wind Farm Project
Sparrowhawk flightlines Winter 2020-2021

0 0.35 0.7 1.4 km

FID	id	VP	TO_co	Date	Time	Flightline
0	0	3	K.	2020-10-09	11:43	1
1	0	3	K.	2020-10-09	16:15	2
2	0	3	K.	2020-10-09	14:28	3
3	0	3	K.	2020-12-09	09:09	4
4	0	1	GP	2021-02-26	10:58	6
5	0	1	GP	2021-02-26	12:50	7
6	0	1	BZ	2021-02-26	15:55	8
7	0	2	BZ	2021-02-28	11:54	9
8	0	2	K.	2021-02-28	12:03	10
9	0	2	K.	2021-02-28	15:25	11
10	0	2	PE	2021-02-28	15:33	12
11	0	2	BZ	2021-02-28	15:36	13
12	0	3	SH	2021-02-04	10:56	5

BTO_name
Kestrel
Kestrel
Kestrel
Kestrel
Golden Plover
Golden Plover
Buzzard
Buzzard
Kestrel
Kestrel
Peregrine
Buzzard
Sparrowhawk

Collision Risk Modelling

Inchamore Wind Farm Development

Inchamore, Coolea, Co. Cork

Compiled by: Veon Ecology,
David M. McGillycuddy B.Sc. (Hons) in Wildlife Biology.

Prepared for: BioSphere Environmental Services.

Completion Date: 2nd March 2023

Table of Contents

Table of Figures

Table of Tables

General Details

Details of Author(s)

Name:	David M. McGillycuddy
Address:	The Yard, Market Yard, Newcastle West, Co Limerick
Company name:	Veon Ltd. Veon Ecology
Tel. no:	M: +353 87 348 9778
E-mail:	dmcgillycuddy@veon.ie
Details of relevant qualifications/ affiliations/years of experience	David M. McGillycuddy B.Sc. (Hons) in Wildlife Biology at MTU, QCIEEM Munster Technological University (MTU) Over 6 years' experience working as an ecologist & wildlife education officer at TBW Eco Centre. Completed several key projects and produced reports regarding Biodiversity Action Plans (BAP), Climate Action Plans (CAP), Natura Impact Statement (NIS), Ecological Impact Assessment (EcIA) & habitat mapping etc.
Describe scope of contribution in preparing this report	Desktop Survey, Collision Risk Modelling, Collision Risk Assessment, Finalising report.

Veon Ltd. Veon Ecology							
Revision	**Description**	**Author:**	**Date**	**Reviewed By:**	**Date**	**Authorised by:**	**Date**
1	Draft Report	DM	31/04/2023	DP	02/05/2023	-	-
2	Final Report	DM	-	-	-	-	-

Executive Summary

This report presents the outcome of a Collision Risk Assessment for target species at the proposed Inchamore Wind Farm Development (Summer 2017 to Winter 2018/2019) located in Inchamore, Coolea, Co. Cork. The contents of this report, prepared by Veon Ecology are true and have been prepared with due regard to the Chartered Institute of Ecology and Environmental Management's (CIEEM) Code of Professional Conduct.

Section 1: INTRODUCTION

1.1 Background

Veon Ltd. (Veon Ecology) has been appointed by BioSphere Environmental Services, to carry out a Collision Risk Assessment for target bird species at the proposed Inchamore Wind Farm Development in Inchamore, Coolea, Co. Cork. This Assessment uses standardised Collision Risk Modelling (CRM) methods.

This document has been prepared by David M. McGillycuddy of (Veon Ecology) Veon Ltd. to assess the collision risk for birds (i.e. target species) at the proposed Inchamore Wind Farm Site. The collision risk assessment, prepared by David M. McGillycuddy B.Sc. (Hons) in Wildlife Biology at MTU, QCIEEM, is based on vantage point surveys undertaken at the development site from the breeding and wintering seasons of 2017 - 2019 inclusive. The data represents a 24-month survey period, consisting of two breeding seasons and two non-breeding (wintering) seasons, in full compliance with the Scottish Natural Heritage guidelines SNH (2017).

Surveys were undertaken from April 2017 to March 2019, from three fixed Vantage Point (VP) locations, (i.e. VP1 – VP3) (**See Appendix 1**). The locations of these VPs were strategically positioned to provide the maximum viewshed of the survey area from the minimum number of locations. Bird data gathered from VP3 was not included in the Collision Risk Modelling (CRM) calculations as this VP did not contribute any coverage to the proposed locations of the Inchamore turbines.

Collision risk is calculated using a mathematical model to predict the numbers of individual birds, of a particular species (i.e. target species), that may be collide with moving wind turbine rotor blades. The modelling method and calculations used in this collision risk assessment follows Scottish Natural Heritage (SNH) guidance often referred to as the Band Model (Band et al. 2007). The calculations and results attained from the Band model must be interpreted with a degree of caution. The bird occupancy method (SNH, 2000) was used to calculate the number of bird transits through the rotors, and the spreadsheet accompanying the SNH report was used to calculate collision probabilities for birds transiting the rotors occupied space.

This collision risk modelling used data from vantage point (VP) surveys carried out in the summers of 2017 and 2018, and winters of 2017/2018 and 2018/2019. VP surveys were SNH (Scottish Natural Heritage) compliant (SNH, 2017). Eight target species were recorded in flight within the study area during survey work. These include the following species Common Kestrel, Eurasian Sparrowhawk, White-tailed Eagle, European Golden Plover, Hen Harrier, Merlin, Peregrine Falcon and Common Buzzard. Two of the target species (White-tailed Eagle and European Golden Plover) recorded were present during the winter surveys only and two (Peregrine Falcon and Common Buzzard) were present during the summer surveys only, while the remaining four (Common Kestrel, Eurasian Sparrowhawk, Hen Harrier and Merlin) were present throughout the year.

Two stages are involved in the model:

- **Stage 1:** This includes the estimation of the number of birds or flights passing through the wind turbines rotor blades swept air space. Two forms of collision risk modelling are considered when referencing the Band Model. These are referred to as the "Regular Flight Model" and the "Random Flight Model". Transits are calculated in this assessment using the "Random Flight" model, due to the bird flight distribution and behaviour recorded.

- **Stage 2:** This includes the calculation of the probability of a bird strike occurring with rotor blades. The probability is calculated using a statistical spreadsheet which considers the turbine parameters and avian biometrics. This spreadsheet is publicly available on the SNH website (https://www.nature.scot/wind-farmimpacts-birds-calculating-probability-collision).

The results of Stage 1 and Stage 2 modelling gives a theoretical annual collision mortality rate and is based on the assumption that birds (i.e. target species) make no attempt to avoid colliding with the proposed turbines. Thus, an informal third stage is applied to the Stage 1 and Stage 2 results.

The final stage of the assessment provides for a "real life" scenario, i.e. to account for the avoidance measures taken by each bird species, worked out as a percentage applied to the stage 1 and 2 results. Birds usually demonstrate high rates of avoidance (i.e. 95-99%) according to SNH (2018). This final stage as a result is typically the most important feature of collision risk modelling.

The Band Model values are solely speculative and representative of worst-case scenario estimates, only drawing conclusions by assuming likely levels of active avoidance by specific species. As such, results obtained are dependent on the quality of field observation data and accuracy of the avoidance rates used and must therefore be interpreted with a certain degree of caution.

1.2 Proposed Development and Site Description

The proposed Inchamore wind farm development is located at Inchamore, Coolea, Co. Cork, approximately 5km west of Ballyvourney. The proposed development site comprises of c. 167 hectares and lies in close proximity to the Cork-Kerry county border. The receiving environment for the proposed wind turbine locations is representative of upland habitats and includes lands under active management for forestry and agriculture. The proposed development site is located in close proximity to other constructed windfarm developments (Grousemount, Midas & Foilgreana Wind Farm).

The proposed wind farm design on which this CRM is based, is comprised of five WTG turbines (Candidate Models: Siemens Gamesa SG 6.6 – 155, Nordex N149/5.X and Vestas V150). The Collision Risk Assessment (CRA) makes assumptions on the turbine specifications, such as rotor diameter and rotational speed. Because the final choice of turbine is not known at this stage, the worst-case scenario is assumed. The worst-case scenario is a combination of the maximum collision risk area (affected by hub height and rotor blade length), maximum number of turbines proposed and minimum turbine downtime (i.e. non-operational time) using the specifications of the candidate WTG turbines. Turbine specifications for the proposed Inchamore Wind Farm development site used as per this CRM are shown below in **Table 1.1**.

Table 1.1: Wind turbine specification and Wind farm Parameters for Inchamore Wind farm development.

Wind Farm Components/Turbine Parameters	
Technical Information and Wind Farm Component	**Data used/Scenario Modelled**
Turbine model	Siemens Gamesa SG 6.6 – 155
Number of turbines	5
Number of blades per turbine rotor	3
Rotor blade maximum chord (m) (i.e., depth of blade)	4.5m
Blade Length (m)	76m
Rotor radius (m)	77.5m
Rotor diameter (m)	155m
Circumference of blade tip (m) (Pi x Rotor Diameter)	486.7m
Swept area (m^2)	18,859.6
Turbine height (m)	180m
Hub height (m)	102.5m
Swept height (m)	25-180m
Maximum height to blade tip (m)	180m
Minimum height to blade tip (m)	25m
Max Tip Speed (m/s)	0.724256m/s
Rotation speed (rpm)	11.2rpm
Rotation period (s) (i.e., seconds per rotation)	5.3571s
Turbine operation time*	85%
Mean pitch angle of the blade during normal operation (degrees)**	13°

* The European Wind Energy Association (2016) provides an average operation time of a turbine of between 70% and 85%. In following the precautionary principal approach this CRM uses the 85% figure.

** The pitch angle of the turbine blade is determined by wind speed, which is variable depending on several factors including, location, local topographic, landscape etc. To maintain a constant operating speed the pitch angle of the blade is altered. The pitch angle of the turbine blade is greater in higher wind speeds to "feather" the wind in order to control rotation speed. The figure of 13° used in this assessment is derived from specifications provided by the client which advocates an average pitch of between 6 – 13 degrees along the length of the turbine blade. In following the precautionary principal approach, the greater 13° figure has been adopted as part of this model.

1.3 Statement of Authority

David M. McGillycuddy B.Sc. (Hons) in Wildlife Biology at MTU, QCIEEM is a qualified ecologist with over 6 years of experience working in the field of ecological research, teaching, and assessment. David is proficient in experimental design and data analysis and has managed a range of large-scale, multi-disciplinary ecological projects. These have included research and targeted management work for species of conservation concern, the design and delivery of practical conservation actions with stakeholders, education and interpretation on the interface between people and the environment and the development of co-ordinated, strategic plans for biodiversity.

David is an ecologist with Veon Ltd. and Veon Ecology and is experienced in several key environmental projects and the production of ecological reports regarding Biodiversity Action Plans (BAP), Climate Action Plans (CAP), Natura Impact Statement (NIS), Ecological Impact Assessments (EcIA), etc.

1.4 Data Sources

The following data and information were provided for this collision risk assessment:

- Data outlining all observations of flight activity recorded during the VP surveys.
- Mapping of the proposed turbine locations.
- Technical specifications for the proposed candidate WTG turbines.
- GIS mapping of flight lines recorded during the summers of 2017 and 2018 and winters of 2017/2018 and 2018/2019 VP surveys.
- Clarification about survey methodology.
- Mapping of the VP locations.

All of the survey data used in this assessment was provided externally by Wetlands Surveys Ireland. Additional information, including technical details (e.g. turbine specifications) were provided by the client.

1.5 Target Species

The key target species were selected in line with SNH (2017) guidance, thereby enabling VP surveys to focus on the species of greatest importance. In general target species are those species that are afforded a higher level of legislation protection and also includes species which are more likely to be subject to impact from wind farms, e.g., breeding and non-breeding species forming qualifying features for nearby SPAs or species listed on Annex I of the Birds Directive.

The following species recorded flights within the rotor swept height and inside the 2km arc of the selected vantage points during the VP surveys across 2017, 2018 and 2019:

- Common Buzzard (*Buteo buteo*)
- Common Kestrel (*Falco tinnunculus*)
- European Golden Plover (*Pluvialis apricaria*)
- Hen Harrier (*Circus cyaneus*)
- Peregrine Falcon (*Falco peregrinus*)

Other species of conservation concern were recorded in the vantage point surveys but were excluded from consideration in the collision risk analysis due to the following reasons:

Eurasian Sparrowhawk (*Accipiter nisus*) were not recorded flying within the collision risk height band. Thus, for this species, the collision risk can be assumed to be effectively zero excluding them from further consideration in the analysis.

Merlin (*Falco columbarius*) were only recorded flying within the collision risk height band from VP 3. VP 3 has been excluded from the analysis, as the viewshed does not include any of the proposed turbine locations. Since there are no turbines located within this viewshed, the predicted number of collisions is zero.

White-tailed Eagle (*Haliaeetus albicilla*) were recorded within the potential collision risk height bands from VPs 1 and 2. Although White-tailed Eagle was recorded within the collision risk height bands, the total flight time of these recordings does not exceed 70 seconds (No. 2 observations). Therefore, this species has been excluded from the analyses due to the low level of flight activity recorded.

1.6 Seasonal Definitions

For the species modelled (i.e. Common Buzzard, Common Kestrel, European Golden Plover, Hen Harrier and Peregrine Falcon), the CRM was constructed using data from the relevant breeding and non-breeding season periods, as defined by NatureScot in relation to Scotland and British Trust of Ornithology (BTO) which is also broadly applicable to Ireland.

The data used in this CRM was collected over a period of 24 months from April 2017 to March 2019 inclusive, thereby providing data for two breeding season cycles and two winter cycles for the target species. For each target species included in the CRM, collision risk predictions were calculated for both relevant seasonal periods within each 12-month cycle (see **Table 1.2** for the seasonal divisions for each species). The sum of these separate summer and winter CRM results was taken as the predicted annual collision risk rather than using results from a single all-year CRM. This method minimised any potential biases that may arise from seasonal variation in daylength and the number of hours of activity available to each species in each month. This was to increase precision of the CRM and to ensure that any potential underestimation or overestimation for a species risk of collision was minimised as much as possible.

Table 1.2: Seasonal divisions of relevant target species.

Species Name	Breeding season start	Breeding season end	Non-breeding season start	Non-breeding season end
Common Buzzard	April	August	September	March
Common Kestrel	April	August	September	March
Golden Plover	April	August	September	March
Hen Harrier	March	August	September	February
Peregrine Falcon	March	August	September	February

The number of hours that birds are potentially active during the day for the breeding and non-breeding season forms part of the CRM model. This is calculated as 15 hours per day for the summer survey period (i.e. the breeding season) and 10 hours per day for the winter survey period (i.e. the non-breeding season). These figures of activity are based on the average calculation of daylight minutes within the season of analysis and are likely to be over-estimated. These figures would be difficult to quantify in simple terms otherwise, although, the use of an over-estimation of species activity time increases the likelihood of a collision as birds are considered to be more active (i.e. increased flights) than if activity hours were reduced. This approach therefore offers an additional precaution in determining collision risk, and therefore a more robust estimation for collision risk assessment.

The hours that a species may potentially be active was calculated to include daylight, one hour before sunrise, and one hour after sunset (dusk) for all species with the exception of golden plover. For this species it was calculated as daylight, one hour before sunrise, one hour after sunset (dusk), and 25% of the night (SHN, 2017). These flight activity hours were calculated from timeanddate.com.

1.7 Limitations and Constraints

There are a number of limitations and constraints associated with pre-planning ecological assessments for potential development sites, as well as constraints and limitations inherent to the collection and analysis of field-based ecological data. The field survey data evaluated as part of this Collision Risk Assessment was received from Wetland Surveys Ireland. The data comprised of the following:

- Bird flight data from timed Vantage Point surveys. This data consisted of flights within the rotor-swept height bands. The vantage point surveys recorded flight heights in five bands: 0-20 m; 20-40 m; 40-80 m; 80-150 m and > 150 m. The 20-40 m; 40-80 m; 80-150 m and > 150 m height bands have been taken to represent the flight activity within the potential collision risk height zone. Flight duration (in seconds) for all bird observations along with data relevant to each flight record (date, weather conditions, timing, VP number (location), etc.) were provided.

- Vantage Point survey effort data (i.e. hours of observations) on a monthly basis during the summer and winter seasons of 2017 - 2019 (April 2017 to March 2019 inclusive) for all VP survey work undertaken.

- Description and metrics for the wind farm as a whole as well as for individual turbine parameters.

- Area viewed from each vantage point.

This CRM relates specifically to the provided vantage point survey data which has not been independently validated by the author of this report. Any variation in the coverage of the vantage points surveyed during fieldwork, flight data, layout of the wind farm/turbine locations as well as the individual turbine specifications would require the outputs from this CRM to be amended.

For field-based surveys, the availability of suitable weather conditions is important with good visibility and little wind or rain. The flight data used as part of this CRM was collected during optimal weather conditions, as determined by Best Practice guidance. As a result, this required the re-arrangement of monthly schedules in some circumstances, with certain VPs being additionally surveyed in one month to compensate for months when no survey work took place. These alterations in survey schedules are indicated within the data provided. It should be noted that these scheduling re-arrangements are still in line with Best Practice guidelines which requires a minimum coverage or two years of data. The requirement in the SNH (2017) guidance is for 36 hours of VP survey effort per season. For a single species, this is equivalent to 72 hours of VP survey effort per year.

There were a small number of flights for which the number of birds, or duration of flight, were not recorded. Where the number of birds was not recorded, it is assumed that the flight referred to a single bird. Where the duration was not recorded, the mean flight duration for that species was used (in the relevant season, if there was sufficient data, or across the entire dataset).

In regard to the Band Model, two forms of collision risk modelling are typically considered. These are generally referred to as the "Regular Flight Model" and the "Random Flight Model". The "Regular Flight Model" is generally applied to flightlines which comprise of a more regular pattern such as a commuting corridor between feeding grounds, migratory routes and roosting sites. As a result, the "Regular Flight Model" is typically more relevant for aquatic bird species, particularly swans and geese. The alternative "Random Flight Model" is more relevant for species and scenarios whereby no apparent flight routes or patterns can be associated with a species within the survey area. Thus, Random flights is most prevalent when investigating hunting or foraging flight behaviour.

Collision Risk Modelling (CRM) adopts a mathematical approach to determining the probability of a bird species colliding with wind turbine rotors at a pre-defined site and is described in detail by Band *et al*. (2007) and Scottish Natural Heritage (SNH, 2000), with additional supporting information provided by Scottish Natural Heritage (SNH, 2018).

This report is based upon field data collected at the Inchamore wind farm development, located at Inchamore, Coolea, Co. Cork, approximately 5km west of Ballyvourney. The proposed development site comprises of c. 167 hectares and lies in close proximity to the County Cork/Kerry border. The receiving environment for proposed wind turbine locations is representative of upland habitats and includes lands under active management for forestry and agriculture. The resulting output from the model indicates the number of birds likely to collide with rotors of all 5 turbines within the proposed wind farm development per year of operation of the overall wind farm as a whole. The inverse of this (i.e. the number of years over which a single fatality would be likely) is additionally calculated.

The "**Random Flight Model**" examines the predicted number of transits through the windfarm site with regard to all flights recorded within the viewshed (i.e. a 2km arc of the vantage point) as randomly occurring. The random flight model therefore assumes that any observed flight could occur both within and outside of the wind farm site with equal likelihood. The viewshed of a given VP should extend to a distance no greater than 2km and include an arc of no greater than 180 degrees, as per the SNH (2017) guidelines. Any flights recorded within the rotor swept height and inside the 2km arc of the vantage point are included in the model.

The Random Flight Model has a number of limitations and assumptions.

- Both habitat and bird activity will remain the same over time and be unchanged during the operational stage of the proposed windfarm development.

- Bird activity is not spatially explicit, i.e. bird activity is equal throughout the viewshed area and this is equal to activity in the proposed windfarm development area.

- All flight activity used in the model occurred within the viewshed area calculated at the lowest swept rotor height. (e.g. if the lowest swept height of the turbine blade is 20m, the viewshed coverage displaying the visibility of the area within the 2km arc at a height of 20m above ground level is used). All flights are assumed to have occurred within this visible area, although many are likely to have been above this. The calculation for survey area visible (AVP) from each VP in the model is therefore highly precautionary as it is likely to have been a larger area of coverage for much of the flight activity.

The "**Regular Flight Model**" examines the predicted number of transits through a cross-sectional area of the windfarm which represents the width of the commuting corridor. A "risk window" comprises of a 2-dimesional line which represents the width of the windfarm in addition to a 500m buffer for each of the turbines, multiplied by the rotor diameter. All flights which pass through the identified risk window, within the swept height of the turbines, are included in the collision risk modelling. Any regular flights more than 500m from the turbine layout can be excluded from analysis.

The Regular Flight Model has a number of limitations and assumptions.

- Firstly, that the turbine rotor swept area is 2-dimensional, i.e. there is a single row of turbines in the windfarm. This represents all turbines within the commuting corridor accounted for by a single straight-line.

- It is assumed that bird activity is spatially explicit.

- Birds in an observed flight only cross the turbine area once and do not pass through the cross-section a second time (or multiple times).

Further details regarding both the Random and Regular Flight Model calculations are available on the SNH website. https://www.nature.scot/wind-farm-impacts-birds-calculating-theoreticalcollision-risk-assuming-no-avoiding-action.

The data used as part of the model, such as the number, size, dimensions and likely functioning of the proposed turbines for the Inchamore Wind Farm Development Site (See **Table 1.1**) forms part of the calculations, along with the available bird biometric data (See **Table 1.2**). These values are modelled with the standardised field data collected using Best Practice methods on surveying birds flight activity within the proposed Inchamore Wind Farm Development Site.

The data is collectively modelled to predict the number of bird flights through the rotors of all turbines within the site on an annual basis (CRM Stage 1) as well as the probability that a bird flying through the turbine will collide with the rotors (CRM Stage 2). The product of the numerical output from these two stages of assessment then predicts the number of birds likely to collide with the rotors of the turbines if no avoiding action is taken. This value is then corrected using the available avoidance rates (CRM Stage 3), to give a final indication of collision risk (number of bird colliding with the turbine rotors per annum).

The steps used to derive the collision risk for birds observed at the proposed development according to the Band Model are summarised below:

- Stage 1 (Band model): this model uses observations of birds flying through the study area during vantage point surveys to calculate the number of birds estimated to fly through the proposed turbines blade swept areas.

- Stage 2 (Band model): this model calculates the collision risk for an individual bird flying through a rotating turbine blade. The collision risk depends on the flight behaviour and biometrics.

- The result of the number of birds calculated to fly through the turbines annually is then multiplied by the collision risk probability. This calculation gives the worst-case scenario and assumes that birds flying through the site make no attempt to avoid turbines.

- Stage 3: An avoidance factor is applied to the result of the collision risk model to account for avoidance of the turbine rotors by bird species. Avoidance rates are available from SNH online bird collision risk guidance (SNH 2018). This avoidance rate corrects for the ability of the birds to detect and move around the turbines. This final output after all steps of modelling is a real-world estimation of the number of collisions that may occur at the proposed wind farm based on observed bird activity during the survey periods.

Several assumptions were made in the calculation of collision risk for the proposed Inchamore Wind Farm Development. These assumptions are tailored specifically to Inchamore Wind Farm Development and are as follows:

- Birds in flight within the study area at heights greater than 20m above ground level are assumed to be in danger of collision with the rotating turbine blades.

- No preference was taken for birds using gliding or flapping flight through the study area for target species as they exhibit both behaviours. In the calculation of the percentage risk of collision for a bird flying through a rotating turbine, the mean of the worst-case scenario (i.e. a bird flying upwind through a turbine using flapping flight whilst the turbine is at its fastest rotation speed) and the best-case scenario (i.e. a bird flying downwind through a rotating turbine using a gliding flight whilst the turbine at its slowest rotation speed) has been used for birds which exhibit both flapping and gliding flight. However, for Golden Plover (*Pluvialis apricaria*) only the mean calculations for flapping flights were used.

The Collision Risk Assessment (CRA) also makes assumptions on the turbine specifications, such as rotor diameter and rotational speed. Because the final choice of turbine will not be known until a later stage in the planning process, the worst-case scenario is assumed. The worst-case scenario is a combination of the maximum collision risk area (i.e. swept area determined by hub height and rotor blade length), maximum number of turbines proposed and turbine operational time. The turbine and wind farm characteristics for the purposes of this assessment at the proposed Inchamore Wind Farm Development Site are presented in **Table 1.1**.

2.1 Determination of Bird Flights Through the Rotor Swept Area

Stage 1 of the CRM determines the number of transits through the rotors for a given period or season. For the calculations below, this is expressed as the number of birds flying through the rotors per season (Breeding and Non-breeding).

Flight data was recorded at fixed vantage point locations from April 2017 to March 2019 inclusive and the data was provided to Veon Ecology to undertake the Collision Risk modelling for the relevant target species. A potential collision risk height (PCH) of between 20m and 180m above ground was established based on the proposed turbines having a maximum blade tip height of 180m, and a rotor diameter of 155m. This ensured that the PCH was within the rotor sweep of the turbine but also, slightly overestimates the risk of collision as it greater than the actual turbine swept area. The flight height of species was classified into height bands (HB) as follows: HB1 = 0-20m, HB2 = 20-40m, HB3 = 40-80m, HB4 = 80-150m, HB5 = 150m+. Behavioural observations were also recorded with the minimum requirement of 36 hours per VP per season (breeding and non-breeding) and 72 hours of VP survey effort per year achieved.

The VP Arc for each VP is a 180° arc with a radius of 2km from the vantage point location, which represents the theoretical maximum coverage area. The viewshed represents the actual area visible to the surveyor at a specified height above ground level from the vantage point location within each VP Arc. GIS computer software was used to generate the viewsheds for each VP. Flight data from the viewshed mapping for each VP was used to inform this CRM.

In the case of birds observed during surveys for the proposed Inchamore Wind Farm Development, flights recorded from surveys were classified for the purpose of the analysis as "randomly" distributed flights which could occur anywhere within the given viewsheds. The "Random Flight Model" is used in cases of irregular flight activity such as that displayed by raptors occupying a recognized territory, or by waders. This model requires calculation of the proportion of time birds were observed flying per unit of survey area. Therefore the "Random Flight Model" was applied for each target species to calculate the predicted number of transits through the proposed wind farm site.

The proportion of flight time between 20 and 180m for a bird species for each of the VPs was calculated. If multiple birds were observed in one flight, the seconds spent at PCH were calculated by multiplying the number of birds observed per flight by the duration of the flight at PCH (in line with SNH, 2000).

The hours that a species may potentially be active in either a breeding or non-breeding season was calculated to include daylight, one hour before sunrise, and one hour after sunset (dusk) for all species with the exception of Golden Plover. For this species it was calculated as daylight, one hour before sunrise, one hour after sunset (dusk), and 25% of the night (SHN, 2017). These flight activity hours were calculated from timeanddate.com.

Flight activity was used to calculate the number of bird passes through the rotor for each VP in turn and per turbine within each viewshed before being calculated for the entire wind farm. The Stage 1 calculation was carried out for each season (i.e. breeding and wintering) for each species.

2.2 Probability of Collision of Birds Passing Through the Rotor Swept Area

The probability of a birds flying through the rotors and colliding with the turbine blades is determined in Stage 2 of the CRM. The probability of a collision depends on the species biometrics including size (both length and wingspan) and average flight speed. In order to simplify the calculations for this CRM, all birds are assumed to be of simple cruciform shape, with the wings half-way down the length of the body. Characteristics of the turbine and rotor blades are also required as part of the calculations, including the pitch and width of the turbine rotor blades and the rotation speed of the proposed turbines. For Stage 2 of the CRM, the turbine rotor blades are assumed to have no thickness, although the blade depth is considered in Stage 1 of the model.

The risk of a bird colliding with the turbine rotor blades changes depending upon whether the bird passes through the rotor swept area towards the tip of the blade (where the blades are only present for a small proportion of the time, having a short chord width and a faster rotational time) or next to the turbine hub (where the blades have a wider chord width, occupy a larger volume of airspace and are travelling at slower speeds). Towards the blade tips, it is the length of the bird that offers greater contribution to the determination of the risk of collision. Closer to the turbine hub, the wingspan of the bird compared to the physical distance between the blades is the controlling factor. The bird is assumed to enter the rotor swept area at random anywhere along the disc.

The calculations determine the collision risk at several locations along the length of the rotor blade (in intervals of 0.05R, where R is the radius of the rotor swept area) using numerical integration of various elements in relation to the rotors (notably angular velocity of the blade and chord width) and the bird (such as the point at which the bird enters the rotor along the radius and the flight speed of the bird). These are calculated for both downwind and up-wind flights and averaged to give a probability of collision per season, assuming no avoiding action is taken.

The calculations are performed in the SNH collision risk model, where the relevant data on the turbines and bird biometrics are entered into the model, and the model estimates the probability of a collision when a bird flies through the rotor area. This calculation is based solely upon the behaviour and biometrics of the bird and the specifications of the turbines proposed at the Inchamore site.

For the Inchamore Wind Farm development site, the average probability of each species passing through the wind farm and colliding with the rotors if it takes no avoiding action is presented in **Table 3.4**.

Section 3: RESULTS

The Collison risks were calculated using flight data recorded during vantage point watches at three fixed vantage point locations (VP1-VP3) within the study area between April 2017 and March 2019. The target species recorded within the potential collision risk zone included Common Buzzard (*Buteo buteo*), Common Kestrel (*Falco tinnunculus*), European Golden Plover (*Pluvialis apricaria*), Hen Harrier (*Circus cyaneus*) and Peregrine Falcon (*Falco peregrinus*).

The calculation parameters are outlined in **Tables 3.1, 3.2** and **Table 3.3**. A worked example of the calculation of collision risk for Hen Harrier is available in Appendix 4. **Table 3.1** below presents the details on the viewshed area for each VP.

Table 3.1: Summary of CRM parameters for VPS at Inchamore Wind Farm.

Vantage Point	VP Arc (ha)	Viewshed area within VP Arc (ha)	Viewshed Coverage (%)	Turbine Buffer Area Within Viewshed (ha)	No. of Turbines Within Viewshed	Total Survey Effort (hrs)
VP 1	628	400	63.69	274.18	4	147.75
VP 2	628	376	59.87	128.98	2	153.5
VP 3	628	306	48.73	58.5	0	139.13

Species-specific morphometric measurements, flight speeds and avoidance rates are shown in **Table 3.2.** The amount of time a species was observed flying at heights of between 20 - 180 metres, i.e. within the Potential Collision Height (PCH), is presented in **Table 3.3** below. Birds in flight within the study area at heights between 20m and 180m are assumed to be in danger of collision with the rotating turbine blades. This is a precautionary approach as the lower extent of the swept area of the turbine blades will be greater than 20m.

Table 3.2: Avian Biometric Data and Avoidance Rates.

Avian Biometric Data and Avoidance Rates				
Species Name	Length (m)	Wingspan (m)	Mean flight speed (m/s)	Avoidance rates (%)
Common Buzzard (*Buteo buteo*)	0.54	1.2	13.3	98
Common Kestrel (*Falco tinnunculus*)	0.34	0.76	10.1	95
European Golden Plover (*Pluvialis apricaria*)	0.275	0.715	17.9	98
Hen Harrier (*Circus cyaneus*)	0.48	1.1	12	99
Peregrine Falcon (*Falco peregrinus*)	0.42	1.02	12.1	98

Table 3.3: Bird biometrics and bird-seconds spent by species at Potential Collision Height (20-180m).

Seconds spent at PCH (2017-2019)							
Species Name (BTO Code)	Seconds in flight at PCH (20-180m)						Total secs at PCH over 24 Months
	2017/2018			2018/2019			
	Summer	Winter	Total	Summer	Winter	Total	
Buzzard (BZ)	0	0	0	93	0	93	93
Kestrel (K.)	60	0	60	2,360	504	2,864	2,924
Golden Plover (GP)	0	61,363	61,363	0	7,725	7,725	69,088
Hen Harrier (HH)	0	6	6	156	25	181	187
Peregrine (PE)	0	0	0	530	0	530	530

Table 3.4: Number of collisions predicted for target species without the application of avoidance rates.

Species	Year	Predicted collisions per season without avoidance rates applied		
		Breeding	Winter	Total
Common Buzzard	2017/18	0.000	0.000	0.000
	2018/19	1.24	0.000	1.24
Common Kestrel	2017/18	0.82	0.000	0.82
	2018/19	23.67	17.22	40.89
European Golden Plover	2017/18	0.000	4164.86	4164.86
	2018/19	0.000	423.49	423.49
Hen Harrier	2017/18	0.000	0.06	0.06
	2018/19	0.000	0.25	0.25
Peregrine	2017/18	0.000	0.000	0.000
	2018/19	6.15	0.000	6.15

Table 3.5: Number of collisions predicted for target species with the application of avoidance rates.

Species	Year	Predicted collisions per season with avoidance rates applied			Predicted collisions over 30-year lifetime of the windfarm		
		Breeding	Winter	Total	Breeding	Winter	Total
Common Buzzard	2017/18	0.000	0.000	0.000	0.000	0.000	0.000
	2018/19	0.012	0.000	0.012	0.372	0.000	0.372
Common Kestrel	2017/18	0.008	0.000	0.008	0.247	0.000	0.247
	2018/19	0.237	0.172	0.409	7.100	5.166	12.266
European Golden Plover	2017/18	0.000	41.649	41.649	0.000	1249.459	1249.459
	2018/19	0.000	4.235	4.235	0.000	127.046	127.046
Hen Harrier	2017/18	0.000	0.001	0.001	0.000	0.017	0.017
	2018/19	0.000	0.002	0.002	0.000	0.075	0.075
Peregrine	2017/18	0.000	0.000	0.000	0.000	0.000	0.000
	2018/19	0.062	0.000	0.062	1.846	0.000	1.846

Table 3.6: Mean number of collisions predicted for target species with avoidance rates.

Target Species Biometrics			
Species Name	Mean no. of predicted collisions per year	Mean no. of predicted collisions per 30 years	Equivalent to 1 bird every x (years)
Buzzard (BZ)	0.006	0.019	166.6
Kestrel (K.)	0.209	6.257	4.8
Golden Plover (GP)	22.942	688.253	0.04
Hen Harrier (HH)	0.002	0.046	500
Peregrine (PE)	0.031	0.923	32.6

Section 4: CONCLUSION

This CRM has been completed for the proposed Inchamore Wind Farm development. The VP survey data used for this CRM was collected over two summer surveys (breeding seasons) and two winter surveys (non-breeding seasons), which meets the requirements of current SNH guidelines.

There are a number of potential sources of uncertainty/error that apply to all CRM analyses. The main potential source of error is the accuracy of the surveys and flight activity data, which will affect the accuracy of the predicted transit rate, and the simplification involved in the calculations of collision probabilities.

The Band method used for this collision risk model is developed using several assumptions, particularly regarding bird characteristics and behaviour, and relies on the accuracy of the available information regarding species avoidance rates, turbine specifications, and survey data. As a result of these limitations and assumptions in relation to the CRM, the predicted collision risk should be considered only an indication of the potential collision risk significance for each target species.

The output of the first two stages of the model presents the number of predicted bird collisions with the proposed wind turbines per annum. This is the result of the number of bird transits through the rotor occupied space per season and the probability of a bird passing through the rotor swept area colliding with the turbine blades.

In the present assessment, the predicted collision risks are very low for all the target species, with only Golden Plover and Kestrel, being predicted to have any collisions within the nominal 30 year. Thus, the only species that are likely to have significant levels of collisions are Common Kestrel (*Falco tinnunculus*) and European Golden Plover (*Pluvialis apricaria*). It is clear from the VP surveys that there is a considerable amount of Golden Plover activity in the area during the non-breeding seasons with much of it seemingly at the Potential Collision Height (i.e. 20-180m). However, as discussed above, collision risk modelling is dependent on many assumptions and can be prone to biases.

The Kestrel, a year-round resident of the area, has a prediction of over six collisions every 30 years. However, this value is also liable to be rather tenuous as a large percentage of recorded kestrel flight activity likely involved hovering birds which suggests that the mean kestrel flight speed used in this CRM (i.e. 10.1 m/s) will not be a true indication of the mean flight speed of the kestrels observed during the surveys. Kestrels fly relatively quickly between hovering spots which may lead to an underestimation of their speed resulting in a greater predicted risk of collision than would likely occur in "real-life" scenarios.

It is most notably the flocking species of Golden Plover which are at the greatest potential risk of impact. With more than 688 collisions predicted every 30 years, Golden Plover is by far the species with the highest predicted collision risk output (See **Table 3.6**). Further assessment of the potential collision risk of Golden Plover at Inchamore is advised due to the potential high level of collisions indicated by this CRM. However, as the Golden Plover recorded are part of a wintering population, a single all-year CRM is likely to overestimate the collision risk of the species. The main activity area for Golden Plover lies within the viewsheds for VP 1 and 2, however, the entire turbine envelope does not occur within these viewsheds. The mean flock size recorded across the 2017/18 and 2018/19 winter seasons was of c. 25 individuals (a total of 21 observations comprising 533 individuals in total, with the peak flock size of 70 birds recorded in January 2018). It should be noted that the amount of time at collision risk height has been derived as a product of flight duration and the number of individuals in the flock. Furthermore, given the apparent random nature of golden plover flights, all of those observed within each viewshed (1 and 2) at collision risk height have been included in the CRM, including flights "out" of the collision-risk area. As such, the results of the CRM are likely to over-estimate the theoretical collision risk for Golden Plover.

In conclusion and with regard to the limitations and assumptions presented by collision risk modelling, the resulting predicted collisions should only be considered an indication and not a definitive result. Thus, the outputs of the collision risk modelling should be used solely as a comparative tool rather than an accurate indicator of bird mortality risk. Therefore, it is advised to interpret the results of CRM analyses as indicating only the order of magnitude of the predicted collision risk for given target species.

Section 5: REFERENCES

Alerstam, T., Rosén, M., Bäckman, J., Ericson, P.G. & Hellgren, O. (2007). Flight speeds among bird species: allometric and phylogenetic effects.

Band, W., Madders, M. and Whitfield, D.P. (2007). Developing field and analytical methods to assess avian collision risk at wind farms. In: Birds and wind power: risk assessment and mitigation. M. DeLucas, G.F.E. Janss and M. Ferrer, Eds.: 259-275.

Chamberlain, D.E., Rehfisch, M.R., Fox, A.D., Desholm, M., Anthony, S.J. 2006. The effect of avoidance rates on bird mortality predictions made by wind turbine collision risk models.

Cramp, S. (1993) Handbook of the Birds of the Western Palaearctic. Oxford University Press, Oxford.

Drewitt, A. & Langston, R. (2006). Assessing the impacts of wind farms on birds.

European Wind Energy Association. 2020. Wind energy's frequently asked questions (FAQ). EWEA, Brussels.

IWEA (Irish Wind Energy Association). 2012. Best Practice Guidelines for the Irish Wind Energy Industry. IWEA, Co. Kildare.

Madders, M. & Whitfield, P.D. (2006). Upland Raptors and the Assessment of Wind Farm Impacts.

Robinson, R.A. 2005. BirdFacts: profiles of birds occurring in Britain & Ireland. BTO, Thetford (Available at http://www.bto.org/birdfacts).

Ruddock, M., Mee, A., Lusby, J., Nagle, A., O'Neill, S. & O'Toole, L. (2016). The 2015 National Survey of Breeding Hen Harrier in Ireland. Irish Wildlife Manuals 93. National Parks and Wildlife Service, Department of the Arts, Heritage and the Gaeltacht, Ireland.

Scottish Natural Heritage (2000). Windfarms and Birds - Calculating a theoretical collision risk assuming no avoiding action. SNH Guidance Note. Available at http://www.snh.gov.uk/docs/C205425.pdf

Scottish Natural Heritage (2017). Recommended Bird Survey Methods to Inform Impact Assessment on Onshore Wind Farms. Version 2.

Scottish Natural Heritage (2018). Use of avoidance rates in the SNH wind farm Collision Risk Model. Available at: https://www.nature.scot/wind-farm-impacts-birds-use-avoidance-rates-snh-wind-farmcollision-risk-model.

timeanddate.com Sunrise, Sunset, and Daylength. Available at: https://www.timeanddate.com

Wilson, M. W., Irwin, S., Norriss, D. W., Newton, S. F., Collins, K., Kelly, T. C. & O'Halloran, J. 2009. The importance of pre-thicket conifer plantations for nesting Hen Harriers Circus cyaneus in Ireland.

Wilson, M. W., Irwin, S., O'Donoghue, B., Kelly, T. C. & O'Halloran, J. 2010. The use of forested landscapes by Hen Harriers in Ireland. COFORD Connects. Environment No. 10.

Section 6: APPENDICES

Appendix 1. FIGURES AND MAPS

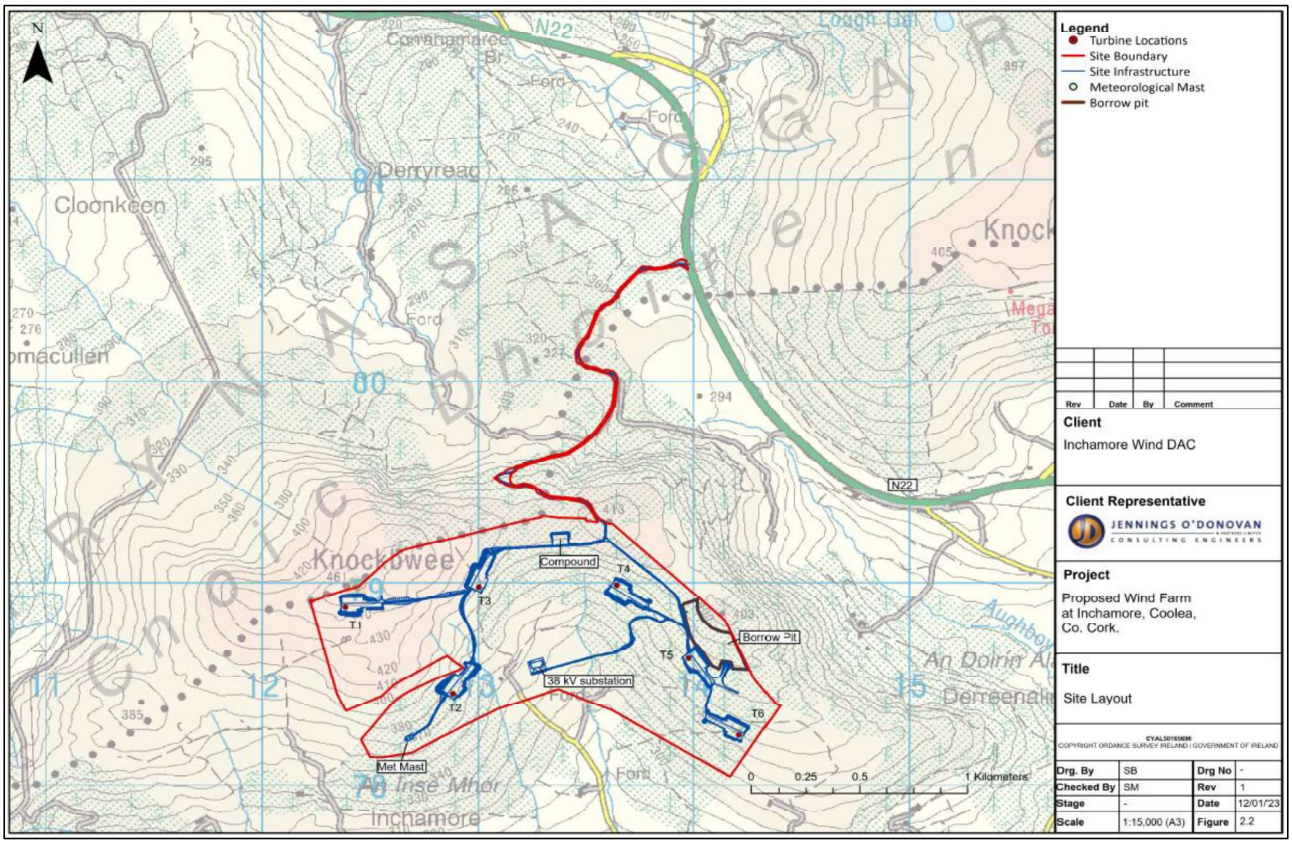


Figure 6.1: Site location and boundary with the outlined area in blue indicating the area proposed for turbines.

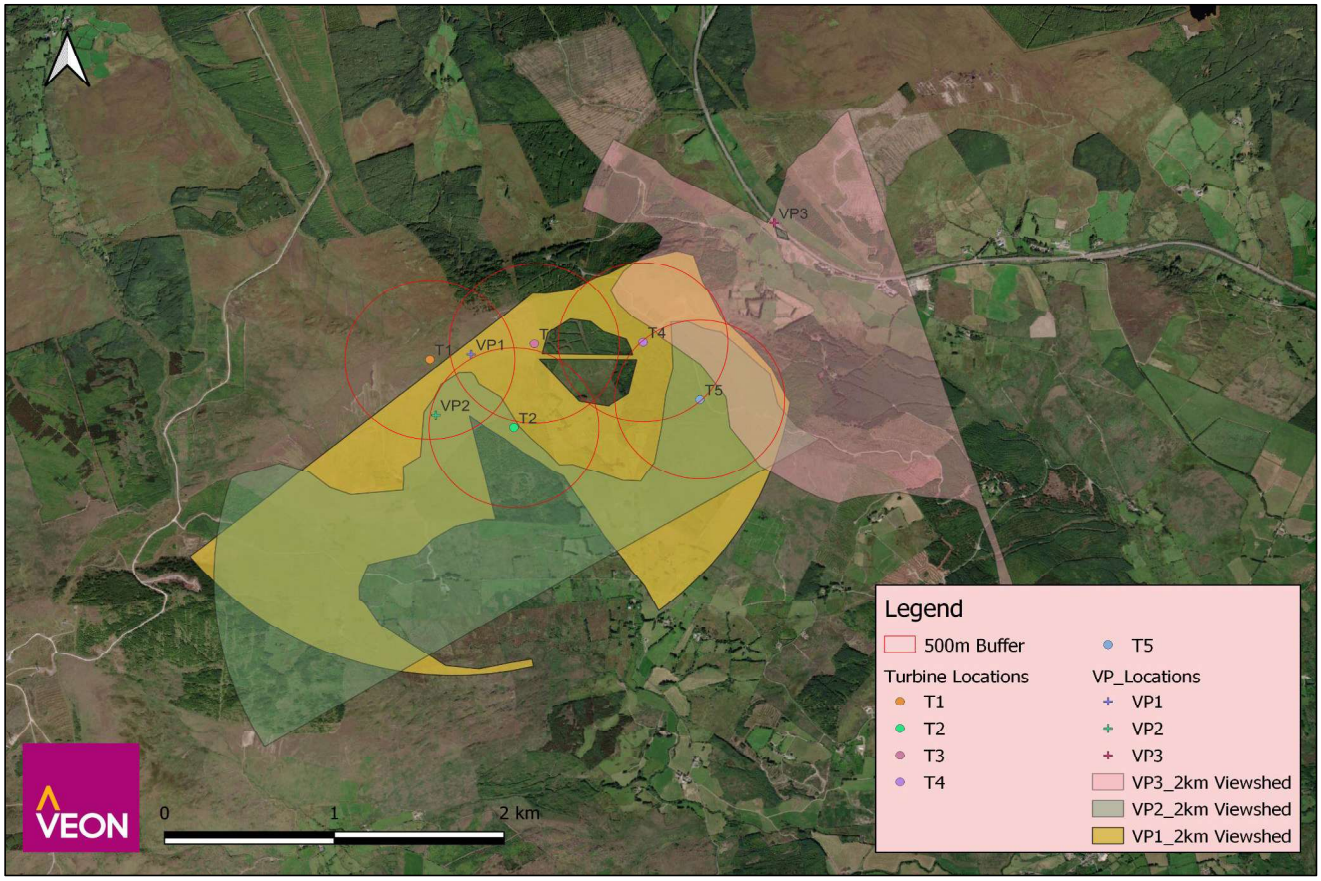


Figure 6.2: Vantage Point locations and viewshed map.

Appendix 2. VANTAGE POINT DATA

VANTAGE POINT SURVEY EFFORT (HOURS) FOR SUMMER 2017

Table 6.1: Inchamore VP data (VP1-3) survey effort Summer 2017.

Survey Effort Data (Summer 2017 April-September)							
Vantage Point	April	May	June	July	August	September	Total Hours
VP 1	6	5.5	0	12	6	6	35.5
VP 2	6	6	6	3	6	6	33
VP 3	6	6	6	0	12	6	36
Total	18	17.5	12	15	24	18	104.5

VANTAGE POINT SURVEY EFFORT (HOURS) FOR WINTER 2017-2018

Table 6.2: Inchamore VP data (VP1-3) survey effort Winter 2017-2018.

Survey Effort Data (Winter 2017-2018 October-March)							
Vantage Point	October	November	December	January	February	March	Total Hours
VP 1	0	12	12	0	0	12	36
VP 2	6	6	6	9	6	6	39
VP 3	6	6	6	6.5	6	0	30.5
Total	12	24	24	15.5	12	6	93.5

VANTAGE POINT SURVEY EFFORT (HOURS) FOR SUMMER 2018

Table 6.3: Inchamore VP data (VP1-3) survey effort Summer 2018.

Survey Effort Data (Summer 2018 April-September)							
Vantage Point	April	May	June	July	August	September	Total Hours
VP 1	7	6	6	12	6	6	43
VP 2	6	3	0	18	9	9	45
VP 3	6	6	6	12.3	6	0	36.3
Total	19	15	12	42.3	21	15	124.3

VANTAGE POINT SURVEY EFFORT (HOURS) FOR WINTER 2018-2019

Table 6.4: Inchamore VP data (VP1-3) survey effort Winter 2018-2019.

Survey Effort Data (Winter 2018-2019 October-March)							
Vantage Point	October	November	December	January	February	March	Total Hours
VP 1	3	6.25	6	6	1	11	33.25
VP 2	6	6	6	6	5.5	7	36.5
VP 3	6	6	6.33	6	6	6	36.33
Total	15	18.25	18.33	18	12.5	24	106.08

Table 6.5: Inchamore VP data (VP1-3) survey effort overview.

Vantage point survey effort (VP 1-3)			
Survey Dataset	**Months**	**Effort/Month**	**Total hours per VP**
Summer 2017	April-September	Variable	33-36 (Mean 34.83)
Winter 2017 - 2018	October-March	Variable	30.5-39 (Mean 34.75)
Summer 2018	April-September	Variable	36.3-45 (Mean 41.43)
Winter 2018 - 2019	October-March	Variable	33.25-36.5 (Mean 34.875)

Table 6.6: All species seconds spent at Potential Collision Height (20-180m) (VP 1-3).

Seconds spent at PCH (2017-2019)							
Species Name	**Seconds in flight at PCH (20-180m)**						**Total secs at PCH over 24 Months**
	2017/2018			**2018/2019**			
	Summer	**Winter**	**Total**	**Summer**	**Winter**	**Total**	
Common Buzzard (*Buteo buteo*)	0	0	0	103	0	103	103
Common Kestrel (*Falco tinnunculus*)	84	0	84	2,589	509	3,098	3,182
Eurasian Sparrowhawk (*Accipiter nisus*)	0	0	0	0	0	0	0
European Golden Plover (*Pluvialis apricaria*)	0	61,363	61,363	0	7,725	7,725	69,088
White-tailed Eagle (*Haliaeetus albicilla*)	20	4	24	0	45	45	69
Hen Harrier (*Circus cyaneus*)	0	6	6	156	30	186	192
Merlin (*Falco columbarius*)	0	37	37	20	0	20	57
Peregrine Falcon (*Falco peregrinus*)	0	0	0	530	0	530	530

Table 6.7: VP data (VP1-3) Survey Effort and Viewshed Coverage.

Vantage Point	VP Arc (ha)	Viewshed area within VP Arc (ha)	Viewshed Coverage (%)	Turbine Buffer Area Within Viewshed (ha)	No. of Turbines Within Viewshed	Total Survey Effort (hrs)
VP 1	628	400	63.69	274.18	4	147.75
VP 2	628	376	59.87	128.98	2	153.5
VP 3	628	306	48.73	58.5	0	139.13

Table 6.8: VP Summer 2017 - Survey Details.

Date	VP no.	Start Time	Duration (Hrs)	Precipitation	Cloud (okta)	Wind	Visibility
25/04/2017	1	10.15	3	Dry	4/8	F 5-6 NW	Excellent-Good (some heat shimmer)
25/04/2017	1	13.45	3	some snow & hail showers	7/8	NW F6-7	V. good-good-excellent (some heat shimmer)
18/05/2017	1	10.4	3	Light rain at start, mainly dry & clear	5/8-7/8	F4-5 W	Moderate - excellent
26/05/2017	1	15.08	0.5	Dry	8/8	F6-7 SE	Moderate
29/05/2017	1	15.12	2	Dry	8/8	F3-4 SSW	V. good
03/07/2017	1	10.26	3	Misty drizzle	7/8	F3-4 SW	Excellent-poor
03/07/2017	1	13.36	3	Misty drizzle	8/8	F3-5 SW	Moderate
31/07/2017	1	10.35	3	Occasional showers; mainly dry	7/8-6/8	F6-7 WSW	Good-excellent
31/07/2017	1	13.35	3	Occasional showers	6/8-8/8	F6-7 WSW	Excellent- moderate
29/08/2017	1	10.3	3	dry	8/8	F2-3 W	Good-moderate
29/08/2017	1	13.3	3	Occasional short showers	7/8-5/8	F3-4 W	Excellent
08/09/2017	1	10.35	3	Occasional short showers	7/8-5/8-8/8	F3-5 W	V.good- moderate
08/09/2017	1	13.45	3	Occ. Brief heavy showers	7/8-6/8	F3-5 W	V.good- poor
21/04/2017	2	10	3	Dry	1/8-5/8	F4-5 NW	Ex. -V.good; some heat shimmer
21/04/2017	2	13.3	3	Dry	3/8-5/8	F3-5 NW	V.good; some heat shimmer
18/05/2017	2	13.5	3	Intermittent showers + dry spells	6/8	F3 -4 NW	Ex./mod/poor
26/05/2017	2	11.57	3	Dry	8/8-7/8	F6-7 ESE	Mod-Good; slight haze
28/06/2017	2	9.45	3	Dry	5/8	F2-3 NW	Excellent
28/06/2017	2	13.05	3	Dry	7/8-5/8	F2-5 SW	Excellent
31/07/2017	2	10.35	3	Showers	7/8	F5 SW	Good
30/08/2017	2	9.5	3	Light drizzle at end of watch	7/8-5/8	F1-4 (variable) NW	V.good
30/08/2017	2	12.5	3	Intermittent misty showers	8/8-5/8	F2-4 WNW	Mod-V.good
11/09/2017	2	11.4	3	Frequent showers	6/8-8/8	F6 W	Good-poor
11/09/2017	2	14.4	3	Frequent showers	6/8	F4-5 W	Mod-poor
20/04/2017	3	11.3	3	Dry	5/8-6/8	F2-3 Var.	Excellent
20/04/2017	3	15	3	Dry	7/8	F3-4 NW	Excellent
15/05/2017	3	10.04	3	Regular misty drizzle/ light showers & dry spells	8/8	F4-5 ENE	Moderate/poor
15/05/2017	3	13.34	3	Occasional showers, misty drizzle & dry clear spells	8/8	F4-5 ENE	Moderate/poor
16/06/2017	3	11.51	3	Dry	3/8	F5 NW	Excellent
16/06/2017	3	15.15	3	Dry	3/8-5/8	Var; F0-F5 NW	Excellent
04/08/2017	3	10.15	3	Medium 20 min shower in last hr of survey	7/8	F1-3 NW/N	V.good
04/08/2017	3	13.45	3	Light spitting on & off for 1st 30 min	8/8-7/8	F1-2 N/NW	V.good
18/08/2017	3	9.25	3	Occ. Showers	7/8-5/8	F4-5 WSW	Good-V.good
18/08/2017	3	12.55	3	showers & dry clear spells	8/8	F3-5 (var./gusty) W	V-good-mod
05/09/2017	3	9.3	3	Dry	6/8-2/8	F3-4 W	V.good
05/09/2017	3	12.3	3	Dry	3/8	F4-5W	Excellent

Table 6.9: VP Winter 2017/2018 - Survey Details.

Date	VP	Time	Duration (hours)	Precipitation	Cloud (okta)	Wind	Visibility
22/12/2017	1	10:15	3	Some misty drizzle	8/8-7/8	F2-4 SW	V.good-Mod
22/12/2017	1	13:15	3	Dry	8/8	F3-4 SW	V.good
23/11/2017	1	10:30	3	Dry	4/8	F4-5 NW	V.good
23/11/2017	1	13:30	3	Dry	8/8	F3-4 NW	V.good
30/11/2017	1	10:30	6	N/A	6/8	F4 NNW-S	Good
15/12/2017	1	10:00	3	Dry	1/8-4/8	F5-6 NW	Good-Ex
15/12/2017	1	13:00	3	Dry	4/8	F5-6 NW	Excellent
08/04/2018	1	12:15	6	N/A	Fog 4/8	F3	Good/ Fog
29/04/2018	1	07:45	6	N/A	3/8	F4	Good
31/12/2017	2	13:40	3	Frequent Showers	8/8	F3-4 SW	Fair-Good
27/10/2017	2	09:30	6		8/8	F1 SW	Poor-Good
15/11/2017	2	11:4	3	Occ. Misty showers; 90% dry	8/8-7/8	F3 WSW	Mod-V.good
15/11/2017	2	14:4	2	Some misty showers	8/8	F3-4 WSW	V.good-poor
23/11/2017	2	09:35	1	Dry	4/8	F5-6 NW	Good
31/12/2017	2	13:40	3	frequent squalls	8/8	SW F3-4	Fair-Good
01/01/2018	2	09:30	3	Heavy showers at first	8/8	W-NW F5-6	Good
19/01/2018	2	12:30	3	Heavy snow showers	7/8	F4 W	Moderate
26/01/2018	2	09:00	3	Occ. showers	6/8	F3	Good
09/02/2018	2	11:05	3	1 brief snow shower	5/8	F2 NW	V.good-poor-v.good
09/02/2018	2	14:05	3	Dry	8/8	F3 NW	V.Good
23/03/2018	2	12:20	3	Light showers	8/8	F3 SE	Moderate/Occ. Poor
23/03/2018	2	15:30	3	Steady light rain	8/8	F3 ESE	Mod
25/10/2017	3	10:00	3	Light spitting for 15 min	8/8	F0	V.Good
25/10/2017	3	13:30	3	Dry	8/8	F0	V.Good
15/11/2017	3	11:00	3	Drizzle	8/8	F2 ENE	-
15/11/2017	3	14:30	3	None	7/8	F3 S	Excellent
01/12/2017	3	9:45	3	Dry	1/8-3/8	F0-1 NW	V.good
01/12/2017	3	12:45	3	Dry	2/8	F0-1 NW	V.good
04/01/2018	3	10:30	3	Occ. Light showers	7/8	F4-5 W	Good
04/01/2018	3	13:30	3.5	Occ. Light showers	7/8	F3-4 W	Good
08/02/2018	3	08:30	3	Drizzle	8/8	F1	Poor-mod
08/02/2018	3	12:00	3	Dry	7/8	F2	Mod-good
09/04/2018	3	09:50	3	Dry	6/8-8/8	F2 SE	Excellent
09/04/2018	3	12:50	3	Dry	8/8	F2/3 SE	Excellent
31/12/2017	4	09:30	4	Frequent Heavy	8/8	SW F3-4	Poor to Good

Table 6.10: VP Summer 2018 - Survey Details.

Date	VP	Time	Duration (hours)	Cloud (okta)	Precipitation	Wind	Visibility
29/04/2018	1	07:45	07:00	3/8	N/A	4	Good
11/05/2018	1	09:30	06:00	8/8-3/8	N/A	SW	Moderate/ low cloud at first - cleared at 13:00
19/06/2018	1	13:00	06:00	8/8	N/A	SW 3	Moderate, low cloud
03/07/2018	1	11:00	06:00	2/8	N/A	E 2	Good
18/07/2018	1	14:00	06:00	7/8	N/A	SSW 1	Good
07/08/2018	1	11:00	06:00	6/8	N/A	WSW 2	Good
26/09/2018	1	12:30	06:00	8/8 at 12:30, 2/8 at 15:00	Nil	SW 1-2	Good
19/04/2018	2	10:35	03:00	8/8-4/8	Dry	F2-3 SW	Excellent
19/04/2018	2	13:35	03:00	4/8	Dry	F2 SW	Excellent
25/05/2018	2	10:30	03:00	3/8	Dry	F2-4N	Excellent
08/07/2018	2	10:00	06:00	4/8	Nil	WNW	Good
17/07/2018	2	13:00	06:00	-	Nil	SSW1	Good
23/07/2018	2	12:45	03:00	8/8	light	F2-3 W	Ok-Poor-Fair
23/07/2018	2	09:15	03:00	8/8	V. light	F2-3 W/SW	Good-Poor-OK, very misty at times
16/08/2018	2	14:00	06:00	5/8	Nil	W2-3	Good
17/08/2018	2	09:00	03:00	8/8	Light showers	F3-4W 5 at times	OK-light mist at times
27/09/2018	2	11:00	04:30	1/8	Nil	WNW 2-3	Mod-good
27/09/2018	2	11:00	04:30	1/8	Nil	WNW 2-3	Mod-good
09/04/2018	3	09:50	03:00	6/8-8/8	Dry	F2 SE	Excellent
09/04/2018	3	12:50	03:00	8/8	Dry	F2/3 SE	Excellent
22/05/2018	3	10:55	03:00	2/8	Dry	F1 NW	Excellent
22/05/2018	3	13:55	03:00	1/8	Dry	F1 NW	Excellent
05/06/2018	3	12:05	03:00	5/8	Dry	F2 SE	Excellent
05/06/2018	3	15:05	03:00	4/8	Dry	F2 SE	V. good (slight haze)
20/07/2018	3	09:55	03:00	8/8	Occ. Light misty drizzle	F0-1 W	V. Good
20/07/2018	3	12:55	03:00	7/8	Dry	F2 WNW	Excellent
31/07/2018	3	08:11	03:19	8/8-7/8	Light-medium-clear with showers at times	F2-3 W at times	Ok-Good with poor-ok during intermittent showers
31/07/2018	3	12:00	03:00	8/8-7/8	Light-medium-clear with showers at times	F2-3 W at times	Ok-Good with poor-ok during intermittent showers
16/08/2018	3	09:10	03:00	6/8-7/8	Changeable, bright to light showers	F0-1 NW - 3-4NW	Good-Ok
16/08/2018	3	12:40	03:00	6/8-7/8	Changeable, bright to light showers	F0-1 NW - 3-4NW	Good-Ok

Table 6.11: VP Winter 2018/2019 - Survey Details.

Date	VP	Time	Duration (hours)	Cloud (okta)	Precipitation	Wind	Visibility
26/09/2018	1	12:30	06:00	8/8 at 12:30, 2/8 at 15:00	Nil	SW 1-2	Good
18/10/2018	1	08:50	03:00	1/8	Dry	F0, building to F1	V. good
30/11/2018	1	10:00	06:15	6/8 -8/8	Showers	F5-6 Strong	Full - poor
20/12/2018	1	09:30	03:00	8/8-6/8	Intermediate misty showers	F3-4	V. good
20/12/2018	1	12:30	03:00	8/8	Dry	F3-4	V. good
17/01/2019	1	09:30	03:00	3/8	None	F1-2 NE	Good-v. good
17/01/2019	1	12:30	03:00	3/8-7/8	None	F1 NE	V. good
15/02/2019	1	10:10	01:00	8/8	Light throughout	F3-4 S	OK
04/03/2019	1	11:50	02:30	8/8	N/A	F3-4W	Good
04/03/2019	1	14:50	02:30	8/8	Heavy sleet with snow	F2-3 W	OK-Good
29/03/2019	1	09:25	06:00	6/8-1/8	N/A	F2	Excellent
17/10/2018	2	10:20	03:00	4/8-8/8	Misty rain - none	F3-4W	OK, low lying mis, cleared at start of VP
17/10/2018	2	13:50	03:00	4/8-8/8	Misty rain - none	F3-4W	OK, low lying mis, cleared at start of VP
16/11/2018	2	09:10	03:00	8/8 low lying fog in areas	Light rain throughout	F2-4	Fair to OK to Poor at times
21/11/2018	2	11:30	03:00	8/8	Dry	F0-1	Mod-v. good
18/12/2018	2	10:10	06:00	8/8-6/8-2/8 (at times)	Light rain showers passing over	F3S	Excellent to OK at times
16/01/2019	2	09:30	03:00	2/8-4/8	Some brief showers	F2-3W	V. good
16/01/2019	2	12:30	03:00	5/8-7/8	Some brief heavy showers	F3W	V. good-good
12/02/2019	2	10:00	03:00	8/8	Misty drizzle clearing	F2-3	Moderate-good
14/02/2019	2	10:15	02:30	8/8	N/A	F4S	Good-poor
04/03/2019	2	14:20	00:30	8/8	Light	F0-2 W	Good
25/03/2019	2	09:25	06:30	1/8	N/A	F1	Excellent
11/10/2018	3	10:30	03:00	6/8-8/8-4/8	Mainly dry, 1 light misty shower	F1	Excellent-v. good
11/10/2018	3	13:30	03:00	3/8	Dry	F1-2	Excellent
15/11/2018	3	09:30	03:00	8/8	Light at start	F0-4 S-SE-SE-W	Ok-Fair
15/11/2018	3	13:00	03:00	8/8	Light at start	F0-4 S-SE-SE-W	Ok-Fair
10/12/2018	3	08:25	06:20	8/8-7/8	Light from 09:00 onwards	F0-F1 calm	OK. Some morning haze light, poor vis 10:30-11:45 with changeable, then good thereafter
08/01/2019	3	09:30	03:00	7/8	None	F2 NW	Good
08/01/2019	3	13:00	03:00	8/8-7/8	None	F2 NW	Good- v. good
12/02/2019	3	09:30	03:00	8/8	Some light drizzle	F1-3 SW	Good
12/02/2019	3	12:30	03:00	7/8	None-some drizzle	F2-3SW	V. good
05/03/2019	3	07:25	03:00	8/8-5/8	Light showers constantly	F0-2 at times	Excellent
05/03/2019	3	10:55	03:00	8/8	Light showers constantly	F0-2 at times	Excellent

Appendix 3. VANTAGE POINT BIRD FLIGHTLINE DATA

Table 6.12: Summer 2017 Bird Flightline Data.

VP	Date	Start Time	End Time	Species	Flight line no.	Species quantity	Start Time	Inside / outside Buffer	Total Duration (s)	0-20 (s)	20-40 (s)	40-80 (s)	80-150 (s)	>150 (s)	Bird Notes
2	31/07/2017	10.35	16.35	Kestrel_K.	9	1	13.02	OUT	1800	1800					Moving along short intervals surveying field while hovering
2	31/07/2017	10.35	16.35	Kestrel_K.	9	1	13.32	IN	300	300					Crossed into viewshed & out of viewshed
2	31/07/2017	10.35	16.35	Kestrel_K.	8	2	13.44	IN	30		30				Pair travelling across viewshed, not hovering
2	31/07/2017	10.35	16.35	Kestrel_K.	7	1	14.26	IN	45	45					Travelling & stopped twice to hover briefly
2	31/07/2017	10.35	16.35	Kestrel_K.	7	1	14.26	OUT	50	50					
2	31/07/2017	10.35	16.35	Kestrel_K.	6	1	14.41	OUT	70	70					Travelling, no hovering
2	31/07/2017	10.35	16.35	Kestrel_K.	5	1	14.53	OUT	1500	1500					Circled, then hovered, then moving small distances to hover
3	04/08/2017	10.15	13.15	Kestrel_K.	1	1	11.48	IN	55	37	18				Flying, hunting, hovering
3	04/08/2017	10.15	13.15	Kestrel_K.	1	1	11.48	OUT	55	38	17				In/Outside site boundary rather than buffer recorded.
3	05/09/2017	9.3	12.3	Kestrel_K.	4	1	11.24	IN	8	8					Hovering, hunting, flying
3	05/09/2017	12.3	15.3	Kestrel_K.	3	1	13.34	IN	22	16	6				
3	05/09/2017	12.3	15.3	Kestrel_K.	2	1	13.51	IN	11	11					
2	11/09/2017	11.4	14.4	Peregrine Falcon_PE	1	1	13:36	IN	10	10					
3	15/05/2017	13.34	16.34	Sparrowhawk_SH	1	1	14.28	IN	19	19					Female or juvenile; flying c.1m altitude, hunting along road & field boundaries. Lost sight behind spur.

VP	Date	Start Time	End Time	Species	Flight line no.	Species quantity	Start Time	Inside / outside Buffer	Total Duration (s)	0-20 (s)	20-40 (s)	40-80 (s)	80-150 (s)	>150 (s)	Bird Notes
3	15/05/2017	13.34	16.34	Sparrowhawk_SH	1	1	14.28	OUT	2	2					
1	29/08/2017	10.3	13.3	Sparrowhawk_SH	3	1	10.3	IN	5	5					A, B & C = same bird. Flushed on approach to VP, flew downhill behind ridge
1	29/08/2017	10.3	13.3	Sparrowhawk_SH	4	1	10.3	IN	3	3					Approached ridge, flushed again, flew behind 2nd ridge
1	29/08/2017	10.3	13.3	Sparrowhawk_SH	5	1	10.3	IN	10	10					Approached 2nd ridge, flushed, flew across heath into conifer plantation
3	05/09/2017	9.3	12.3	Sparrowhawk_SH	2	1	10.3	IN	7	7					Male; took small passerine from low branch of spruce tree
3	05/09/2017	9.3	12.3	Sparrowhawk_SH	2	1	10.3	OUT	3	3					

Table 6.13: Winter 2017/2018 Bird Flightline Data.

VP	Date	Start Time	End Time	Species	Flight line no.	Species quantity	Start Time	Inside / outside Buffer	Total Duration (s)	0-20 (s)	20-40 (s)	40-80 (s)	80-150 (s)	>150 (s)	Bird Notes
2	15/11/2017	14.4	16.55	Golden Plover_GP	11		14.4								Heard calling overhead; obscured by cloud; could tell general location & direction of flight from calls
1	22/01/2018	10.15	13.15	Golden Plover_GP	20	12	10.5	IN	169	17	101	51			
1	23/11/2017	10.3	13.3	Golden Plover_GP	1	11	10.55	IN	15	15					Lost sight behind rise to west of VP1
1	23/11/2017	10.3	13.3	Golden Plover_GP	2	12	12.35	IN	11	11					Lost sight behind rise; appeared to be landing
1	23/11/2017	10.3	13.3	Golden Plover_GP	3	c. 35	12.56	IN	105	73	32				c. 25 followed closely by 10. Appeared to land behind rise, same area as above
1	23/11/2017	10.3	13.3	Golden Plover_GP	4	15	13.27	IN	18	18					Probably arrived earlier, + disturbed. Other GO flightpaths (1,4, & 5) considered influx from N + E
1	23/11/2017	10.3	13.3	Golden Plover_GP	5	c.40	13.15-13.25	IN							4 flocks of c.10 flushed& flew along FP A when area approached to confirm landing
1	23/11/2017	13.3	16.3	Golden Plover_GP	6	c.30	13.5	IN	18	18					
1	23/11/2017	13.3	16.3	Golden Plover_GP	7	16	13.54	IN	15	15					
1	23/11/2017	13.3	16.3	Golden Plover_GP	8	10	14	IN	4	4					
2	23/11/2017	9.35	10.2	Golden Plover_GP	9	4	9.48	IN	10	10					
2	23/11/2017	9.35	10.2	Golden Plover_GP	10	4	9.54	IN	18	18					
1	15/12/2017	13	16	Golden Plover_GP	13	10	14.52	IN	15	15					
1	15/12/2017	13	16	Golden Plover_GP	14	12	15.54	IN	13	13					

VP	Date	Start Time	End Time	Species	Flight line no.	Species quantity	Start Time	Inside / outside Buffer	Total Duration (s)	0-20 (s)	20-40 (s)	40-80 (s)	80-150 (s)	>150 (s)	Bird Notes
1	15/12/2017	13	16	Golden Plover_GP	15	12	15.55	IN	45	10	35				Assume same flock as (2) above; appeared to land behind rise west of VP
2	19/01/2018	12.3	15.3	Golden Plover_GP	23	1	14.21	IN					200		Calling & travelling
2	19/01/2018	12.3	15.3	Golden Plover_GP	23	1	14.21	OUT					129		
1	22/01/2018	10.15	13.15	Golden Plover_GP	17	1	10.12	IN	9	9					Flushed on route to VP, flew off low calling
1	22/01/2018	10.15	13.15	Golden Plover_GP	18	c.40	10.3	IN	335	140	160	35			
1	22/01/2018	10.15	13.15	Golden Plover_GP	18	c.40	10.3	OUT	15		15				
1	22/01/2018	10.15	13.15	Golden Plover_GP	19	c.35	10.36	IN	42	32	10				Presume landed on bog
1	22/01/2018	10.15	13.15	Golden Plover_GP	21	c.70	11.55	IN	627		43	478	106		Lost in clouds
1	22/01/2018	10.15	13.15	Golden Plover_GP	21	c.70	11.55	OUT	228			120	108		
1	22/01/2018	13.15	16.15	Golden Plover_GP	22	3	15.43	IN	15		15				
2	26/01/2018	9	12	Golden Plover_GP	24	3	9.4	IN	132				132		Calling & travelling
2	26/01/2018	9	12	Golden Plover_GP	25	1	11.18	IN	160					160	Calling & travelling
2	26/01/2018	9	12	Golden Plover_GP	25	1	11.18	OUT	20					20	Calling & travelling
2	26/01/2018	9	12	Golden Plover_GP	26	1	11.5	IN	50					50	Calling & travelling
2	23/03/2018	12:20	15:20	Golden Plover_GP	35	18	12:40	IN	270	54	216				
1	08/04/2018	12:15	18:15	Golden Plover_GP	44	16	12:12	IN	7	7					Fog <150m visibility
1	08/04/2018	12:15	18:15	Golden Plover_GP	45	7	12:21	IN	8	8					Fog <150m visibility
1	08/04/2018	12:15	18:15	Golden Plover_GP	46	43	16:24	IN / OUT	29		29				
1	22/01/2018	13.15	16.15	Hen Harrier_HH	4	1	15.46	IN	13	13					Male colouring on upper parts, but juvenile underneath & around face
1	22/01/2018	13.15	16.15	Hen Harrier_HH	5	1	15.47	IN	45	45					Same individual as (2) above
2	09/02/2018	11.05	14.05	Hen Harrier_HH	7	1	11.53	IN	55	49	6				Ringtail; mobbed by RN

VP	Date	Start Time	End Time	Species	Flight line no.	Species quantity	Start Time	Inside / outside Buffer	Total Duration (s)	0-20 (s)	20-40 (s)	40-80 (s)	80-150 (s)	>150 (s)	Bird Notes
2	09/02/2018	14.05	17.05	Hen Harrier_HH	8	1	14.4	IN	7	7					Male
2	09/02/2018	14.05	17.05	Hen Harrier_HH	8	1	14.40	OUT	8	8					
3	04/01/2018	10.3	13	Kestrel_K.	1	1	11.58	IN	7	7					Seen briefly- lost below hill/WD4
3	15/11/2017	11	14	Merlin_ML	1	1	11.59	IN	20				20		Flew straight through, flushing approx. 60 SG
3	15/11/2017	11	14	Merlin_ML	1	1	11.59	OUT	17				17		
3	01/12/2017	12.45	15.45	Sparrowhawk_SH	-	1	15.31	IN	4	4					
3	01/12/2017	12.45	15.45	Sparrowhawk_SH	-			OUT	16	16					
1	22/01/2018	10.15	13.15	White-tailed Eagle_WE	1	1	10.53	OUT	26	6	20				Silhouette only observed, so age not determined
1	22/01/2018	10.15	13.15	White-tailed Eagle_WE	1	1	10.53	IN	8	2	4				Ground beneath flightpath not visible (hidden behind ridge) so mapping accuracy reduced

Table 6.14: Summer 2018 Bird Flightline Data.

VP	Date	Observation No.	Species	Quanity	Start	In/Out	Duration	0-20 (s)	20-40 (s)	40-80 (s)	80-150 (s)	>150 (s)	Flightline Map	Flightline No.
2	27/09/2018	1	Buzzard_BZ	1	11:26	In	93		93				2-8-A-1	1
2	27/09/2018	1	Buzzard_BZ	1	11:26	Out	10		10				2-8-A-1	1
2	27/09/2018	4	Hen harrier_HH	1	15:06	In	214	58	156				2-8-A-2	2
2	27/09/2018	4	Hen harrier_HH	1	15:06	Out	5		5				2-8-A-2	2
2	23/07/2018	1	Kestrel_K.	2	13:16	Out	15		5	10			-	-
2	23/07/2018	1	Kestrel_K.	2	13:16	In	600	50	500	50			-	-
2	08/07/2018	1	Kestrel_K.	1	13:42	In	791	312	479				2-8-A-3	1
2	08/07/2018	2	Kestrel_K.	1	15:45	In	296	98	198				2-8-A-3	2
2	16/08/2018	1	Kestrel_K.	1	18:15	In	293			293			2-8-A-3	4
2	17/07/2018	1	Kestrel_K.	1	15:33	In	429	184	245				2-8-A-3	3
3	22/05/2018	1	Kestrel_K.	1	13:21	In	160	16	144				2-8-A-3	7
3	22/05/2018	2	Kestrel_K.	1	13:59	In	94	14	80				2-8-A-3	8
3	22/05/2018	3	Kestrel_K.	1	14:22	In	52	47	5				2-8-A-3	9
2	27/09/2018	2	Kestrel_K.	1	12:01	In	7	7					2-8-A-3	5
2	27/09/2018	3	Kestrel_K.	1	12:05	In	207	162	45				2-8-A-3	6
1	26/09/2018	1	Kestrel_K.	1	13:46	In	7	7					2-8-A-3	10
1	26/09/2018	2	Kestrel_K.	1	14:28	In	11	11					2-8-A-3	11
1	26/09/2018	3	Kestrel_K.	1	14:29	In	12	12					2-8-A-3	12
3	20/07/2018	1	Merlin_ML	1	10:18	Out	20		20				2-8-A-5	1
2	19/04/2018	1	Peregrine_PE	1	16:31	In	590	60	90	150	290		2-8-A-6	1
2	19/04/2018	1	Peregrine_PE	1	16:31	Out	10				10		2-8-A-6	1

Table 6.15: Winter 2018/2019 Bird Flightline Data.

VP	Date	Observation No.	Species	Quantity	Start	In/Out	Duration	0-20 (s)	20-40 (s)	40-80 (s)	80-150 (s)	>150 (s)	Flightline Map	Flightline No.
2	18/12/2018	1	Golden Plover_GP	35	10:40	In	25			15	10		2-8-B-2	10
2	18/12/2018	2	Golden Plover_GP	10	11:21	In	120				120		2-8-B-2	11
1	29/03/2019	-	Golden Plover_GP	-	09:26	In	Heard only						-	-
1	20/12/2018	2	Golden Plover_GP	30	15:33	In	25	18	7				2-8-B-2	1
1	15/02/2019	1	Golden Plover_GP	12	10:05	In	25	5	5	10	5		2-8-B-2	2
1	04/03/2019	1	Golden Plover_GP	28	12:03	In	300	100	50	50			2-8-B-2	3
1	04/03/2019	1	Golden Plover_GP	28	12:08	In	240	240					2-8-B-2	3
1	04/03/2019	2	Golden Plover_GP	20	12:12	In	10	10					2-8-B-2	4
1	04/03/2019	2	Golden Plover_GP	20	12:12	In	1,680	1,680					2-8-B-2	4
1	04/03/2019	1	Golden Plover_GP	28	12:12	In	1,680	1680					2-8-B-2	5
1	04/03/2019	3	Golden Plover_GP	20	12:40	In	5	5					2-8-B-2	6
1	04/03/2019	3	Golden Plover_GP	48	12:40	In	5	5					2-8-B-2	6
1	04/03/2019	4	Golden Plover_GP	48	13:12	In	25	20	5				2-8-B-2	7
1	04/03/2019	5	Golden Plover_GP	48	13:13	In	35	5	5	5	15	5	2-8-B-2	8
1	04/03/2019	5	Golden Plover_GP	48	13:13	Out	5	5					2-8-B-2	8
1	04/03/2019	6	Golden Plover_GP	48	13:29	In	20	5	5	10			2-8-B-2	9
1	04/03/2019	6	Golden Plover_GP	48	13:29	Out	40			5	5	25	2-8-B-2	9
2	14/02/2019	-	Golden Plover_GP	-	12:00	In	Heard only						-	-
2	17/10/2018	1	Hen Harrier_HH	1	13:59	In	5		20					1
3	11/10/2018	1	Hen Harrier_HH	1	14:15	In	20		5					2
2	16/01/2019	2	Hen Harrier_HH	1	10:07	In	5		5					3
1	26/09/2018	1	Kestrel_K.	1	13:46	In	7	7					2-8-A-3	10
1	26/09/2018	2	Kestrel_K.	1	14:28	In	11	11					2-8-A-3	11
1	26/09/2018	3	Kestrel_K.	1	14:29	In	12	12					2-8-A-3	12
1	18/10/2018	1	Kestrel_K.	1	14:02	In	150	50	120				2-8-B-5	1
1	18/10/2018	2	Kestrel_K.	1	14:14	In	480	96	384				2-8-B-5	2
3	11/10/2018	2	Kestrel_K.	1	15:58	In	289		5				2-8-B-5	3
3	15/11/2018	1	Kestrel_K.	1	12:24	Out	5			25			2-8-B-5	4
3	12/02/2019	2	Kestrel_K.	1	13:13	In	25	25					2-8-B-5	5
3	05/03/2019	1	Kestrel_K.	1	09:49	In	5	5					2-8-B-5	6

VP	Date	Observation No.	Species	Quantity	Start	In/Out	Duration	0-20 (s)	20-40 (s)	40-80 (s)	80-150 (s)	>150 (s)	Flightline Map	Flightline No.
2	18/12/2018	3	White-tailed Eagle_WE	1	13:32	In	45	5	35	5			2-8-B-9	1
2	18/12/2018	3	White-tailed Eagle_WE	1	13:32	Out	15	10	5				2-8-B-9	1

Appendix 4. COLLISION RISK ASSESSMENT CALCULATIONS

Table 6.16: Bird-seconds spent by species at Potential Collision Height (20-180m) for each VP.

Species (BTO Code)	Year	VP 1 Seconds spent at PCH		VP 2 Seconds spent at PCH	
		Summer	Winter	Summer	Winter
Buzzard (BZ)	2017/18	0	0	0	0
	2018/19	0	0	93	0
Kestrel (K.)	2017/18	0	0	60	0
	2018/19	0	509	2,360	0
Golden Plover (GP)	2017/18	0	56,696	0	4,694
	2018/19	0	4,930	0	2,075
Hen Harrier (HH)	2017/18	0	0	0	6
	2018/19	0	0	0	25
Peregrine (PE)	2017/18	0	0	0	0
	2018/19	0	0	530	0

Table 6.17: Bird biometrics and bird-seconds spent by species at Potential Collision Height (20-180m).

Seconds spent at PCH (2017-2019)										
Species Name (BTO Code)	Length (m)	Wingspan (m)	Mean flight speed (m/s)	Seconds in flight at PCH (25-180m)						Total secs at PCH over 24 Months
				2017/2018			2018/2019			
				Summer	Winter	Total	Summer	Winter	Total	
Buzzard (BZ)	0.54	1.2	13.3	0	0	0	93	0	93	93
Kestrel (K.)	0.34	0.76	10.1	60	0	60	2,360	504	2,864	2,924
Golden Plover (GP)	0.275	0.715	17.9	0	61,363	61,363	0	7,725	7,725	69,088
Hen Harrier (HH)	0.48	1.1	12	0	6	6	156	25	181	187
Peregrine (PE)	0.42	1.02	12.1	0	0	0	530	0	530	530

Table 6.18: Probability of collision – Stage 2 Calculations.

key Target Species Stage 2 Calculations							
Species Name (BTO Code)	Flapping bird			Gliding bird			Mean probability of Collision Risk (Flapping + Gliding)/2
	Upwind	Downwind	Average	Upwind	Downwind	Average	
Buzzard (BZ)	8.3%	3.9%	6.1%	8.1%	3.7%	5.9%	6%
Kestrel (K.)	8.5%	3.5%	6.0%	8.4%	3.4%	5.9%	5.95%
Golden Plover (GP)	6.2%	2.7%	4.5%	N/A	N/A	N/A	4.5%
Hen Harrier (HH)	8.5%	3.9%	6.2%	8.3%	3.7%	6.0%	6.1%
Peregrine (PE)	8.1%	3.6%	5.8%	8.0%	3.4%	5.7%	5.75%

No preference was taken for birds using flapping or gliding flight through the study area for species which exhibit both behaviours. In the calculation of the percentage risk of collision for a bird flying through a rotating turbine, the mean of the worst-case scenario (i.e. a bird flying upwind through a turbine using flapping flight whilst the turbine is at its fastest rotation speed) and the best-case scenario (i.e. a bird flying downwind through a rotating turbine using a gliding flight whilst the turbine at its slowest rotation speed) has been used for species which exhibit both flapping and gliding flight. For Golden plover only the mean calculations for flapping flights were used.

Table 6.19: Avian Biometric Data and Avoidance Rates.

Avian Biometric Data and Avoidance Rates				
Species Name	Length (m)	Wingspan (m)	Mean flight speed (m/s)	Avoidance rates (%)
Common Buzzard (*Buteo buteo*)	0.54	1.2	13.3	98
Common Kestrel (*Falco tinnunculus*)	0.34	0.76	10.1	95
European Golden Plover (*Pluvialis apricaria*)	0.275	0.715	17.9	98
Hen Harrier (*Circus cyaneus*)	0.48	1.1	12	99
Peregrine Falcon (*Falco peregrinus*)	0.42	1.02	12.1	98

Appendix 5. WORKED CALCULATIONS

Table 6.20: Target species breeding and non-breeding season periods.

Key target species breeding and non-breeding season periods				
Species Name	**Breeding season start**	**Breeding season end**	**Non-breeding season start**	**Non-breeding season end**
Common Buzzard (*Buteo buteo*)	April	August	September	March
Common Kestrel (*Falco tinnunculus*)	April	August	September	March
Eurasian Sparrowhawk (*Accipiter nisus*)	April	August	September	March
European Golden Plover (*Pluvialis apricaria*)	April	August	September	March

Table 6.21: Avian Biometric Data and Avoidance Rates.

Avian Biometric Data and Avoidance Rates				
Species Name	**Length (m)**	**Wingspan (m)**	**Mean flight speed (m/s)**	**Avoidance rates (%)**
Hen Harrier (*Circus cyaneus*)	0.48	1.1	12	99

Table 6.22: Probability of collision – Stage 2 Calculations.

Key Target Species Stage 2 Calculations							
Species Name (BTO Code)	**Flapping bird**			**Gliding bird**			**Mean probability of Collision Risk (Flapping + Gliding)/2**
	Upwind	**Downwind**	**Average**	**Upwind**	**Downwind**	**Average**	
Hen Harrier (HH)	**8.5%**	**3.9%**	**6.2%**	**8.3%**	**3.7%**	**6.0%**	**6.1%**

Table 6.23: Calculation of collision risk for Hen Harrier passing (Gliding) through rotor area.

K: [1D or [3D] (0 or 1)	1		**Calculation of alpha and p(collision) as a function of radius**								
NoBlades	3					Upwind:			Downwind:		
MaxChord	4.5	m	r/R	c/C	α	collide		contribution	collide		contribution
Pitch (degrees)	13		radius	chord	alpha	length	p(collision)	from radius r	length	p(collision)	from radius r
BirdLength	0.48	m	0.025	0.575	5.28	17.60	0.82	0.00103	16.44	0.77	0.00096
Wingspan	1.1	m	0.075	0.575	1.76	6.26	0.29	0.00219	5.09	0.24	0.00178
F: Flapping (0) or gliding (+1)	1		0.125	0.702	1.06	4.70	0.22	0.00274	3.28	0.15	0.00191
			0.175	0.860	0.75	4.25	0.20	0.00347	2.50	0.12	0.00204
Bird speed	12	m/sec	0.225	0.994	0.59	3.98	0.19	0.00417	1.96	0.09	0.00206
RotorDiam	155	m	0.275	0.947	0.48	3.29	0.15	0.00422	1.37	0.06	0.00176
RotationPeriod	5.36	sec	0.325	0.899	0.41	2.99	0.14	0.00454	1.17	0.05	0.00178
			0.375	0.851	0.35	2.66	0.12	0.00465	0.93	0.04	0.00163
			0.425	0.804	0.31	2.39	0.11	0.00473	0.76	0.04	0.00151
			0.475	0.756	0.28	2.17	0.10	0.00480	0.64	0.03	0.00141
Bird aspect ratioo: β	0.44		0.525	0.708	0.25	1.98	0.09	0.00484	0.54	0.03	0.00133
			0.575	0.660	0.23	1.81	0.08	0.00486	0.48	0.02	0.00130
			0.625	0.613	0.21	1.67	0.08	0.00486	0.53	0.02	0.00155
			0.675	0.565	0.20	1.54	0.07	0.00484	0.57	0.03	0.00179
			0.725	0.517	0.18	1.42	0.07	0.00479	0.59	0.03	0.00200
			0.775	0.470	0.17	1.31	0.06	0.00472	0.60	0.03	0.00218
			0.825	0.422	0.16	1.20	0.06	0.00463	0.61	0.03	0.00235
			0.875	0.374	0.15	1.11	0.05	0.00452	0.61	0.03	0.00249
			0.925	0.327	0.14	1.02	0.05	0.00438	0.61	0.03	0.00261
			0.975	0.279	0.14	0.93	0.04	0.00422	0.60	0.03	0.00271
				Overall p(collision) =			**Upwind**	**8.3%**		**Downwind**	**3.7%**
								Average	**6.0%**		

Table 6.24: Calculation of collision risk for Hen Harrier passing (Flapping) through rotor area.

K: [1D or [3D] (0 or 1)	1		**Calculation of alpha and p(collision) as a function of radius**								
NoBlades	3					Upwind:			Downwind:		
MaxChord	4.5	m	r/R	c/C	α	collide		contribution	collide		contribution
Pitch (degrees)	13		radius	chord	alpha	length	p(collision)	from radius r	length	p(collision)	from radius r
BirdLength	0.48	m	0.025	0.575	5.28	19.71	0.92	0.00115	18.55	0.87	0.00108
Wingspan	1.1	m	0.075	0.575	1.76	6.96	0.32	0.00243	5.80	0.27	0.00203
F: Flapping (0) or gliding (+1)	0		0.125	0.702	1.06	5.12	0.24	0.00299	3.70	0.17	0.00216
			0.175	0.860	0.75	4.55	0.21	0.00371	2.81	0.13	0.00229
Bird speed	12	m/sec	0.225	0.994	0.59	4.21	0.20	0.00442	2.20	0.10	0.00231
RotorDiam	155	m	0.275	0.947	0.48	3.48	0.16	0.00446	1.56	0.07	0.00201
RotationPeriod	5.36	sec	0.325	0.899	0.41	2.99	0.14	0.00454	1.17	0.05	0.00178
			0.375	0.851	0.35	2.66	0.12	0.00465	0.93	0.04	0.00163
			0.425	0.804	0.31	2.39	0.11	0.00473	0.76	0.04	0.00151
			0.475	0.756	0.28	2.17	0.10	0.00480	0.64	0.03	0.00141
Bird aspect ratioo: β	0.44		0.525	0.708	0.25	1.98	0.09	0.00484	0.54	0.03	0.00133
			0.575	0.660	0.23	1.81	0.08	0.00486	0.48	0.02	0.00130
			0.625	0.613	0.21	1.67	0.08	0.00486	0.53	0.02	0.00155
			0.675	0.565	0.20	1.54	0.07	0.00484	0.57	0.03	0.00179
			0.725	0.517	0.18	1.42	0.07	0.00479	0.59	0.03	0.00200
			0.775	0.470	0.17	1.31	0.06	0.00472	0.60	0.03	0.00218
			0.825	0.422	0.16	1.20	0.06	0.00463	0.61	0.03	0.00235
			0.875	0.374	0.15	1.11	0.05	0.00452	0.61	0.03	0.00249
			0.925	0.327	0.14	1.02	0.05	0.00438	0.61	0.03	0.00261
			0.975	0.279	0.14	0.93	0.04	0.00422	0.60	0.03	0.00271
				Overall p(collision) =			**Upwind**	**8.5%**		**Downwind**	**3.9%**
								Average	**6.2%**		

Table 6.25: Calculation of collision risk for Hen Harrier Non-Breeding Season 2018/2019.

Hen Harrier, Winter VP Surveys: 2018-2019				
Measurements	Code	Value		
Rotor radius (metres)	R	77.5		
Rotor diameter (metres)	RD	155		
Max chord width of turbine blades (metres)	d	4.5		
Bird length (metres)	l	0.48		
Average flight speed (m/s)	s	12		
Daily Duration of Activity (hrs)	TDD	10		
Length of Season (days)	Tss	181		
Wingspan (m)		1.1		
Mean pitch of blade (degrees)		13		
Rotors per turbine		3		
Rotational period (seconds)		5.36		
Turbine operational time (%)		85		
			Vantage Point	
			VP 1	VP 2
Total Survey time over 6 months (secs)	T		119700	131400
Total flight at Rotor Height 20 - 180m (bird-secs)	sPCH		0	25
No. of turbines in viewshed	x		4	2
Survey area visible from VP (hectares)	Avp		400	376
Flight Risk Area, i.e. 500m buffer of turbines within viewshed (hectares)	Afr		274.18	128.98
Availability of species activity during survey period (hrs)	Sa		1810	1810
Stage 1 Calculations				
Measurements	Code	Calculation		
Proportion of Bird flight-time between 20 - 180m	t	sPCH/T	0	0.000190259
Flight activity in visible area per hectare	F	t/Avp	0	5.06007E-07
Proportion of Bird flight time in Risk Area	Trisk	F*Afr	0	6.52648E-05
Bird occupancy of Risk Area (hrs/season)	n	Trisk*Sa	0	0.118129331
Flight Risk volume (m3)	Vw	(Afr*RD)*10000	424979000	199919000
Actual volume of air swept by rotors (m3)	o	x*(πr2(d+l))	375683.73	187841.865
Bird occupancy of rotor swept area (bird-secs)	b	3600*(n*(o/Vw))	0	0.399575239
Time taken for Bird to pass through rotors (secs)	v	(d+l)/s	0.415	0.415
Number of Bird passes through the rotor during survey period	N	b/v	0	0.9628319
Total transits adjusted for maximum operation of turbines (85%)	Tn	N*0.85	0	0.818407115
Number of transits per turbine within viewshed	TnT	Tn/x	0	1.636814231
Average TnT of all VP's (VP 1-2)	ATnT	(TnT1+TnT2+TnT3+.....)/2	0.818407115	
Number of transits across windfarm	NT	ATnT*(Total no. turbines)	4.092035576	
Stage 2 Calculation	Calculation	Result		
Collision Probability (%)	(Model)	6.10%		
Collisions during study period	NT*Collision Probabi	0.25		
Collisions during study period with 99% Avoidance Rate	*0.01	0.002496142		
Over 30-year duration of windfarm	*30	0.074884251		

Table 6.26: Number of collisions predicted for Hen Harrier with the application of avoidance rates.

Species	Year	Predicted collisions per season with avoidance rates applied			Predicted collisions over 30-year lifetime of the windfarm		
		Breeding	Winter	Total	Breeding	Winter	Total
Hen Harrier	2017/18	0.000	0.001	0.001	0.000	0.017	0.017
	2018/19	0.000	0.002	0.002	0.000	0.075	0.075

Table 6.27: Mean number of collisions predicted for Hen Harrier with avoidance rates.

Target Species Biometrics			
Species Name	Mean no. of predicted collisions per year	Mean no. of predicted collisions per 30 years	Equivalent to 1 bird every x (years)
Hen Harrier (HH)	0.002	0.046	500

Prepared for;

Jennings O' Donovan

Inchamore Windfarm (IWF)

Site Specific Flood Risk Assessment (SFRA)

JENNINGS O'DONOVAN & PARTNERS LIMITED
CONSULTING ENGINEERS

Project no. 603679 R4 (04) IWF SFRA

ISO 9001 ISO 14001 OHSAS 18001 DNV REGISTERED DNV REGISTERED DNV REGISTERED
INVESTORS IN PEOPLE

RSK

MARCH 2023

RSK GENERAL NOTES

Project No.: 603679 R4 (03) IWF SFRA

Title: Inchamore Wind Farm Site - Flood Risk Assessment

Client: Jennings O'Donovan

Date: 15/05/2023

Office: RSK Dublin

Status: 03 FINAL

Author	Lissa Colleen McClung	**Technical reviewer**	Sven Klinkenbergh
Signature		Signature	
Date:	01/03/2023	Date:	25/05/2023
Project manager	Sven Klinkenbergh	**Quality reviewer**	
Signature		Signature	
Date:	25/05/2023	Date:	

CONTENTS

APPENDICES

1 INTRODUCTION

RSK Ireland was commissioned to carry out a Flood Risk Assessment by Jennings O'Donovan & Partners (JOD, the Client) on behalf of Coillte and SSE (the Developer/s). The assessment is in support of the planning application for the Inchamore Wind Farm (IWF, The Project) in Co. Cork.

This flood risk assessment has been carried out in accordance with the Department of Housing and Local Government (DEHLG) and the Office of Public Works (OPW) document *"The Planning Process and Flood Risk Management Guidelines for Planning Authorities"* published in November 2009. This Assessment identifies and sets out possible mitigation measures against potential risks of flooding from various sources. Sources of possible flooding include coastal, fluvial, pluvial (direct heavy rain), groundwater and human/mechanical error. This report provides an assessment of the subject site for flood risk purposes only.

RSK (Ireland) Ltd. (RSK), part of RSK Group, is a consultancy providing environmental services in the hydrological, hydrogeological and other environmental disciplines. The company and group provide consultancy to clients in both the public & private sectors. More information can be found at www.rskgroup.com. The principal members of the RSK EIA team involved in this assessment include the following persons;

- Sven Klinkenbergh – B.Sc. (Environmental Science), P.G.Dip. (Environmental Protection) – Associate, Project Manager and EIA Lead Author with c. 10 years industry experience in the preparation of hydrological and hydrogeological reports.
- Project Scientist: Lissa Colleen McClung - B.Sc. (Hons.) Environmental Studies, M.Sc. (Hons.) Environmental Science. Current Role: Graduate Project Scientist
- Project Scientist: Mairéad Duffy – B.Sc. (Environmental Science), M.Sc. (Climate Change). Current Role: Graduate Project Scientist

2 SOURCES OF INFORMATION

2.1 Introduction

Desk Study

2.1.1 EPA

The Environmental Protection Agency (EPA) Maps Application was consulted to identify to local hydrology around the vicinity of the site along with specific Water Framework Directive (WFD) statuses and risks [1].

2.1.2 Flood Maps

Flood Hazard Maps, produced by the Office of Public Works under the Lee, Cork Harbour & Youghal Bay Catchment Flood Risk Management Plan (CFRAM) were investigated to determine present-day risks to flooding in relation to the Project. The Office of Public Works (OPW) mapping study for Ireland is available on their website[2]

2.1.3 Google Earth Pro

National Grid Reference and topography mapping of the study site setting was drawn from Google Earth Pro (2022) *TerraMetrics; version 7.3 (beta),* Inchamore, Cahir Co. Cork, Ireland. 51°95'29.30" N 9°26'19.61" W, Eye alt 4.65 km. Places layers. SIO, NOAA, US Navy, NGA, GEBCO.

2.1.4 GSI

Geological Survey Ireland Spatial Resources from the Department of the Environment, Climate and Communications, were utilised to determine the Site's hydrogeology, site-specific aquifer and vulnerability, borehole/well information, soil and subsoils data as well as Corine 2018 land use classification.[3]

[1] EPA Unified GIS Application (2022)

[2] OPW Flood Maps and Catchment Flood Risk Assessment and Management (CFRAM) Programme (2022)

[3] Geological Survey Ireland Spatial Resources (2022)

2.1.5 OSI

Records from the National mapping agency of Ireland, the Ordnance Survey, were studied, on the websites interactive GeoHive Map Viewer (i.e., First Edition 6-inch map (1839-1842)) to determine the Site's flood history.[4]

[4] Government of Ireland and Ordnance Survey Ireland (2022)

3 SITE DESCRIPTION

3.1 Location

Site Name: Inchamore Wind Farm

Site Address: Carrigalougha Hill, Sheehy Mountains, Inchi More, Co. Cork,

Site Grid Reference ITM: 513376.5, 578930.1

The Site is located 5.9 km west of Ballyvourney, Co. Cork and shares the county boundary between Cork and Kerry. It is 54 km west of Cork City, and 23 km north-east of Kenmare, Co. Kerry. The Project is located within the townlands of Inchamore, Mileeny Derryreag and Derreenaling. The Site is characterised by relatively complex (hilly) topography with associated elevations ranging between 460 metres Above Ordnance Datum (m AOD) in the north-western side of the Site to 350 m AOD towards the eastern side of the Site.

The Site extends to approximately 170 ha of which (c. 145.4 ha) largely consists of low yielding, commercial forestry. The remaining land (24.6 ha) is third party property and the principal land use in the general area consists of a mix of agricultural sheep and cattle grazing, farmland, agricultural structures and open mountain heath.

The proposed Site is shown in **Figure 3.1 Site Location Map with Hydrology**.

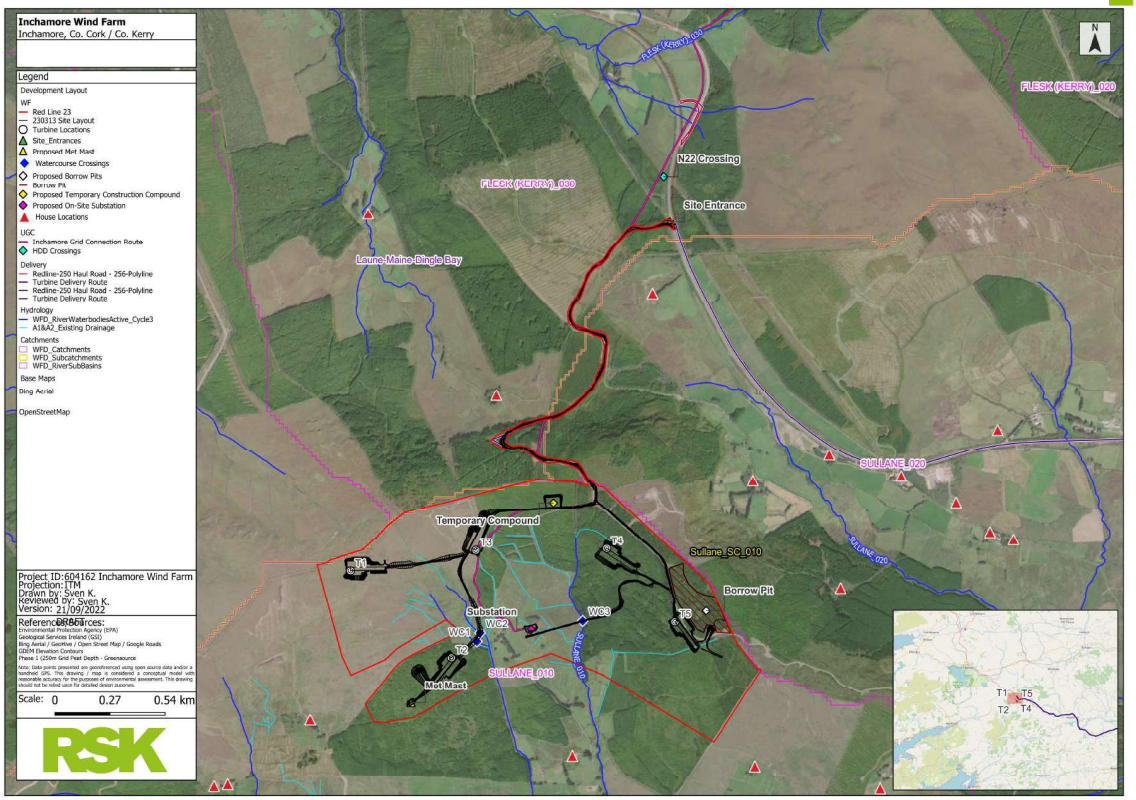


Figure 3.1 Site Location Map with Hydrology

3.2 Site Hydrology

Surface water networks draining the site are mapped and presented in **EIAR Chapter 9 - Figure 9.2 –Surface Water Network Wind Farm**.

The Project is situated within the Lee, Cork Harbour and Youghal Bay catchment (ID: 19, Area: 2182km^2). Surface water runoff associated with the Site drains into the Sullane sub catchment and/or Sullane_010 river sub basins. In terms of local drainage and non-mapped surface water features the site characterised by extensive artificial drainage networks including in association with agricultural and land reclamation / improvement works, forestry drainage networks, and cut drains in peat and peat cutting activities.

All surface waters draining from the Site eventually combine in Carrigadrohid Reservoir, from which waters eventually flow to Cork Harbour and into the Celtic Sea.

3.3 Site Soil & Subsoil Geology

Consultation with available soil maps (SIS, EPA, Teagasc) indicate the primary soil type across the Site is that of 'Blanket Peat' while smaller areas of the Site are classified as 'Peaty Gleys - Acid Poorly Drained Mineral Soils with Peaty Topsoil'; 'Acid Brown Earths / Brown Podzolics - Acid Deep Well Drained Mineral'; and 'Podzols (Peaty), Lithosols, Peats with some outcropping rock – Acid Shallow, lithosolic or podzolic type soils potentially with peaty topsoil'. Soils are presented in **EIAR Chapter 8 - Figure 8.4 a – Soils (SIS).** Several rocky outcrops have been mapped by the GSI, particularly at higher elevations - i.e., the north-western corner of the Site boundary and along the northern and eastern boundary of the Site. Furthermore, many minor rocky outcrops were also observed across the Site during Site walkovers.

Consultation with available subsoil maps, shown in **EIAR Chapter 8 - Figure 8.5 a - Subsoils**, indicate that subsoil types across the Site and include mainly 'Blanket Peat' with small-scale portions of Sandstone Till and areas of Bedrock at or near the surface.

Several rocky outcrops have been mapped by the GSI, particularly at higher elevations - i.e., the north-western corner of the Site boundary and along the northern and eastern boundary of the Site. Furthermore, many minor rocky outcrops were also observed across the Site during Site walkovers. Thin peat and exposed rock were observed at existing cut

and fill locations, in particular, along the existing Site tracks associated with agricultural and forestry practices in the area.

3.4 Site Hydrogeology

The bedrock aquifer underlying the Project has been assigned the GSI aquifer classification of 'Locally Important Aquifer (Ll)' that is; bedrock which is moderately productive only in local zones. Aquifer association with the site is presented in **EIAR Chapter 9 -** Appendix **9.9 b –Bedrock Aquifer Overview.**

There are no mapped karst features within 10 km of the Project.

3.5 Groundwater Vulnerability & Recharge

Presented in **EIAR Chapter 9 - Figure 9.8 a - Aquifer Vulnerability Overview,** consultation with the GSI Groundwater Map Viewer indicates that the Wind Farm Site is underlain by areas classified predominantly mapped as 'Extreme (E)' vulnerability rating which tend to be at lower elevations, with some areas mapped as 'Rock at or Near Surface (X)' vulnerability rating particularly at higher elevations. Both the Turbine Delivery Route and Grid Connection Route traverse land with groundwater vulnerability ratings ranging from 'Moderately Vulnerable' to 'Extreme Vulnerability'

The entirety of the Site and Grid Connection Route are underlain by a Locally Important Aquifer (Ll) which possess a maximum annual recharge capacity of 200 mm effective rain fall.

The Site is characterised by low to very low recharge rates in overburden (soils/subsoils) and very low recharge capacity in the underlying bedrock aquifer, which can be seen in **EIAR Chapter 9 - Figure 9.10 a - Groundwater Recharge Overview.** This implies that, particularly during seasonally wet or extreme meteorological conditions, the majority of water (rain) introduced to the Site will drain off the site as surface water runoff, and the rejected recharge water volumes will likely discharge to surface waters relatively rapidly and locally, i.e., a 'flashy regime'. As such, the surface water network associated with the Site is characterised as having a rapid hydrological response to rainfall.

3.6 The Project

The Project, is comprised of five no. proposed turbines, one met mast and associated ancillary infrastructure (Turbine Foundations, Site Access Roads, Turbine Hardstands,

drainage infrastructure etc.). Each portion of the Site is connected via existing and proposed Site Access Roads which includes for connection to a substation at the Site.

The Project will be connected to the national grid at Ballyvouskill Substation. The Grid Connection Route is approximately 19.9km and comprised of wind farm / forest tracks, public roads and ESB access track. The Grid Connection cable will be buried, with intermittent cable joint bays and other ancillary infrastructure where required.

4 FLOOD RISK ASSESSMENT

4.1 Introduction

4.1.1 Guidelines for FRAs

This Flood Risk Assessment Report follows the guidelines set out in the DEHLG/OPW *Guidelines on the Planning Process and Flood Risk Management* published in November 2009. This assessment will address where surface water and groundwater within or around the site boundary comes from (i.e., the source), how and where it flows (i.e., the pathways) and the people and assets affected by it (i.e., the receptors). This stage aims to quantify the risk posed to the development and to the surrounding environment by this development.

In line with DEHLG Guidelines for Planning Authorities – Flood Risk Management (2009);

Flood Risk Assessment Stage 1, or Preliminary Drainage Assessment

Stage 1 Flood risk identification – to identify whether there may be any flooding or surface water management issues related to either the area of regional planning guidelines, development plans and LAP's or a proposed development site that may warrant further investigation at the appropriate lower-level plan or planning application levels;

Flood Risk Assessment Stage 2

Stage 2 Initial flood risk assessment – to confirm sources of flooding that may affect a plan area or proposed development site, to appraise the adequacy of existing information and to scope the extent of the risk of flooding which may involve preparing indicative flood zone maps. Where hydraulic models exist the potential impact of a development on flooding elsewhere and of the scope of possible mitigation measures can be assessed. In addition, the requirements of the detailed assessment should be scoped; and

Flood Risk Assessment Stage 3

Stage 3 Detailed flood risk assessment – to assess flood risk issues in sufficient detail and to provide a quantitative appraisal of potential flood risk to a proposed or existing development or land to be zoned, of its potential impact on flood risk elsewhere and of the effectiveness of any proposed mitigation measures.

4.1.1.1 Sources of Flooding

The components to be considered in the identification and assessment of flood risk are:

- Tidal flooding from high sea levels

- Fluvial flooding from water courses
- Pluvial flooding from rainfall / surface water
- Ground Water –flooding from springs / raised ground water
- Human/mechanical error –flooding due to human or mechanical error

4.1.2 Scoping & Assessing Flood Risk

The two components of flood risk, as outlined in the FRM Guidelines, are the likelihood of flooding and the potential consequences arising from planned works; expressed as:

Flood Risk = Probability of flooding x Consequences of flooding

- *Likelihood of flooding is normally defined as the percentage probability of a flood of a given magnitude or severity occurring or being exceeded in any given year. For example, a 1% probability indicates the severity of a flood that is expected to be exceeded on average once in 100 years, i.e., it has a 1 in 100 (1%) chance of occurring in any one year.*
- *Consequences of flooding depend on the hazards associated with the flooding (e.g., depth of water, speed of flow, rate of onset, duration, wave- action effects, water quality), and the vulnerability of people, property and the environment potentially affected by a flood (e.g., the age profile of the population, the type of development, presence and reliability of mitigation measures etc).*

4.1.3 Assessing Likelihood of Flood Risk

In the FRM Guidelines, the likelihood of a flood occurring in an area is identified and separated into Flood Zones **Figure 4.1 - Indicative Flood Zone Map,** which indicate a high, moderate or low risk of flooding from fluvial or tidal sources, defined as follows:

- Flood Zone A - Where the probability of flooding is highest (greater than 1% Annual Exceedance Probability (AEP) or 1 in 100 for river flooding and 0.5% AEP or 1 in 200 for coastal flooding) and where a wide range of receptors would be located and therefore vulnerable.
- Flood Zone B - Where the probability of flooding is moderate (between 0.1% AEP or 1 in 1000 and 1% AEP or 1 in 100 for river flooding and between 0.1% AEP or 1 in 1000 year and 0.5% AEP or 1 in 200 for coastal flooding); and
- Flood Zone C - Where the probability of flooding is low (less than 0.1% AEP or 1 in 1000 for both river and coastal flooding).

Figure 4.1: Indicative flood zone map (OPW, 2009)

As outlined in the FRM Guidelines, future developments must avoid where possible areas at risk of flooding, as such, essential infrastructure including electricity substations should be located within Flood Zone C. Presented in **Figure 4.2,** from the OPW (2009), a Justification Test is a guiding document that aims to determine the appropriateness of a particular development in areas that may be at risk of flooding. A Justification Test is required to assess such proposals in the light of proper planning and sustainable development objectives.

	Flood Zone A	Flood Zone B	Flood Zone C
Highly vulnerable development (including essential infrastructure)	Justification Test	Justification Test	Appropriate
Less vulnerable development	Justification Test	Appropriate	Appropriate
Water-compatible development	Appropriate	Appropriate	Appropriate

Figure 4.2: Matrix of vulnerability versus flood zone to illustrate appropriate development and that required to meet the Justification Test (OPW, 2009)

4.2 Stage 1 – Flood Risk Identification

The flood risk identification stage was carried out in order to establish whether a flood risk exists within the boundaries of the Project or the surrounding vicinity.

4.2.1 Existing Flood Records

Inspection of Base Maps from Ordinance Survey of Ireland records, i.e. First Edition 6-inch map (1839-1842) indicate that Wind Farm Site itself, the Turbine Delivery Route (TDR) and the Grid Connection Route (GCR) are not susceptible to flooding. The National Flood Hazard Mapping database operated by the OPW also confirms there are no areas represented as being low, medium or high probability risk to flood areas within Site boundaries. Furthermore, there have been no recorded flood events on the OPW Database in the immediate vicinity of the Project.

Approximately 1.5 km downgradient (south) of the Site boundary, the OPW (2009) has mapped the Sullane_010 under the 'National Indicative Fluvial Mapping – Present Day' as a Low and Medium Probability Scenario, i.e., a 0.1% AEP and 1% AEP, respectively, as depicted in **Figure 4.3** below.

It should be noted, according to the OPW, the 'Present Day Scenario' is also referred to as the Current Scenario and has been generated using methodologies based on historic flood data, without taking account of potential changes due to climate change. The 'High-End Future Scenario' extents - which have also been mapped approximately 1.5 km downgradient of the Site - were generated taking in the potential effects of climate change using an increase in rainfall of 30%.

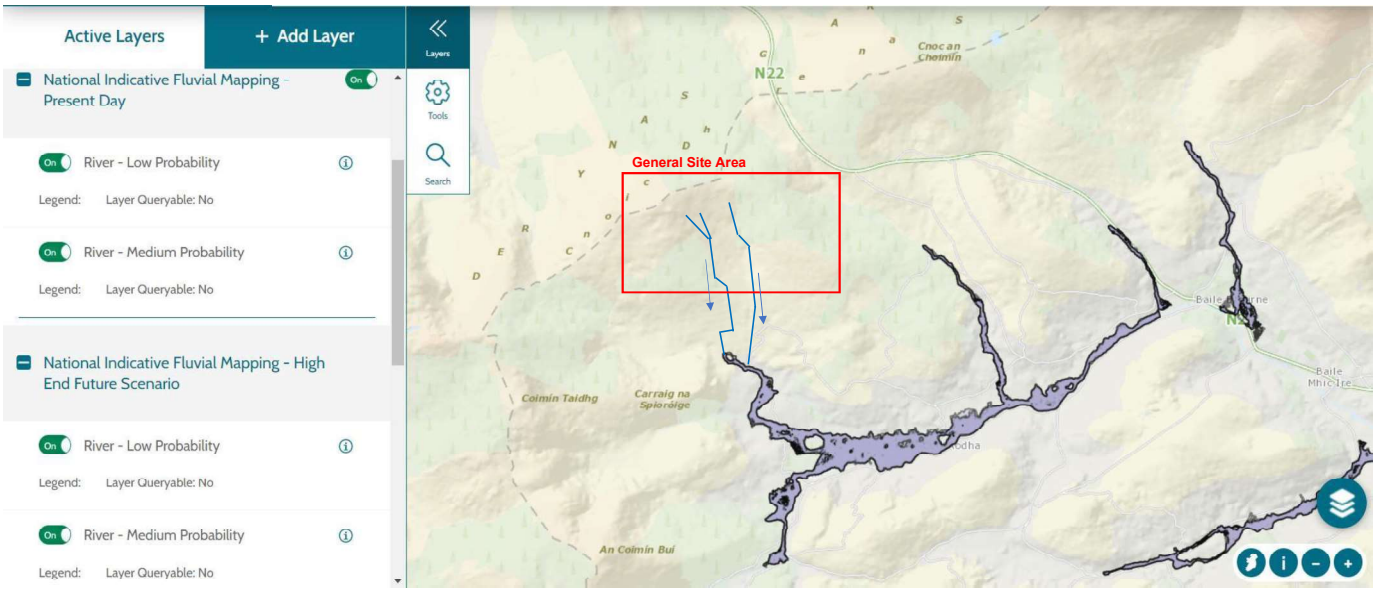


Figure 4.3: National Indicative Fluvial Mapping 'Present Day' or 'Current Scenario' and 'High End Future Scenarios' down stream of the proposed development as mapped by the Office of Public Works Flood Maps (OPW, 2022).

4.2.2 Tidal Flooding

Tidal flooding is caused by elevated sea levels or overtopping by wave action. No coastal flood zones are identified at the site or surrounding area. Bantry Bay is located 30 km southwest of the Site. Due to both the inland nature and significant elevation of the Project, the residual risk from tidal flooding is considered low.

4.2.3 Fluvial Flooding

Fluvial flooding is caused by rivers, watercourses or ditches overflowing. Historic flood maps dating (1839-1842), were reviewed for the Project area and did not indicate a history of flooding at the site from small streams or tributaries found within or near Site boundaries. Furthermore, recent, comprehensive flood-maps, produced by the OPW (2018) under the Lee, Cork Harbour & Youghal Bay Catchment Flood Risk Management Plan (CFRAM) programme do not indicate any flood extents within the proposed Site boundaries, nor its immediate surrounding vicinity. All areas outside the 0.1% AEP flood extent (the Project), are classified as residing in Flood Zone C. Therefore, CFRAM flood-maps confirm that the Project Site resides in Flood Zone C and is a suitable development for this area.

4.2.4 Pluvial Flooding

Pluvial flooding is usually caused by intense rainfall that may only last a few hours, often referred to as flooding from surface water. Surface water flooding can also occur as a result of overland flow or ponding during periods of extreme prolonged rainfall. During pluvial flooding events, water follows natural valley lines, creating flow paths along roads, through and around developments and ponding in low spots, which often coincide with fluvial floodplains in low lying areas. It is generally noted, areas at risk from fluvial flooding will almost certainly be at risk from pluvial flooding. Pluvial flood maps produced as part of the OPW's CFRAM do not indicate pluvial flood zones at the Site, or surrounding area. Therefore, the residual risk from pluvial flooding is considered low.

4.2.5 Groundwater Flooding

Groundwater flooding can occur on some sites in connection with high water tables and increased recharge following long periods of wet weather. Groundwater flooding typically occurs in areas underlain by limestone and where underlying geology is highly permeable with high capacity to receive and store rainfall. The groundwater underneath the site is

located within both a *Locally Important* Aquifer- Bedrock which is Moderately Productive only in Local Zones.

Groundwater observations during SI rotary core drilling indicate that the underlying bedrock is weathered to a minor degree only, with minor volumes of groundwater perched on top of bedrock in the subsoil underlying the site, and no significant water strike encountered (maximum drill depth was approximately 10.5m). Groundwater flow directions are presumed to follow the topography of the area. Groundwater flow paths are considered to be short due to the underlying bedrock aquifer being poorly productive. From reviewing available water level records, and taking into account the elevation of the site, there is no evidence of groundwater flooding within the Project Site.

4.2.6 Project

The Project comprising of new access tracks, hardstands and associated ancillary infrastructure will include land take (Agriculture / Forestry) and the replacement of vegetated lands and soils with relatively impermeable surfaces. This presents the potential for a net decrease in recharge potential (rain percolating through soils to groundwater) and increase in the hydrological response to rainfall (quantity and rate of surface water runoff) at the site, which will potentially adversely impact on flood risk areas within or downstream of the site.

4.2.7 Human and/or Mechanical Error

Construction of drainage channels and enhancement of existing drainage associated with the Project has the potential to impact the hydrological regime at the Site. In particular human error related to poor design, or if poorly managed during construction phase of a development, the installation of drainage channels and associated infrastructure such as culverts or attenuation features can lead to excessive *wetting and/or drying* in areas of the site which does not conform to baseline conditions i.e., localised flooding or excessive draining.

4.2.8 FRA Stage 1 Conclusions

This Flood Risk Assessment was compiled and based on data presented in public records, in accordance with the guidelines set out in the DEHLG/OPW *Guidelines on the Planning Process and Flood Risk Management* published in November 2009. From reviewing the available records there was no evidence of historic flooding at the Site. Furthermore, comprehensive flood maps produced by the OPW under the Lee, Cork Harbour & Youghal

Bay Catchment Flood Risk Management Plan (CFRAM) confirm that the Project resides in a Flood Zone C.

The nature of the development is industrial as opposed to residential or leisure, and as such, this type of development is categorized as a 'Less Vulnerable Development', according to FRM Guidelines. Therefore, the Project is considered an 'appropriate' development for Flood Zone C.

In keeping with the Stage 1 Flood Risk Assessment, the review of available information has identified no flood hazards for the Project.

The Project has the potential to lead to a net decrease in recharge potential and net increase in the hydrological response to rainfall at the site, potentially leading to adverse impacts on flood risk areas downstream of the site. The extent of the risk of flooding and potential impact of a development on flooding elsewhere (downstream) requires FRA Stage 2.

4.3 Stage 2 – Initial Flood Risk Assessment

4.3.1 Assessing Potential Impacts of Development – Sites Downgradient

While the Catchment Flood Risk Management Plan (CFRAM) programme did not indicate any flood extents within the proposed Site boundaries, nor its immediate surrounding vicinity, however downgradient of the site, there are probable flood areas. The closest mapped probable flood areas are associated with;

- The Sullane (030) river approximately ten kilometres to the southeast of the site near Ballymarkeery town.

To highlight, there has been only 1 no. recorded localised flood events between the Site and the CFRAM mapped probable flood areas. This event 'Flooding at Coolea, Milleeny and Derreenaling' took place on 11/09/2015, however no further information about the event was available.

In regard to the Grid Connection Route, there are no recorded historic flood events along the proposed Grid Connection Route. However, there is a portion of the route near the proposed HDD crossing of Stream 3 (ITM: 517767, 583303), that crosses both a National Indicative Fluvial Mapping (NIFM) Medium (1% AEP) and Low (0.1% AEP) probability scenario. Both these risks are mapped for the current and future scenarios.

In regard to the Turbine Delivery Route, there have been several 'Single' and 'Reoccurring' Flood Events along the Sullane, in particular near the townlands of Baile Bhuirne, Macroom and closer to Cork Harbour along the River Lee. It is proposed that the TDR will utilise the Macroom to Ballyvourney Dual Carriageway. Along this route, NIFM flood risks have been identified at the following crossing locations:

- ITM: 519851, 578443
- ITM: 527446, 573948
- ITM: 535259 ,572778

Furthermore, where the Sullane meets the River Lee, south of Macroom CFRAM River Flood Extents have been mapped for the surrounding areas of 0.1%, 1% and 10% AEP, where the Turbine Delivery Route follows the N22.

4.3.2 Assessing Potential Effects of Development – Increased Hydraulic Loading

4.3.2.1 Rainfall and Evapotranspiration

Rainfall data for the region associated with the Project site has been assessed in terms of the following parameters;

- Historical average and max monthly rainfall and effective rainfall. Effective rainfall is calculated as being rainfall minus evapotranspiration equals effective rainfall, or the amount of rainfall which will contribute to surface water runoff discharge volumes and/or groundwater recharge.
- Potential significant storm events including events with a 1 in 100-year return period over 1 hour duration, 25-day duration (inferred using available data).
- Daily 2020 rain (specifically in relation to meteorological conditions at the time of site surveys).

Data from the meteorological stations listed in **Table 4.1**, are used in this assessment[5]. Using data presented in **Table 4.3**, storm event of 25 days duration with a 1 in 100-year return period is inferred to be 498.3mm. For the purpose of this environmental impact assessment, predicted extreme or worst-case values are used, as presented in **Table 4.2:** EIA Specific Assessment Data. Rain fall amounts in the three days preceding baseline sampling events are presented in EIAR **Chapter 9 - Table 9.11: Rainfall Prior to Baseline Sampling Events.**

Table 4.1: EIA Specific Assessment Data (Met Eireann, 2021)

Category	Value
Average Annual Effective Rainfall (Long term) (mm/year)	1,323.41
Max monthly effective rainfall (mm/month)	680.2
1 in 100 Year Rainfall Event (1 hour duration) (mm/hour)	32.5
1 in 100 Year Rainfall Event (25-day duration) (mm/hour)	498.3
Minimum monthly evapotranspiration (mm/month)	9.7

Rainfall trends are presented in **EIAR Chapter 9 - Figure 9.5**.

[5] Met Eireann, Historical Data, Available at; www.met.ie, Accessed March 2021

Table 4.2: Meteorological Stations (Met Eireann, 2021)

Category	Meteorological Station/s & Data Set	Approx. Distance from the Site (km)
Rainfall (Historical Monthly)	M.BALLINGEARY 1948-2020	4
Rainfall (2020/21 Monthly/Daily)	M.BALLINGEARY 1948-2020	4
Evapotranspiration	Cork Airport – 2016-2019 Minimum	50

Table 4.3: Met Eireann Return Period Rainfall Depths (Irish Grid; 113392, 78786)[6]

Met Eireann
Return Period Rainfall Depths for sliding Durations
Irish Grid: Easting: 113392, Northing: 78786,

	Interval		Years												
DURATION	6months,	1year,	2,	3,	4,	5,	10,	20,	30,	50,	75,	100	150,	200,	250,	500,
5 mins	3.1,	4.0,	4.5,	5.1,	5.6,	5.9,	6.9,	8.0,	8.7,	9.6,	10.4,	11.0	11.9,	12.6,	13.2,	N/A ,
10 mins	4.4,	5.6,	6.3,	7.2,	7.7,	8.2,	9.6,	11.1,	12.1,	13.4,	14.5,	15.4	16.6,	17.6,	18.4,	N/A ,
15 mins	5.1,	6.6,	7.4,	8.4,	9.1,	9.6,	11.3,	13.1,	14.2,	15.7,	17.1,	18.1	19.6,	20.7,	21.6,	N/A ,
30 mins	7.2,	9.2,	10.2,	11.6,	12.5,	13.2,	15.4,	17.8,	19.2,	21.2,	22.9,	24.2	26.2,	27.6,	28.8,	N/A ,
1 hours	10.2,	12.8,	14.2,	16.1,	17.3,	18.2,	21.1,	24.1,	26.0,	28.6,	30.8,	32.5	35.0,	36.9,	38.4,	N/A ,
2 hours	14.3,	17.9,	19.7,	22.2,	23.8,	25.0,	28.8,	32.8,	35.3,	38.6,	41.5,	43.6	46.8,	49.2,	51.2,	N/A ,
3 hours	17.5,	21.7,	23.8,	26.8,	28.7,	30.1,	34.5,	39.2,	42.1,	46.0,	49.3,	51.8	55.5,	58.3,	60.6,	N/A ,
4 hours	20.1,	24.9,	27.3,	30.6,	32.8,	34.4,	39.3,	44.5,	47.7,	52.1,	55.8,	58.5	62.7,	65.7,	68.2,	N/A ,
6 hours	24.6,	30.3,	33.1,	37.0,	39.5,	41.4,	47.2,	53.2,	57.0,	62.1,	66.3,	69.5	74.3,	77.9,	80.7,	N/A ,
9 hours	30.0,	36.8,	40.1,	44.7,	47.6,	49.8,	56.6,	63.7,	68.1,	74.0,	78.9,	82.6	88.1,	92.2,	95.5,	N/A ,
12 hours	34.6,	42.2,	45.9,	51.1,	54.4,	56.9,	64.5,	72.4,	77.2,	83.7,	89.2,	93.4	99.4,	104.0,	107.6,	N/A ,
18 hours	42.3,	51.3,	55.6,	61.7,	65.6,	68.5,	77.4,	86.6,	92.2,	99.8,	106.2,	110.9	117.9,	123.2,	127.4,	N/A ,
24 hours	48.7,	58.9,	63.8,	70.6,	75.0,	78.2,	88.1,	98.3,	104.6,	113.0,	120.1,	125.3	133.1,	138.9,	143.5,	159.0,
2 days	64.3,	76.4,	82.2,	90.2,	95.2,	99.0,	110.4,	122.0,	129.1,	138.5,	146.4,	152.2	160.8,	167.1,	172.2,	189.0,
3 days	77.6,	91.4,	97.9,	106.9,	112.5,	116.7,	129.3,	142.1,	149.9,	160.1,	168.7,	175.0	184.3,	191.2,	196.7,	214.8,
4 days	89.8,	105.0,	112.1,	121.9,	128.1,	132.6,	146.3,	160.1,	168.6,	179.6,	188.8,	195.6	205.5,	212.8,	218.7,	237.9,
6 days	112.1,	129.7,	138.0,	149.3,	156.3,	161.5,	177.1,	192.8,	202.2,	214.7,	224.9,	232.5	243.5,	251.7,	258.2,	279.3,
8 days	132.7,	152.5,	161.8,	174.4,	182.2,	188.0,	205.2,	222.5,	232.9,	246.5,	257.7,	265.9	278.0,	286.8,	293.8,	316.8,
10 days	152.3,	174.1,	184.3,	198.1,	206.6,	212.9,	231.6,	250.3,	261.5,	276.2,	288.3,	297.1	310.0,	319.5,	327.0,	351.5,
12 days	171.2,	194.9,	205.8,	220.7,	229.9,	236.6,	256.7,	276.8,	288.8,	304.4,	317.3,	326.7	340.5,	350.5,	358.5,	384.5,
16 days	207.5,	234.6,	247.1,	263.9,	274.3,	281.9,	304.5,	327.0,	340.4,	357.8,	372.2,	382.6	397.8,	408.9,	417.7,	446.3,
20 days	242.6,	272.7,	286.6,	305.2,	316.7,	325.1,	350.0,	374.6,	389.3,	408.4,	424.0,	435.4	451.9,	463.9,	473.5,	504.4,
25 days	285.2,	318.9,	334.3,	355.1,	367.8,	377.1,	404.6,	431.7,	447.9,	468.8,	485.8,	498.3	516.3,	529.4,	539.8,	573.4,

NOTES:
N/A Data not available
These values are derived from a Depth Duration Frequency (DDF) Model
For details refer to:
'Fitzgerald D. L. (2007), Estimates of Point Rainfall Frequencies, Technical Note No. 61, Met Eireann, Dublin',
Available for download at www.met.ie/climate/dataproducts/Estimation-of-Point-Rainfall-Frequencies_TN61.pdf

[6] Met Eireann, Rainfall Return Periods, Available at; https://www.met.ie/climate/services/rainfall-return-periods, Accessed October 2022

4.3.2.2 Preliminary Water Balance Assessment

For the purposes of assessing changes in runoff at the site as a function of the Project, the following data compiled from GIS mapping software and **Table 2.5 of Chapter 2** is considered (**FRA Section 3 – Site Description** and **EIAR Chapter 9 – Section 9.3 Baseline Description**);

- Turbine Foundations = 5 No. x 3,064 m^2 = 15,320 m^2
- Turbine Hardstands = 23,700 m^2
- Upgraded Access Roads = 15,998 m^2
- New Access Roads = 41,400m^2
- Meteorological Mast Foundations = 100m^2
- Temporary Construction Compound = 3,640 m^2
- Substation = 1,314 m^2
- Borrow Pit = 38,674 m^2
- 1 in 100-year rainfall event = c. 32.5mm of rainfall in 1 hour.
- Recharge capacity = 20% of Effective Rainfall (Note: This is considered a conservative value i.e., higher potential recharge coefficient in the range associated with the site. In areas of peat the recharge will be considerably less, and considering the capped recharge of the underlying bedrock aquifer the rate of recharge will likely be considerably less across the site, particularly during wet / winter months associated with elevated flood risk generally).
- There are a number of River Flow Estimate (Hydrotools) on the EPA database which detail river discharge rates (Q) including discharge percentile data available for surface water features associated with the site. Consultation with the EPA Hydronet map viewer indicates that the estimated River Discharge (Q) of the Sullare_010, (Segment Code: 19_618), situated directly downstream of the Project c. 2.0 kilometres, has been observed to reach up to c. 0.42m^3/second (January). Further downstream c. 5.2 kilometres, just before the Br nr Coolea Hydrometric station (operational) the river flow has been observed to reach c. 2.06m^3/second (December).

This assessment is considered a simple preliminary water balance assessment for the purposes of qualifying and adding context to potential impacts of the Project in terms of hydrological response to rainfall and flooding. It considers and uses site specific data as well as associated downstream attribute data. (Note: This is not considered advanced modelling for flood risk assessment (FRA Stage 3)).

Table 4.4 summarises a preliminary water balance analysis and potential net increase in runoff for the Site during a 1-in-100-year storm event relative to baseline conditions. Approximate area for the Development (1,701,733 m^2), is calculated for the entire redline boundary landholding for the site.

Table 4.4: Net Increase in Runoff as a function of the Development per Micro-catchment Areas and Baseline Runoff Volumes

(1 in 100 Year Hour Storm Event)

Micro-catchment Areas and Baseline Runoff Volumes (1 in 100 Year Hour Storm Event)								
Development	**Approximate Area (m2)**	**1 in 100 Year Rainfall Event (m/hour Rain)**	**Capped Recharge Capacity. Percentage of Effective Rainfall** (Conservative Value for Water Balanace Calc's)	**Rejected Recharge / Runoff (m/hour Rain)**	**Runoff Discharge Rate (m3/hour)**	**Runoff Discharge Rate (m3/sec)**	**Net Increase (m3/sec)**	**Net Increase as percentage against baseline micro-catchment runoff (%)**
Inchamore WF	1,701,733.00	0.0325	20.00%	0.026	44,245.06	12.29	0.253	2.06%
				Total	**44245.058**	**12.29**	**0.253**	2.06%

Water balance calculations allow for the addition of area for hardstand infrastructure required (land take) during the construction and operational phases of the Development. This equates to approximately 140,146 m^2. A 1 in 100-year storm event scenario results in a net increase of surface water runoff associated with the Development, calculated to be c. 0.253m^3/sec, or 2.06% relative to the Site area (redline boundary). This net increase relative to the scale of the Site or the scale of the associated catchment is considered an imperceptible or negligible impact of the Development. With suitable mitigation measures, **Section 4.3.3** below and **Section 9.6.1.2** of **Chapter 9**, the pressure to the surface water bodies and sites downgradient can be reduced to a neutral to beneficial impact.

4.3.3 Mitigation Measures Associated with the Development

Flood Relief Schemes, outlined by the OPW, are in place for Ballymarkeery town (flood area identified above), which include Measures Applicable in All Areas, detailed as:

- Sustainable Urban Drainage Systems (SUDS). Objective: Planning authorities will seek to reduce the extent of hard surfacing and paving and require the use of sustainable drainage techniques to reduce the potential impact of development on flood risk downstream.
- Land Use Management and Natural Flood Risk Management. Objective: during the project-level assessments of physical works and more broadly at a catchment-level to identify any measures, such as natural water retention measures (such as restoration of wetlands and woodlands), that can have benefits for Water Framework Directive, flood risk management and biodiversity objectives.

Under the 2013-2015 Work Programme of the Common Implementation Strategy (CIS) for the Water Framework Directive (WFD), and in response to the 2012 Blueprint to Safeguard Europe's Water Resources proposals, the Working Group Programme of Measures has developed guidance for supporting the implementation of Natural Water Retention Measures (NWRM) in Europe (European Commission, 2015).

The OPW and EPA Catchments Unit in conjunction with Local Authorities are actively adopting and promoting NWRM as part of a broader suite of mitigation measures that

could contribute to the achievement of environmental objectives (WFD) set out in the second River Basin Management Plan (RBMP) (EPA Catchment Unit, 2020).

Flood Relief Scheme and flood risk management Objectives such as Land Use Management and Natural Flood Risk Management are relevant to the Project , whereby; the assessment and design of the Project will qualify and mitigate any potential adverse impact in terms of hydrological response to rainfall and flood risk within or downstream of the site. The objective of mitigation in this respect will be to achieve, at a minimum, a neutral impact, and to identify and promote beneficial impacts (net decrease in hydrological response to rainfall) at the site, particularly in terms of Natural Water Retention Measures (NWRM) as part of baseline conditions, namely; restoration of peatlands, wetlands and woodlands.

To mitigate any net change in hydraulic loading to surface waters during the construction and operational phase of the Project, the following examples will be utilised where appropriate;

- Check dams, dams, other flow restricting infrastructure
- Collector drains
- Permanent stilling ponds
- Attenuation lagoons
- Buffered outfalls to vegetated areas
- Rewetting peatlands
- Controlling dewatering flow/pump rates;
- Restricting pumped water discharge directly to drainage or surface water networks.
- Offline storage ponds, overland sediment traps,
- Floodplain and riparian woodland
- Riverbank restoration
- River morphology and floodplain restoration – removal of embankments, re-meandered river reach
- In stream structure – large woody debris
- Catchment woodlands
- Land and soil management practices – cover crops, cross contour hedgerows.

The Project has the potential to result in increased volumes of runoff during the operational phase relative to baseline conditions. However, with the appropriate environmental engineering controls and mitigation measures, previously outlined, these potential impacts will be reduced.

The combined attenuation capacity of the proposed drainage infrastructure will be designed to attenuate net increase in water runoff, including during extreme storm events relative to greenfield or baseline runoff rates with an additional 20% taking into account of climate change. These mitigation measures required during the construction and operational phases will buffer the discharge rate and reduce the hydrological response to rainfall at the site, maintain (or improve) the hydrological regime at the site, in turn reducing loading on the receiving surface water drainage network. This will mitigate against the potential for rapid runoff and rapid hydrological responses to rainfall, lessening the likelihood to flooding of the drainage network or downstream of the Project.

Mitigation measures will be considered and designed in line with engineering and construction best practices and methodologies, including the following guidance documents (non-exhaustive);

- Scottish Environment Protection Agency (SEPA) (2009) Flood Risk Management (Scotland) Act 2009 – Surface Water management Planning Guidance
- Scottish Environment Protection Agency (SEPA) (2015) Natural Flood Management Handbook
- CIRIA (2006) Control of Water Pollution from Linear Construction Projects – Technical Guidance
- CIRIA (2015) The SuDS Manual (C753)

With regard to the risk of flooding along the Grid Connection Route, the cables and cable ducting will be designed and installed to prevent ingress of water during their design life. Furthermore, proposed cable joint bay locations will be located as far as practicable outside of the estimated (AEP) floodplains.

The following observations and recommendations are made with a view to ensuring mitigation measures are designed and deployed effectively;

- The magnitude of potential net increase in runoff as a function for the Project at the Site is considered adverse but imperceptible, that is; quantifiable but without significant impact relative to the appropriate scale (flood risk areas downstream of the site and associated with a much larger catchment compared to the site boundary). However, in terms cumulative runoff and flood risk, and as detailed in general mitigation measures as part of CFRAM areas, detailed engineered design of the Project and with a view to applying mitigation measures adequately and appropriately will be required, that is; drainage, attenuation and associated infrastructure is designed and specified by a competent water infrastructure engineer, which will include modelling of runoff in site drainage, to ensure that all aspects ate sufficiently specified. Drainage modelling, including assessment of inundation rates, lag times and discharge rates, will be particularly useful in sensitive peatland areas, or where particularly sensitive environmental attributes exist downstream, for example, ecological attributes where surface water runoff and surface water quality are linked (**EIAR Chapter 9**).
- Detailed design and specification of drainage, attenuation and associated infrastructure have been included in a detailed Surface Water Management Plan (SWMP, Management Plan 3 in the **CEMP, Appendix 2.1**) prior to the commencement of the construction phase which will include detailed development drainage layout and details regarding construction, maintenance, monitoring and emergency response. It is recommended that this is done in conjunction with relevant stakeholders including relevant authorities and other stakeholders such as landholders etc. in line with River Basin Management practices i.e., engagement at local level.

4.4 FRA Stage 2 – Conclusions

A 1 in 100-year storm event scenario results in a net increase of surface water runoff associated with the Project, calculated to be c. 0.121m^3/second, or 1.01% relative to the Site area (redline boundary). This net increase relative to the scale of the Site or the scale of the associated catchment is considered an adverse but imperceptible to slight impact of the Project.

The Project will use the latest best practice guidance to ensure that flood risk within or downstream of the Site is not increased as a function of the Project, i.e., a neutral impact at a minimum.

Considering the Project does not acutely or significantly impact on a probable flood risk area directly, FRA Stage 3 including advanced flood modelling is not required.

A Surface Water Management Plan (SWMP) (**Appendix 2.1; Management Plan 3**) has been prepared and will be updated prior to the construction phase commencing, with a view to ensuring that the surface water runoff at the Site is managed effectively and does not exacerbate flood risk on site or to the flood risk areas downstream of the site. It is recommended that this is done in consultation with relevant stakeholders.

As the associated drainage - some of which is permeant for the lifetime of the Project, will be attenuated for greenfield run-off, the Project will not increase the risk of flooding elsewhere in the catchment. Based on this information, the Project complies with the appropriate policy guidelines for the area and is at no risk of flooding.

5 REFERENCES

EPA (2021) "3rd Cycle Draft Lee, Cork Harbour and Youghal Bay Catchment Report (HA 19)" *Environmental Protection Agency-Catchment Science & Management Unit.* Version no (1). Available at: < https://catchments.ie/wp-content/files/catchmentassessments/19%20Lee,%20Cork%20Harbour%20and%20Youghal%20Bay%20Catchment%20Summary%20WFD%20Cycle%203.pdf> Accessed October 2022.

EPA (2022a) 'GSI EPA Maps', *Geological Survey Ireland*, Available at: <https://gis.epa.ie/EPAMaps/>.

EPA Catchments Unit (2020) *Natural Water Retention Measures – implementing the Flood Risk Management Plans* [Online] Available at: https://www.catchments.ie/natural-water-retention-measures-implementing-the-flood-risk-management-plans/ [Accessed: October 2022]

European Commission (2015) "Directorate-General for Environment, EU policy document on natural water retention measures: by the drafting team of the WFD CIS Working Group Programme of Measures (WG PoM)", *Publications Office*. Available at: <https://data.europa.eu/doi/10.2779/396202> Accessed October 2022.

European Union (EU) (2014) *Natural Water Retention Measures -Technical Report - 2014 – 082.*

Google Earth Pro (2022) *TerraMetrics; version 7.3 (beta),* Gortyrahilly, Cahir Co. Cork, Ireland. 51°53'48.34" N 9°13'46.76" W, Eye alt 4.65 km. Places layers. SIO, NOAA, US Navy, NGA, GEBCO.

GSI (2022) 'Geological Survey Ireland Spatial Resources', *Geological Survey Ireland- Division of Department of the Environment, Climate and Communications-Story Map Series*, Available at: <https://dcenr.maps.arcgis.com/apps/MapSeries/index.html?appid=a30af518e87a4c0ab2fbde2aaac3c228>.

Office of Public Works (2009) "The Planning System and Flood Risk Management, Guidelines for Planning Authorities" *Environment, Heritage and Local Government*, Available at: <https://www.opr.ie/wp-content/uploads/2019/08/2009-Planning-System-Flood-Risk-Mgmt-1.pdf>.

Office of Public Works (2022) "Flood Hazard Maps", Available at: <https://www.floodinfo.ie/map/floodmaps/>.

OSI (2022) 'GeoHive Map Viewer', *Government of Ireland,* Available at: < https://webapps.geohive.ie/mapviewer/index.html>.

APPENDIX A

APPENDIX B

APPENDIX C

Appendix 9.3 - Baseline Surface Water Hydro-Chemistry & Discharge Rate Database.

(Minerex File Ref. 3188-011.xls)

Minerex Environmental

Sample Details	Sampling Event (Date Sampled)		LIMITS re EIA (Ref. NRA) Indicative Limits Re.: Bathing, Drinking Surface Water reg's.				
Sample ID	ALL			SW1	SW2	SW3	SW4
Site	ALL			A2-Inchamore	A2-Inchamore	A2-Inchamore	A2-Inchamore
Project COC Reference - SW R1	12/08/2020	Dry / Low Flow		3188-028-COC1	3188-028-COC1	3188-028-COC1	3188-028-COC1
Project COC Reference - SW R2	26/08/2020	Wet / High Flow		3188-028-COC2	3188-028-COC2	3188-028-COC2	3188-028-COC2
Project COC Reference - SW R3	24/02/2021	Wet / High Flow		3188-028-COC4	3188-028-COC4	3188-028-COC4	3188-028-COC4
Project COC Reference - SW R4	16/03/2021	Dry / Low Flow		3188-028-COC3	3188-028-COC3	3188-028-COC3	3188-028-COC3
Sample Type	ALL	Medum		Surface Water	Surface Water	Surface Water	Surface Water
Grid Reference for Sampling Location	ALL	Irish Grid		513031.2, 578569.0	513613.1, 577809.8	513338.0, 577571.8	512057.7, 577399.8
Field Data - Discharge							
Surface Water Feature	ALL	Type		Ditch	Drain	Drain	Ditch
Description of sample location	ALL	Type		Alongside feature	Road bridge	Road bridge	Road bridge
Width of Water Body	ALL	m		<1.0	1.5	2	3
Depth (d)	ALL	m		<0.2	<0.25	<0.25	<0.5
Total Rain 3 Days Prior (Table 9.11)	12/08/2020	mm/72hours		0.0			
Total Rain 3 Days Prior (Table 9.11)	26/08/2020	mm/72hours		59.7			
Total Rain 3 Days Prior (Table 9.11)	24/02/2021	mm/72hours		47.8			
Total Rain 3 Days Prior (Table 9.11)	16/03/2021	mm/72hours		8.1			
Estimated Discharge Rate (Q)	12/08/2020	l/sec		1 to 2	6 to 8	6 to 8	30
Estimated Discharge Rate (Q)	26/08/2020	l/sec		5 to 6	8 to 10	20 to 25	50 to 60
Estimated Discharge Rate (Q)	24/02/2021	l/sec		5 to 6	10 to 15	20 to 25	50 to 60
Estimated Discharge Rate (Q)	16/03/2021	l/sec		2 to 4	6 to 8	6 to 8	10
Laboratory Data - Hydrochemistry							
Alkalinity, Bicarbonate as CaCO3	12/08/2020	mg/l		9.11	22.5	18	16
Alkalinity, Bicarbonate as CaCO3	26/08/2020	mg/l		4.5	7.5	9	18.6
Alkalinity, Bicarbonate as CaCO3	24/02/2021	mg/l		2.5	4	2	3.5
Alkalinity, Bicarbonate as CaCO3	16/03/2021	mg/l		5.5	7.5	5.5	10.3
Alkalinity, Total as CaCO3	12/08/2020	mg/l		9.11	22.5	18	16
Alkalinity, Total as CaCO3	26/08/2020	mg/l		4.5	7.5	9	18.6
Alkalinity, Total as CaCO3	24/02/2021	mg/l		2.5	4	2	3.5
Alkalinity, Total as CaCO3	16/03/2021	mg/l		5.5	7.5	5.5	10.3
Ammoniacal Nitrogen as N (low level)	12/08/2020	mg/l	0.02	0.0245	0.0121	0.0243	0.028
Ammoniacal Nitrogen as N (low level)	26/08/2020	mg/l	0.02	0.0164	0.0177	0.0321	0.018
Ammoniacal Nitrogen as N (low level)	24/02/2021	mg/l	0.02	0.037	0.036	0.024	0.032
Ammoniacal Nitrogen as N (low level)	16/03/2021	mg/l	0.02	0.04	0.042	0.029	0.042
Apparent Colour	12/08/2020	mg/l Pt/Co		30.8	31.2	97	65.8
Apparent Colour	26/08/2020	mg/l Pt/Co		96	62.7	165	79.3
Apparent Colour	24/02/2021	mg/l Pt/Co		37.4	75.2	52	61.3
Apparent Colour	16/03/2021	mg/l Pt/Co		20.4	35.9	20.9	27.8
Conductivity @ 20 deg.C	12/08/2020	mS/cm	2.5	0.0578	0.057	0.0757	0.0625
Conductivity @ 20 deg.C	26/08/2020	mS/cm	2.5	0.0427	0.0304	0.063	0.0526
Conductivity @ 20 deg.C	24/02/2021	mS/cm	2.5	0.025	0.0377	0.0281	0.0293
Conductivity @ 20 deg.C	16/03/2021	mS/cm	2.5	0.0539	0.0706	0.0568	0.0634
Nitrate as NO3	12/08/2020	mg/l		0.539	<0.3	<0.3	<0.3
Nitrate as NO3	26/08/2020	mg/l		0.374	<0.3	<0.3	0.456
Nitrate as NO3	24/02/2021	mg/l		<0.3	0.384	<0.3	<0.3
Nitrate as NO3	16/03/2021	mg/l		<0.3	<0.3	<0.3	<0.3
Nitrite as NO2	12/08/2020	mg/l	0.05	<0.05	<0.05	<0.05	<0.05
Nitrite as NO2	26/08/2020	mg/l	0.05	<0.05	<0.05	<0.05	<0.05
Nitrite as NO2	24/02/2021	mg/l	0.05	0.273	<0.05	<0.05	<0.05
Nitrite as NO2	16/03/2021	mg/l	0.05	<0.05	<0.05	<0.05	<0.05
pH	12/08/2020	pH Units	>6 & <9	6.88	7.08	7.13	7.13
pH	26/08/2020	pH Units	>6 & <9	5.73	6.59	6.35	6.96
pH	24/02/2021	pH Units	>6 & <9	6.69	6.74	6.47	7.03
pH	16/03/2021	pH Units	>6 & <9	6.75	6.97	7.38	7.25
Phosphate (Ortho as P)	12/08/2020	mg/l		<0.02	<0.02	<0.02	<0.02
Phosphate (Ortho as P)	26/08/2020	mg/l		<0.02	<0.02	<0.02	<0.02
Phosphate (Ortho as P)	24/02/2021	mg/l		<0.02	<0.02	<0.02	<0.02
Phosphate (Ortho as P)	16/03/2021	mg/l		<0.02	<0.02	<0.02	<0.02
Phosphorus (tot.unfilt)	12/08/2020	µg/l		<20	<20	24.1	<20
Phosphorus (tot.unfilt)	26/08/2020	µg/l		<20	<20	23.1	<20
Phosphorus (tot.unfilt)	24/02/2021	µg/l		<20	<20	<20	<20
Phosphorus (tot.unfilt)	16/03/2021	µg/l		<20	<20	<20	<20
Suspended solids, Total	12/08/2020	mg/l	25	<2	<2	<2	<2
Suspended solids, Total	26/08/2020	mg/l	25	<2	<2	<2	<2
Suspended solids, Total	24/02/2021	mg/l	25	<2	2.55	<2	<2
Suspended solids, Total	16/03/2021	mg/l	25	<2	<2	<2	<2
True Colour	12/08/2020	mg/l Pt/Co		24.7	21.1	76.6	48.3
True Colour	26/08/2020	mg/l Pt/Co		84.7	51.9	143	66.3
True Colour	24/02/2021	mg/l Pt/Co		31.4	61.2	44.2	51.4
True Colour	16/03/2021	mg/l Pt/Co		13.8	26.8	14.2	20.2
Turbidity	12/08/2020	ntu		0.54	0.674	2.06	1.17
Turbidity	26/08/2020	ntu		1.28	0.562	1.53	0.885
Turbidity	24/02/2021	ntu		0.561	3.65	1.62	2.22
Turbidity	16/03/2021	ntu		0.805	1.28	0.694	0.452

Unit 7-8 Hawarden Business Park
Manor Road (off Manor Lane)
Hawarden
Deeside
CH5 3US
Tel: (01244) 528700
Fax: (01244) 528701
email: hawardencustomerservices@alsglobal.com
Website: www.alsenvironmental.co.uk

Minerex Environmental
Taney hall
Eglinton Terrace
Dundrum
Dublin
Dublin 14

Attention: Sven Klinkenbergh

CERTIFICATE OF ANALYSIS

Date of report Generation:	20 August 2020
Customer:	Minerex Environmental
Sample Delivery Group (SDG):	200814-71
Your Reference:	3188-A2-COC1
Location:	Inchamore, Co. Cork
Report No:	564014

We received 4 samples on Friday August 14, 2020 and 4 of these samples were scheduled for analysis which was completed on Thursday August 20, 2020. Accredited laboratory tests are defined within the report, but opinions, interpretations and on-site data expressed herein are outside the scope of ISO 17025 accreditation.

Should this report require incorporation into client reports, it must be used in its entirety and not simply with the data sections alone.

Chemical testing (unless subcontracted) performed at ALS Life Sciences Ltd Hawarden (Method codes TM) or ALS Life Sciences Ltd Aberdeen (Method codes S).

All sample data is provided by the customer. The reported results relate to the sample supplied, and on the basis that this data is correct.
Incorrect sampling dates and/or sample information will affect the validity of results.

Approved By:

Sonia McWhan
Operations Manager

CERTIFICATE OF ANALYSIS

SDG:	200814-71	**Client Reference:**	3188-A2-COC1	**Report Number:**	564014
Location:	Inchamore, Co. Cork	**Order Number:**		**Superseded Report:**	

Received Sample Overview

Lab Sample No(s)	Customer Sample Ref.	AGS Ref.	Depth (m)	Sampled Date
22656606	3188-SW1		0.00 - 0.00	12/08/2020
22656623	3188-SW2		0.00 - 0.00	12/08/2020
22656636	3188-SW3		0.00 - 0.00	12/08/2020
22656649	3188-SW4		0.00 - 0.00	12/08/2020

Maximum Sample/Coolbox Temperature (°C) : **17.4**

ISO5667-3 Water quality - Sampling - Part3 -
During Transportation samples shall be stored in a cooling device capable of maintaining a temperature of (5±3)°C.

ALS have data which show that a cool box with 4 frozen icepacks is capable of maintaining pre-chilled samples at a temperature of (5±3)°C for a period of up to 24hrs.

Only received samples which have had analysis scheduled will be shown on the following pages.

Validated

CERTIFICATE OF ANALYSIS

SDG:	200814-71	**Client Reference:**	3188-A2-COC1	**Report Number:**	564014
Location:	Inchamore, Co. Cork	**Order Number:**		**Superseded Report:**	

Results Legend

X Test

N No Determination Possible

Sample Types -
S - Soil/Solid
UNS - Unspecified Solid
GW - Ground Water
SW - Surface Water
LE - Land Leachate
PL - Prepared Leachate
PR - Process Water
SA - Saline Water
TE - Trade Effluent
TS - Treated Sewage
US - Untreated Sewage
RE - Recreational Water
DW - Drinking Water Non-regulatory
UNL - Unspecified Liquid
SL - Sludge
G - Gas
OTH - Other

Lab Sample No(s)					22656606				22656623				22656636				22656649
Customer Sample Reference					3188-SW1				3188-SW2				3188-SW3				3188-SW4
AGS Reference																	
Depth (m)					0.00 - 0.00				0.00 - 0.00				0.00 - 0.00				0.00 - 0.00
Container					500ml Plastic (ALE208)	H2SO4 (ALE244)	HNO3 Unfiltered (ALE204)	NaOH (ALE245)	500ml Plastic (ALE208)	H2SO4 (ALE244)	HNO3 Unfiltered (ALE204)	NaOH (ALE245)	500ml Plastic (ALE208)	H2SO4 (ALE244)	HNO3 Unfiltered (ALE204)	NaOH (ALE245)	500ml Plastic (ALE208)	H2SO4 (ALE244)	HNO3 Unfiltered (ALE204)	NaOH (ALE245)
Sample Type					SW	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW
Alkalinity as CaCO3	All	NDPs: 0 Tests: 4			X				X				X				X			
Ammonium Low	All	NDPs: 0 Tests: 4				X				X				X				X		
Anions by Kone (w)	All	NDPs: 0 Tests: 4			X				X				X				X			
Colour Test	All	NDPs: 0 Tests: 4			X				X				X				X			
Conductivity (at 20 deg.C)	All	NDPs: 0 Tests: 4			X				X				X				X			
Nitrite by Kone (w)	All	NDPs: 0 Tests: 4						X				X				X				X
pH Value	All	NDPs: 0 Tests: 4			X				X				X				X			
Phosphate by Kone (w)	All	NDPs: 0 Tests: 4			X				X				X				X			
Suspended Solids	All	NDPs: 0 Tests: 4			X				X				X				X			
Total Metals by ICP-MS	All	NDPs: 0 Tests: 4					X				X				X				X	
Turbidity in waters	All	NDPs: 0 Tests: 4			X				X				X				X			

Validated

CERTIFICATE OF ANALYSIS

SDG: 200814-71 **Client Reference:** 3188-A2-COC1 **Report Number:** 564014
Location: Inchamore, Co. Cork **Order Number:** **Superseded Report:**

Results Legend	
#	ISO17025 accredited.
M	mCERTS accredited.
aq	Aqueous / settled sample.
diss.filt	Dissolved / filtered sample.
tot.unfilt	Total / unfiltered sample.
*	Subcontracted - refer to subcontractor report for accreditation status.
**	% recovery of the surrogate standard to check the efficiency of the method. The results of individual compounds within samples aren't corrected for the recovery
(F)	Trigger breach confirmed
1-3+$@	Sample deviation (see appendix)

Component	LOD/Units	Method	Customer Sample Ref.	3188-SW1	3188-SW2	3188-SW3	3188-SW4		
			Depth (m)	0.00 - 0.00	0.00 - 0.00	0.00 - 0.00	0.00 - 0.00		
			Sample Type	Surface Water (SW)	Surface Water (SW)	Surface Water (SW)	Surface Water (SW)		
			Date Sampled	12/08/2020	12/08/2020	12/08/2020	12/08/2020		
			Sample Time	00:00	00:00	00:00	00:00		
			Date Received	14/08/2020	14/08/2020	14/08/2020	14/08/2020		
			SDG Ref	200814-71	200814-71	200814-71	200814-71		
			Lab Sample No.(s)	22656606	22656623	22656636	22656649		
			AGS Reference						
Suspended solids, Total	<2 mg/l	TM022		<2 #	<2 #	<2 #	<2 #		
Alkalinity, Total as CaCO3	<2 mg/l	TM043		9.11 #	22.5 #	18 #	16 #		
Alkalinity, Bicarbonate as CaCO3	<2 mg/l	TM043		9.11	22.5	18	16		
Ammoniacal Nitrogen as N (low level)	<0.01 mg/l	TM099		0.0245 #	0.0121 #	0.0243 #	0.028 #		
Conductivity @ 20 deg.C	<0.02 mS/cm	TM120		0.0578 #	0.057 #	0.0757 #	0.0625 #		
Phosphorus (tot.unfilt)	<20 µg/l	TM152		<20 #	<20 #	24.1 #	<20 #		
Nitrite as NO2	<0.05 mg/l	TM184		<0.05 #	<0.05 #	<0.05 #	<0.05 #		
Phosphate (Ortho as P)	<0.02 mg/l	TM184		<0.02 #	<0.02 #	<0.02 #	<0.02 #		
Nitrate as NO3	<0.3 mg/l	TM184		0.539	<0.3	<0.3	<0.3		
Turbidity	<0.1 ntu	TM195		0.54 ♦ #	0.674 ♦ #	2.06 ♦ #	1.17 ♦ #		
pH	<1 pH Units	TM256		6.88 #	7.08 #	7.13 #	7.13 #		
Apparent Colour	<1 mg/l Pt/Co	TM261		30.8	31.2	97	65.8		
True Colour	<1 mg/l Pt/Co	TM261		24.7	21.1	76.6	48.3		

CERTIFICATE OF ANALYSIS

SDG:	200814-71	**Client Reference:**	3188-A2-COC1	**Report Number:**	564014
Location:	Inchamore, Co. Cork	**Order Number:**		**Superseded Report:**	

Table of Results - Appendix

Method No	Reference	Description
TM022	Method 2540D, AWWA/APHA, 20th Ed., 1999 / BS 2690: Part120 1981;BS EN 872	Determination of total suspended solids in waters
TM043	Method 2320B, AWWA/APHA, 20th Ed., 1999 / BS 2690: Part109 1984	Determination of alkalinity in aqueous samples
TM099	BS 2690: Part 7:1968 / BS 6068: Part2.11:1984	Determination of Ammonium in Water Samples using the Kone Analyser
TM120	Method 2510B, AWWA/APHA, 20th Ed., 1999 / BS 2690: Part 9:1970	Determination of Electrical Conductivity using a Conductivity Meter
TM152	Method 3125B, AWWA/APHA, 20th Ed., 1999	Analysis of Aqueous Samples by ICP-MS
TM184	EPA Methods 325.1 & 325.2,	The Determination of Anions in Aqueous Matrices using the Kone Spectrophotometric Analysers
TM195	Colour and Turbidity of water. Methods for the Examination of Waters and Associated Materials. HMSO, 1981, ISBN 0 11 751955 3.	Determination of Turbidity in Waters & Associated Matrices
TM256	The measurement of Electrical Conductivity and the Laboratory determination of pH Value of Natural, Treated and Wastewaters. HMSO, 1978. ISBN 011 751428 4.	Determination of pH in Water and Leachate using the GLpH pH Meter
TM261	Colour and Turbidity of Waters, Methods for the Examination of Waters and Associated Materials, HMSO, 1981, ISBN 0 11 7519553.	Determination of True and Apparent Colour by Spectrophotometry

NA = not applicable.

Chemical testing (unless subcontracted) performed at ALS Life Sciences Ltd Hawarden (Method codes TM) or ALS Life Sciences Ltd Aberdeen (Method codes S).

CERTIFICATE OF ANALYSIS

SDG:	200814-71	**Client Reference:**	3188-A2-COC1	**Report Number:**	564014
Location:	Inchamore, Co. Cork	**Order Number:**		**Superseded Report:**	

Test Completion Dates

Lab Sample No(s)	22656606	22656623	22656636	22656649
Customer Sample Ref.	3188-SW1	3188-SW2	3188-SW3	3188-SW4
AGS Ref.				
Depth	0.00 - 0.00	0.00 - 0.00	0.00 - 0.00	0.00 - 0.00
Type	Surface Water	Surface Water	Surface Water	Surface Water
Alkalinity as CaCO3	19-Aug-2020	19-Aug-2020	19-Aug-2020	19-Aug-2020
Ammonium Low	18-Aug-2020	19-Aug-2020	18-Aug-2020	18-Aug-2020
Anions by Kone (w)	17-Aug-2020	19-Aug-2020	19-Aug-2020	19-Aug-2020
Colour Test	18-Aug-2020	18-Aug-2020	18-Aug-2020	18-Aug-2020
Conductivity (at 20 deg.C)	19-Aug-2020	19-Aug-2020	19-Aug-2020	19-Aug-2020
Nitrite by Kone (w)	17-Aug-2020	19-Aug-2020	19-Aug-2020	17-Aug-2020
pH Value	19-Aug-2020	19-Aug-2020	19-Aug-2020	19-Aug-2020
Phosphate by Kone (w)	20-Aug-2020	20-Aug-2020	20-Aug-2020	20-Aug-2020
Suspended Solids	20-Aug-2020	19-Aug-2020	19-Aug-2020	19-Aug-2020
Total Metals by ICP-MS	19-Aug-2020	19-Aug-2020	19-Aug-2020	19-Aug-2020
Turbidity in waters	18-Aug-2020	18-Aug-2020	18-Aug-2020	18-Aug-2020

Appendix

General

1. Results are expressed on a dry weight basis (dried at 35ºC) for all soil analyses except for the following: NRA and CEN Leach tests, flash point LOI, pH, ammonium as NH4 by the BRE method, VOC TICs and SVOC TICs.

2. If sufficient sample is received a sub sample will be retained free of charge for 30 days after analysis is completed (e-mailed) for all sample types unless the sample is destroyed on testing. The prepared soil sub sample that is analysed for asbestos will be retained for a period of 6 months after the analysis date. All bulk samples will be retained for a period of 6 months after the analysis date. All samples received and not scheduled will be disposed of one month after the date of receipt unless we are instructed to the contrary. Once the initial period has expired, a storage charge will be applied for each month or part thereof until the client cancels the request for sample storage. ALS reserve the right to charge for samples received and stored but not analysed.

3. With respect to turnaround, we will always endeavour to meet client requirements wherever possible, but turnaround times cannot be absolutely guaranteed due to so many variables beyond our control.

4. We take responsibility for any test performed by sub-contractors (marked with an asterisk). We endeavour to use UKAS/MCERTS Accredited Laboratories, who either complete a quality questionnaire or are audited by ourselves. For some determinands there are no UKAS/MCERTS Accredited Laboratories, in this instance a laboratory with a known track record will be utilised.

5. If no separate volatile sample is supplied by the client, or if a headspace or sediment is present in the volatile sample, the integrity of the data may be compromised. This will be flagged up as an invalid VOC on the test schedule and the result marked as deviating on the test certificate.

6. NDP - No determination possible due to insufficient/unsuitable sample.

7. Results relate only to the items tested.

8. LoDs (Limit of Detection) for wet tests reported on a dry weight basis are not corrected for moisture content.

9. **Surrogate recoveries** - Surrogates are added to your sample to monitor recovery of the test requested. A % recovery is reported, results are not corrected for the recovery measured. Typical recoveries for organics tests are 70-130%. Recoveries in soils are affected by organic rich or clay rich matrices. Waters can be affected by remediation fluids or high amounts of sediment. Test results are only ever reported if all of the associated quality checks pass; it is assumed that all recoveries outside of the values above are due to matrix affect.

10. Stones/debris are not routinely removed. We always endeavour to take a representative sub sample from the received sample.

11. In certain circumstances the method detection limit may be elevated due to the sample being outside the calibration range. Other factors that may contribute to this include possible interferences. In both cases the sample would be diluted which would cause the method detection limit to be raised.

12. Mercury results quoted on soils will not include volatile mercury as the analysis is performed on a dried and crushed sample.

13. For leachate preparations other than Zero Headspace Extraction (ZHE) volatile loss may occur.

14. For the BSEN 12457-3 two batch process to allow the cumulative release to be calculated, the volume of the leachate produced is measured and filtered for all tests. We therefore cannot carry out any unfiltered analysis. The tests affected include volatiles GCFID/GCMS and all subcontracted analysis.

15. Analysis and identification of specific compounds using GCFID is by retention time only, and we routinely calibrate and quantify for benzene, toluene, ethylbenzenes and xylenes (BTEX). For total volatiles in the C5-C12 range, the total area of the chromatogram is integrated and expressed as ug/kg or ug/l. Although this analysis is commonly used for the quantification of gasoline range organics (GRO), the system will also detect other compounds such as chlorinated solvents, and this may lead to a falsely high result with respect to hydrocarbons only. It is not possible to specifically identify these non-hydrocarbons, as standards are not routinely run for any other compounds, and for more definitive identification, volatiles by GCMS should be utilised.

16. We are accredited to MCERTS for sand, clay and loam/topsoil, or any of these materials - whether these are derived from naturally occurring soil profiles, or from fill/made ground, as long as these materials constitute the major part of the sample. Other coarse granular material such as concrete, gravel and brick are not accredited if they comprise the major part of the sample.

17. **Tentatively Identified Compounds (TICs)** are non-target peaks in VOC and SVOC analysis. All non-target peaks detected with a concentration above the LoD are subjected to a mass spectral library search. Non-target peaks with a library search confidence of >75% are reported based on the best mass spectral library match. When a non-target peak with a library search confidence of <75% is detected it is reported as “mixed hydrocarbons”. Non-target compounds identified from the scan data are semi-quantified relative to one of the deuterated internal standards, under the same chromatographic conditions as the target compounds. This result is reported as a semi-quantitative value and reported as Tentatively Identified Compounds (TICs). TICs are outside the scope of UKAS accreditation and are not moisture corrected.

18. **Sample Deviations**

If a sample is classed as deviated then the associated results may be compromised.

1	**Container with Headspace provided for volatiles analysis**
2	**Incorrect container received**
3	**Deviation from method**
§	**Sampled on date not provided**
♦	**Sample holding time exceeded in laboratory**
@	**Sample holding time exceeded due to late arrival of instructions or samples**

19. **Asbestos**

When requested, the individual sub sample scheduled will be analysed in house for the presence of asbestos fibres and asbestos containing material by our documented in house method TM048 based on HSG 248 (2005), which is accredited to ISO17025. If a specific asbestos fibre type is not found this will be reported as “Not detected”. If no asbestos fibre types are found all will be reported as “Not detected” and the sub sample analysed deemed to be clear of asbestos. If an asbestos fibre type is found it will be reported as detected (for each fibre type found). Testing can be carried out on asbestos positive samples, but, due to Health and Safety considerations, may be replaced by alternative tests or reported as No Determination Possible (NDP). The quantity of

Identification of Asbestos in Bulk Materials & Soils

The results for identification of asbestos in bulk materials are obtained from supplied bulk materials which have been examined to determine the presence of asbestos fibres using ALS (Hawarden) in-house method of transmitted/polarised light microscopy and central stop dispersion staining, based on HSG 248 (2005).

The results for identification of asbestos in soils are obtained from a homogenised sub sample which has been examined to determine the presence of asbestos fibres using ALS (Hawarden) in-house method of transmitted/polarised light microscopy and central stop dispersion staining, based on HSG 248 (2005).

Asbestos Type	Common Name
Chrysotile	White Asbestos
Amosite	Brown Asbestos
Crocidolite	Blue Asbestos
Fibrous Actinolite	-
Fibrous Anthophyllite	-
Fibrous Tremolite	-

Visual Estimation Of Fibre Content

Estimation of fibre content is not permitted as part of our UKAS accredited test other than: - Trace - Where only one or two asbestos fibres were identified.

Respirable Fibres

Respirable fibres are defined as fibres of <3 µm diameter, longer than 5 µm and with aspect ratios of at least 3:1 that can be inhaled into the lower regions of the lung and are generally acknowledged to be most important predictor of hazard and risk for cancers of the lung.
Standing Committee of Analysts, *The Quantification of Asbestos in Soil (2017).*

Further guidance on typical asbestos fibre content of manufactured products can be found in HSG 264.

The identification of asbestos containing materials and soils falls within our schedule of tests for which we hold UKAS accreditation, however opinions, interpretations and all other information contained in the report are outside the scope of UKAS accreditation.

Unit 7-8 Hawarden Business Park
Manor Road (off Manor Lane)
Hawarden
Deeside
CH5 3US
Tel: (01244) 528700
Fax: (01244) 528701
email: hawardencustomerservices@alsglobal.com
Website: www.alsenvironmental.co.uk

Minerex Environmental
Taney hall
Eglinton Terrace
Dundrum
Dublin
Dublin 14

Attention: Sven Klinkenbergh

CERTIFICATE OF ANALYSIS

Date of report Generation:	05 September 2020
Customer:	Minerex Environmental
Sample Delivery Group (SDG):	200828-87
Your Reference:	3188-A2-COC2
Location:	Inchamore, Co. Cork
Report No:	566071

We received 4 samples on Friday August 28, 2020 and 4 of these samples were scheduled for analysis which was completed on Saturday September 05, 2020. Accredited laboratory tests are defined within the report, but opinions, interpretations and on-site data expressed herein are outside the scope of ISO 17025 accreditation.

Should this report require incorporation into client reports, it must be used in its entirety and not simply with the data sections alone.

Chemical testing (unless subcontracted) performed at ALS Life Sciences Ltd Hawarden (Method codes TM) or ALS Life Sciences Ltd Aberdeen (Method codes S).

All sample data is provided by the customer. The reported results relate to the sample supplied, and on the basis that this data is correct.
Incorrect sampling dates and/or sample information will affect the validity of results.
The customer is not permitted to reproduce this report except in full without the approval of the laboratory.

Approved By:

Sonia McWhan

Operations Manager

CERTIFICATE OF ANALYSIS

SDG:	200828-87	**Client Reference:**	3188-A2-COC2	**Report Number:**	566071
Location:	Inchamore, Co. Cork	**Order Number:**		**Superseded Report:**	

Received Sample Overview

Lab Sample No(s)	Customer Sample Ref.	AGS Ref.	Depth (m)	Sampled Date
22737270	3188-SW1		0.00 - 0.00	27/08/2020
22737286	3188-SW2		0.00 - 0.00	26/08/2020
22737302	3188-SW3		0.00 - 0.00	26/08/2020
22737315	3188-SW4		0.00 - 0.00	26/08/2020

Only received samples which have had analysis scheduled will be shown on the following pages.

Validated

CERTIFICATE OF ANALYSIS

SDG:	200828-87	**Client Reference:**	3188-A2-COC2	**Report Number:**	566071
Location:	Inchamore, Co. Cork	**Order Number:**		**Superseded Report:**	

Results Legend

X Test

N No Determination Possible

Sample Types -
S - Soil/Solid
UNS - Unspecified Solid
GW - Ground Water
SW - Surface Water
LE - Land Leachate
PL - Prepared Leachate
PR - Process Water
SA - Saline Water
TE - Trade Effluent
TS - Treated Sewage
US - Untreated Sewage
RE - Recreational Water
DW - Drinking Water Non-regulatory
UNL - Unspecified Liquid
SL - Sludge
G - Gas
OTH - Other

Lab Sample No(s)					22737270				22737286				22737302				22737315
Customer Sample Reference					3188-SW1				3188-SW2				3188-SW3				3188-SW4
AGS Reference																	
Depth (m)					0.00 - 0.00				0.00 - 0.00				0.00 - 0.00				0.00 - 0.00
Container					500ml Plastic (ALE208)	H2SO4 (ALE244)	HNO3 Unfiltered (ALE204)	NaOH (ALE245)	500ml Plastic (ALE208)	H2SO4 (ALE244)	HNO3 Unfiltered (ALE204)	NaOH (ALE245)	500ml Plastic (ALE208)	H2SO4 (ALE244)	HNO3 Unfiltered (ALE204)	NaOH (ALE245)	1lplastic (ALE221)	H2SO4 (ALE244)	HNO3 Unfiltered (ALE204)	NaOH (ALE245)
Sample Type					SW	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW
Alkalinity as CaCO3	All	NDPs: 0 Tests: 4			X				X				X				X			
Ammonium Low	All	NDPs: 0 Tests: 4				X				X				X				X		
Anions by Kone (w)	All	NDPs: 0 Tests: 4			X				X				X				X			
Colour Test	All	NDPs: 0 Tests: 4			X				X				X				X			
Conductivity (at 20 deg.C)	All	NDPs: 0 Tests: 4			X				X				X				X			
Nitrite by Kone (w)	All	NDPs: 0 Tests: 4						X				X				X				X
pH Value	All	NDPs: 0 Tests: 4			X				X				X				X			
Phosphate by Kone (w)	All	NDPs: 0 Tests: 4			X				X				X				X			
Suspended Solids	All	NDPs: 0 Tests: 4			X				X				X				X			
Total Metals by ICP-MS	All	NDPs: 0 Tests: 4					X				X				X				X	
Turbidity in waters	All	NDPs: 0 Tests: 4			X				X				X				X			

Validated

CERTIFICATE OF ANALYSIS

SDG: 200828-87 **Client Reference:** 3188-A2-COC2 **Report Number:** 566071
Location: Inchamore, Co. Cork **Order Number:** **Superseded Report:**

Results Legend	
#	ISO17025 accredited.
M	mCERTS accredited.
aq	Aqueous / settled sample.
diss.filt	Dissolved / filtered sample.
tot.unfilt	Total / unfiltered sample.
*	Subcontracted - refer to subcontractor report for accreditation status.
**	% recovery of the surrogate standard to check the efficiency of the method. The results of individual compounds within samples aren't corrected for the recovery
(F)	Trigger breach confirmed
1-3+$@	Sample deviation (see appendix)

Component	LOD/Units	Method	Customer Sample Ref.	3188-SW1	3188-SW2	3188-SW3	3188-SW4		
			Depth (m)	0.00 - 0.00	0.00 - 0.00	0.00 - 0.00	0.00 - 0.00		
			Sample Type	Surface Water (SW)	Surface Water (SW)	Surface Water (SW)	Surface Water (SW)		
			Date Sampled	27/08/2020	26/08/2020	26/08/2020	26/08/2020		
			Sample Time	00:00	00:00	00:00	00:00		
			Date Received	28/08/2020	28/08/2020	28/08/2020	28/08/2020		
			SDG Ref	200828-87	200828-87	200828-87	200828-87		
			Lab Sample No.(s)	22737270	22737286	22737302	22737315		
			AGS Reference						
Suspended solids, Total	<2 mg/l	TM022		<2 #	<2 #	<2 #	<2 #		
Alkalinity, Total as CaCO3	<2 mg/l	TM043		4.5 #	7.5 #	9 #	18.6 #		
Alkalinity, Bicarbonate as CaCO3	<2 mg/l	TM043		4.5	7.5	9	18.6		
Ammoniacal Nitrogen as N (low level)	<0.01 mg/l	TM099		0.0164 #	0.0177 #	0.0321 #	0.018 #		
Conductivity @ 20 deg.C	<0.02 mS/cm	TM120		0.0427 #	0.0304 #	0.063 #	0.0526 #		
Phosphorus (tot.unfilt)	<20 µg/l	TM152		<20 #	<20 #	23.1 #	<20 #		
Nitrite as NO2	<0.05 mg/l	TM184		<0.05 #	<0.05 #	<0.05 #	<0.05 #		
Phosphate (Ortho as P)	<0.02 mg/l	TM184		<0.02 #	<0.02 #	<0.02 #	<0.02 #		
Nitrate as NO3	<0.3 mg/l	TM184		0.374	<0.3	<0.3	0.456		
Turbidity	<0.1 ntu	TM195		1.28 ♦ #	0.562 ♦ #	1.53 ♦ #	0.885 ♦ #		
pH	<1 pH Units	TM256		5.73 #	6.59 #	6.35 #	6.96 #		
Apparent Colour	<1 mg/l Pt/Co	TM261		96	62.7	165	79.3		
True Colour	<1 mg/l Pt/Co	TM261		84.7	51.9	143	66.3		

CERTIFICATE OF ANALYSIS

SDG:	200828-87	**Client Reference:**	3188-A2-COC2	**Report Number:**	566071
Location:	Inchamore, Co. Cork	**Order Number:**		**Superseded Report:**	

Table of Results - Appendix

Method No	Reference	Description
TM022	Method 2540D, AWWA/APHA, 20th Ed., 1999 / BS 2690: Part120 1981;BS EN 872	Determination of total suspended solids in waters
TM043	Method 2320B, AWWA/APHA, 20th Ed., 1999 / BS 2690: Part109 1984	Determination of alkalinity in aqueous samples
TM099	BS 2690: Part 7:1968 / BS 6068: Part2.11:1984	Determination of Ammonium in Water Samples using the Kone Analyser
TM120	Method 2510B, AWWA/APHA, 20th Ed., 1999 / BS 2690: Part 9:1970	Determination of Electrical Conductivity using a Conductivity Meter
TM152	Method 3125B, AWWA/APHA, 20th Ed., 1999	Analysis of Aqueous Samples by ICP-MS
TM184	EPA Methods 325.1 & 325.2,	The Determination of Anions in Aqueous Matrices using the Kone Spectrophotometric Analysers
TM195	Colour and Turbidity of water. Methods for the Examination of Waters and Associated Materials. HMSO, 1981, ISBN 0 11 751955 3.	Determination of Turbidity in Waters & Associated Matrices
TM256	The measurement of Electrical Conductivity and the Laboratory determination of pH Value of Natural, Treated and Wastewaters. HMSO, 1978. ISBN 011 751428 4.	Determination of pH in Water and Leachate using the GLpH pH Meter
TM261	Colour and Turbidity of Waters, Methods for the Examination of Waters and Associated Materials, HMSO, 1981, ISBN 0 11 7519553.	Determination of True and Apparent Colour by Spectrophotometry

NA = not applicable.

Chemical testing (unless subcontracted) performed at ALS Life Sciences Ltd Hawarden (Method codes TM) or ALS Life Sciences Ltd Aberdeen (Method codes S).

CERTIFICATE OF ANALYSIS

SDG:	200828-87	**Client Reference:**	3188-A2-COC2	**Report Number:**	566071
Location:	Inchamore, Co. Cork	**Order Number:**		**Superseded Report:**	

Test Completion Dates

Lab Sample No(s)	22737270	22737286	22737302	22737315
Customer Sample Ref.	3188-SW1	3188-SW2	3188-SW3	3188-SW4
AGS Ref.				
Depth	0.00 - 0.00	0.00 - 0.00	0.00 - 0.00	0.00 - 0.00
Type	Surface Water	Surface Water	Surface Water	Surface Water
Alkalinity as CaCO3	04-Sep-2020	04-Sep-2020	04-Sep-2020	03-Sep-2020
Ammonium Low	03-Sep-2020	03-Sep-2020	05-Sep-2020	05-Sep-2020
Anions by Kone (w)	03-Sep-2020	03-Sep-2020	03-Sep-2020	03-Sep-2020
Colour Test	03-Sep-2020	03-Sep-2020	03-Sep-2020	03-Sep-2020
Conductivity (at 20 deg.C)	02-Sep-2020	02-Sep-2020	02-Sep-2020	02-Sep-2020
Nitrite by Kone (w)	03-Sep-2020	03-Sep-2020	03-Sep-2020	03-Sep-2020
pH Value	02-Sep-2020	02-Sep-2020	02-Sep-2020	02-Sep-2020
Phosphate by Kone (w)	03-Sep-2020	03-Sep-2020	03-Sep-2020	03-Sep-2020
Suspended Solids	03-Sep-2020	03-Sep-2020	03-Sep-2020	03-Sep-2020
Total Metals by ICP-MS	04-Sep-2020	04-Sep-2020	04-Sep-2020	04-Sep-2020
Turbidity in waters	03-Sep-2020	03-Sep-2020	03-Sep-2020	03-Sep-2020

Appendix

General

1. Results are expressed on a dry weight basis (dried at 35ºC) for all soil analyses except for the following: NRA and CEN Leach tests, flash point LOI, pH, ammonium as NH4 by the BRE method, VOC TICs and SVOC TICs.

2. If sufficient sample is received a sub sample will be retained free of charge for 30 days after analysis is completed (e-mailed) for all sample types unless the sample is destroyed on testing. The prepared soil sub sample that is analysed for asbestos will be retained for a period of 6 months after the analysis date. All bulk samples will be retained for a period of 6 months after the analysis date. All samples received and not scheduled will be disposed of one month after the date of receipt unless we are instructed to the contrary. Once the initial period has expired, a storage charge will be applied for each month or part thereof until the client cancels the request for sample storage. ALS reserve the right to charge for samples received and stored but not analysed.

3. With respect to turnaround, we will always endeavour to meet client requirements wherever possible, but turnaround times cannot be absolutely guaranteed due to so many variables beyond our control.

4. We take responsibility for any test performed by sub-contractors (marked with an asterisk). We endeavour to use UKAS/MCERTS Accredited Laboratories, who either complete a quality questionnaire or are audited by ourselves. For some determinands there are no UKAS/MCERTS Accredited Laboratories, in this instance a laboratory with a known track record will be utilised.

5. If no separate volatile sample is supplied by the client, or if a headspace or sediment is present in the volatile sample, the integrity of the data may be compromised. This will be flagged up as an invalid VOC on the test schedule and the result marked as deviating on the test certificate.

6. NDP - No determination possible due to insufficient/unsuitable sample.

7. Results relate only to the items tested.

8. LoDs (Limit of Detection) for wet tests reported on a dry weight basis are not corrected for moisture content.

9. **Surrogate recoveries** - Surrogates are added to your sample to monitor recovery of the test requested. A % recovery is reported, results are not corrected for the recovery measured. Typical recoveries for organics tests are 70-130%. Recoveries in soils are affected by organic rich or clay rich matrices. Waters can be affected by remediation fluids or high amounts of sediment. Test results are only ever reported if all of the associated quality checks pass; it is assumed that all recoveries outside of the values above are due to matrix affect.

10. Stones/debris are not routinely removed. We always endeavour to take a representative sub sample from the received sample.

11. In certain circumstances the method detection limit may be elevated due to the sample being outside the calibration range. Other factors that may contribute to this include possible interferences. In both cases the sample would be diluted which would cause the method detection limit to be raised.

12. Mercury results quoted on soils will not include volatile mercury as the analysis is performed on a dried and crushed sample.

13. For leachate preparations other than Zero Headspace Extraction (ZHE) volatile loss may occur.

14. For the BSEN 12457-3 two batch process to allow the cumulative release to be calculated, the volume of the leachate produced is measured and filtered for all tests. We therefore cannot carry out any unfiltered analysis. The tests affected include volatiles GCFID/GCMS and all subcontracted analysis.

15. Analysis and identification of specific compounds using GCFID is by retention time only, and we routinely calibrate and quantify for benzene, toluene, ethylbenzenes and xylenes (BTEX). For total volatiles in the C5-C12 range, the total area of the chromatogram is integrated and expressed as ug/kg or ug/l. Although this analysis is commonly used for the quantification of gasoline range organics (GRO), the system will also detect other compounds such as chlorinated solvents, and this may lead to a falsely high result with respect to hydrocarbons only. It is not possible to specifically identify these non-hydrocarbons, as standards are not routinely run for any other compounds, and for more definitive identification, volatiles by GCMS should be utilised.

16. We are accredited to MCERTS for sand, clay and loam/topsoil, or any of these materials - whether these are derived from naturally occurring soil profiles, or from fill/made ground, as long as these materials constitute the major part of the sample. Other coarse granular material such as concrete, gravel and brick are not accredited if they comprise the major part of the sample.

17. **Tentatively Identified Compounds (TICs)** are non-target peaks in VOC and SVOC analysis. All non-target peaks detected with a concentration above the LoD are subjected to a mass spectral library search. Non-target peaks with a library search confidence of >75% are reported based on the best mass spectral library match. When a non-target peak with a library search confidence of <75% is detected it is reported as “mixed hydrocarbons”. Non-target compounds identified from the scan data are semi-quantified relative to one of the deuterated internal standards, under the same chromatographic conditions as the target compounds. This result is reported as a semi-quantitative value and reported as Tentatively Identified Compounds (TICs). TICs are outside the scope of UKAS accreditation and are not moisture corrected.

18. **Sample Deviations**

If a sample is classed as deviated then the associated results may be compromised.

1	**Container with Headspace provided for volatiles analysis**
2	**Incorrect container received**
3	**Deviation from method**
§	**Sampled on date not provided**
♦	**Sample holding time exceeded in laboratory**
@	**Sample holding time exceeded due to late arrival of instructions or samples**

19. **Asbestos**

When requested, the individual sub sample scheduled will be analysed in house for the presence of asbestos fibres and asbestos containing material by our documented in house method TM048 based on HSG 248 (2005), which is accredited to ISO17025. If a specific asbestos fibre type is not found this will be reported as “Not detected”. If no asbestos fibre types are found all will be reported as “Not detected” and the sub sample analysed deemed to be clear of asbestos. If an asbestos fibre type is found it will be reported as detected (for each fibre type found). Testing can be carried out on asbestos positive samples, but, due to Health and Safety considerations, may be replaced by alternative tests or reported as No Determination Possible (NDP). The quantity of

Identification of Asbestos in Bulk Materials & Soils

The results for identification of asbestos in bulk materials are obtained from supplied bulk materials which have been examined to determine the presence of asbestos fibres using ALS (Hawarden) in-house method of transmitted/polarised light microscopy and central stop dispersion staining, based on HSG 248 (2005).

The results for identification of asbestos in soils are obtained from a homogenised sub sample which has been examined to determine the presence of asbestos fibres using ALS (Hawarden) in-house method of transmitted/polarised light microscopy and central stop dispersion staining, based on HSG 248 (2005).

Asbestos Type	Common Name
Chrysotile	White Asbestos
Amosite	Brown Asbestos
Crocidolite	Blue Asbestos
Fibrous Actinolite	-
Fibrous Anthophyllite	-
Fibrous Tremolite	-

Visual Estimation Of Fibre Content

Estimation of fibre content is not permitted as part of our UKAS accredited test other than: - Trace - Where only one or two asbestos fibres were identified.

Respirable Fibres

Respirable fibres are defined as fibres of <3 µm diameter, longer than 5 µm and with aspect ratios of at least 3:1 that can be inhaled into the lower regions of the lung and are generally acknowledged to be most important predictor of hazard and risk for cancers of the lung.
Standing Committee of Analysts, *The Quantification of Asbestos in Soil (2017).*

Further guidance on typical asbestos fibre content of manufactured products can be found in HSG 264.

The identification of asbestos containing materials and soils falls within our schedule of tests for which we hold UKAS accreditation, however opinions, interpretations and all other information contained in the report are outside the scope of UKAS accreditation.

Unit 7-8 Hawarden Business Park
Manor Road (off Manor Lane)
Hawarden
Deeside
CH5 3US
Tel: (01244) 528700
Fax: (01244) 528701
email: hawardencustomerservices@alsglobal.com
Website: www.alsenvironmental.co.uk

Minerex Environmental
Taney hall
Eglinton Terrace
Dundrum
Dublin
Dublin 14

Attention: Sven Klinkenbergh

CERTIFICATE OF ANALYSIS

Date of report Generation:	04 March 2021
Customer:	Minerex Environmental
Sample Delivery Group (SDG):	210301-15
Your Reference:	3188-A2-COC4
Location:	Inchamore, Co. Cork
Report No:	589280

We received 4 samples on Monday March 01, 2021 and 4 of these samples were scheduled for analysis which was completed on Thursday March 04, 2021. Accredited laboratory tests are defined within the report, but opinions, interpretations and on-site data expressed herein are outside the scope of ISO 17025 accreditation.

Should this report require incorporation into client reports, it must be used in its entirety and not simply with the data sections alone.

Chemical testing (unless subcontracted) performed at ALS Life Sciences Ltd Hawarden (Method codes TM) or ALS Life Sciences Ltd Aberdeen (Method codes S).

All sample data is provided by the customer. The reported results relate to the sample supplied, and on the basis that this data is correct.
Incorrect sampling dates and/or sample information will affect the validity of results.

Approved By:

Sonia McWhan
Operations Manager

CERTIFICATE OF ANALYSIS

SDG:	210301-15	**Client Reference:**	3188-A2-COC4	**Report Number:**	589280
Location:	Inchamore, Co. Cork	**Order Number:**		**Superseded Report:**	

Received Sample Overview

Lab Sample No(s)	Customer Sample Ref.	AGS Ref.	Depth (m)	Sampled Date
23815010	3188-A2-SW1 (Inch. 1)		0.00 - 0.00	24/02/2021
23815030	3188-A2-SW2 (Inch. 2)		0.00 - 0.00	24/02/2021
23815049	3188-A2-SW3 (Inch. 3)		0.00 - 0.00	24/02/2021
23815061	3188-A2-SW4 (Inch. 4)		0.00 - 0.00	24/02/2021

Only received samples which have had analysis scheduled will be shown on the following pages.

Validated

CERTIFICATE OF ANALYSIS

SDG:	210301-15	**Client Reference:**	3188-A2-COC4	**Report Number:**	589280
Location:	Inchamore, Co. Cork	**Order Number:**		**Superseded Report:**	

Results Legend

X Test

N No Determination Possible

Sample Types -
S - Soil/Solid
UNS - Unspecified Solid
GW - Ground Water
SW - Surface Water
LE - Land Leachate
PL - Prepared Leachate
PR - Process Water
SA - Saline Water
TE - Trade Effluent
TS - Treated Sewage
US - Untreated Sewage
RE - Recreational Water
DW - Drinking Water Non-regulatory
UNL - Unspecified Liquid
SL - Sludge
G - Gas
OTH - Other

Lab Sample No(s)			23815010			23815030				23815049				23815061			
Customer Sample Reference			3188-A2-SW1 (Inch. 1)			3188-A2-SW2 (Inch. 2)				3188-A2-SW3 (Inch. 3)				3188-A2-SW4 (Inch. 4)			
AGS Reference																	
Depth (m)			0.00 - 0.00			0.00 - 0.00				0.00 - 0.00				0.00 - 0.00			
Container			500ml Plastic (ALE208)	H2SO4 (ALE244)	NaOH (ALE245)	500ml Plastic (ALE208)	H2SO4 (ALE244)	HNO3 Unfiltered (ALE204)	NaOH (ALE245)	500ml Plastic (ALE208)	H2SO4 (ALE244)	HNO3 Unfiltered (ALE204)	NaOH (ALE245)	500ml Plastic (ALE208)	H2SO4 (ALE244)	HNO3 Unfiltered (ALE204)	NaOH (ALE245)
Sample Type			SW	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW
Alkalinity as CaCO3	All	NDPs: 0 Tests: 4	X			X				X				X			
Ammonium Low	All	NDPs: 0 Tests: 4		X			X				X				X		
Anions by Kone (w)	All	NDPs: 0 Tests: 4	X			X				X				X			
Colour Test	All	NDPs: 0 Tests: 4	X			X				X				X			
Conductivity (at 20 deg.C)	All	NDPs: 0 Tests: 4	X			X				X				X			
Nitrite by Kone (w)	All	NDPs: 0 Tests: 4			X				X				X				X
pH Value	All	NDPs: 0 Tests: 4	X			X				X				X			
Phosphate by Kone (w)	All	NDPs: 0 Tests: 4	X			X				X				X			
Suspended Solids	All	NDPs: 0 Tests: 4	X			X				X				X			
Total Metals by ICP-MS	All	NDPs: 0 Tests: 4	X					X				X				X	
Turbidity in waters	All	NDPs: 0 Tests: 4	X			X				X				X			

Validated

CERTIFICATE OF ANALYSIS

SDG:	210301-15	**Client Reference:**	3188-A2-COC4	**Report Number:**	589280
Location:	Inchamore, Co. Cork	**Order Number:**		**Superseded Report:**	

Results Legend

#	ISO17025 accredited.
M	mCERTS accredited.
aq	Aqueous / settled sample.
diss.filt	Dissolved / filtered sample.
tot.unfilt	Total / unfiltered sample.
*	Subcontracted - refer to subcontractor report for accreditation status.
**	% recovery of the surrogate standard to check the efficiency of the method. The results of individual compounds within samples aren't corrected for the recovery
(F)	Trigger breach confirmed
1-4+$@	Sample deviation (see appendix)

Component	LOD/Units	Method	Customer Sample Ref.	3188-A2-SW1 (Inch. 1)	3188-A2-SW2 (Inch. 2)	3188-A2-SW3 (Inch. 3)	3188-A2-SW4 (Inch. 4)		
			Depth (m)	0.00 - 0.00	0.00 - 0.00	0.00 - 0.00	0.00 - 0.00		
			Sample Type	Surface Water (SW)	Surface Water (SW)	Surface Water (SW)	Surface Water (SW)		
			Date Sampled	24/02/2021	24/02/2021	24/02/2021	24/02/2021		
			Sample Time	00:00	00:00	00:00	00:00		
			Date Received	01/03/2021	01/03/2021	01/03/2021	01/03/2021		
			SDG Ref	210301-15	210301-15	210301-15	210301-15		
			Lab Sample No.(s)	23815010	23815030	23815049	23815061		
			AGS Reference						
Suspended solids, Total	<2 mg/l	TM022		<2 #	2.55 #	<2 #	<2 #		
Alkalinity, Total as CaCO3	<2 mg/l	TM043		2.5 #	4 #	2 #	3.5 #		
Alkalinity, Bicarbonate as CaCO3	<2 mg/l	TM043		2.5	4	2	3.5		
Ammoniacal Nitrogen as N (low level)	<0.01 mg/l	TM099		0.037 #	0.036 #	0.024 #	0.032 #		
Conductivity @ 20 deg.C	<0.02 mS/cm	TM120		0.025 #	0.0377 #	0.0281 #	0.0293 #		
Phosphorus (tot.unfilt)	<20 µg/l	TM152		<20 2 #	<20 #	<20 #	<20 #		
Nitrite as NO2	<0.05 mg/l	TM184		0.273 #	<0.05 #	<0.05 #	<0.05 #		
Phosphate (Ortho as P)	<0.02 mg/l	TM184		<0.02 #	<0.02 #	<0.02 #	<0.02 #		
Nitrate as NO3	<0.3 mg/l	TM184		<0.3	0.384	<0.3	<0.3		
Turbidity	<0.1 ntu	TM195		0.561 @ #	3.65 @ #	1.62 @ #	2.22 @ #		
pH	<1 pH Units	TM256		6.69 #	6.74 #	6.47 #	7.03 #		
Apparent Colour	<1 mg/l Pt/Co	TM261		37.4	75.2	52	61.3		
True Colour	<1 mg/l Pt/Co	TM261		31.4	61.2	44.2	51.4		

CERTIFICATE OF ANALYSIS

SDG:	210301-15	**Client Reference:**	3188-A2-COC4	**Report Number:**	589280
Location:	Inchamore, Co. Cork	**Order Number:**		**Superseded Report:**	

Table of Results - Appendix

Method No	Reference	Description
TM022	Method 2540D, AWWA/APHA, 20th Ed., 1999 / BS 2690: Part120 1981;BS EN 872	Determination of total suspended solids in waters
TM043	Method 2320B, AWWA/APHA, 20th Ed., 1999 / BS 2690: Part109 1984	Determination of alkalinity in aqueous samples
TM099	BS 2690: Part 7:1968 / BS 6068: Part2.11:1984	Determination of Ammonium in Water Samples using the Kone Analyser
TM120	Method 2510B, AWWA/APHA, 20th Ed., 1999 / BS 2690: Part 9:1970	Determination of Electrical Conductivity using a Conductivity Meter
TM152	Method 3125B, AWWA/APHA, 20th Ed., 1999	Analysis of Aqueous Samples by ICP-MS
TM184	EPA Methods 325.1 & 325.2,	The Determination of Anions in Aqueous Matrices using the Kone Spectrophotometric Analysers
TM195	Colour and Turbidity of water. Methods for the Examination of Waters and Associated Materials. HMSO, 1981, ISBN 0 11 751955 3.	Determination of Turbidity in Waters & Associated Matrices
TM256	The measurement of Electrical Conductivity and the Laboratory determination of pH Value of Natural, Treated and Wastewaters. HMSO, 1978. ISBN 011 751428 4.	Determination of pH in Water and Leachate using the GLpH pH Meter
TM261	Colour and Turbidity of Waters, Methods for the Examination of Waters and Associated Materials, HMSO, 1981, ISBN 0 11 7519553.	Determination of True and Apparent Colour by Spectrophotometry

NA = not applicable.

Chemical testing (unless subcontracted) performed at ALS Life Sciences Ltd Hawarden (Method codes TM) or ALS Life Sciences Ltd Aberdeen (Method codes S).

CERTIFICATE OF ANALYSIS

SDG:	210301-15	**Client Reference:**	3188-A2-COC4	**Report Number:**	589280
Location:	Inchamore, Co. Cork	**Order Number:**		**Superseded Report:**	

Test Completion Dates

Lab Sample No(s)	23815010	23815030	23815049	23815061
Customer Sample Ref.	3188-A2-SW1 (In ch. 1)	3188-A2-SW2 (In ch. 2)	3188-A2-SW3 (In ch. 3)	3188-A2-SW4 (In ch. 4)
AGS Ref.				
Depth	0.00 - 0.00	0.00 - 0.00	0.00 - 0.00	0.00 - 0.00
Type	Surface Water	Surface Water	Surface Water	Surface Water
Alkalinity as CaCO3	03-Mar-2021	03-Mar-2021	03-Mar-2021	03-Mar-2021
Ammonium Low	04-Mar-2021	04-Mar-2021	04-Mar-2021	04-Mar-2021
Anions by Kone (w)	04-Mar-2021	04-Mar-2021	04-Mar-2021	04-Mar-2021
Colour Test	04-Mar-2021	04-Mar-2021	04-Mar-2021	04-Mar-2021
Conductivity (at 20 deg.C)	03-Mar-2021	03-Mar-2021	03-Mar-2021	03-Mar-2021
Nitrite by Kone (w)	02-Mar-2021	02-Mar-2021	02-Mar-2021	02-Mar-2021
pH Value	02-Mar-2021	02-Mar-2021	02-Mar-2021	02-Mar-2021
Phosphate by Kone (w)	02-Mar-2021	02-Mar-2021	02-Mar-2021	03-Mar-2021
Suspended Solids	02-Mar-2021	02-Mar-2021	02-Mar-2021	02-Mar-2021
Total Metals by ICP-MS	03-Mar-2021	03-Mar-2021	03-Mar-2021	03-Mar-2021
Turbidity in waters	02-Mar-2021	02-Mar-2021	02-Mar-2021	02-Mar-2021

Appendix

General

1. Results are expressed on a dry weight basis (dried at 35ºC) for all soil analyses except for the following: NRA and CEN Leach tests, flash point LOI, pH, ammonium as NH4 by the BRE method, VOC TICs and SVOC TICs.

2. If sufficient sample is received a sub sample will be retained free of charge for 30 days after analysis is completed (e-mailed) for all sample types unless the sample is destroyed on testing. The prepared soil sub sample that is analysed for asbestos will be retained for a period of 6 months after the analysis date. All bulk samples will be retained for a period of 6 months after the analysis date. All samples received and not scheduled will be disposed of one month after the date of receipt unless we are instructed to the contrary. Once the initial period has expired, a storage charge will be applied for each month or part thereof until the client cancels the request for sample storage. ALS reserve the right to charge for samples received and stored but not analysed.

3. With respect to turnaround, we will always endeavour to meet client requirements wherever possible, but turnaround times cannot be absolutely guaranteed due to so many variables beyond our control.

4. We take responsibility for any test performed by sub-contractors (marked with an asterisk). We endeavour to use UKAS/MCERTS Accredited Laboratories, who either complete a quality questionnaire or are audited by ourselves. For some determinands there are no UKAS/MCERTS Accredited Laboratories, in this instance a laboratory with a known track record will be utilised.

5. If no separate volatile sample is supplied by the client, or if a headspace or sediment is present in the volatile sample, the integrity of the data may be compromised. This will be flagged up as an invalid VOC on the test schedule and the result marked as deviating on the test certificate.

6. NDP - No determination possible due to insufficient/unsuitable sample.

7. Results relate only to the items tested.

8. LoDs (Limit of Detection) for wet tests reported on a dry weight basis are not corrected for moisture content.

9. **Surrogate recoveries** - Surrogates are added to your sample to monitor recovery of the test requested. A % recovery is reported, results are not corrected for the recovery measured. Typical recoveries for organics tests are 70-130%. Recoveries in soils are affected by organic rich or clay rich matrices. Waters can be affected by remediation fluids or high amounts of sediment. Test results are only ever reported if all of the associated quality checks pass; it is assumed that all recoveries outside of the values above are due to matrix affect.

10. Stones/debris are not routinely removed. We always endeavour to take a representative sub sample from the received sample.

11. In certain circumstances the method detection limit may be elevated due to the sample being outside the calibration range. Other factors that may contribute to this include possible interferences. In both cases the sample would be diluted which would cause the method detection limit to be raised.

12. Mercury results quoted on soils will not include volatile mercury as the analysis is performed on a dried and crushed sample.

13. For leachate preparations other than Zero Headspace Extraction (ZHE) volatile loss may occur.

14. For the BSEN 12457-3 two batch process to allow the cumulative release to be calculated, the volume of the leachate produced is measured and filtered for all tests. We therefore cannot carry out any unfiltered analysis. The tests affected include volatiles GCFID/GCMS and all subcontracted analysis.

15. Analysis and identification of specific compounds using GCFID is by retention time only, and we routinely calibrate and quantify for benzene, toluene, ethylbenzenes and xylenes (BTEX). For total volatiles in the C5-C12 range, the total area of the chromatogram is integrated and expressed as ug/kg or ug/l. Although this analysis is commonly used for the quantification of gasoline range organics (GRO), the system will also detect other compounds such as chlorinated solvents, and this may lead to a falsely high result with respect to hydrocarbons only. It is not possible to specifically identify these non-hydrocarbons, as standards are not routinely run for any other compounds, and for more definitive identification, volatiles by GCMS should be utilised.

16. We are accredited to MCERTS for sand, clay and loam/topsoil, or any of these materials - whether these are derived from naturally occurring soil profiles, or from fill/made ground, as long as these materials constitute the major part of the sample. Other coarse granular material such as concrete, gravel and brick are not accredited if they comprise the major part of the sample.

17. **Tentatively Identified Compounds (TICs)** are non-target peaks in VOC and SVOC analysis. All non-target peaks detected with a concentration above the LoD are subjected to a mass spectral library search. Non-target peaks with a library search confidence of >75% are reported based on the best mass spectral library match. When a non-target peak with a library search confidence of <75% is detected it is reported as "mixed hydrocarbons". Non-target compounds identified from the scan data are semi-quantified relative to one of the deuterated internal standards, under the same chromatographic conditions as the target compounds. This result is reported as a semi-quantitative value and reported as Tentatively Identified Compounds (TICs). TICs are outside the scope of UKAS accreditation and are not moisture corrected.

18. **Sample Deviations**

If a sample is classed as deviated then the associated results may be compromised.

1	**Container with Headspace provided for volatiles analysis**
2	**Incorrect container received**
3	**Deviation from method**
4	**Matrix interference**
♦	**Sample holding time exceeded in laboratory**
@	**Sample holding time exceeded due to late arrival of instructions or samples**
§	**Sampled on date not provided**

19. **Asbestos**

When requested, the individual sub sample scheduled will be analysed in house for the presence of asbestos fibres and asbestos containing material by our documented in house method TM048 based on HSG 248 (2005), which is accredited to ISO17025. If a specific asbestos fibre type is not found this will be reported as "Not detected". If no asbestos fibre types are found all will be reported as "Not detected" and the sub sample analysed deemed to be clear of asbestos. If an asbestos fibre type is found it will be reported as detected (for each fibre type found). Testing can be carried out on asbestos positive samples, but, due to Health and Safety considerations, may be replaced by alternative tests or reported as No Determination Possible (NDP). The quantity of asbestos present is not determined unless specifically requested.

Identification of Asbestos in Bulk Materials & Soils

The results for identification of asbestos in bulk materials are obtained from supplied bulk materials which have been examined to determine the presence of asbestos fibres using ALS (Hawarden) in-house method of transmitted/polarised light microscopy and central stop dispersion staining, based on HSG 248 (2005).

The results for identification of asbestos in soils are obtained from a homogenised sub sample which has been examined to determine the presence of asbestos fibres using ALS (Hawarden) in-house method of transmitted/polarised light microscopy and central stop dispersion staining, based on HSG 248 (2005).

Asbestos Type	Common Name
Chrysotile	White Asbestos
Amosite	Brown Asbestos
Crocidolite	Blue Asbestos
Fibrous Actinolite	-
Fibrous Anthophyllite	-
Fibrous Tremolite	-

Visual Estimation Of Fibre Content

Estimation of fibre content is not permitted as part of our UKAS accredited test other than: - Trace - Where only one or two asbestos fibres were identified.

Respirable Fibres

Respirable fibres are defined as fibres of <3 µm diameter, longer than 5 µm and with aspect ratios of at least 3:1 that can be inhaled into the lower regions of the lung and are generally acknowledged to be most important predictor of hazard and risk for cancers of the lung.
Standing Committee of Analysts, *The Quantification of Asbestos in Soil (2017).*

Further guidance on typical asbestos fibre content of manufactured products can be found in HSG 264.

The identification of asbestos containing materials and soils falls within our schedule of tests for which we hold UKAS accreditation, however opinions, interpretations and all other information contained in the report are outside the scope of UKAS accreditation.

Section 1 - Identification of The Material and Supplier

Clearbore Pty Ltd
62 Mt Tootie Rd
Bilpin, NSW 2758
AUSTRALIA

AUS Freecall 1800 013 210
AUS Fax (02) 4567 0122
NZ Freecall 0800 443 537
NZ Freefax 0800 443 538

Chemical nature:	Organic acid with indicator dye.
Trade Name:	**Clearbore**
Product Use:	Bore water pump cleaner.
Creation Date:	**February, 2009**
This version issued:	**January 2019** and is valid for 5 years from this date.

Section 2 - Hazards Identification

Statement of Hazardous Nature

This product is classified as: Xn, Harmful. Xi, Irritating. Hazardous according to the criteria of SWA.

Not a Dangerous Good according to the Australian Dangerous Goods (ADG) Code.

Risk Phrases: R36, R21/22. Irritating to eyes. Harmful in contact with skin and if swallowed.
Safety Phrases: S2, S20, S22, S45, S24/25, S36/39. Keep out of reach of children. When using, do not eat or drink. Do not breathe dust. In case of accident or if you feel unwell, contact a doctor or Poisons Information Centre immediately (show this MSDS where possible). Avoid contact with skin and eyes. Wear suitable protective clothing and eye/face protection.
SUSMP Classification: S6
ADG Classification: None allocated. Not a Dangerous Good under the ADG Code.
UN Number: None allocated

GHS Signal word: WARNING.

HAZARD STATEMENT:

H302: Harmful if swallowed.
H312: Harmful in contact with skin.
H320: Causes eye irritation.

PREVENTION

P102: Keep out of reach of children.
P264: Wash contacted areas thoroughly after handling.
P280: Wear protective gloves, protective clothing and eye or face protection.
P281: Use personal protective equipment as required.

RESPONSE

P311: If swallowed, call a POISON CENTER or doctor.
P337: If eye irritation persists: seek medical attention.
P353: Rinse skin or shower with water.
P301+P330+P331: IF SWALLOWED: Rinse mouth. Do NOT induce vomiting.
P305+P351+P338: IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing.
P337+P313: If eye irritation persists: Get medical advice.
P370+P378: Not Combustible. Use extinguishing media suited to burning materials.

DISPOSAL

P501: Dispose of contents and containers to landfill.

Emergency Overview

Physical Description & Colour: Blue crystalline solid.
Odour: No odour.
Major Health Hazards: harmful in contact with skin, and if swallowed, eye irritant.

Potential Health Effects

Inhalation:
Short Term Exposure: Available data indicates that this product is not harmful. However product may be mildly irritating, although unlikely to cause anything more than mild transient discomfort.
Long Term Exposure: No data for health effects associated with long term inhalation.

Skin Contact:
Short Term Exposure: Available data shows that this product is harmful, but symptoms are not available. In addition product may be irritating, but is unlikely to cause anything more than mild transient discomfort.
Long Term Exposure: No data for health effects associated with long term skin exposure.

Eye Contact:
Short Term Exposure: This product is an eye irritant. Symptoms may include stinging and reddening of eyes and watering which may become copious. Other symptoms may also become evident. If exposure is brief, symptoms should disappear once exposure has ceased. However, lengthy exposure or delayed treatment may cause permanent damage.
Long Term Exposure: No data for health effects associated with long term eye exposure.

Ingestion:
Short Term Exposure: Significant oral exposure is considered to be unlikely. Available data shows that this product is harmful, but symptoms are not available. However, this product is an oral irritant. Symptoms may include burning sensation and reddening of skin in mouth and throat. Other symptoms may also become evident, but all should disappear once exposure has ceased.
Long Term Exposure: No data for health effects associated with long term ingestion.

Carcinogen Status:
SWA: No significant ingredient is classified as carcinogenic by SWA.
NTP: No significant ingredient is classified as carcinogenic by NTP.
IARC: No significant ingredient is classified as carcinogenic by IARC.

Section 3 - Composition/Information on Ingredients

Ingredients	CAS No	Conc,%	TWA (mg/m^3)	STEL (mg/m^3)
Oxalic acid	144-62-7	>60	1	2
Other non hazardous ingredients	secret	to 100	not set	not set

This is a commercial product whose exact ratio of components may vary slightly. Minor quantities of other non hazardous ingredients are also possible.

The SWA TWA exposure value is the average airborne concentration of a particular substance when calculated over a normal 8 hour working day for a 5 day working week. The STEL (Short Term Exposure Limit) is an exposure value that may be equalled (but should not be exceeded) for no longer than 15 minutes and should not be repeated more than 4 times per day. There should be at least 60 minutes between successive exposures at the STEL. The term "peak "is used when the TWA limit, because of the rapid action of the substance, should never be exceeded, even briefly.

Section 4 - First Aid Measures

General Information:
You should call The Poisons Information Centre if you feel that you may have been poisoned, burned or irritated by this product. The number is 13 1126 from anywhere in Australia (0800 764 766 in New Zealand) and is available at all times. Have this MSDS with you when you call.

Inhalation: No first aid measures normally required. However, if inhalation has occurred, and irritation has developed, remove to fresh air and observe until recovered. If irritation becomes painful or persists more than about 30 minutes, seek medical advice.
Skin Contact: Quickly and gently brush away excess solids. Wash gently and thoroughly with warm water (use non-abrasive soap if necessary) for 10-20 minutes or until product is removed. Under running water, remove contaminated clothing, shoes and leather goods (e.g. watchbands and belts) and completely decontaminate them before reuse or discard.
Eye Contact: Quickly and gently brush particles from eyes. Immediately flush the contaminated eye(s) with lukewarm, gently flowing water for 20 minutes or until the product is removed, while holding the eyelid(s) open. Take care not to rinse contaminated water into the unaffected eye or onto the face. Obtain medical attention immediately. Take special care if exposed person is wearing contact lenses.
Ingestion: If swallowed, do NOT induce vomiting. Wash mouth with water and contact a Poisons Information Centre, or call a doctor.

Section 5 - Fire Fighting Measures

Fire and Explosion Hazards: There is no risk of an explosion from this product under normal circumstances if it is involved in a fire. Violent steam generation or eruption may occur upon application of direct water stream on hot liquids.
Fire decomposition products from this product may be toxic if inhaled. Take appropriate protective measures.
Extinguishing Media: Not Combustible. Use extinguishing media suited to burning materials.
Fire Fighting: If a significant quantity of this product is involved in a fire, call the fire brigade.

Flash point:	Combustible solid.
Upper Flammability Limit:	No data.
Lower Flammability Limit:	No data.
Autoignition temperature:	No data.
Flammability Class:	Combustible solid.

Section 6 - Accidental Release Measures

Accidental release: In the event of a major spill, prevent spillage from entering drains or water courses. Wear full protective clothing including eye/face protection. All skin areas should be covered. See below under Personal Protection regarding Australian Standards relating to personal protective equipment. Suitable materials for protective clothing include rubber, Nitrile, butyl rubber, neoprene. Eye/face protective equipment should comprise as a minimum, protective goggles. If there is a significant chance that dusts are likely to build up in cleanup area, we recommend that you use a suitable Dust Mask. Use a P1 mask, designed for use against mechanically generated particles eg silica & asbestos. Otherwise, not normally necessary.
Stop leak if safe to do so, and contain spill. Sweep up and shovel or collect recoverable product into labelled containers for recycling or salvage, and dispose of promptly. Consider vacuuming if appropriate. Recycle containers wherever possible after careful cleaning. After spills, wash area preventing runoff from entering drains. If a significant quantity of material enters drains, advise emergency services. This material may be suitable for approved landfill. Ensure legality of disposal by consulting regulations prior to disposal. Thoroughly launder protective clothing before storage or re-use. Advise laundry of nature of contamination when sending contaminated clothing to laundry.

Section 7 - Handling and Storage

Handling: Keep exposure to this product to a minimum, and minimise the quantities kept in work areas. Check Section 8 of this MSDS for details of personal protective measures, and make sure that those measures are followed. The measures detailed below under "Storage" should be followed during handling in order to minimise risks to persons using the product in the workplace. Also, avoid contact or contamination of product with incompatible materials listed in Section 10.
Storage: This product is a Scheduled Poison. Observe all relevant regulations regarding sale, transport and storage of this schedule of poison. Store packages of this product in a cool place. Make sure that containers of this product are kept tightly closed. Keep containers dry and away from water. Make sure that the product does not come into contact with substances listed under "Incompatibilities" in Section 10. Check packaging - there may be further storage instructions on the label.

Section 8 - Exposure Controls and Personal Protection

The following Australian Standards will provide general advice regarding safety clothing and equipment:

Respiratory equipment: **AS/NZS 1715**, Protective Gloves: **AS 2161**, Occupational Protective Clothing: AS/NZS 4501 set 2008, Industrial Eye Protection: **AS1336** and **AS/NZS 1337**, Occupational Protective Footwear: **AS/NZS2210**.

SWA Exposure Limits	**TWA (mg/m^3)**	**STEL (mg/m^3)**
Oxalic acid	1	2

No special equipment is usually needed when occasionally handling small quantities. The following instructions are for bulk handling or where regular exposure in an occupational setting occurs without proper containment systems.
Ventilation: This product should only be used in a well ventilated area. If natural ventilation is inadequate, use of a fan is suggested.
Eye Protection: Protective glasses or goggles should be worn when this product is being used. Failure to protect your eyes may cause them harm. Emergency eye wash facilities are also recommended in an area close to where this product is being used.
Skin Protection: Prevent skin contact by wearing impervious gloves, clothes and, preferably, apron. Make sure that all skin areas are covered. See below for suitable material types.
Protective Material Types: We suggest that protective clothing be made from the following materials: rubber, nitrile, butyl rubber, neoprene.

Respirator: If there is a significant chance that dusts are likely to build up in the area where this product is being used, we recommend that you use a suitable Dust Mask. Otherwise, not normally necessary.
Eyebaths or eyewash stations and safety deluge showers should be provided near to where this product is being used.

Section 9 - Physical and Chemical Properties:

Physical Description & colour:	Blue crystalline solid.
Odour:	No odour.
Boiling Point:	No specific data. Expected to decompose before boiling.
Freezing/Melting Point:	187°C
Volatiles:	No specific data. Expected to be low at 100°C.
Vapour Pressure:	Negligible at normal ambient temperatures.
Vapour Density:	No data.
Specific Gravity:	1.65 at 20°C
Water Solubility:	Soluble.
pH:	2 approx (concentration not given)
Volatility:	Negligible at normal ambient temperatures.
Odour Threshold:	No data.
Evaporation Rate:	No data.
Coeff Oil/water Distribution:	No data
Autoignition temp:	No data.

Section 10 - Stability and Reactivity

Reactivity: This product is unlikely to react or decompose under normal storage conditions. However, if you have any doubts, contact the supplier for advice on shelf life properties.
Conditions to Avoid: This product should be kept in a cool place, preferably below 30°C. Keep containers tightly closed. Containers should be kept dry.
Incompatibilities: strong oxidising agents, zinc, tin, aluminium and their alloys.
Fire Decomposition: Carbon dioxide, and if combustion is incomplete, carbon monoxide and smoke. Water. Carbon monoxide poisoning produces headache, weakness, nausea, dizziness, confusion, dimness of vision, disturbance of judgment, and unconsciousness followed by coma and death.
Polymerisation: This product will not undergo polymerisation reactions.

Section 11 - Toxicological Information

Local Effects:
Target Organs: There is no data to hand indicating any particular target organs.

Classification of Hazardous Ingredients

Ingredient	Risk Phrases
Oxalic Acid	Conc>=5%: Xn; R21/22

Section 12 - Ecological Information

This product is biodegradable. It will not accumulate in the soil or water or cause long term problems. This product is unlikely to accumulate in body tissues.

Section 13 - Disposal Considerations

Disposal: This product may be recycled if unused, or if it has not been contaminated so as to make it unsuitable for its intended use. If it has been contaminated, it may be possible to reclaim the product by filtration, distillation or some other means. If neither of these options is suitable, consider controlled incineration, or landfill.

Section 14 - Transport Information

ADG Code: This product is not classified as a Dangerous Good. No special transport conditions are necessary unless required by other regulations.

Section 15 - Regulatory Information

AICS: All of the significant ingredients in this formulation are compliant with NICNAS regulations.
The following ingredient: Oxalic acid, is mentioned in the SUSMP.

Section 16 - Other Information

This MSDS contains only safety-related information. For other data see product literature.

Acronyms:

ADG Code	Australian Code for the Transport of Dangerous Goods by Road and Rail (7th edition)
AICS	Australian Inventory of Chemical Substances
SWA	Safe Work Australia, formerly ASCC and NOHSC
CAS number	Chemical Abstracts Service Registry Number
IARC	International Agency for Research on Cancer
NTP	National Toxicology Program (USA)
R-Phrase	Risk Phrase
SUSMP	Standard for the Uniform Scheduling of Medicines & Poisons
UN Number	United Nations Number

THIS MSDS SUMMARISES OUR BEST KNOWLEDGE OF THE HEALTH AND SAFETY HAZARD INFORMATION OF THE PRODUCT AND HOW TO SAFELY HANDLE AND USE THE PRODUCT IN THE WORKPLACE. EACH USER MUST REVIEW THIS MSDS IN THE CONTEXT OF HOW THE PRODUCT WILL BE HANDLED AND USED IN THE WORKPLACE.

IF CLARIFICATION OR FURTHER INFORMATION IS NEEDED TO ENSURE THAT AN APPROPRIATE RISK ASSESSMENT CAN BE MADE, THE USER SHOULD CONTACT THIS COMPANY SO WE CAN ATTEMPT TO OBTAIN ADDITIONAL INFORMATION FROM OUR SUPPLIERS

OUR RESPONSIBILITY FOR PRODUCTS SOLD IS SUBJECT TO OUR STANDARD TERMS AND CONDITIONS, A COPY OF WHICH IS SENT TO OUR CUSTOMERS AND IS ALSO AVAILABLE ON REQUEST.

Please read all labels carefully before using product.

This MSDS is prepared in accord with the SWA document “Preparation of Safety Data Sheets for Hazardous Chemicals - Code of Practice” (December 2011)

http://www.kilford.com.au/ Phone +61 2 9251 4532