Rigged Hill Windfarm Repowering

Technical Appendix A8.1 Habitat and Peat Assessment

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A8.1 Habitat and Peat Assessment

1. This section includes raw data for the assessments of habitat and active peat in **Chapter 8: Ecology and Fisheries**. The scientific names of plants species have been shortened, e.g. Erio vagi refers to *Eriophorum vaginatum*. The coverage of each plant species is described using the DOMIN scheme. The cover of peat-forming plants (*Sphagnum* and *Eriophorum* spp), atypical plants (e.g. grasses, rushes) and bare peat are provided as percentages of the total plot, as per the NIEA guidance note on active peat. The 'modifications / hydrological conditions' column refers to any forms of anthropogenic disturbance, and to microtopography (hummocks and hollows). Finally, a decision is made on whether or not the habitat could be classified as active peat, and a rationale for the decision is provided.

Table 1 Active Peat Assessments at all proposed turbine foundation and hardstand locations

		DOMIN		Cover								
Location	**Peat**	**Vascular plants**	**Bryophytes**	**Sphagnum**	**Erio vagi**	**Erio angu**	**Total**	**Atypical species**	**Bare peat**	**Modifications / hydrological condition**	**Active peat?**	**Rationale**
Turbine 1, Plot 1	0.6	Erio vagi 6, Call vulg 6, Desc flex 4, Junc effu 3, Gali saxa 3, Pote erec 2, Erio angu 1	Rhyt squa 8, Rhyt lore 5, Pleu schr 3	0	30	<1	30	15	0	Dry mossy hummocks	N	Moderate cover of Eriophorum vaginatum, but negligible cover of other peat-forming species, and atypical species present
Turbine 1, Plot 2	0.3	Erio vagi 6, Holc lana 5, Anth odor 3, Junc effu 1, Junc arti 1, Rume acet 1, Erio angu 1, Card prat 1, Cirs diss 1	Rhyt squa 10	0	30	<1	30	30	0	Dry mossy hummocks	N	Moderate cover of Eriophorum vaginatum, but negligible cover of other peat-forming species, and atypical species present
Turbine 1, Plot 3	0.6	Call vulg 8, Erio vagi 7, Vacc myrt 3	Rhyt lore 8, Hypn jutl 6, Spha capi 4, Rhyt squa 3, Poly comm 3	capi 10	40	0	50	<5	0	Wet modified bog	Y	High cover of peat-forming species, few atypical species, hydrology mostly intact
Turbine 1, Plot 4	0.6	Erio vagi 6, Desc flex 6, Holc lana 6, Anth odor 5, Luzu mult 4, Ranu acri 2, Rume acet 2, Card prat 2, Myri gale 1	Rhyt squa 10, Hylo sple 4, Pseu puru 2	0	30	0	30	70	0	Enriched area beside road	N	Moderate cover of Eriophorum vaginatum, but negligible cover of other peat-forming species, and atypical species abundant
Turbine 1, Plot 5	0.6	Erio vagi 8, Call vulg 5, Eric tetr 4, Holc lana 4, Anth odor 3	Hylo sple 7, Hypn jutl 7, Rhyt lore 6, Rhyt squa 4, Spha capi 4, Thui tama 3	capi 5	60	0	65	5 - 10	0	Wet modified bog	Y	High cover of peat-forming species, few atypical species, hydrology mostly intact
Turbine 2, Plot 1	1.6	Call vulg 9, Erio vagi 4, Eric tetr 4, Clad port 2	Hypn jutl 10, Dicr scop 2	0	10	0	10	0	0	Hummock in uneven area	N	Low cover of peat-forming species, hydrology severely modified
Turbine 2, Plot 2	0.7	Call vulg 9, Eric cine 5, Erio vagi 4, Clad port 4	Hypn jutl 9	0	10	0	10	15	0	Hag near two drains	N	Low cover of peat-forming species, hydrology severely modified, atypical species present
Turbine 2, Plot 3	1.5	Call vulg 10, Erio vagi 4, Clad port 1	Hypn jutl 10, Rhyt squa 2	0	10	0	10	0	0	Very uneven, surface cracked, like hag	N	Low cover of peat-forming species, hydrology severely modified
Turbine 2, Plot 4	0.3	Moll caer 10, Erio vagi 5, Call vulg 4, Eric cine 2, Erio angu 1, Pice sitc 1	None	0	15	<1	15	<1	0	Enriched by runoff from hardstand. Spruce sapling beside plot	N	Low cover of peat-forming species, hydrology severely modified
Turbine 2, Plot 5	0.3	Erio vagi 7, Call vulg 7, Eric tetr 3, Erio angu 2, Care bine 2, Moll caer 1	Hypn jutl 7, Raco lanu 5, Spha capi 4	capi 5	50	<1	55	0	0	Uneven ground, near hardstand	Y	High cover of peat-forming species, few atypical species, hydrology mostly intact
Turbine 3, Plot 1	0.2	Erio vagi 8, Erio angu 4, Call vulg 4, Care pani 4, Junc squa 4, Care bine 4, Pote erec 2, Eric tetr 1	Spha capi 7, Hypn jutl 7, Spha papi 4, Spha cusp 4, Rhyt lore 4, Hylo sple 4, Rhyt squa 2, Poly comm 1	capi 40 cusp 10 papi 5	60	5	120	5 - 10	0	Wet modified bog	Y	High cover of peat-forming species, few atypical species, hydrology mostly intact, but peat layer shallow

		DOMIN		Cover								
Location	**Peat**	**Vascular plants**	**Bryophytes**	**Sphagnum**	**Erio vagi**	**Erio angu**	**Total**	**Atypical species**	**Bare peat**	**Modifications / hydrological condition**	**Active peat?**	**Rationale**
Turbine 3, Plot 2	0.6	Erio vagi 8, Eric tetr 4, Call vulg 4, Junc squa 4, Tric germ 4, Erio angu 3, Moll care 3, Agro cani 3, Pote erec 2	Spha capi 8, Rhyt lore 4, Hypn jutl 4, Rhyt squa 3, Spha papi 2	capi 70 papi <1	60	<5	130	5	0	Wet modified bog	Y	High cover of peat-forming species, few atypical species, hydrology mostly intact
Turbine 3, Plot 3	0.5	Call vulg 7, Erio vagi 5, Anth odor 4, Erio angu 3, Care bine 2	Rhyt squa 7, Rhyt lore 7, Pseu puru 5, Hylo sple 5, Thui tama 3	0	25	<5	25 - 30	5	0	Near road and shallow drain	N	Moderate cover of Eriophorum vaginatum, but negligible cover of other peat-forming species, and atypical species present
Turbine 3, Plot 4	0.5	Erio vagi 7, Moll caer 7, Call vulg 5, Erio angu 1, Junc squa 1	Hylo sple 7, Rhyt squa 7, Rhyt lore 6, Poly comm 3	0	40	<1	40	0	0	Hummock in cutover bog	Y	Moderate cover of peat-forming species, no atypical species, although peat layer is shallow
Turbine 3, Plot 5	0.5	Erio vagi 9, Eric tetr 4, Agro cani 3, Pote erec 3, Erio angu 2	Spha capi 7, Rhyt lore 6, Hylo sple 4, Rhyt squa 4, Poly comm 3, Spha papi 2	capi 40 papi <1	80	<1	120	5	0	Wet modified bog	Y	High cover of peat-forming species, few atypical species, hydrology mostly intact
Turbine 4, Plot 1	0.3	Nard stri 8, Agro cani 6, Anth odor 5, Desc flex 5, Care bine 4, Care pani 4	Rhyt squa 10, Hylo sple 4, Pleu schr 3	0	0	0	0	100	0	Grassy mound on edge of former track	N	No peat-forming species present, habitat highly modified
Turbine 4, Plot 2	0.3	Nard stri 7, Care bine 6, Desc felx 5, Anth odor 4, Luzu mult 4, Pote erec 2, Gali saxa 2	Rhyt squa 6, Hylo sple 5	0	0	0	0	100	0	Grassy mound on edge of former track	N	No peat-forming species present, habitat highly modified
Turbine 4, Plot 3	0.2	Nard stri 8, Junc squa 5, Desc flex 5, Anth odor 5, Gali saxa 3, Vacc myrt 2, Pote erec 2	Rhyt squa 8, Hylo sple 4, Pleu schr 4, Dicr scop 3, Poly comm 3, Pseu puru 2	0	0	0	0	100	0	Grassy mound on edge of former track	N	No peat-forming species present, habitat highly modified
Turbine 4, Plot 4	0.3	Nard stri 7, Desc flex 6, Care bine 5, Anth odor 5, Gali saxa 3	Hylo sple 6, Pleu schr 5	0	0	0	0	100	0	Near shallow drain	N	No peat-forming species present, shallow peat layer
Turbine 4, Plot 5	0.3	Nard stri 8, Agro cani 5, Junc squa 4, Anth odor 4, Desc flex 4, Care bine 4, Pote erec 2	Rhyt squa 8, Hylo sple 4, Pleu schr 4, Thui tama 3	0	0	0	0	100	0	None	N	No peat-forming species present, shallow peat layer
Turbine 5, Plot 1	0.3	Junc squa 6, Desc flex 5, Gali saxa 3, Pote erec 2, Anth odor 2	Hylo sple 9, Rhyt squa 6, Poly comm 4, Pseu puru 4	0	0	0	0	80	0	Dry mossy hummock	N	No peat-forming species present, shallow peat layer
Turbine 5, Plot 2	0.3	Call vulg 8, Junc squa 5, Desc flex 4, Anth odor 2	Rhyt lore 8, Rhyt squa 5, Hylo sple 5, Pleu schr 2	0	0	0	0	25	0	Dry mossy hummock	N	No peat-forming species present, shallow peat layer
Turbine 5, Plot 3	0.3	Junc squa 7, Call vulg 5, Desc flex 5, Anth odor 3, Gali saxa 3, Pote erec 2	Rhyt squa 10, Hylo sple 4, Poly comm 3	0	0	0	0	60	0	Dry mossy hummock	N	No peat-forming species present, shallow peat layer
Turbine 5, Plot 4	0.3	Junc squa 9, Call vulg 4, Anth odor 4, Desc flex 4, Gali saxa 3, Erio angu 2, Pote erec 2	Rhyt squa 8, Hylo sple 5, Rhyt lore 5, Poly comm 4, Spha capi 1	capi <1	0	<1	1	80	0	Dry mossy hummock	N	Negligible cover of peat-forming species, shallow peat layer
Turbine 5, Plot 5	0.3	Junc squa 7, Agro cani 6, Desc flex 6, Anth odor 3, Erio angu 2, Gali saxa 2, Pote erec 2	Rhyt squa 9, Hylo sple 7, Pleu schr 2	0	0	<1	<1	90	0	Dry mossy hummock	N	Negligible cover of peat-forming species, shallow peat layer

		DOMIN		Cover								
Location	**Peat**	**Vascular plants**	**Bryophytes**	**Sphagnum**	**Erio vagi**	**Erio angu**	**Total**	**Atypical species**	**Bare peat**	**Modifications / hydrological condition**	**Active peat?**	**Rationale**
Turbine 6, Plot 1	0.4	Moll caer 9, Erio angu 4, Junc squa 3, Care bine 3, Care pani 3, Gali saxa 3	Thui tama 8, Hylo sple 5, Hypn jutl 4, Rhyt lore 4, Rhyt squa 3, Poly comm 3	0	0	5	5	5	0	None	N	Negligible cover of peat-forming species, shallow peat layer
Turbine 6, Plot 2	0.4	Junc squa 7, Moll caer 6, Desc flex 6, Erio vagi 3, Gali saxa 3, Erio angu 2, Junc arti 2, Call vulg 2, Care pani 2	Thui tama 6, Rhyt lore 6, Spha capi 5, Poly comm 4	capi 20	<5	<1	20 - 25	25	0	Vehicle tracks	N	Low cover of peat-forming species, atypical species present, flush habitat
Turbine 6, Plot 3	0.4	Moll caer 5, Agro cani 5, Junc squa 5, Call vulg 4, Care bine 3, Gali saxa 3, Care pani 2, Pote ere 2, Anth odor 2	Spha papi 6, Rhyt lore 6, Spha capi 5, Pseu puru 3, Poly comm 3, Rhyt squa 3	papi 30 capi 20	0	0	50	25	0	Vehicle tracks	Y	High cover of Sphagnum mosses. Flush habitat on shallow peat, but a localised pocket of active peat
Turbine 6, Plot 4	0.3	Erio vagi 5, Moll caer 5, Gali saxa 4, Junc squa 3, Pote erec 1	Poly comm 8, Hypn jutl 7, Hylo sple 7, Rhyt lore 7	0	10	0	10	5	0	Dry mossy hummock	N	Low cover of peat-forming species, atypical species present, shallow peat
Turbine 6, Plot 5	0.4	Moll caer 7, Junc squa 7, Erio angu 3, Care bine 3, Gali saxa 3, Erio vagi 2, Call vulg 2, Pote erec 2	Hylo sple 8, Rhyt squa 6, Thui tama 5, Hypn jutl 5, Poly comm 3, Spha tene 2	tene <1	<1	<5	5	35	0	Dry mossy hummock	N	Low cover of peat-forming species, atypical species present, shallow peat
Turbine 7, Plot 1	0.3	Anth odor 5, Desc flex 4, Gali saxa 4, Junc squa 3, Luzu mult 3, Erio angu 2, Equi sp. 1	Hylo sple 8, Rhyt squa 7, Gali saxa 4, Poly comm 4	0	0	<1	<1	50	0	Dry mossy hummock on sloping ground	N	Negligible cover of peat-forming species, shallow peat layer
Turbine 7, Plot 2	0.3	Call vulg 9, Erio vagi 4, Moll caer 4, Vacc myrt 2	Hylo sple 8, Rhyt lore 7, Rhyt squa 5	0	5	0	0	0	0	Hummock on sloping ground	N	Negligible cover of peat-forming species, shallow peat layer
Turbine 7, Plot 3	0.3	Call vulg 8, Moll caer 7, Erio vagi 3, Anth odor 3, Agro cani 3, Desc flex 3, Gali saxa 3, Vacc myrt 3, Pote erec 1	Hylo sple 8, Rhyt lore 6, Rhyt squa 2	0	<5	0	<5	5-10	0	Hummock on sloping ground	N	Negligible cover of peat-forming species, shallow peat layer
Turbine 7, Plot 4	0.5	Call vulg 9, Vacc myrt 4, Erio vagi 3, Moll caer 3, Agro cani 3, Erio angu 1	Rhyt squa 7, Rhyt lore 7, Hylo sple 6, Poly comm 3, Pseu puru 1	0	<5	<1	5	<5	0	Hummock on sloping ground	N	Negligible cover of peat-forming species, shallow peat layer
Turbine 7, Plot 5	0.5	Call vulg 9, Erio vagi 5, Moll caer 4, Gali saxa 2, Pote erec 1	Hylo sple 8, Rhyt squa 7, Poly comm 3, Pseu puru 2	0	15	0	15	0	0	Hummock on sloping ground	N	Low cover of peat-forming species, shallow peat

Table 2 Active Peat Assessment at Turbine 1 (30 quadrats)

		DOMIN		Cover								
Location	**Peat**	**Vascular plants**	**Bryophytes**	**Sphagnum**	**Erio vagi**	**Erio angu**	**Total**	**Atypical species**	**Bare peat**	**Modifications / hydrological condition**	**Active peat?**	**Rationale**
1	0.4	Call vulg 8, Erio vagi 5, Desc flex 4, Gali saxa 2, Agro cani 1, Pote erec 1	Rhyt squa 6, Hylo sple 6, Rhyt lore 5	0	25	0	25	5	0	Dry mossy hummock	N	Low cover of peat-forming species, atypical species present, shallow peat layer
2	0.5	Erio vagi 5, Call vulg 5, Desc flex 5, Gali saxa 4	Rhyt squa 8, Hylo sple 6, Rhyt lore 6, Pleu schr 5	0	20	0	20	25	0	Dry mossy hummock	N	Low cover of peat-forming species, atypical species present, shallow peat layer

		DOMIN		Cover								
Location	**Peat**	**Vascular plants**	**Bryophytes**	**Sphagnum**	**Erio vagi**	**Erio angu**	**Total**	**Atypical species**	**Bare peat**	**Modifications / hydrological condition**	**Active peat?**	**Rationale**
3	0.3	Erio vagi 8, Call vulg 6, Desc flex 3	Rhyt lore 7, Poly comm 3	0	65	0	65	<5	0	Dry mossy hummock	N	High cover of Eriophorum vaginatum, but no other peat-forming species present, and habitat is more representative of dry heath
4	0.4	Call vulg 9, Erio vagi 5	Rhyt lore 7, Spha capi 5, Poly comm 4	capi 20	25	0	45	0	0	Level ground near shallow drain	Y	Moderate cover of peat-forming species, no atypical species, although peat layer is shallow
5	0.6	Erio vagi 8, Call vulg 8, Eric tetr 2, Pote erec 1	Spha capi 8, Rhyt lore 7, Hypn jutl 5	capi 60	55	0	115	0	0	None	Y	High cover of peat-forming species, no atypical species, hydrology mostly intact
6	0.4	Call vulg 9, Erio vagi 5, Desc flex 4, Agro cani 1	Rhyt lore 8, Hylo sple 5, Poly comm 4, Spha capi 3, Spha papi 2	capi <5 papi <1	25	0	30	5	0	Hummock, Sphagnum is in small depression	N	Moderate cover of peat-forming species, but atypical species present, and shallow peat layer
7	0.6	Desc flex 5, Erio vagi 4, Gali saxa 4	Rhyt squa 10, Hylo sple 4, Poly comm 4	0	10	0	10	20	0	Dry mossy hummock	N	Low cover of peat-forming species, atypical species present
8	0.5	Call vulg 9, Erio vagi 6, Desc flex 5, Agro cani 2	Rhyt squa 7, Hypn jutl 6, Hylo sple 5, Ploy comm 4, Pleu schr 4, Spha capi 4	capi 5	30	0	35	20	0	Dry mossy hummock	N	Moderate cover of peat-forming species, but atypical species present, and shallow peat layer
9	1.1	Call vulg 9, Erio vagi 5, Vacc myrt 2	Rhyt squa 6, Rhyt lore 5, Hylo sple 5, Hypn jutl 5	0	20	0	20	0	0	Artificial mound near drain	N	Low cover of peat-forming species, hydrology severely modified
10	0.0									Road	N	Artificial surface
11	0.5	Call vulg 8, Erio vagi 7, Agro cani 2	Rhyt squa 8, Rhyt lore 5, Pleu schr 5, Hylo sple 4, Spha capi 4, Poly comm 3	capi 5	50	0	55	<1	0	Dry mossy hummock	Y	High cover of peat-forming species, hydrology mostly intact, although peat layer is shallow
12	0.3	Call vulg 9, Erio vagi 6, Agro cani 3	Rhyt lore 8, Hylo sple 7, Poly comm 4, Pleu schr 3, Spha capi 2	capi <5	30	0	30 - 35	<5	0	Dry mossy hummock	N	Moderate cover of peat-forming species, but atypical species present, and shallow peat layer
13	0.5	Call vulg 8, Desc flex 6, Erio vagi 5, Vacc myrt 3, Agro cani 3, Gali saxa 1	Rhyt squa 10, Rhyt lore 3	0	15	0	15	30	0	Dry mossy hummock	N	Low cover of peat-forming species, atypical species present, shallow peat layer
14	0.5	Call vulg 8, Erio vagi 6, Desc flex 4, Holc lana 4, Junc effu 2, Gali saxa 1	Hypn jutl 8, Rhyt lore 6, Rhyt squa 4, Spha capi 3	capi <5	30	0	30 - 35	10	0	Dry mossy hummock	N	Moderate cover of peat-forming species, but atypical species present, and shallow peat layer
15	0.5	Call vulg 9, Erio vagi 6	Rhyt squa 7, Rhyt lore 6, Poly comm 2, Dicr scop 2	0	30	0	30	0	0	Dry hummock in cutover bog	N	Moderate cover of Eriophorum vaginatum, but no other peat-forming species present, and habitat is more representative of dry heath
16	0.0	No vegetation								Road	N	Artificial surface

		DOMIN		Cover								
Location	**Peat**	**Vascular plants**	**Bryophytes**	**Sphagnum**	**Erio vagi**	**Erio angu**	**Total**	**Atypical species**	**Bare peat**	**Modifications / hydrological condition**	**Active peat?**	**Rationale**
17	0.7	Call vulg 7, Erio vagi 5, Gali saxa 1	Rhyt squa 8, Rhyt lore 7	0	25	0	25	0	0	Hummock in cutover bog	N	Moderate cover of Eriophorum vaginatum, but no other peat-forming species present, and habitat is more representative of dry heath
18	0.5	Call vulg 8, Erio vagi 7, Eric tetr 4, Vacc myrt 1	Spha capi 8, Rhyt lore 5, Hypn jutl 4	capi 70	45	0	115	0	0	Wet modified bog	Y	High cover of peat-forming species, although peat layer is shallow and habitat is highly modified
19	0.5	Call vulg 10, Erio vagi 5, Eric tetr 2	Spha capi 5, Hypn jutl 5, Rhyt lore 5, Spha fall 3	capi 20 fall <5	25	0	45	0	0	Wet modified bog	Y	Moderate cover of peat-forming species, no atypical species, hydrology mostly intact
20	0.6	Call vulg 9, Erio vagi 5, Agro cani 4	Rhyt lore 8, Hylo sple 5	0	20	0	20	5	0	Hummock near road	N	Low cover of peat-forming species
21	0.0	No vegetation								Road	N	Artificial surface
22	0.4	Call vulg 9, Erio vagi 6, Eric tetr 4	Rhyt lore 8, Hypn jutl 7, Spha capi 3	capi <5	30	0	30 - 35	0	0	Wet modified bog	Y	Moderate cover of peat-forming species, no atypical species, hydrology mostly intact
23	0.4	Call vulg 8, Erio vagi 5, Vacc myrt 3	Rhyt lore 7, Spha capi 4	capi 10	25	0	35	0	0	Wet modified bog	Y	Moderate cover of peat-forming species, no atypical species, hydrology mostly intact
24	0.0	No vegetation								Road	N	Artificial surface
25	0.4	Call vulg 10, Erio vagi 4, Eric tetr 2	Rhyt squa 6, Rhyt lore 6, Poly comm 5, Hypn jutl 4	0	10	0	10	0	0	Near disturbed area	N	Low cover of peat-forming species
26	0.6	Erio vagi 6, Call vulg 6, Desc flex 4, Junc effu 3, Gali saxa 3, Pote erec 2, Erio angu 1	Rhyt squa 8, Rhyt lore 5, Pleu schr 3	0	30	<1	30	15	0	Dry mossy hummocks	N	Moderate cover of Eriophorum vaginatum, but negligible cover of other peat-forming species, and atypical species present
27	0.3	Erio vagi 6, Holc lana 5, Anth odor 3, Junc effu 1, Junc arti 1, Rume acet 1, Erio angu 1, Card prat 1, Cirs diss 1	Rhyt squa 10	0	30	<1	30	30	0	Dry mossy hummocks	N	Moderate cover of Eriophorum vaginatum, but negligible cover of other peat-forming species, and atypical species present
28	0.6	Call vulg 8, Erio vagi 7, Vacc myrt 3	Rhyt lore 8, Hypn jutl 6, Spha capi 4, Rhyt squa 3, Poly comm 3	capi 10	40	0	50	<5	0	Wet modified bog	Y	High cover of peat-forming species, few atypical species, hydrology mostly intact
29	0.6	Erio vagi 6, Desc flex 6, Holc lana 6, Anth odor 5, Luzu mult 4, Ranu acri 2, Rume acet 2, Card prat 2, Myri gale 1	Rhyt squa 10, Hylo sple 4, Pseu puru 2	0	30	0	30	70	0	Enriched area beside road	N	Moderate cover of Eriophorum vaginatum, but negligible cover of other peat-forming species, and atypical species abundant

		DOMIN		Cover								
Location	**Peat**	**Vascular plants**	**Bryophytes**	**Sphagnum**	**Erio vagi**	**Erio angu**	**Total**	**Atypical species**	**Bare peat**	**Modifications / hydrological condition**	**Active peat?**	**Rationale**
30	0.6	Erio vagi 8, Call vulg 5, Eric tetr 4, Holc lana 4, Anth odor 3	Hylo sple 7, Hypn jutl 7, Rhyt lore 6, Rhyt squa 4, Spha capi 4, Thui tama 3	capi 5	60	0	65	5 - 10	0	Wet modified bog	Y	High cover of peat-forming species, few atypical species, hydrology mostly intact
										Total	Y N	11 (31%) 24 (69%) The majority of the area is not active peat

Table 3 Active Peat Assessment at Turbine 3 (30 plots)

		DOMIN		Cover								
Location	**Peat**	**Vascular plants**	**Bryophytes**	**Sphagnum**	**Erio vagi**	**Erio angu**	**Total**	**Atypical species**	**Bare peat**	**Modifications / hydrological condition**	**Active peat?**	**Rationale**
1	0.4	Call vulg 9, Erio angu 5, Care pani 2, Pote ere 1	Rhyt lore 8, Hylo sple 5, Spha capi 2	capi <1	0	20	20	<1	0	Cutover, but level	N	Low cover of peat-forming species, shallow peat layer
2	0.0	No vegetation								Road	N	Artificial surface
3	0.0	No vegetation								Road	N	Artificial surface
4	0.0	No vegetation								Road	N	Artificial surface
5	0.0	No vegetation								Road	N	Artificial surface
6	0.2	Call vulg 8, Moll caer 7, Junc squa 5, Erio vagi 4, Care bine 2, Eric tetr 2	Rhyt squa 6, Hylo sple 5, Rhyt lore 5, Hypn jutl 4, Pleu schr 3	0	5	0	5	20	0	Uneven ground, gentle slope	N	Low cover of peat-forming species, atypical species present, shallow peat layer
7	0.4	Erio vagi 9, Erio angu 4, Desc flex 4, Call vulg 4, Gali saxa 3, Pote erec 3	Rhyt lore 8, Hylo sple 7, Hypn jutl 6, Spha papi 3, Spha capi 3, Pleu schr 3	papi <5 capi <5	80	5	90	5	0	Enriched flush near road	Y	High cover of peat-forming species, although peat layer is shallow, and habitat is acid flush
8	0.4	Erio vagi 8, Desc flex 5, Agro cani 4, Eric tetr 4, Call vulg 3, Erio angu 1	Spha capi 7, Hypn jutl 5, Hylo sple 5, Rhyt squa 5, Rhyt lore 5, Spha papi 4, Spha subn 4, Poly comm 4	capi 40 papi 5 subn 5	70	<1	120	15	0	Hummock in uneven ground	Y	High cover of peat-forming species, although peat layer is shallow, and habitat is acid flush
9	0.3	Call vulg 8, Desc flex 6, Junc squa 6, Erio vagi 3, Erio angu 3, Pote erec 2	Rhyt squa 7, Rhyt lore 6, Hylo sple 5, Poly comm 5, Hypn jutl 5	0	<5	<5	5	30	0	Gentle slope, shallow drain within plot	N	Low cover of peat-forming species, atypical species present, shallow peat layer
10	0.4	Call vulg 8, Moll caer 5, Desc flex 5, Erio vagi 4, Erio angu 4, Anth odor 3, Care pani 3, Pote erec 2	Hylo sple 7, Rhyt lore 6, Hypn jutl 5, Spha papi 3	papi <5	10	5	15 - 20	20	0	Wet enriched area near road	N	Low cover of peat-forming species, atypical species present, flush habitat
11	-	Call vulg 8, Moll caer 6, Junc squa 5, Erio vagi 4, Anth odor 2, Pote erec 2	Rhyt lore 7, Thui tama 6, Hypn jutl 6, Rhyt squa 4	0	5	0	5	15	0	Low mound in cable trench, disturbed	N	Low cover of peat-forming species, atypical species present
12	-	Junc effu 8, Nard stric 5, Holc lana 5, Anth odor 4, Cirs arve 1	Rhy squa 7	0	0	0	0	100	0	Enriched area beside hardstand	N	No peat-forming species present, habitat highly modified
13	0.0	No vegetation								Hardstand	N	Artificial surface

		DOMIN		Cover								
Location	**Peat**	**Vascular plants**	**Bryophytes**	**Sphagnum**	**Erio vagi**	**Erio angu**	**Total**	**Atypical species**	**Bare peat**	**Modifications / hydrological condition**	**Active peat?**	**Rationale**
14	0.3	Anth odor 8, Holc lana 6, Erio vagi 4, Erio angu 4, Desc flex 4, Call vulg 2, Cirs arve 1, Luzu mult 1	Rhyt squa 8, Hylo sple 4	0	10	5	15	90	0	Dry enriched area near hardstand	N	Few peat-forming species present, habitat highly modified
15	0.4	Call vulg 7, Desc flex 6, Erio vagi 5, Gali saxa 3, Agro cani 3, Pote erec 1, Luzu mult 1	Rhyt lore 8, Liverwort 6, Hylo sple 4	0	25	0	25	25	0	Hag / hummock	N	Low cover of peat-forming species, atypical species present, hydrology severely modified
16	0.5	Erio vagi 7, Dec flex 5, Gali saxa 3, Erio angu 2, Pote ere 2, Luzu mult 1	Spha capi 7, Poly comm 5, Rhyt lore 5, Pleu schr 4, Hypn jutl 4	capi 50	40	<1	90	20	0	Gentle slope near shallow drain	Y	High cover of peat-forming species, although peat layer is shallow
17	0.4	Call vulg 6, Desc flex 6, Erio vagi 5, Agro cani 3, Eric tetr 2, Luzu mult 2, Pote erec 2, Erio angu 1	Rhyt squa 7, Rhyt lore 6, Hylo sple 5, Hypn jutl 5, Spha capi 4	capi 10	25	<1	35	35	0	Gentle slope near shallow drain	N	Moderate cover of peat-forming species, but several atypical species present, and shallow peat layer
18	0.4	Erio vagi 7, Call vulg 5, Eric tetr 3, Gali saxa 2, Pote erec 2	Rhyt squa 8, Rhyt lore 7, Hylo sple 4, Hypn jutl 4	0	35	0	35	0	0	Gentle slope near shallow drain	Y	Moderate cover of peat-forming species, no atypical species, hydrology mostly intact
19	0.4	Erio vagi 7, Call vulg 5, Vacc myrt 5, Tric germ 3, Pote erec 2, Erio angu 1	Rhyt squa, Rhyt lore 6, Poly comm 6, Hypn jutl 4, Hylo sple 4	0	40	<1	40	0	0	Gentle slope near shallow drain	Y	Moderate cover of peat-forming species, no atypical species, hydrology mostly intact
20	0.4	Agro cani 7, Erio vagi 5, Anth odor 5, Desc flex 5, Call vulg 4, Junc squa 4, Pote ere 2	Rhyt squa 19, Poly comm 6, Hypn jutl 4, Dicr scop 1	0	20	0	20	60	5	Gentle slope near shallow drain	N	Low cover of peat-forming species, atypical species abundant, and shallow peat layer
21	0.3	Erio vagi 6, Desc flex 6, Anth odor 6, Agro cani 5, Call vulg 4, Luzu mult 4, Gali saxa 3	Rhyt squa 10	0	30	0	30	40	0	Enriched area beside hardstand and shallow drain	N	Moderate cover of peat-forming species, but several atypical species present, and shallow peat layer
22	0.5	Call vulg 7, Erio vagi 6, Desc flex 5, Agro cani 5, Anth odor 4, Gali saxa 3, Luzu mult 2, Pote erec 2	Rhy squa 8, Rhyt lore 6, Hylo sple 4	0	30	0	30	30	0	Enriched area near hardstand	N	Moderate cover of peat-forming species, but several atypical species present, and shallow peat layer
23	0.6	Erio vagi 8, Call vulg 6, Agro cani 3, Anth odor 2, Pote erec 2, Vacc myrt 2, Luzu mult 1	Rhyt squa 7, Hypn jutl 6, Hylo sple 5, Rhyt lore 5	0	60	0	60	5	0	Dry hard enriched ground beside hardstand	Y	Moderate cover of peat-forming species, few atypical species, hydrology mostly intact
24	0.3	Agro cani 7, Anth odor 6, Desc flex 6, Junc squa 6, Erio angu 3, Luzu mult 2, Gali saxa 2, Pote erec 2	Rhyt squa 8, Hylo sple 6. Thui tama 5, Poly comm 3	0	0	<1	<1	100	0	Dry enriched area near hardstand	N	No peat-forming species present, habitat highly modified
25	0.0	No vegetation								Hardstand	N	Artificial surface
26	0.2	Erio vagi 8, Erio angu 4, Call vulg 4, Care pani 4, Junc squa 4, Care bine 4, Pote erec 2, Eric tetr 1	Spha capi 7, Hypn jutl 7, Spha papi 4, Spha cusp 4, Rhyt lore 4, Hylo sple 4, Rhyt squa 2, Poly comm 1	capi 40 cusp 10 papi 5	60	5	120	5 - 10	0	Wet modified bog	Y	High cover of peat-forming species, few atypical species, hydrology mostly intact, but peat layer shallow

		DOMIN		Cover								
Location	**Peat**	**Vascular plants**	**Bryophytes**	**Sphagnum**	**Erio vagi**	**Erio angu**	**Total**	**Atypical species**	**Bare peat**	**Modifications / hydrological condition**	**Active peat?**	**Rationale**
27	0.6	Erio vagi 8, Eric tetr 4, Call vulg 4, Junc squa 4, Tric germ 4, Erio angu 3, Moll care 3, Agro cani 3, Pote erec 2	Spha capi 8, Rhyt lore 4, Hypn jutl 4, Rhyt squa 3, Spha papi 2	capi 70 papi <1	60	<5	130	5	0	Wet modified bog	Y	High cover of peat-forming species, few atypical species, hydrology mostly intact
28	0.5	Call vulg 7, Erio vagi 5, Anth odor 4, Erio angu 3, Care bine 2	Rhyt squa 7, Rhyt lore 7, Pseu puru 5, Hylo sple 5, Thui tama 3	0	25	<5	25 - 30	5	0	Near road and shallow drain	N	Moderate cover of Eriophorum vaginatum, but negligible cover of other peat-forming species, and atypical species present
29	0.5	Erio vagi 7, Moll caer 7, Call vulg 5, Erio angu 1, Junc squa 1	Hylo sple 7, Rhyt squa 7, Rhyt lore 6, Poly comm 3	0	40	<1	40	0	0	Hummock in cutover bog	Y	Moderate cover of peat-forming species, no atypical species, although peat layer is shallow
30	0.5	Erio vagi 9, Eric tetr 4, Agro cani 3, Pote erec 3, Erio angu 2	Spha capi 7, Rhyt lore 6, Hylo sple 4, Rhyt squa 4, Poly comm 3, Spha papi 2	capi 40 papi <1	80	<1	120	5	0	Wet modified bog	Y	High cover of peat-forming species, few atypical species, hydrology mostly intact
										Total	Y N	10 (33%) 20 (67%) The majority of the area is <u>not</u> active peat

Rigged Hill Windfarm Repowering

Technical Appendix A8.2: Habitats Regulation Assessment

Appendix - Volume 3
July 2019

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Non-Technical Summary

1. The aim of the report is to identify, quantify and evaluate the impacts of the Development on Natura 2000 sites. It will assist the planning authority with an Appropriate Assessment for the project, which is a requirement of the *Conservation (Natural Habitats, etc.) Regulations (Northern Ireland) 1995* (as amended).

2. The Development is within the catchment of the Castle River, which provides a distant hydrological connection to the 'River Roe & Tributaries' Special Area of Conservation (SAC). In order to assist the planning authority with their Appropriate Assessment, this document includes: a description of relevant Natura 2000 sites, an appraisal of potential source-pathway-receptor relationships, an assessment of potential impacts, details of proposed avoidance / mitigation measures, and an assessment of residual impacts.

3. A range of hydrological mitigation measures will be implemented during the construction, operation and decommissioning phases of the Development in order to prevent the pollution of local watercourses, and thus any associated impacts on the 'River Roe & Tributaries' SAC. These measures have been designed by the project hydrologist and are outlined in full in **Chapter 7: Hydrology, Hydrogeology, Geology, Soils and Peat**, but they are summarised in this document in order to assist with the Appropriate Assessment process. Subject to the successful implementation of the mitigation measures, the hydrologist has concluded that there will be no significant residual impacts on receiving waters or aquatic fauna. Consequently, we conclude that the Development will not adversely affect the integrity of any Natura 2000 sites.

1 Introduction

1.1 Background to Appropriate Assessment

4. Approximately 6.5% of the land area of Northern Ireland is included in the European Network of Natura 2000 sites, which includes Special Protection Areas (SPAs) to protect important areas for birds, and Special Areas of Conservation (SACs) to protect habitats and non-avian fauna. Legislative protection for these sites is provided by the *European Council Birds Directive* (79/409/EEC) and the *E.C. Habitats Directive* (92/43/EEC, as amended), which are transposed into Northern Irish law by the *Conservation (Natural Habitats, etc.) Regulations (Northern Ireland) 1995* (as amended).

5. To ensure compliance with these regulations, the competent authority (Northern Irish planning authorities and other public bodies) must consider the potential impacts of any development on the integrity of the Natura 2000 network. Regulation 43 states that the competent authority must carry out an 'appropriate assessment' of the implications of any development on Natura 2000 sites, and "*shall agree to the plan or project only after having ascertained that it will not adversely affect the integrity of a European site*". To assist the competent authority with this assessment, the applicant is often required to provide supporting information in a document known as a Habitats Regulations Assessment.

6. The first stage of the assessment is a simple screening exercise to determine whether a development has potential to affect any Natura 2000 sites. If there is any risk of a significant effect, either alone or in combination with other plans or projects, the development should proceed to the second stage of the process, which is known as 'Appropriate Assessment' (AA). An AA is a detailed assessment of any potential impacts on Natura 2000 sites, and may include details of mitigation measures that will be employed to avoid or minimise impacts.

1.2 Statement of authority

7. All surveying and reporting was carried out by NM Ecology Ltd. The surveyor has eleven years of professional experience, including eight years as an ecological consultant, one year as a local authority biodiversity officer, and two years managing an NGO overseas. He has an MSc in Ecosystem Conservation and Landscape Management from NUI Galway and a BSc in Environmental Science from Queens University Belfast.

8. He regularly carries out ecological surveys and impact assessments for developments throughout Ireland and Northern Ireland, including wind farms, infrastructural projects (roads, water mains, powerlines, etc), and a range of commercial and residential developments. He is a member of the Chartered Institute of Ecology and Environmental Management, and operates in accordance with their code of professional conduct.

1.3 Methods

9. This document is a Habitats Regulations Assessment (HRA), which is submitted as part of an Environmental Statement (ES) for the Development. All of the information required for an Appropriate Assessment can be found in **Chapter 8: Ecology and Fisheries**, **Chapter 9: Ornithology** and **Chapter 7: Hydrology, Hydrogeology, Geology, Soils and Peat**, but for ease of reference we have summarised all relevant information in this document.

10. This document has been prepared with reference to the following guidelines:

- *The Habitats Regulations: a guide for competent authorities* (Department of the Environment, Northern Ireland, 2002);
- *Assessment of plans and projects significantly affecting Natura 2000 sites: Methodological guidance on the provisions of Article 6(3) and (4), E.C.*, 2002.;
- *Guidelines for Ecological Impact Assessment in the U.K and Ireland: Terrestrial, Freshwater, Coastal and Marine* (Chartered Institute of Ecology and Environmental Management, 2018).

11. A desk-based study was conducted using data from the following sources:

- Other chapters of the ES;
- Qualifying Interests of Natura 2000 sites from the Northern Ireland Environment Agency (www.doeni.gov.uk/niea/protected_areas_home) and the Joint Nature Conservation Committee (jncc.defra.gov.uk/protectedsites/);
- Bedrock, soil, subsoil and aquifer maps from the Geological Survey of Northern Ireland Geoindex, and information on water quality from the NIEA River Basin Plan Interactive Map; and
- The Northern Area Plan 2016, other relevant documents from the Causeway Coast and Glens Borough Council, and details of permitted or proposed developments from the Northern Ireland Planning Portal (www.planningni.gov.uk/index.htm).

12. All web-based resources were accessed between March 2017 and May 2019. The Site was visited on a regular basis throughout 2017, 2018 and 2019.

1.4 Receiving environment

13. The Operational Rigged Hill Windfarm is situated on the summit of Rigged Hill (377 m AOD), and is part of a ridge between Temain Hill to the south of the Site (376 m) and Boyd's Mountain to the north of the site (329 m). The Site includes the Operational Rigged Hill Windfarm and additional lands on the western slope of the hill. The surrounding landscape is characterised by conifer plantations, moorland and heathland, while the lower slopes are predominantly in agricultural use.

14. The underlying bedrock geology is basalt, which is a poor aquifer. Superficial geology is predominantly glacial till, with peat on the crest of the hill. The Site is in the catchment of the Castle River, which is a tributary of the River Roe; these watercourses are part of the North Western International River Basin District. Under the Water Framework Directive monitoring scheme, the Castle River is classified as having good overall status. Further details are provided in **Chapter 7: Hydrology, Hydrogeology, Geology, Soils and Peat**.

2 Description of Natura 2000 sites

2.1 Identification of Natura 2000 sites within the zone of influence

15. The Site is not within or adjacent to any Natura 2000 sites. A map of Natura 2000 sites within 15 km of the Site is provided in **Figure 1**, and details of each site are provided in **Table 1.**

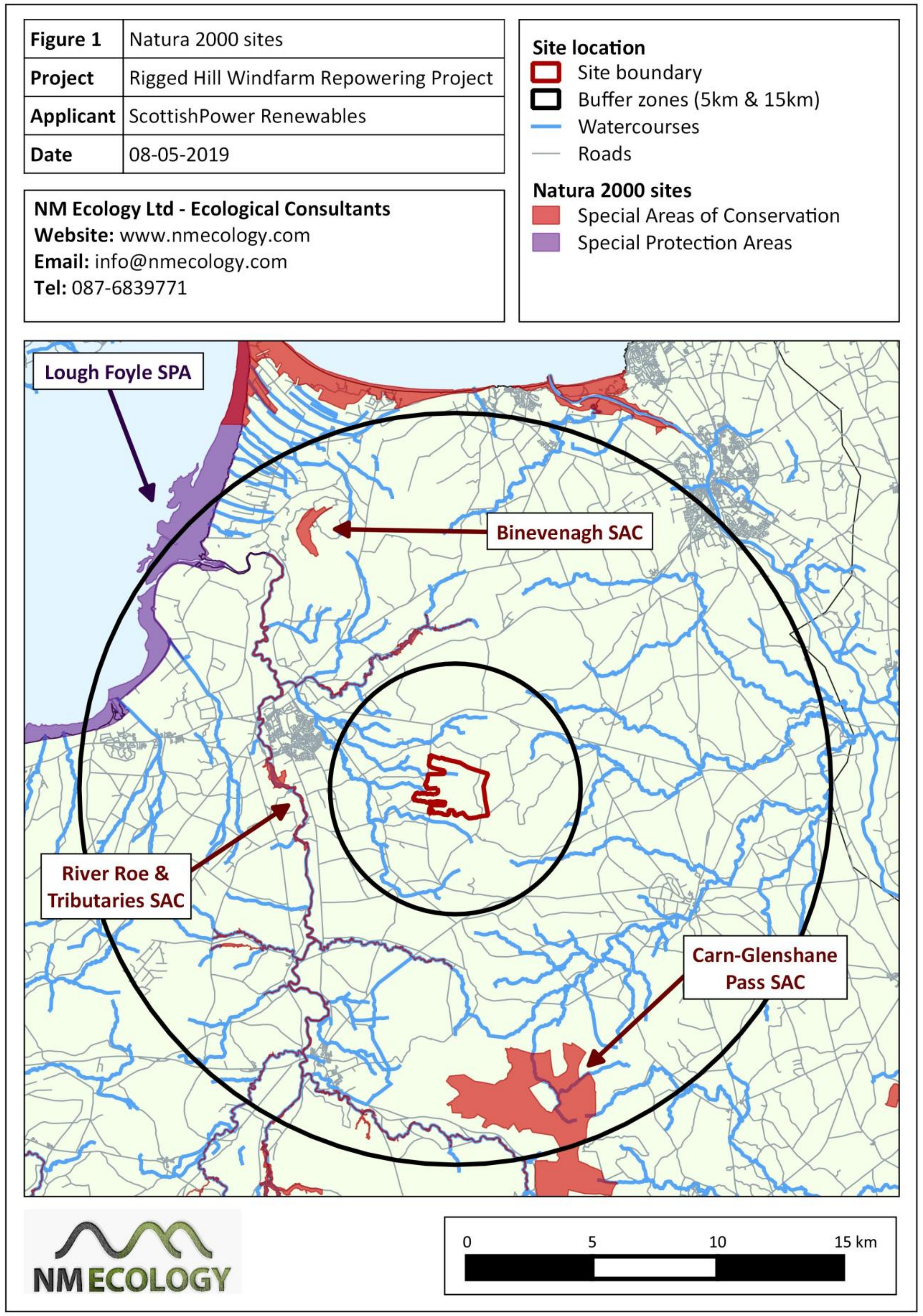


Table 1: Natura 2000 sites within 15 km of the Site

Site name	Distance	Qualifying Interests	Potential pathways for effects
River Roe & Tributaries	3.8 km north-west	**Annex I Habitats:** • Watercourses • Old sessile oak woodlands **Annex II Species:** • Otter *(Lutra lutra)* • Atlantic salmon (*Salmo salar)*	Indirect hydrological connection via the Castle River.
Carn / Glenshane Pass SAC	9.1 km south	**Annex I Habitats:** • Blanket bog	None
Binevenagh SAC	9.2 km north	**Annex I Habitats:** • Species-rich *Nardus* grasslands • Calcareous scree	None
Lough Foyle SPA	11 km north-west	**Special Conservation Interests:** • Light-bellied brent goose (*Branta bernicla hrota)* (wintering) • Whooper swan (*Cygnus cygnus*)(wintering) • Bar-tailed godwit (*Limosa lapponica*) (wintering)	Indirect hydrological connection via the Castle River and River Roe.

2.2 Appraisal of potential pathways for indirect impacts on Natura 2000 sites

16. Indirect impacts on Natura 2000 sites can occur if there is a viable pathway between the source (the Site) and the receptor (the habitats and species for which a Natura 2000 site has been designated). The most common pathway for impacts is surface water: for example, if a pollutant is washed into a river and carried downstream into a Natura 2000 site that has been designated for aquatic habitats and/or fauna. Other potential pathways are groundwater, air (e.g. sound waves or airborne dust), or land (e.g. flow of liquids, vibration). The zone of effect for hydrological impacts can be several kilometres, but for air and land it is rarely more than one hundred metres. The magnitude of impacts (e.g. the concentration of pollutants) usually decreases as the distance between source and receptor increases. An appraisal of potential pathways between the Development and nearby Natura 2000 sites is provided below.

17. The Castle River provides a hydrological connection between the Site and the ‘River Roe & Tributaries’ SAC, via approximately 7 km of intervening watercourse. This is considered to be a rather distant hydrological pathway, because the intervening waters would dilute any pollutants to low concentrations before they could reach the SAC. However, if a precautionary approach is adopted, there is a risk that pollution associated with the Development could contribute to cumulative negative impacts on water quality in the River Roe, which could reduce the quality of the habitat for Atlantic Salmon. All other pathways for impacts on this SAC can be ruled out due to distance.

18. There is also a distant hydrological connection to the Lough Foyle SPA, which covers a large section of coastline to the north-west of the Site, including the outflow of the River Roe. However, any measures taken to avoid or minimise impacts on the ‘River Roe and Tributaries’ SAC would also avoid or minimise impacts on the SPA, so detailed assessment of the SPA is considered unnecessary.

19. The Carn-Glenshane Pass SAC and Binevenagh SAC are both located 9 km from the Site, and are not connected to the River Roe or any other associated watercourses, so surface water pathways can be ruled out. The distances involved are too great for groundwater, air and land pathways, so these pathways can be ruled out for both SACs.

3 Description of the Development

3.1 Characteristics of the Development

20. Construction will commence with the decommissioning of the Operational Rigged Hill Windfarm, which will involve the removal of all existing turbines, and some redundant sections of access road. The proposed Development will then be constructed, comprising seven wind turbines with a maximum blade-tip height of up to 137m, and associated hardstanding areas, access roads, substation, permanent meteorological mast, grid connection and Energy Storage Units. A new site entrance will be constructed at the Terrydoo Road, and an access track will be constructed up the hill in the west of the Site. Construction compounds will be used temporarily during construction works, and some temporary, small-scale construction work will be required along the transport route in order to facilitate the delivery of turbine components. Detailed descriptions and drawings of the proposed works can be reviewed in the ES **Chapter 3: Development Description**.

3.2 Embedded mitigation

21. Embedded mitigation measures are set out within the outline Demolition / Construction Environmental Management Plan (DCEMP) (provided as **Technical Appendix A3.1**). This document is supplemented by the Water Construction and Environmental Plan (WCEMP), provided as **Technical Appendix A7.2**, which will form part of the final DCEMP prepared, which sets out site-specific pollution-prevention measures. They include established and effective good practice methods, to which the Developer will be committed as part of any planning consent.

In other sections of the ES, the DCEMP and WCEMP are considered to be 'embedded mitigation' (i.e. forming an inherent part of the Development), and impacts are assessed subject to these measures. However, Appropriate Assessment requires a precautionary approach to the implementation of mitigation, and for the purposes of this Habitat Regulations Assessment, we do not consider embedded mitigation (as outlined in **Technical Appendices A3.1 and A7.2**) in Stage 1 of the AA process. Instead, the hydrological mitigation is treated as traditional mitigation measures in Stage 2.

3.3 Plans or Projects in the surrounding area (potential in-combination effects)

3.3.1 Plans

The regional development plan for the Site is the Northern Area Plan 2016, specifically the sections relevant to Ballymoney Borough Council. The only reference to wind energy developments relates to Areas of Significant Archaeological Interest, and no other aspects of the plan were identified that could lead to potential in-combination effects with the Development. Other plans relevant to renewable energy developments are discussed in Chapter 5 of the ES; no potential in-combination effects were identified in any of these plans.

3.3.2 Other developments

22. The Site is located in a rural setting surrounded by agricultural land, farm buildings and one-off houses. It is a settled area and is not subject to significant development pressure. The Northern Ireland planning portal was searched for other developments within the surrounding area, and a small number of live or recently-approved applications were found. Permission was granted in 2015 for a single wind turbine with a 58.5 m blade-tip height, located approx. 500 m south-west of the Site (planning reference: B/2014/0221/F); this site is referred to as 'Temain Road' in **Technical Appendix A2.3**. At the time of writing, the turbine had not yet been constructed, and the permission had a five-year validity, so it is likely that the development will be constructed prior to 2020. It is noted that an Environmental Construction Method Statement was submitted as part of the application, which includes a range of pollution-prevention and site-management measures. A subsequent application for a new laneway along the access route for the new turbine was also approved in 2015 (planning reference: LA01/2015/0009/F). All other live or recently-approved planning applications in the surrounding area were for residential extensions and other small-scale projects, none of which would pose a risk of in-combination impacts

4 Assessment of potential impacts

23. Impacts assessments for watercourses, birds and ecology are provided in ES **Chapter 7: Hydrology, Hydrogeology, Geology, Soils and Peat, Chapter 8: Ecology and Fisheries** and **Chapter 9: Ornithology**. A brief summary of these impact assessments is provided below, but reference should be made to relevant chapters of the ES for further details.

4.1 Direct effects (construction, operation and decommissioning phases)

24. The Site is not within or adjacent to any Natura 2000 sites, so there is no risk of habitat loss, fragmentation or any other direct effects.

4.2 Indirect effects (initial decommissioning / construction phase)

4.2.1 Suspended sediments

25. Suspended sediments refer to silt, mud or other fine sediments that become dissolved in water. Sediment can be carried into waterbodies by rainwater runoff from exposed ground or sediment stock-piles, during de-watering of excavations (groundwater or surface water), or when installing culverts in watercourses. If the construction of the Development caused the release of significant quantities of suspended sediments in the Castle River catchment, they could potentially be carried downstream into the River Roe & Tributaries SAC. It is noted that the SAC is located more than 7 km downstream, and thus that any suspended sediments would be diluted to low concentrations before they could reach the SAC. However, on a precautionary basis, and without consideration of embedded mitigation, it is possible that suspended sediments produced during decommissioning / construction works could contribute to diffuse pollution in the River Roe.

26. A Peat Slide Risk Assessment (PSRA) is included in **Technical Appendix A7.1**. Within the Development footprint, some localised low-risk zones were identified, but the majority of the site had a generally-negligible hazard rank. On this basis, in the absence of mitigation, the Development is considered to result in a potential effect of negligible significance, and would therefore not be significant in accordance with the EIA Regulations. Therefore, there is not considered to be a risk of sudden releases of suspended sediments from peat slides, and thus no negative effects on the River Roe & Tributaries SAC.

4.2.2 Other pollutants

27. Construction work will involve the pouring of concrete for turbine foundations, and requires fuels for construction vehicles; both substances are highly toxic to aquatic life. Potential effects on water quality are an issue of risk management, because if the development proceeds as intended, there should be no release of cement or hydrocarbon pollutants into nearby waterbodies. However, it is possible that accidental or unplanned events could cause localised releases of pollutants in the Site, which could be washed into watercourses and carried downstream.

28. As noted above, the River Roe & Tributaries SAC is located more than 7 km downstream, so any pollutants would be diluted to low concentrations before they could reach the SAC. However, on a precautionary basis, and without consideration of embedded mitigation, it is possible that pollutants produced during decommissioning / construction works could contribute to diffuse pollution in the lake.

4.3 Indirect effects (operational phase)

4.3.1 Suspended sediments, peat slides and other pollutants

29. No significant releases of suspended sediments or other pollutants are anticipated during the operation of the Development. As a result, there is no risk of impacts on the River Roe & Tributaries SAC.

4.4 Indirect effects (final decommissioning phase)

4.4.1 Suspended sediments, peat slides and other pollutants

30. Impacts during the decommissioning of the Development would be similar in character to impacts during the initial decommissioning/construction phases, although the works will be lesser in extent and thus the magnitude of impacts may be lower.

4.5 Potential cumulative / in-combination impacts (all phases)

31. Cumulative impacts are of particular relevance for pollution events, as a small discharge of pollutants from a new development could act in combination with other existing and future developments to have a larger cumulative effect. As noted in Section 3.3.2, planning permission was granted in 2015 for a single wind turbine on Temain Road, just outside the southern boundary of the applicant's landholding.

32. It is possible that the single turbine development could be constructed at the same time as the proposed access road. The single turbine will be located a short distance from the headwaters of the Castle River, so there is a potential risk of in-combination effects on water quality if the two developments were constructed concurrently. However, it is noted that an *Environmental Construction Method Statement* was submitted as part of the application, which includes a range of pollution-

prevention and site-management measures. A series of measures are also set out below (Section 5) to minimise the potential impacts of the proposed development on water quality. Therefore, the risk of in-combination effects is considered to be negligible.

5 Screening statement

33. In the absence of mitigation measures, there is a risk that pollutants generated during the initial decommissioning/construction works (and to a lesser extent the final decommissioning works) could cause 'likely significant effects' on the River Roe & Tributaries SAC. Therefore, it is not possible to rule out impacts on Stage 1 of the AA process, and the Development will proceed to Stage 2: Appropriate Assessment. Mitigation measures are outlined in Section 6, and residual impacts are considered in Section 7.

6 Proposed mitigation measures

6.1 Pollution-prevention measures (construction and decommissioning phases)

34. A range of hydrological mitigation measures have been proposed for the decommissioning / construction phases of the Development, which are described in the outline Demolition / Construction Environmental Management Plan (DCEMP, **Technical Appendix A3.1**) and the Water Construction and Environmental Plan (WCEMP, **Technical Appendix A7.2).** In other sections of the ES these documents are described as embedded mitigation, and thus are considered to form an inherent part of the Development. However, Appropriate Assessment requires a precautionary approach to the implementation of mitigation, so for the purposes of this Habitat Regulations Assessment, the content of the DCEMP and WCEMP are considered to be traditional mitigation measures.

35. In summary, the hydrological mitigation measures for the decommissioning / construction phases of the Development, as outlined in the DCEMP and WCEMP are:

- Buffer zones for watercourses, and restrictions on works within these zones;
- Measures for the control of exposed sediments;
- A system of interceptor drains and settlement ponds to control suspended sediments;
- Procedures for the storage of cement (and related materials), for the pouring of concrete, and the cleaning of equipment;
- Procedures for the storage of hydrocarbons, for the refuelling of vehicles, and for responses to any spills; and
- Monitoring and maintenance of the implementation of these measures.

36. The system of interceptor drains and settlement ponds will remain in place during the operation of the Development, and will be monitored and maintained as required.

7 Residual Impacts

37. Residual impacts on surface water are summarised in **Chapter 7: Hydrology, Hydrogeology, Geology, Soils and Peat** as follows:

38. *"*Subject to the implementation of] *the mitigation measures described in Technical Appendix 7.2, all identified potential effects have been assessed as being of negligible significance. The mitigation measures proposed are established measures that are widely used in construction projects and which the Applicant and its contractors are well used to undertaking. Given the levels of certainty in the success of application of the mitigation measures and their effectiveness it is appropriate that the mitigation measures form an inherent part of the Development and are taken into account and assumed to be fully effective in the determination of this application.*

39. *No significant residual effects are predicted for all phases of the Development, and are therefore not significant in terms of the EIA Regulations."*

40. No developments were identified that would be likely to cause cumulative / in-combination effects.

8 Conclusion

41. In this Habitats Regulations Assessment we provide supporting information to assist the local authority with an Appropriate Assessment of the Development. We have identified pathways to one SAC within the zone of influence; in a worst-case scenario there is a risk of likely significant effects on the qualifying interests of this site, notably Atlantic salmon. In response, a series of hydrological mitigation measures have been recommended by specialists in these fields (refer to **Chapter 7: Hydrology, Hydrogeology, Geology, Soils and Peat** for further details), which will avoid or minimise the risk of significant negative impacts upon the special conservation interests of the SAC. As a result, we conclude that the Development will not adversely affect the integrity of any Natura 2000 sites.

Rigged Hill Windfarm Repowering

Technical Appendix A8.3: Bat Survey Report

Volume 3 – Technical Appendix
July 2019

SCOTTISHPOWER RENEWABLES

1 Introduction

1.1 Assessment brief

1. The aim of this report is to identify, quantify and evaluate the effects of the Development on bat species. It forms part of **Chapter 8: Ecology and Fisheries** of the Environmental Statement (ES).

2. This document provides the results of a series of bat surveys that were carried out at the Site in 2017 and 2018. Based on these findings, an assessment of potential risks to local bat populations is provided, and mitigation measures are proposed.

1.2 Statement of authority

3. All surveying and reporting was carried out by NM Ecology Ltd. The surveyor has eleven years of professional experience, including eight years as an ecological consultant, one year as a local authority biodiversity officer, and two years managing an NGO overseas. He has an MSc in Ecosystem Conservation and Landscape Management from NUI Galway and a BSc in Environmental Science from Queens University Belfast.

4. He is a member of the Chartered Institute of Ecology and Environmental Management, and operates in accordance with their code of professional conduct. He regularly carries out bat surveys for development projects throughout Ireland and Northern Ireland, particularly for windfarms. He has carried out bat surveys for more than ten years, and has completed a number of training courses in bat surveying and mitigation.

2 Assessment Methodology

2.1 Scoping

5. Survey methods were developed with reference to the *NIEA Specific Requirements: Bat Surveys* (NIEA, 2017)[1], and the Bat Conservation Trust (BCT) *Bat Surveys for Professional Ecologists: Good Practice Guidelines* (3rd edition: Collins et al. 2016[2], and Chapter 10 of the 2nd edition guidelines: Hundt *et al.* 2012[3]). It is noted that the Bat Conservation Trust guidelines have recently been superseded by *Bats and Onshore Wind Turbines: Survey, Assessment and Mitigation* (Scottish Natural Heritage, 2019)[4], but the SNH guidelines had not been published when the surveys were carried out in 2017 and 2018, so all survey methods discussed in this report are based on the Bat Conservation Trust (2016) guidelines.

6. The Study Area for bat assessments was the Indicative Developable Area, i.e. the locations in which turbines would be located. This is because Wind Turbines provide a potential source of effects on bats, but other aspects of infrastructure (e.g. internal roads) do not pose a risk. Following walkover surveys of the Study Area, it was considered to have relatively low suitability for bats, as there were no potential roost features within the site and surroundings, all habitat features in the vicinity of the proposed turbine locations were of relatively low-value for foraging bats (i.e. heathland and blanket bog), the only significant linear habitat features (e.g. hedgerows or treelines) were around the perimeter of the Site, and because the Site is exposed to high winds for most of the year (hence its suitability for wind turbines). Therefore, the Site was initially considered to have low suitability for bats, and the minimum survey effort outlined in Table 10.2 of the BCT 2nd edition guidelines was proposed. This would have involved a minimum of five nights of automated detectors surveys and one transect survey during each of the three survey seasons (spring, summer and autumn).

7. However, in order to provide a more accurate baseline assessment of the site, the applicant elected to increase the survey effort for automated-detector surveys to 30 nights in spring, summer and autumn 2017. Following the installation of a meteorological mast in July 2017, additional sampling of bat activity at a height of 45 m above ground level was undertaken. Transect surveys were carried during the spring, summer and autumn survey periods, as per the BCT 3rd edition guidelines.

8. Following a review of the 2017 data, it was decided that additional automated detector surveys would be carried out in 2018 in order to complete the dataset. The first year provided a comprehensive temporal assessment of bat activity throughout the active period, and addressed some concerns raised in consultation with the NIEA – NED in 2017, notably an assessment of bat activity at height, and a comparison of activity between open heathland / moorland habitats and the forest edge. The second year was designed to fill some temporal gaps in the dataset, notably to cover the months of July and September (which were not sampled intensively in 2017), and to assess any spatial patterns in bat activity.

2.2 Automated detector surveys

9. Automated-detector surveys were carried out using *Song Meter SM4BATZC* detectors (Wildlife Acoustics Inc.) and Anabat Express detectors (Titley Scientific Inc.). External microphones were mounted on a cane at a height of 1.5 m above ground level.

10. In the first year of surveying (2017), the proposed locations for new wind turbines had not been determined, so six detectors were situated to provide a broad coverage of the Study Area, including the crest of the hill (east of the site), the lower plateau (west of the site), and the edge of the conifer plantation on the site boundary. In general, the same locations were surveyed in all sampling periods, but the locations of three detectors were adjusted from May to June following a meeting with the Northern Ireland Environment Agency (Natural Environment Division). A seventh microphone was installed at a height of approximately 45m on the temporary met mast in mid-August 2017, allowing monitoring of bat activity at height in the August and October 2017 sampling periods, and throughout 2018 (**Figure 1**). Sampling was carried out for a total of 93 nights in 2017: 9th – 22nd of May, 9th – 25th of June, 1st – 31st August, and 1st to 31st October.

11. In the second year (2018), thirteen potential turbine locations had been identified, and automated detector surveys were carried out concurrently at all locations. A fourteenth detector was connected to a microphone on the met mast in order to sample at height. The same sampling locations were used in all sampling periods. Sampling was carried out for a total of 39 nights in 2018: 9th – 21st of May, 11th – 24th of July, and 12th to 23rd September.

12. Weather data was collected on-site for the duration of the sampling period. A meteorological mast for the Operational Rigged Hill Windfarm was installed in 1994, but had ceased to function by the time of survey, so a portable weather station was put in place from May to August 2017 (Aercus Instruments, model WS2083). However, when the applicant installed a temporary meteorological mast in July 2017, all subsequent weather data was collected at this location. Weather data for each survey night are presented in Appendix 2.

2.3 Transect surveys

13. Transect surveys were carried out in 2017 to identify important feeding areas and commuting routes in the Study Area. Surveys started at sunset and lasted for a period of 2-3 hours, and the total ground coverage was approximately 6 to 7 km. As noted above, the final turbine locations had not been determined at the time of survey, so the transects covered representative sections of the Study Area. All surveys were undertaken using an *EM3*+ bat detector (Wildlife Acoustics, USA) and an Anabat Express detector in transect mode, allowing sonograms to be recorded for later analysis.

2.4 Roost surveys

14. There is only one building within the boundary of the Study Area: the existing substation of the Operational Rigged Hill Windfarm, which is an industrial structure that is considered to be of negligible value for bats. There are no mature trees, or any other built structures, within or adjacent to the Study Area. Therefore, it was not considered necessary to carry out any surveys for bat roosts.

2.5 Data analysis

2.5.1 Species identification

15. Sonograms from automated detectors were obtained in the 'zero-crossing' format and viewed using AnalookW software (Corben 2014). During transect surveys, bats were identified acoustically in the field and confirmed by sonograms displayed on the EM3+ detector, but calls were also recorded on an Anabat Express for confirmation. Species were identified with reference to *British Bat Calls: A Guide to Species Identification* (Russ 2012)[5], based primarily on frequency and call shape, but occasionally with reference to call slope for *Myotis* spp.

16. It is acknowledged that *Myotis* spp. have very similar calls, and that the classification of sonograms can be imprecise, so all *Myotis* records in this document should be considered as *conferre* records, i.e. *Myotis* cf *daubentonii*. In a similar manner, there can be overlaps in call frequency between *Pipistrellus* spp, particularly at frequencies of 50 kHz. If a bat call could not be confidently identified to species level, it was recorded as an unidentified bat, or identified only to genus level (e.g. *Myotis* spp.). Social calls were also classified as unidentified bats unless they closely matched the examples provided in Russ (2012).

[1] Northern Ireland Environment Agency, 2017. NIEA Specific Requirements: Bat Surveys. Available online at https://www.daera-ni.gov.uk/publications/bat-surveys-specifications
[2] Collins, J., 2016. *Bat surveys for professional ecologists: good practice guidelines* (3rd edition). Bat Conservation Trust, London.
[3] Hundt, L., 2012. *Bat Surveys: Good Practice Guidelines document*. (2nd edition) Bat Conservation Trust, London
[4] Scottish Natural Heritage (in association with Natural England, Natural Resources Wales, RenewableUK, Scottish Power Renewables, Ecotricity Ltd, the University of Exeter and the Bat Conservation Trust), 2019. *Bats and onshore wind turbines: survey, assessment and mitigation*. Available online at https://www.nature.scot/professional-advice/planning-and-development/renewable-energy-development.
[5] Russ, J.M., 2012. *British Bat Calls: A Guide to Species Identification*. Pelagic Publishing, Exeter, UK

2.5.2 Calculation and comparison of bat activity indices

17. At present there is not a standard system to categorise bat activity as low, moderate or high, because activity levels vary depending on the species involved and the location of a site. In other parts of the UK the *Ecobat* tool (managed by the Mammal Society, Lintott et al. 2018) can be used to benchmark activity levels based on other data collected in the region, but there is not currently a large enough dataset from Northern Ireland to provide reliable results. Data from Britain cannot be applied to Northern Ireland, due to differences in the relative abundances of some species, notably Leisler's bat.

18. Therefore, for the purposes of this report we use a bespoke system to discuss and compare levels of bat activity at the Site, as outlined in the **Table 1**. For ease of comparison, bat activity levels are classified into four categories based on a simple count of bat passes in any night, and cells are coloured using shades of blue. For the purposes of this assessment, any species that regularly has more than 50 bat passes per night (i.e. moderate to high activity) is considered to have a significant level of activity, which would warrant further consideration in an impact assessment.

Table 1: Terminology and colour-scheme used to categorise bat activity levels

Category	Number of bat passes
Negligible	≤9
Low	10 - 49
Moderate	50 - 99
High	≥100

It should be noted that activity levels can only be compared within a species and not between species, due to differences in the detection distances for each species and their flight characteristics. For example, if there is low activity by brown long-eared bats (a species with short-range echolocation pulses) and moderate activity by Leisler's bats (which has long-range echolocation pulses), it does not necessarily mean that Leisler's bats are more abundant than brown long-eared bats at that location.

3 Baseline Description

3.1 Automated detector surveys 2017

19. As noted in Section 2.2, the Applicant elected to carry out a significantly higher level of automated-detector surveying than would usually be undertaken for a site with low suitability for bats. This comprised a total of 93 survey nights in 2017, with 14 nights in May (9th – 22nd), 17 in June (9th – 25th), 31 in August (1st – 31st) and 31 in October (1st – 31st). Six locations were sampled in each period, with a seventh detector attached to a microphone at 45 m height on the meteorological mast in August and October, giving a total survey effort of 620 nights in 2017. This is considered to be a very high level of survey effort in comparison to the levels recommended in the BCT survey guidelines (2nd edition, 2012). Survey results are summarised below, and presented in full in Appendix 1.

3.1.1 May

20. There was a total of 599 bat passes over the 14-night sampling period, giving an average of 7.1 bat passes per location per night. When considered using the abundance categories listed in **Table 1**, 71 of the 84 sampling nights (85%) had negligible activity, 11 had low activity (13%), and 2 had moderate activity (2%), with no nights of high activity. Bat activity was relatively similar at all sampling locations. Overall, bat activity during the May sampling period was considered to be negligible.

21. The vast majority of passes were Leisler's bat (444 passes, 74% of all passes). The proportions of other species were as follows: common pipistrelle (110, 18%), soprano pipistrelle (17 passes, 3%), unidentified pipistrelle (11 passes, 2%), and brown long-eared bats (2 passes, <1%). 15 passes (3%) were very faint or could not be identified to species level, and were listed as unidentified bats.

22. Weather conditions during the survey period were rather variable, covering the transition from spring into early summer. Average nightly temperatures only exceeded 10 ºC on two nights, and the minimum value was 5.5 ºC. Average wind speeds were below 5 m/s on 10 of the 14 survey nights. The nights of highest bat activity were the 9th (217 passes) and 22nd of May (118 passes). Average nightly wind speeds were 0.8 m/s and 2.5 m/s respectively, which is below the standard cut-in speed of wind turbines.

3.1.2 June

23. There was a total of 2,644 bat passes over the 17-night sampling period, giving an average of 25.9 bat passes per location per night. 63 of the 102 sampling nights (62%) had negligible activity, 21 had low activity (21%), 8 had moderate activity (8%) and 10 had high activity (10%). The highest levels of bat activity were recorded at sampling location R3, which was in the south-west of the site on the lower plateau. Overall, bat activity during the May sampling period was considered to be low, but with moderate activity at some locations.

The vast majority of passes were Leisler's bat (2,419 passes, 92% of all passes), followed by common pipistrelle (155 passes, 6%), soprano pipistrelle (39 passes, 1%), unidentified pipistrelle (16 passes, 1%), *Myotis* spp (1 passes, 0%), brown long-eared (10 passes, <1%), and unidentified bats (4 passes, <1%).

24. Weather conditions during the survey period were mild, with average nightly temperatures exceeding 10 ºC on 10 of the 17 nights, and a minimum of 7.4 ºC. Average wind speeds were moderate to high, exceeding 5 m/s on all but two of the nights, and reaching 13 m/s on one occasion. The nights of highest bat activity were the 17th (441 passes) and 18th of June (728 passes), on which average nightly wind speeds were 4.4 m/s and 2.4 m/s respectively; these are two of the nights with lowest wind speed during the sampling period.

3.1.3 August

25. There was a total of 10,667 bat passes over the 31-night sampling period, giving an average of 49.1 bat passes per location per night. 80 of the 217 sampling nights (37%) had negligible activity, 79 had low activity (36%), 26 had moderate activity (12%) and 32 had high activity (15%). The highest levels of bat activity were recorded at sampling location R1, which was in the north-west of the site on the lower plateau, but bat activity was relatively evenly distributed throughout the remainder of the Site. Overall, bat activity during the May sampling period was considered to be moderate, but with high activity at some locations.

26. The majority of passes were Leisler's bat (7,662 passes, 72% of all records), followed by common pipistrelle (1,559 passes, 15%), soprano pipistrelle (1,102 passes, 10%), Nathusius' pipistrelle (36 passes, <1%), *Myotis* spp (120 passes, 1%), and unidentified bats (188 passes, 2%).

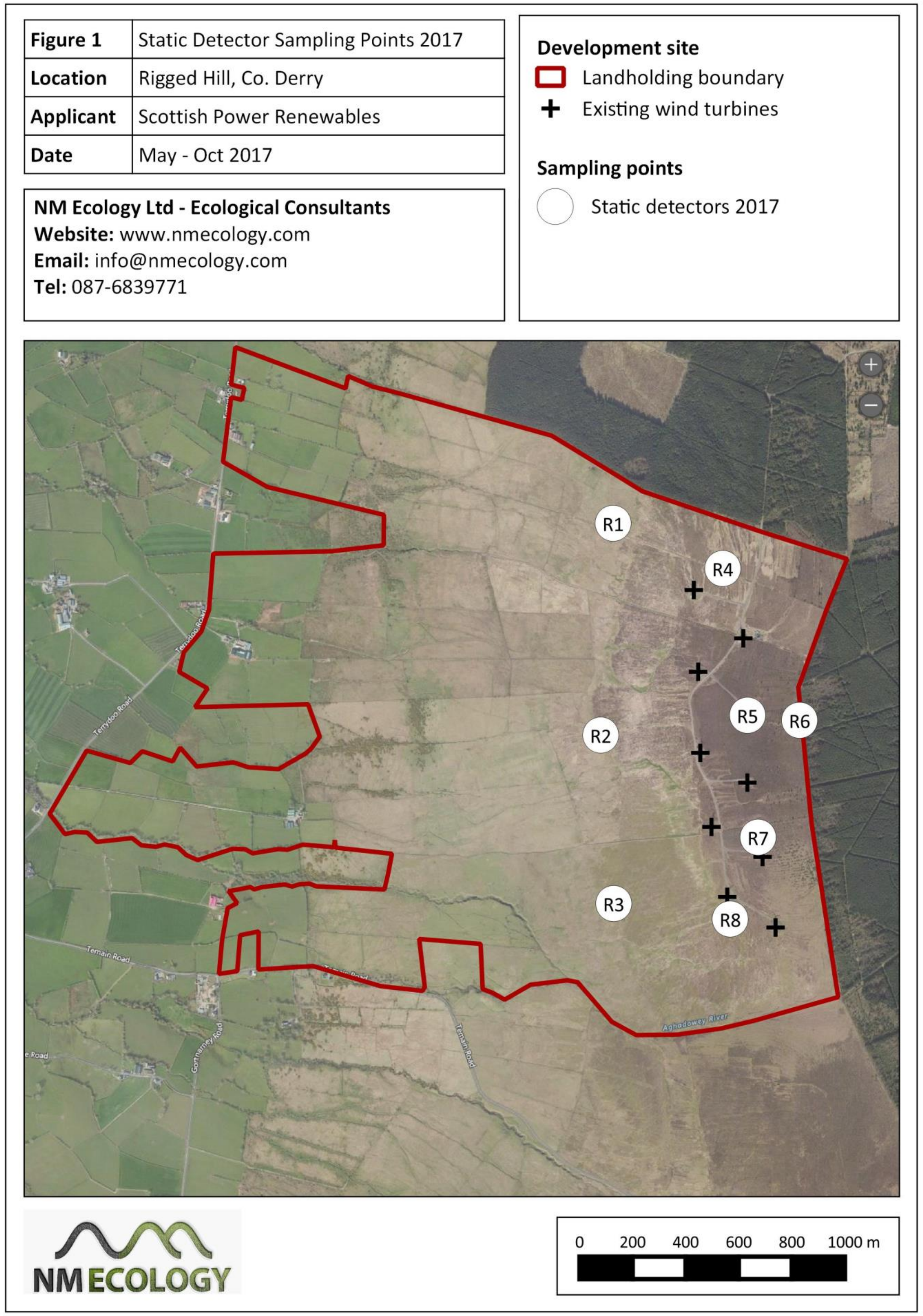
27. Weather conditions during the survey period were mild, with average nightly temperatures exceeding 10 ºC on 18 of the 31 nights, and a minimum of 7.6 ºC. Average wind speeds were moderate to high, exceeding 5 m/s on 23 nights. The nights of highest bat activity were the 8th (1,067 passes), 14th (1,214 passes), 26th (2,012 passes) and 30th (1,145 passes). on which average nightly wind speeds were 3.8, 4.3, 4.1 and 2.7 m/s respectively.

3.1.4 October

28. There was a total of 963 bat passes over the 31-night sampling period, giving an average of 5.2 bat passes per location per night. 199 of the 217 sampling nights (91%) had negligible activity, 12 had low activity (6%), 4 had moderate activity (2%) and 2 had high activity (1%). The highest levels of bat activity were recorded at sampling location R4, which was in the north of the site on the crest of the hill, but bat activity was relatively evenly distributed throughout the remainder of the Site. Overall, bat activity during the May sampling period was considered to be negligible.

29. The majority of passes were common pipistrelles (439 passes, 46% of all records), followed by soprano pipistrelles (277 passes, 29%), Leisler's bat (180 passes, 19%), *Myotis* spp (22 passes, 2%), Nathusius' pipistrelle (4 passes, <1%), and unidentified bats (41 passes, 4%).

30. Weather conditions during the survey period were rather variable, covering the transition from summer into autumn. Weather conditions during the survey period were cold, with average nightly temperatures exceeding 10 ºC on only 2 of the 31 nights, and a minimum of 4.7 ºC. Average wind speeds were high, exceeding 5 m/s on all but 3 of the nights. The nights of highest bat activity were the 15th (450 passes) and 23rd (144 passes), on which average nightly wind speeds were 8.2 and 11.3 m/s respectively.



31.

3.2 Automated detector surveys 2018

32. Sampling was carried out on a total of 39 survey nights in 2018, with 13 nights in May (9^{th} – 21^{st}), 14 in July (11^{th} – 24^{th}) and 12 in September (12^{th} – 23^{rd}). Fourteen locations were sampled in each period, including one location at height, giving a total survey effort of 546 nights in 2018. Survey results are summarised below, and presented in full in Appendix 1.

3.2.1 May

33. There was a total of 243 bat passes over the 13-night sampling period, giving an average of 1.5 bat passes per location per night. 151 of the 156 sampling nights (97%) had negligible activity, 4 had low activity (3%), and 1 had moderate activity (<1%), with no nights of high activity. The highest levels of bat activity were recorded at sampling location B2, which was in the north of the site on the line of the ridge, but bat activity was relatively evenly distributed throughout the remainder of the Site. Overall, bat activity during the May sampling period was considered to be negligible.

34. The vast majority of passes were Leisler's bat (208 passes, 86% of all passes), followed by common pipistrelle (21 passes, 9%), soprano pipistrelle (11 passes, 4%), *Myotis* spp (1 pass, <1%), and unidentified bats (2 passes, 1%).

35. Weather conditions during the survey period were cold, with average nightly temperatures exceeding 10 ºC on only 1 of the 13 nights, and a minimum of 3.5 ºC. Average wind speeds were high, exceeding 5 m/s on all of the nights, and reaching 17.2 m/s on one occasion. The nights of highest bat activity were the 14^{th} (48 passes) and 17^{th} (139 passes), on which average nightly wind speeds were 6.6 m/s and 6.9 m/s respectively; these are two of the nights of lowest wind speed in the sampling period.

3.2.2 July

36. There was a total of 4,205 bat passes over the 14-night sampling period, giving an average of 21.5 bat passes per location per night. 104 of the 196 sampling nights (53%) had negligible activity, 69 had low activity (35%), 16 had moderate activity (8%) and 7 had high activity (4%). The highest levels of bat activity were recorded at sampling locations B4, A4 and B6, which are located in the south of the site at the ridgeline and lower plateau. Overall, bat activity during the May sampling period was considered to be low, but with moderate to high activity at some locations.

The vast majority of passes were Leisler's bat (3,715 passes, 88% of all passes), followed by common pipistrelle (269 passes, 6%), soprano pipistrelles (104 passes, 3%), *Myotis* spp (99 passes, 2%), Nathusius' pipistrelles (2 passes, <1%), and unidentified bats (16 passes, <1%).

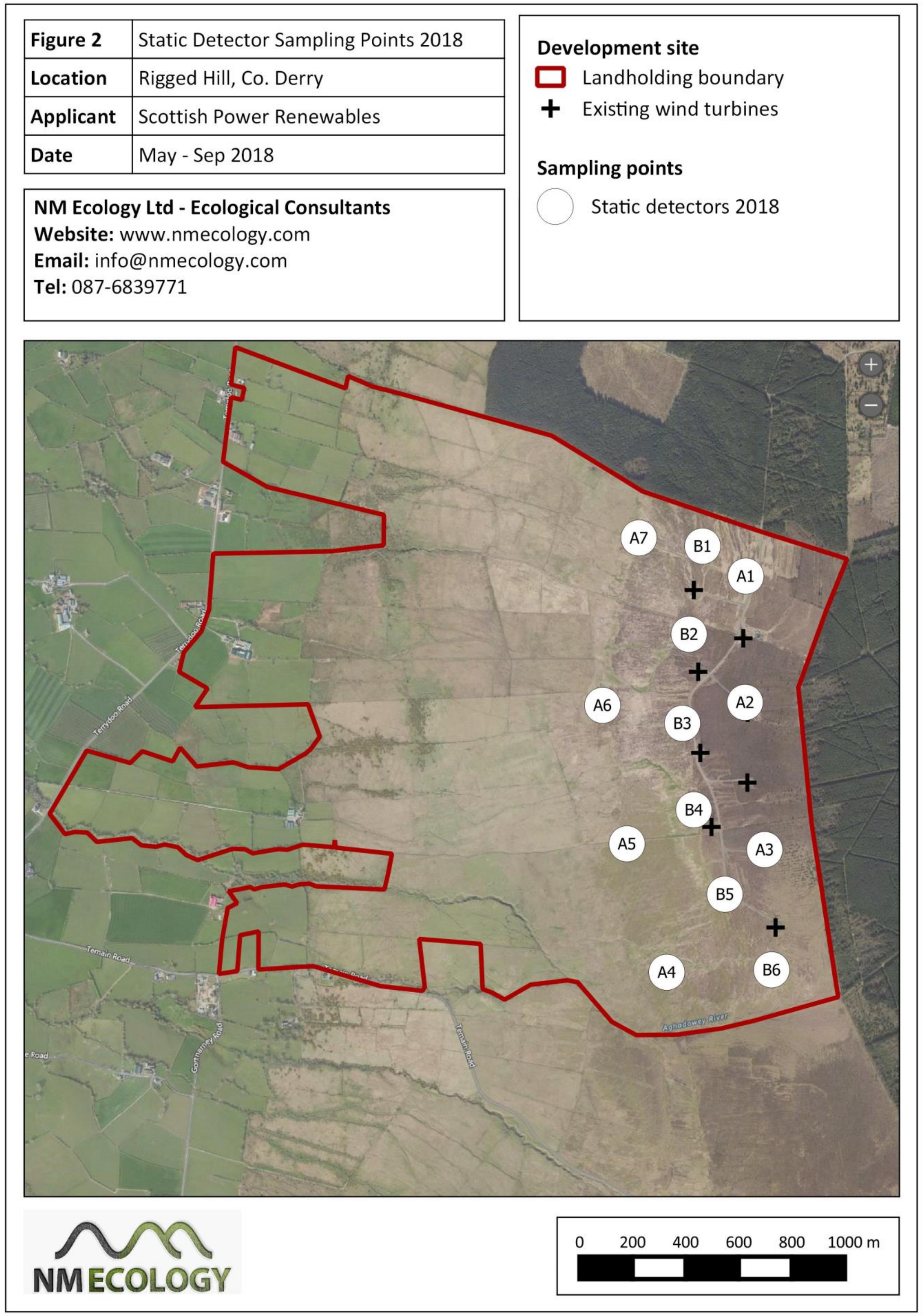
37. Weather conditions during the survey period were warm, with average nightly temperatures exceeding 10 ºC on 11 of the 14 nights, and a minimum of 8.3 ºC. Average wind speeds were moderate to high, exceeding 5 m/s on all but 2 of the nights, and reaching 15.2 m/s on one occasion. The night of highest bat activity was the 17^{th} (876 passes), which also had the lowest average wind speed (2.0 m/s).

3.2.3 September

38. There was a total of 58 bat passes over the 12-night sampling period, giving an average of 0.4 bat passes per location per night. 143 of the 144 sampling nights (99%) had negligible activity and 1 had low activity (1%), with no nights of moderate or high activity. Overall, bat activity was considered to be negligible at all locations.

39. The species proportions were as follows: Leisler's bat (21 passes, 36% of all records), common pipistrelle (10 passes, 17%), *Myotis* spp (14 passes, 24%), Nathusius' pipistrelle (6 passes, 11%), soprano pipistrelle (4 passes, 7%), and unidentified bats (3 passes, 5%).

40. Weather conditions during the survey period were cold, with average nightly temperatures exceeding 10 ºC on only 2 of the 12 nights, and a minimum of 2.6 ºC. Average wind speeds were high, exceeding 5 m/s on all nights, and reaching 23.8 m/s on one occasion. The nights of highest bat activity were the 14^{th} (18 passes) and 16^{th} (22 passes), on which average nightly wind speeds were 8.6 m/s and 10.0 m/s respectively.



41.

3.3 Transect surveys

3.3.1 May

42. The survey was carried out on the 10th of May 2017. Post-sunset temperatures were 8 – 11 ºC, wind speeds were approx. 2 - 3 m/s, and there was no rain. Sunset was at 21:17, so the survey started at 21:20 and ended at 00:30. The surveyors entered the site from the southern boundary, then followed a loop around the western part of the existing wind farm, passed along the edge of the conifer plantation on the northern boundary of the site, and then returned through the eastern part of the site in the vicinity of the operational turbines (see **Figure 3**).

43. Five bats were recorded during the survey: 1 common pipistrelle and 1 Leisler's bat along the edge of the forestry on the northern boundary of the site, and 1 *Myotis* sp., 1 Leisler's bat and 1 soprano pipistrelle near the southern boundary of the site. Overall, this gives a Bat Activity Index (BAI) of 1.67 bat passes per hour.

3.3.2 July

44. The survey was carried out on the 31st of July 2017. Post-sunset temperatures were 12 – 14 ºC, wind speeds were approx. 1 - 2 m/s, and there was no rain. Sunset was at 21:29, so the survey started at 21:30 and ended at 00:30. A similar route was followed to the first survey: the surveyors entered the site from the southern boundary, then followed a loop around the western part of the existing wind farm, passed along the edge of the conifer plantations on the northern and eastern boundaries of the site, and then returned through the eastern part of the site in the vicinity of the operational turbines (see **Figure 4**).

45. 68 bats were recorded, of which 25 were Leisler's bat, 24 were soprano pipistrelle, and 19 were common pipistrelles. Overall, this gives a Bat Activity Index (BAI) of 22.6 bat passes per hour. Bat records were highest in the western part of the site, with frequent Leisler's passes in the south-west of the site, and frequent pipistrelle passes in the centre-west of the site. There was relatively-frequent pipistrelle activity along the edge of the forestry on the northern and eastern boundaries of the site. Most of the pipistrelles were observed flying at a height of approx. 2 – 3 m above ground level, but Leisler's bats were flying at heights of >5m.

3.3.3 October

46. The survey was carried out on the 27th of October 2017. Post-sunset temperatures were 9 to 13 ºC, wind speeds were approximately 3 to 4 m/s, and there was no rain. Sunset was at 18:02, so the survey started at 18:00 and ended at 21:10. The survey route followed approximately the same route as the summer transect, but was carried out in the opposite direction (see **Figure 5**).

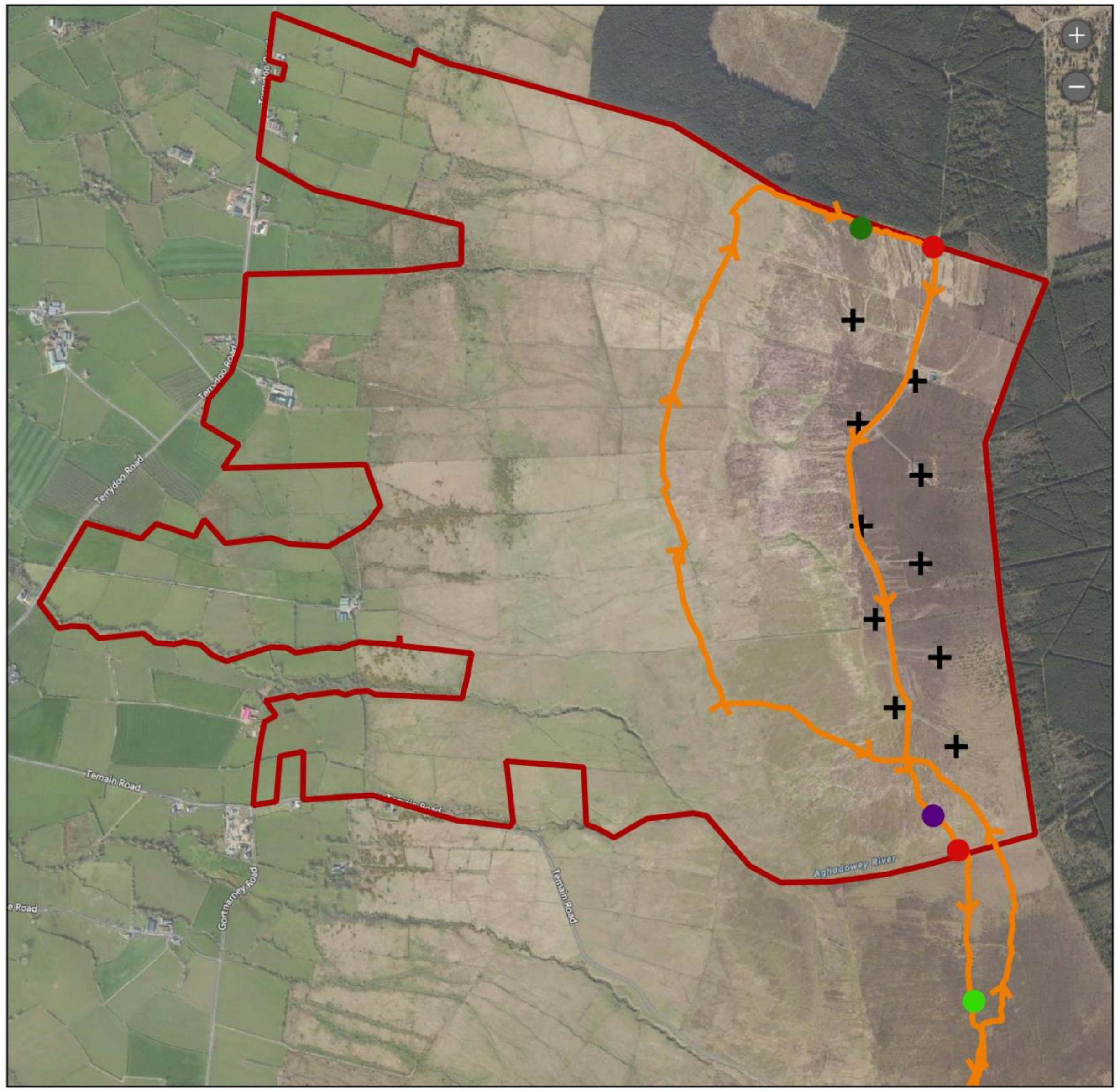
47. Only one bat was encountered during the survey: a common pipistrelle bat over open ground in the south of the Study Area. No bats were recorded at any of the proposed turbine locations.

Figure 3	Bat transect survey - May 2017
Location	Rigged Hill, Co. Derry
Applicant	Scottish Power Renewables
Date	09-05-2017

NM Ecology Ltd - Ecological Consultants
Website: www.nmecology.com
Email: info@nmecology.com
Tel: 087-6839771

Bat survey locations
Transect route

Bats encountered
Leisler's bat
Soprano pipistrelle
Common pipistrelle
Myotis sp.



NM ECOLOGY

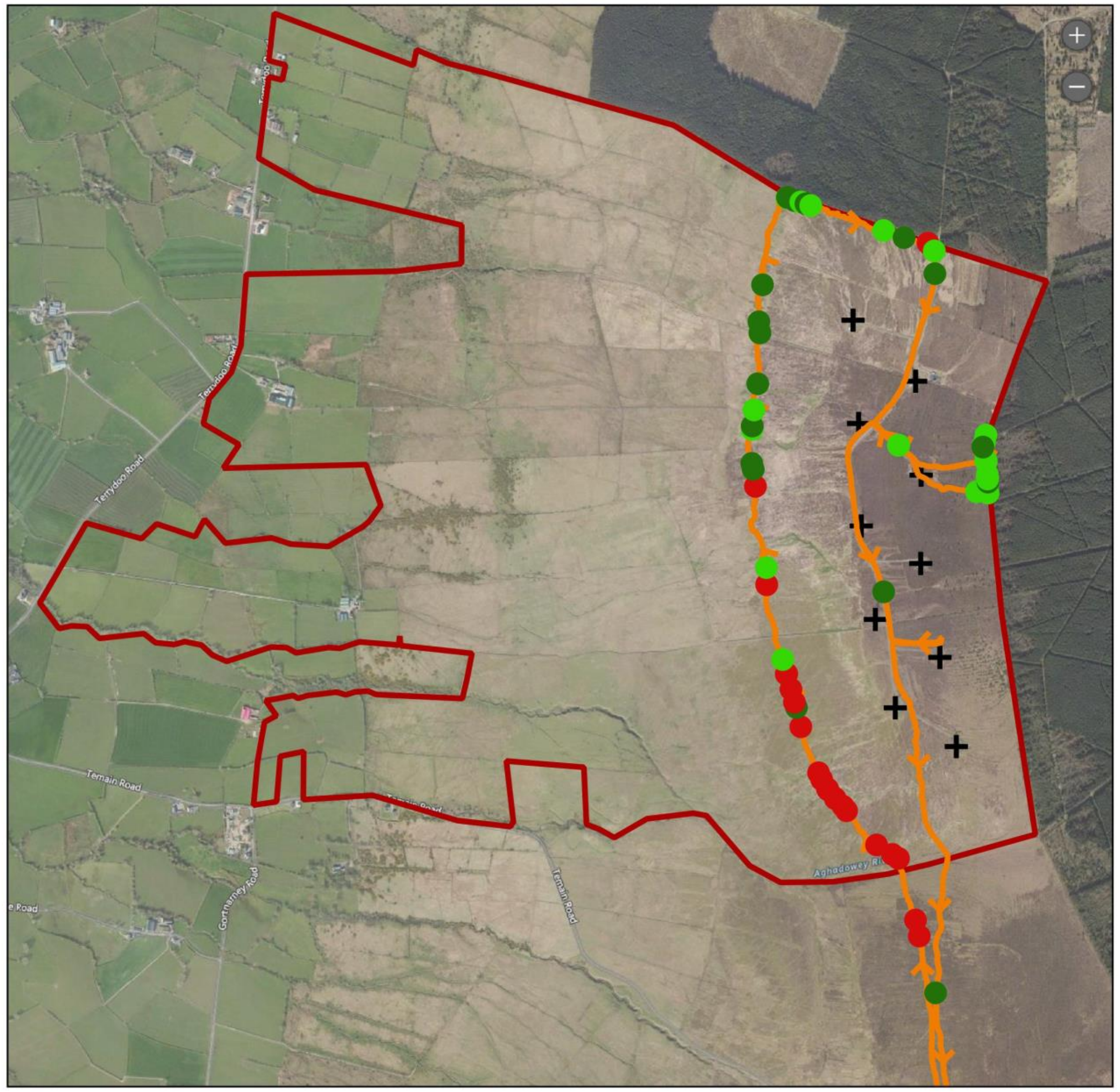
0 200 400 600 800 1000 m

Figure 4	Bat transect survey - July 2017
Location	Rigged Hill, Co. Derry
Applicant	Scottish Power Renewables
Date	31-07-2017

NM Ecology Ltd - Ecological Consultants
Website: www.nmecology.com
Email: info@nmecology.com
Tel: 087-6839771

Bat survey locations
Transect route

Bats encountered
Leisler's bat
Soprano pipistrelle
Common pipistrelle



NM ECOLOGY

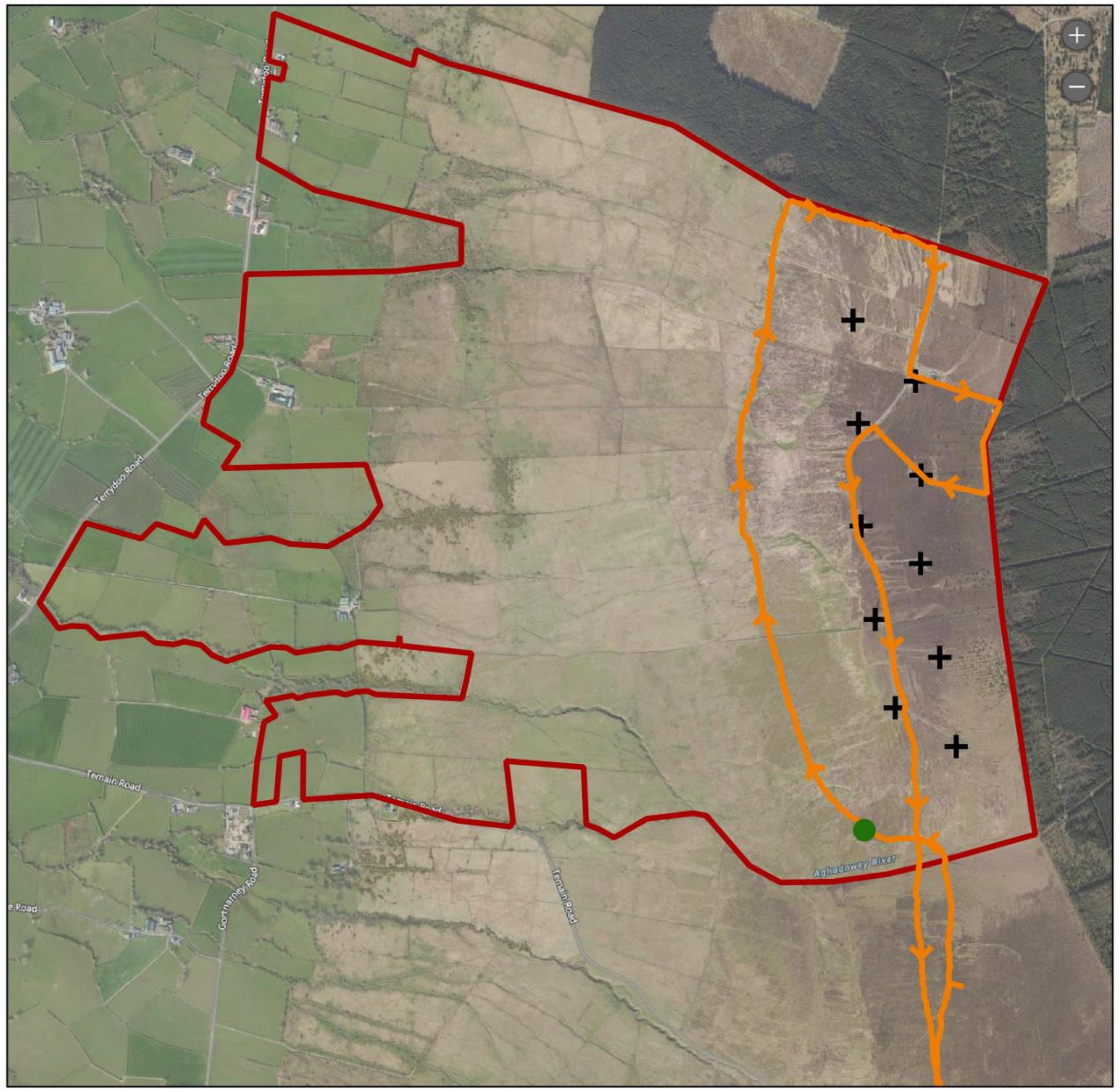
0 200 400 600 800 1000 m

Figure 5	Bat transect survey - Oct 2017
Location	Rigged Hill, Co. Derry
Applicant	Scottish Power Renewables
Date	27-10-2017

Bat survey locations
Transect route

Bats encountered
Common pipistrelle

NM Ecology Ltd - Ecological Consultants
Website: www.nmecology.com
Email: info@nmecology.com
Tel: 087-6839771



0 200 400 600 800 1000 m

NM ECOLOGY

4 Data analysis

4.1 Summary of Year 1 surveys (2017)

48. The most-frequently recorded species was Leisler's bat, which made up 72% of all bat records, and was the most abundant species in all months except October. Common pipistrelles comprised 15% of records, and soprano pipistrelles comprised 10% of records. All other species had negligible activity.

49. The highest levels of bat activity were recorded in June (2,644 bat passes) and August (10,667 passes), with much lower activity in May (599 passes) and October (963 passes). There was moderate to high activity of Leisler's bat on a regular basis in June and August, and on an occasional basis for common and soprano pipistrelles. Weather conditions appeared to influence bat activity, as the nights of highest activity were typically during periods of low wind speeds and warm temperatures.

50. Bat activity (primarily Leisler's bats) was highest at sampling points R1, R2 and R3 (refer to **Figure 1**), which were located in the west of the survey area, on a plateau that is located approx. 50 - 60m lower in elevation than the existing turbines. In June and August there was moderate to high bat activity at these locations on up to 50% of the nights. There was slightly higher bat activity at the forest edge (R6) than on open ground (R5), but activity levels were much lower than those recorded on the lower plateau in the west of the site. Therefore, bat activity was not restricted to the linear vegetation features around the margins of the site, and bats were foraging over open moorland and heathland habitats.

51. A map showing the sampling points in 2017 is provided in **Figure 1**, and a breakdown of survey results at each sampling point on each date is provided in **Tables 2 – 4**. For ease of comparison, cells are shaded in accordance with the abundance categories outlined in **Table 1**.

4.2 Summary of Year 2 surveys (2018)

52. The most-frequently recorded species was Leisler's bat, which comprised 88% of all records, and was the most abundant species in all months. Common pipistrelles comprised 7% of records, and soprano pipistrelles comprised 2.5% of records. All other species were recorded in negligible numbers.

53. The highest level of bat activity was in July (4,205 bat passes), with negligible activity in May (243 passes) and September (58 passes). In July, there was moderate - high activity of Leisler's bat on a regular basis, but not for any other species or in the other two months. As before, the nights of highest bat activity occurred when wind speeds were low and temperatures were warm. For example, the night of highest Leisler's bat activity on the 17th of July had an average temperature of 10.3 ^{o}C and an average wind speed of 2 m/s.

54. Bat activity (primarily of Leisler's bats) was highest at sampling points B3 – B6, which are located at the ridgeline of the upper plateau, at the top of a steep bank. Activity on the plateau in the west of the site (sampling points A4 – A7), was relatively low, in contrast with the 2017 results. The microphone on the met mast still appeared to be functioning in July 2018, and activity levels were broadly similar to those of the closest ground-level sampling point (B5) on all nights except the 17th of July.

55. A map showing the sampling points in 2018 is provided in **Figure 2**, and a breakdown of survey results at each sampling point on each date is provided in **Tables 5 – 7**.

Table 2: Distribution of Leisler's bat passes by location and date in 2017. Cells are colour-coded in four activity categories, as outlined in Section 3.1. The final column in each month shows the percentage of nights that had greater than 50 passes (i.e. moderate to high activity).

	May														
Site	9	10	11	12	13	14	15	16	17	18	19	20	21	22	>50
R1	31	0	0	0	25	1	0	3	5	3	32	0	0	7	0%
R2	25	0	0	0	2	0	0	0	0	9	0	0	4	2	0%
R3	17	0	0	0	23	0	0	2	2	7	5	0	0	27	0%
R4	37	5	0	0	0	0	2	0	1	8	7	0	3	29	0%
R5	15	1	0	0	9	0	0	0	0	1	3	3	7	45	0%
R8	16	0	0	0	8	1	0	3	0	5	2	0	0	1	0%

	June																	
	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	>50
R2	0	0	0	19	3	0	0	14	82	140	38	4	140	12	53	3	3	24%
R3	0	12	0	56	28	25	0	239	216	117	122	0	67	4	17	188	0	41%
R4	0	0	0	15	3	0	3	6	30	61	40	0	13	2	0	0	0	6%
R5	0	0	0	0	1	6	0	4	5	141	29	1	0	0	0	0	2	6%
R6	0	0	0	14	24	0	0	19	28	106	30	10	12	0	0	0	0	6%
R8	0	3	0	18	14	3	0	1	28	119	18	6	0	1	0	0	1	6%

	August																															
	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	>50
R1	50	18	0	4	110	0	160	473	191	79	25	12	4	174	38	78	20	114	54	0	2	0	94	186	82	235	20	8	1	203	36	48%
R2	14	7	0	1	10	0	43	108	118	63	6	103	5	147	89	65	60	26	94	2	1	8	58	55	81	218	38	53	0	64	83	52%
R5	30	0	0	5	56	7	10	74	13	24	0	8	7	95	10	1	5	0	4	0	0	0	33	0	24	160	16	11	5	124	3	16%
R6	20	3	1	0	50	1	7	93	42	22	9	7	23	230	23	0	12	0	6	3	7	0	7	19	1	60	7	3	0	70	29	16%
R7	35	1	0	7	24	1	9	13	12	37	2	10	12	44	22	7	9	0	16	0	0	0	25	5	3	141	18	0	1	105	3	6%
R8 G	42	29	0	1	64	7	13	8	21	19	52	7	23	82	30	0	24	8	26	3	8	0	29	24	32	178	6	9	3	134	5	16%
R8 H	36	9	0	1	59	0	7	9	13	7	0	19	11	52	29	0	1	0	24	0	0	0	21	3	9	130	0	5	0	189	8	13%

	October																															
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	>50
R1	0	0	0	0	0	0	12	0	1	0	0	0	0	0	5	0	0	0	0	0	0	0	0	0	0	14	0	0	0	0	0	0%
R2	0	0	0	3	17	0	10	1	0	0	0	0	0	0	34	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0%
R5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	16	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0	0%
R6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	11	0	0	0	0	0	0%
R7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	23	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0%
R8 G	0	0	0	0	0	0	0	2	0	0	0	0	0	0	14	0	0	0	0	0	0	2	0	0	1	3	0	0	0	0	0	0%
R8 H	0	0	0	0	0	0	0	2	0	0	0	0	0	0	4	0	0	0	0	0	16	2	0	0	1	9	0	0	0	0	0	0%

Table 3: Distribution of common pipistrelle bat passes by location and date in 2017.

	May														
Location	9	10	11	12	13	14	15	16	17	18	19	20	21	22	>50
R1	5	0	1	0	2	0	0	0	3	0	8	0	0	1	0%
R2	10	0	0	0	0	0	0	0	2	0	0	1	0	0	0%
R3	0	0	0	0	0	0	0	2	2	3	0	0	0	0	0%
R4	13	3	0	0	6	0	0	1	0	1	2	3	1	1	0%
R5	16	5	1	0	0	0	0	0	0	0	0	0	0	5	0%
R8	8	0	0	0	0	0	0	0	1	0	0	3	0	0	0%

	June																	
	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	>50
R2	0	0	0	4	1	1	0	1	9	8	13	0	0	0	0	0	0	0%
R3	0	1	3	0	2	0	0	3	5	5	2	0	0	0	0	0	0	0%
R4	0	0	0	1	3	0	0	0	4	1	5	0	0	0	0	0	0	0%
R5	0	0	0	3	2	0	0	1	2	5	0	0	0	0	0	0	0	0%
R6	0	0	0	0	16	0	0	2	18	13	9	0	2	0	0	0	0	0%
R8	0	0	0	1	2	0	0	0	3	1	2	0	1	0	0	0	0	0%

	August																															
Location	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	>50
R1	1	1	0	4	2	0	35	107	5	0	0	4	0	40	0	10	2	11	6	0	0	1	11	0	11	38	5	16	0	6	10	3%
R2	1	0	0	0	4	0	11	50	0	0	1	5	0	6	1	1	1	23	18	0	0	1	2	0	26	22	0	14	0	8	0	3%
R5	3	0	0	0	5	1	3	10	0	0	0	1	1	40	4	1	2	0	5	0	0	0	5	0	5	52	7	6	1	39	14	3%
R6	6	1	0	2	8	0	5	18	7	2	0	6	10	44	5	4	3	0	18	0	0	0	12	1	6	70	10	17	1	37	21	3%
R7	2	1	0	0	3	0	9	2	0	1	0	0	1	34	5	0	0	0	4	0	0	0	4	0	4	84	1	1	3	30	14	3%
R8 G	9	0	0	1	8	0	0	4	1	0	0	3	3	63	3	3	0	0	1	0	0	0	4	0	10	115	4	1	1	55	17	10%
R8 H	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	0	0	0	3	1	0%

	October																															
Location	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	>50
R1	0	0	0	9	17	0	0	0	0	0	0	0	0	0	22	0	0	0	0	0	0	0	0	0	0	8	0	0	2		0	0%
R2	0	0	0	0	1	0	10	0	0	0	0	0	0	0	18	0	0	0	0	0	0	1	0	0	0	3	0	0	0	0	0	0%
R5	0	0	0	0	0	0	0	1	0	0	0	0	0	0	28	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0%
R6	0	0	0	2	7	0	8	9	0	0	0	0	0	0	93	0	0	0	0	0	0	21	89	4	4	11	0	0	4	5	0	6%
R7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	40	0	0	0	0	0	0	2	1	0	0	0	0	0	0	0	0	0%
R8 G	0	0	0	0	0	0	0	0	0	0	0	0	0	0	11	0	0	0	0	0	0	5	1	0	0	2	0	0	0	0	0	0%
R8 H	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0%

Table 4: Distribution of soprano pipistrelle bat passes by location and date in 2017.

Location	May 9	10	11	12	13	14	15	16	17	18	19	20	21	22	>50
R1	2	0	0	0	0	0	0	0	0	0	2	0	0	0	0%
R2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0%
R3	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0%
R4	3	0	0	0	0	0	0	1	0	0	0	0	0	0	0%
R5	1	1	0	0	0	0	0	0	0	0	3	0	0	0	0%
R8	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0%

	June 9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	>50
R2	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0%
R3	0	0	0	0	1	0	0	0	0	0	2	0	0	0	0	0	0	0%
R4	0	0	0	0	0	0	0	2	2	1	1	0	0	0	0	0	0	0%
R5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0%
R6	1	1	0	4	4	0	0	1	2	5	4	0	0	0	0	1	0	0%
R8	0	1	0	0	2	0	0	0	0	1	0	0	0	0	0	0	0	0%

Location	August 01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	>50
R1	5	2	0	0	2	0	5	28	8	0	0	2	5	11	0	1	2	1	7	0	0	0	9	0	3	17	2	16	0	2	0	0%
R2	0	0	0	4	0	1	12	9	2	0	1	6	0	5	3	1	0	0	6	0	0	0	2	0	4	17	1	20	2	3	0	0%
R5	4	1	0	1	1	0	7	3	2	1	0	1	3	15	6	1	1	0	2	0	0	0	5	0	0	268	2	7	1	8	14	3%
R6	7	2	0	1	2	1	7	37	2	0	2	2	9	32	8	6	0	6	7	0	0	0	16	1	9	32	3	32	0	10	9	0%
R7	4	0	0	0	2	0	3	4	4	0	0	2	0	10	3	0	1	0	0	1	0	0	10	1	1	49	1	1	0	2	3	0%
R8 G	5	2	0	1	3	1	3	5	1	2	0	2	4	34	4	0	2	0	1	0	0	0	3	0	3	68	2	7	0	15	7	3%
R8 H	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0%

Location	October 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	>50
R1	0	0	0	0	3	0	1	1	0	0	1	0	0	0	6	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0%
R2	0	0	0	0	1	0	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	4	0	0	2	1	0	0	2	0	0	0%
R5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0%
R6	0	0	0	3	13	0	5	3	0	0	0	0	0	0	87	0	0	0	0	0	0	29	50	0	14	10	0	1	4	1	0	6%
R7	0	0	0	0	0	0	1	0	0	0	0	0	1	0	11	0	0	0	0	0	0	2	0	0	1	1	0	0	2	0	0	0%
R8 G	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	2	0	0	0	1	0	0	0	0	0	0%
R8 H	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0%

Table 5: Leisler's records from May, July and September 2018.

May	9	10	11	12	13	14	15	16	17	18	19	20	21	>50
A1	0	0	0	0	0	3	0	0	0	2	1	0	0	0%
A2	0	0	0	0	0	1	0	0	10	6	0	0	0	0%
A3	0	0	1	0	0	3	0	1	3	2	0	0	0	0%
B1	0	0	0	0	0	3	0	0	2	1	0	0	0	0%
B2	0	0	0	0	3	1	0	0	2	55	0	0	0	8%
B3	2	0	0	0	0	5	0	0	2	0	0	0	0	0%
B4	0	0	0	0	0	9	0	0	0	12	0	0	0	0%
B5	0	0	0	0	0	0	0	0	0	20	0	0	0	0%
B6	0	0	0	5	0	8	0	0	0	23	0	0	0	0%
Met mast	0	0	0	0	0	4	0	0	0	1	0	0	0	0%
A4	0	0	2	0	0	0	0	0	1	5	0	0	0	0%
A5	0	1	0	0	0	3	0	1	1	2	0	0	0	0%
A6	0	0	0	0	0	0	0	0	0	0	0	0	0	0%
A7	0	0	0	0	0	0	0	0	1	0	0	0	0	0%

July	11	12	13	14	15	16	17	18	19	20	21	22	23	24	>50
A1	2	5	7	0	0	3	0	9	4	0	0	2	14	8	0%
A2	1	3	2	0	0	1	2	2	1	0	0	1	12	8	0%
A3	3	12	7	4	0	2	46	5	0	1	0	3	63	13	7%
B1	3	24	13	10	8	10	70	50	5	4	0	9	38	21	14%
B2	2	6	3	3	0	5	28	41	2	0	0	2	13	8	0%
B3	8	23	24	4	6	10	103	25	25	0	0	9	67	21	14%
B4	9	61	28	34	1	55	375	80	114	0	4	122	54	77	57%
B5	0	13	13	12	0	1	159	8	10	0	0	36	2	25	7%
B6	15	51	12	11	8	8	123	16	7	0	2	31	139	90	29%
Met mast	1	21	27	13	0	6	18	5	11	0	0	22	0	23	0%
A4	4	18	4	6	0	14	51	14	10	10	36	81	66	48	21%
A5	2	7	8	33	26	14	0	14	17	10	21	42	43	46	0%
A6	1	5	3	15	0	6	37	11	5	5	6	10	0	7	0%
A7	5	9	1	3	6	2	1	2	9	0	6	3	5	5	0%

Sept	12	13	14	15	16	17	18	19	20	21	22	23	>50
A1	0	0	1	0	0	0	0	0	0	0	0	0	0%
A2	0	0	0	0	0	0	0	0	0	0	0	0	0%
A3	0	0	0	0	0	0	0	0	0	0	0	0	0%
B1	0	1	0	0	0	0	0	0	0	0	0	0	0%
B2	0	0	0	0	1	0	0	0	0	0	0	0	0%
B3	0	0	0	0	0	0	0	0	0	0	0	0	0%
B4	0	0	0	0	0	0	0	0	0	0	0	0	0%
B5	0	0	0	0	0	0	0	0	0	1	0	1	0%
B6	0	0	0	0	13	0	0	0	0	0	0	0	0%
Met mast	0	0	0	0	0	0	0	0	0	0	0	0	0%
A4	0	0	0	0	1	0	0	0	0	0	0	0	0%
A5	0	0	0	0	0	0	0	0	0	0	0	0	0%
A6	0	0	1	0	0	0	0	0	0	0	0	0	0%
A7	0	0	0	0	1	0	0	0	0	0	0	0	0%

Table 6: Common pipistrelle records from May, July and September 2018.

May	9	10	11	12	13	14	15	16	17	18	19	20	21	>50
A1	0	0	0	0	0	1	1	0	1	0	0	0	0	0%
A2	0	0	0	0	0	0	0	0	0	0	0	0	0	0%
A3	0	0	0	0	0	0	0	0	0	1	0	0	1	0%
B1	0	0	0	2	0	1	0	0	0	0	0	0	0	0%
B2	1	0	0	0	0	2	0	0	1	2	0	0	0	0%
B3	0	0	0	1	0	0	0	0	0	0	0	0	0	0%
B4	0	0	0	0	0	0	0	0	0	0	0	0	0	0%
B5	0	0	0	0	0	0	0	0	0	0	0	0	0	0%
B6	0	0	0	0	0	0	0	0	0	0	0	0	0	0%
Met mast	0	0	0	0	0	0	0	0	0	0	0	0	0	0%
A4	0	0	0	0	0	1	0	0	0	4	0	0	0	0%
A5	0	0	0	0	0	0	0	0	0	0	0	0	0	0%
A6	0	0	0	0	0	0	0	0	0	0	0	0	0	0%
A7	0	0	0	0	0	0	1	0	0	0	0	0	0	0%

July	11	12	13	14	15	16	17	18	19	20	21	22	23	24	>50
A1	0	1	2	0	0	1	0	0	1	0	0	1	1	0	0%
A2	0	0	0	0	0	0	0	0	1	0	0	0	1	1	0%
A3	0	1	0	0	0	0	1	2	1	0	1	3	15	0	0%
B1	0	0	1	0	1	5	3	0	0	0	0	1	5	1	0%
B2	0	2	1	0	0	0	1	2	0	0	1	1	3	1	0%
B3	1	0	0	0	0	0	4	0	6	0	0	1	4	1	0%
B4	0	4	0	0	0	6	3	2	7	0	0	0	6	0	0%
B5	0	0	0	0	0	0	4	2	0	0	0	1	1	2	0%
B6	0	6	2	0	0	0	2	1	0	0	0	2	4	0	0%
Met mast	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0%
A4	0	1	0	1	0	1	14	1	9	1	1	11	14	0	0%
A5	0	1	5	3	5	2	0	1	16	0	1	16	5	1	0%
A6	0	0	1	0	0	0	7	0	0	0	0	1	0	0	0%
A7	1	3	1	0	1	0	1	0	2	0	0	2	1	1	0%

Sept	12	13	14	15	16	17	18	19	20	21	22	23	>50
A1	1	0	0	0	1	0	0	0	0	0	0	0	0%
A2	0	0	0	0	0	0	0	0	0	0	0	0	0%
A3	0	0	1	0	0	0	0	0	0	0	0	0	0%
B1	1	0	0	0	0	0	0	0	0	0	0	0	0%
B2	0	0	0	0	0	0	0	0	0	0	0	0	0%
B3	0	0	0	0	0	0	0	0	0	0	0	0	0%
B4	0	0	0	0	0	0	0	0	0	0	0	0	0%
B5	0	0	0	0	0	0	0	0	0	0	0	0	0%
B6	0	0	0	0	0	0	0	0	0	0	0	0	0%
Met mast	0	0	0	0	0	0	0	0	0	0	0	0	0%
A4	0	0	1	0	0	0	0	0	0	0	0	0	0%
A5	2	0	0	0	0	0	0	0	0	0	0	0	0%
A6	0	0	0	0	0	0	0	0	0	0	0	0	0%
A7	0	0	0	0	1	0	0	0	2	0	0	0	0%

Table 7: Soprano pipistrelle records from May, July and September 2018.

May	9	10	11	12	13	14	15	16	17	18	19	20	21	>50
A1	0	0	0	0	0	0	0	0	0	1	0	0	0	0%
A2	0	1	0	0	0	0	0	0	0	0	0	0	0	0%
A3	0	0	0	0	0	0	0	0	0	0	0	0	0	0%
B1	0	0	0	1	0	0	0	0	0	0	0	0	0	0%
B2	0	0	0	0	0	1	0	0	0	0	0	0	0	0%
B3	0	0	0	0	0	0	0	0	0	0	0	0	0	0%
B4	0	0	0	0	0	0	0	0	0	0	0	0	0	0%
B5	0	0	0	0	0	0	0	0	0	0	0	0	0	0%
B6	0	0	0	0	0	0	0	1	0	0	0	0	0	0%
Met mast	0	0	0	0	0	0	0	0	0	0	0	0	0	0%
A4	0	0	0	0	0	0	0	0	0	0	0	0	0	0%
A5	0	0	0	0	0	0	0	0	0	1	0	0	0	0%
A6	0	0	0	0	0	0	0	0	0	0	0	0	0	0%
A7	0	0	0	1	0	2	0	0	1	1	0	0	0	0%

July	11	12	13	14	15	16	17	18	19	20	21	22	23	24	>50
A1	0	2	0	0	0	0	1	0	1	0	0	3	0	2	0%
A2	0	0	0	0	0	0	0	1	0	0	0	2	0	0	0%
A3	0	0	0	0	0	0	0	0	1	0	0	5	3	2	0%
B1	1	0	0	0	0	0	1	0	2	0	0	6	0	0	0%
B2	0	0	1	1	0	0	0	0	0	0	0	3	0	0	0%
B3	0	0	0	0	0	0	0	0	0	0	0	2	1	1	0%
B4	0	0	0	0	0	0	2	0	0	0	0	5	2	0	0%
B5	0	1	0	0	0	0	6	0	0	0	0	0	1	0	0%
B6	0	1	1	0	0	0	1	0	0	0	0	6	2	1	0%
Met mast	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0%
A4	0	0	1	0	0	0	1	0	1	0	0	1	1	1	0%
A5	0	1	0	0	0	1	0	0	1	0	0	7	1	0	0%
A6	0	0	0	1	0	0	1	0	0	0	0	4	0	1	0%
A7	2	0	1	0	1	0	0	0	0	0	1	4	0	0	0%

Sept	12	13	14	15	16	17	18	19	20	21	22	23	>50
A1	0	0	0	0	0	0	0	0	0	0	0	0	0%
A2	0	0	0	0	0	0	0	0	0	0	0	0	0%
A3	0	0	0	0	0	0	0	0	0	0	0	0	0%
B1	0	0	0	0	0	0	0	0	0	0	0	0	0%
B2	0	0	0	0	0	0	0	0	0	0	0	0	0%
B3	0	0	1	0	0	0	0	0	0	0	0	0	0%
B4	0	0	0	0	0	0	0	0	0	0	0	0	0%
B5	0	0	0	0	0	0	0	0	0	0	0	0	0%
B6	1	0	0	0	1	0	0	0	0	0	0	0	0%
Met mast	0	0	0	0	0	0	0	0	0	0	0	0	0%
A4	0	0	0	0	0	0	0	0	0	0	0	0	0%
A5	1	0	0	0	0	0	0	0	0	0	0	0	0%
A6	0	0	0	0	0	0	0	0	0	0	0	0	0%
A7	0	0	0	0	0	0	0	0	0	0	0	0	0%

4.3 Species profiles

56. Due to interspecific differences in foraging strategies and flight behaviour, the risk of fatalities from wind turbines varies significantly between bat species. In Ireland, Leisler's bats and Nathusius' pipistrelles are considered to have a high risk of impacts from wind turbines, while common pipistrelles and soprano pipistrelles are considered to have a medium risk (EUROBATS and Natural England guidance). To facilitate comparisons between sampling locations and months, summaries for each of these four species are provided below. For the purposes of this assessment, any species that regularly has more than 50 bat passes per night (i.e. moderate to high activity) is considered to have a significant level of activity, which would warrant inclusion in an impact assessment.

4.3.1 Leisler's bat

57. Leisler's bat was the most-frequently recorded species in both years, comprising 72% and 88% of all bat passes in 2017 and 2018, respectively. The activity levels were highest in June and August in 2017 and July in 2018, and lowest in May, September and October, suggesting that Leisler's bats only use the site in significant numbers in the mid-summer period. Activity appears to be influenced by weather conditions, particularly low wind speeds and mild temperatures. There does not appear to be a clear spatial pattern to activity, as bats were recorded in greatest numbers on the plateau in the west of the site in 2017, but on the ridgeline of the upper plateau in 2018.

58. During the June – August peak in activity, moderate to high numbers of passes were recorded at some sampling points on up to 50% of nights, which is considered to be a significant level of activity. On this basis, and because Leisler's bats are considered to have a high risk from wind turbines, they are considered to be a sensitive ecological receptor, and will be included in the impact assessment. Detailed analysis of their use of the site is provided in Sections 4.4 – 4.9, including an appraisal of temporal activity patterns, the influence of weather conditions on their activity, and activity at height.

4.3.2 Common pipistrelle

59. Common pipistrelles were the second most-frequently recorded species, comprising 15% and 7% of all records in the two years. Activity levels were highest in August 2017, but there was not the pronounced mid-summer peak that was observed for Leisler's bats. Activity levels in 2018 were negligible in all months. As for Leisler's bats, the nights of highest activity appeared to occur when wind speeds were low and temperatures were mild. There does not appear to be a clear spatial pattern to activity, as bats were recorded in all parts of the site.

60. There were some nights of moderate to high activity in August 2017, but not on a regular basis at any location. On this basis, common pipistrelles are not considered to use the site in significant numbers, and therefore are not considered to be a sensitive ecological receptor, so they will not be included in the impact assessment.

4.3.3 Soprano pipistrelle

61. Soprano pipistrelles were the third most-frequently recorded species, comprising 10% and 3% of all records in the two years. Activity levels were highest in August 2017, but there was not the pronounced mid-summer peak that was observed for Leisler's bats. Activity levels in 2018 were negligible in all months. As with the other species, there did not appear to be a clear spatial pattern to activity, although it was occasionally recorded in moderate numbers on the forest edge (sampling point R6) in October 2017, suggesting that it favoured linear habitat features rather than open ground.

62. There were some nights of moderate to high activity in 2017, but not on a regular basis at any location. On this basis, soprano pipistrelles are not considered to use the site in significant numbers, and therefore are not considered to be a sensitive ecological receptor, so they will not be included in the impact assessment.

4.3.4 Nathusius' pipistrelle

63. In total, there were only 40 passes of Nathusius' pipistrelle in 2017 and 8 passes in 2018, accounting for 0.3% and 0.2% of all records, respectively. 36 of the 40 passes in 2017 were in August, but the spatial distribution of passes was very evenly distributed, with between 4 and 8 passes of these species at each of the six ground-level sampling points. As there were only 4 passes in October, it is clear that the proposed development site is not used as a migration route for this species. Overall, it can be concluded that the site is of little importance for Nathusius' pipistrelle, and they will not be included in the impact assessment.

4.4 Comparison of activity at ground level and height (2017)

64. Sampling was carried out concurrently at both ground level and 45m height for 31 nights in August 2017 and 31 nights in October 2017. The results can be reviewed in **Tables 2 – 4** for Leisler's bats, common pipistrelles and soprano pipistrelles, for which sampling point R8 G was located at ground level at the base of the met mast, and R8 H was located at 45 m on the met mast. Some sampling was also carried out at height in 2018, but the microphone had been in place for a year at that stage, and it was not possible to assess its condition (the met mast is not climbable), so it is not certain that the data were reliable.

65. Leisler's activity was very similar at both ground level and height throughout the sampling period in 2017, as almost all of the moderate and high counts were matched at each location. However, it is important to note that an elevated microphone effectively has twice the coverage of a ground-level microphone, as it covers a spherical zone both above and below the microphone, whereas the ground-level microphone only covers a hemispherical zone above the microphone. If the data were corrected to account for the difference in coverage, there was effectively twice as much activity at ground level than at height.

66. The detection radius of Leisler's bat is estimated to be approx. 20 – 30 m (*pers. obs.*), so the effective coverage of the microphone at 45 m on the met mast was approx. 25 – 65 m above ground level (potentially 15 – 75 m), while the ground-level microphone would cover 0 – 20m above ground level (potentially 0 – 30m). There is some overlap between the coverage areas at the furthest extent of the detection distance, but many bats flying past the met mast would have only been detected by one of the microphones. Therefore, it appears that most Leisler's bats were flying at relatively low heights (generally below the blade sweep of modern wind turbines), although there was still moderate to high levels of activity at height on several occasions.

67. In contrast, there was a pronounced difference in pipistrelle activity between ground level and height. In August there were 306 common pipistrelle passes and 175 soprano pipistrelle passes at ground level at R8, but only 10 and 1 passes of these species at height, respectively. In October there were 19 common pipistrelle passes and 4 soprano pipistrelle passes at ground level, but no passes of either species at height. The detection range for pipistrelle bats is estimated to be approx. 10 – 20 m (*pers. obs.*), so the effective coverage of the microphone at 45 m on the met mast was approx. 35 – 55 m above ground level (potentially 25 – 65 m), while the ground-level microphone would cover 0 – 10 m above ground level (potentially 0 – 20 m). As so few pipistrelles were recorded on the elevated microphone, it appears that they were flying at relatively low heights, and thus would be below the potential blade sweep of modern wind turbines (typically 30 – 35 m above ground level at the lowest point).

4.5 Comparison between bat activity at the forest edge and the open moorland (2017)

68. At a meeting with the NIEA-NED in May 2017, the edge of the conifer plantation along the northern and eastern boundaries of the proposed development site was identified as a possible linear commuting route around the site, and it was requested that the bat survey should investigate this possibility using a pair of detectors. As a result, the layout of bat detectors was adjusted so that one detector would be placed at the forest edge (location R6), and a second placed 150m away in open moorland habitat (R5). A comparison of the total counts of each species in June, August and October 2017 between the open moorland and forest edge is presented in **Table 8**.

Table 8: Comparison of bat activity between the open moorland and forest edge in 2017

Species	Period	Open	Edge	% Difference
Leisler's bat	June	189	243	
	August	725	755	
	October	20	13	
	Total	**934**	**1,011**	**8%**
Common pipistrelle	June	13	60	
	August	205	314	
	October	29	257	
	Total	**247**	**631**	**155%**
Soprano pipistrelle	June	1	23	
	August	354	243	
	October	6	220	
	Total	**361**	**486**	**35%**

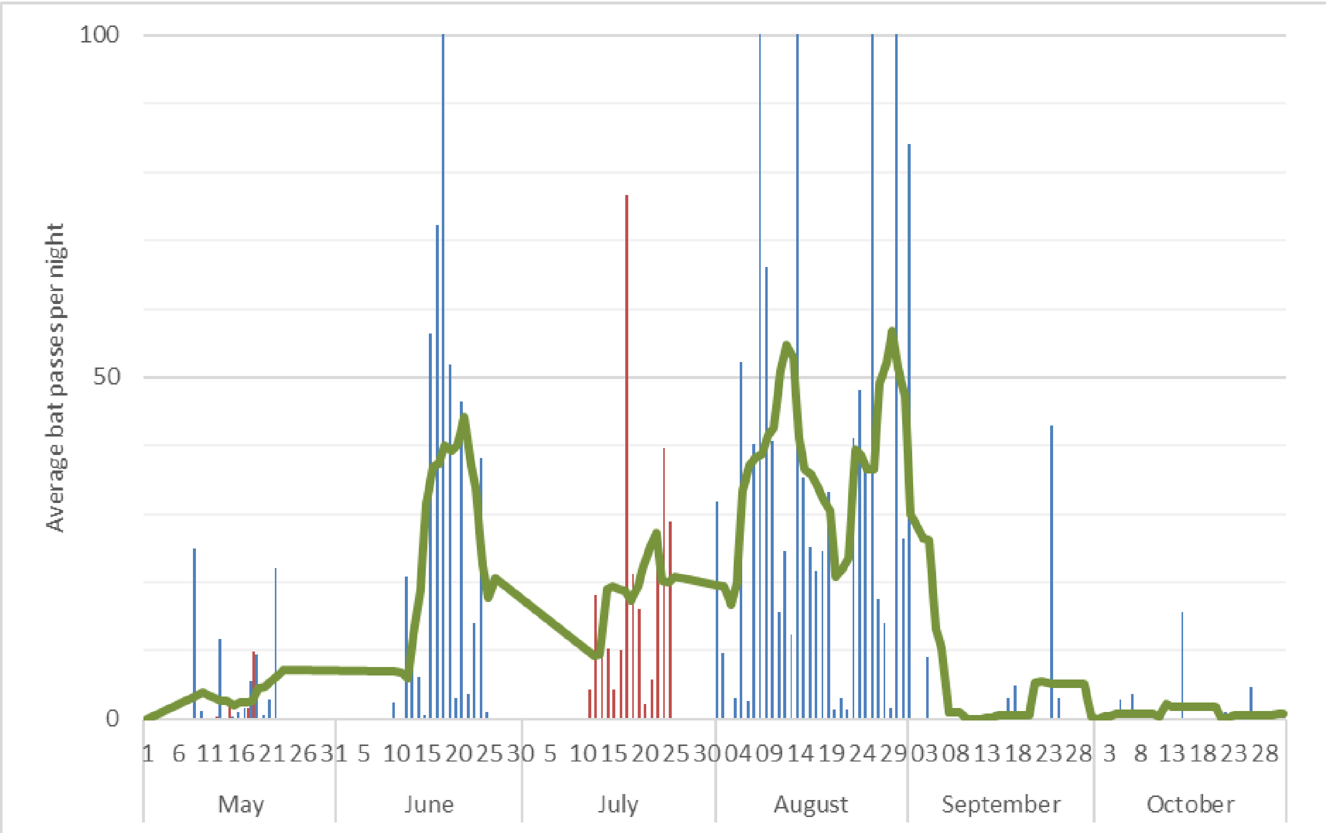
69. The counts for Leisler's bat were very similar at the two locations, with only 8% more passes at the forest edge than the open moorland; this result is expected, because Leisler's bats typically forage in open air rather than along linear habitat features. In contrast, the counts of common pipistrelle were significantly higher along the forest edge, with 155% more passes at the forest edge, and consistently higher counts at the edge during all survey periods. Soprano pipistrelles had 35% more passes at the forest edge than in the open moorland, and would have had a more contrasting result except for a single anomalous result in the open moorland on the 26th of August, in which 268 passes were recorded on a single night.

4.6 Seasonal variation in bat activity

70. Bat activity is strongly influenced by seasonal cycles. Bats are usually most active during summer months, when insects are abundant, air temperatures are high, and wind speeds are low. Activity levels are lowest in winter months, when bats enter periods of torpor / hibernation during periods of cold or unfavourable weather, and only emerge during periods of mild weather. Spring and autumn are variable periods, in which bat activity is strongly influenced by weather conditions. Therefore, the levels of bat activity recorded at a site often vary significantly over the course of a year.

71. Surveys were undertaken between May and October, covering the spring, summer and autumn periods. A combined temporal profile for Leisler's bats is provided in Figure 6 below, based on the average number of bat passes per sampling location per night. Bats were recorded in all months, but there was a clear peak in activity in June, July and August, with much lower counts in May, September and October. Surveys were carried out in May and September in both years, so the low counts in these months were consistent between years.

Figure 6: Temporal profile of Leisler's bats during the sampling period. Counts from 2017 are shown in blue, counts from 2018 are shown in red, and a trend line is shown in green.



4.7 Time of night

72. Bat activity typically varies greatly throughout the night, reflecting changes in bat behaviour throughout their active period. The highest levels of activity often occur immediately after sunrise, as bats emerge from their roosts, commute to their feeding locations, and feed intensively for 2 – 3 hours. In the middle part of the night there is often a lull of activity, in which bat activity drops to very low levels, followed by a second, smaller peak in activity in the hours before sunrise. This activity pattern is thought to be influenced by the activity patterns of insect prey, which also peak during the sunset and sunrise periods.

73. Leisler's bat activity was assessed in ten-minute intervals during the three months of highest bat activity: June 2017, July 2018 and August 2017. Based on the sunset and sunrise times, the percentage of bat activity in each of the three hours after sunset and prior to sunrise was calculated in each of the three months. The results are shown in **Table 8** and **Figures 7 - 9**. The middle of the night (i.e. all hours between the three-hour periods mentioned above) was also counted for comparative purposes: in June the night length was relatively short and the remainder only amounted to 50 – 60 minutes, whereas in August the night length was much longer, and the remainder was as much as 4.5 hours.

Table 8: Percentage of bat activity recorded in the three hours after sunset and prior to sunrise.

Period	Jun-17	Jul-18	Aug-17	Average
0 - 1 hour after sunset	31%	16%	46%	31%
1 - 2 hours after sunset	30%	38%	24%	31%
2 - 3 hours after sunset	4%	10%	9%	8%
Remainder	2%	17%	8%	9%
2 - 3 hours before sunrise	7%	11%	2%	7%
1 - 2 hours before sunrise	21%	6%	5%	10%
0 - 1 hour before sunrise	6%	3%	5%	5%

74. The results broadly correspond with the standard pattern of bat activity, with a clear peak of activity within 2 hours of sunset on most nights, accounting for 62% of all bat passes, and a second smaller peak approx. 1 – 3 hours before sunrise. This pattern of activity is clearly visible in Figures 7 – 9, in which the size of the circle indicates the number of bat passes recorded in ten-minute periods. There was a consistent drop in activity in the middle of the night in all periods (i.e. all times other than three hours after sunset and three hours after sunrise), with the exception of the 17th of July 2018, in which there was a high level of activity between 01:00 and 03:00. However, this was one of the nights with lowest wind speed recorded during the study (average speed 2 m/s), and is considered to be an anomalous result. With this exception, the middle of the night generally accounted for no more than 10% of all bat passes in each of the three months.

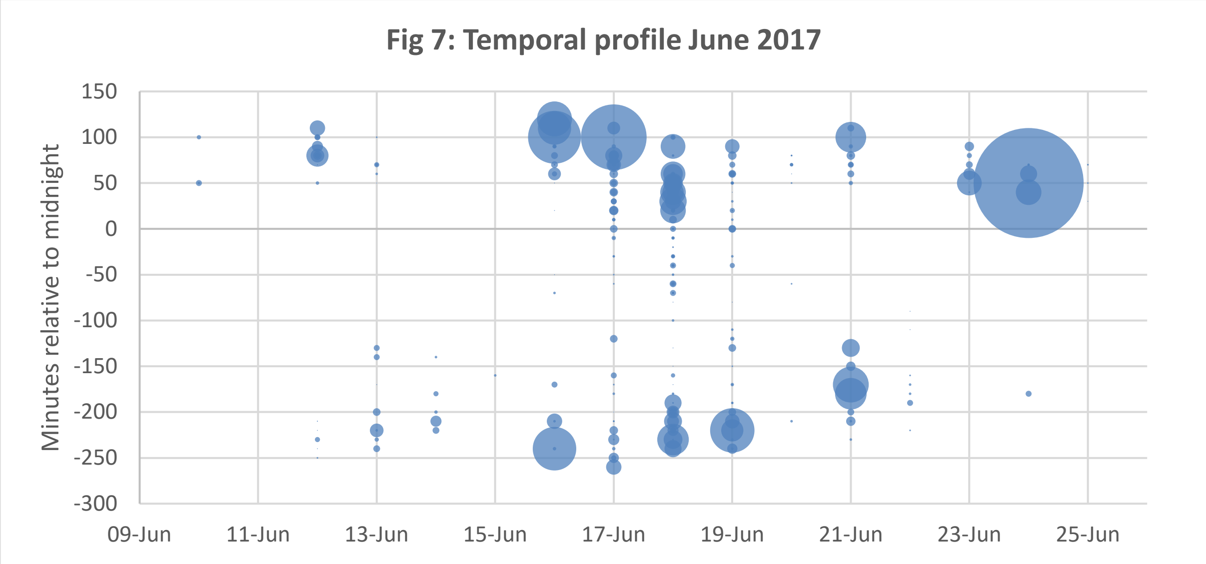
4.8 Influence of weather conditions on bat activity

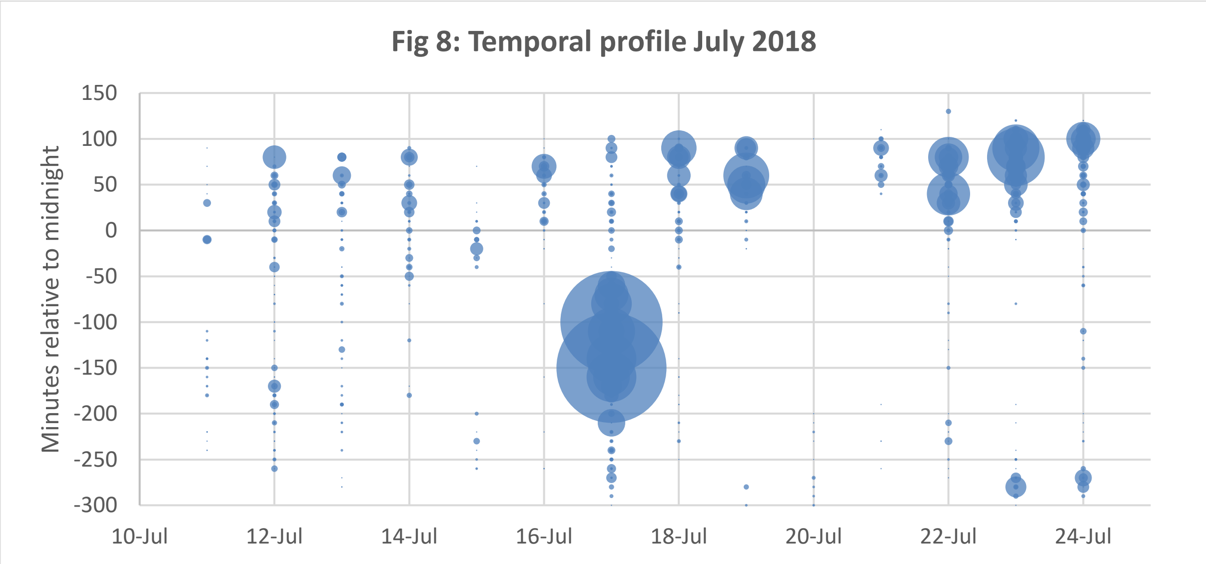
75. Considering that the site is highly exposed to the prevailing winds, it is logical that the peak in Leisler's activity would be related to weather conditions. There are few potential roosting opportunities (e.g. old buildings or mature trees) in the vicinity of the proposed development site, so any bats using the site would have to travel several kilometres to reach it. Wind speeds are often lowest in the mid-summer period, and atmospheric temperatures are highest, so these are the months in which bats would be most likely to travel such distances and to ascend to such altitudes.

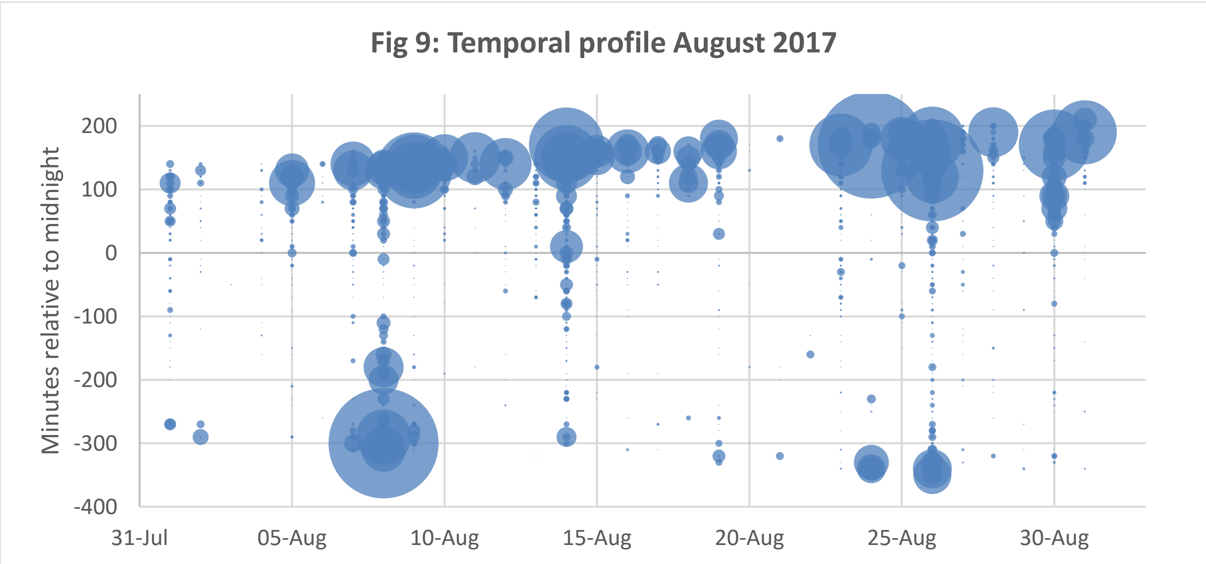
76. To investigate this further, potential relationships between bat activity and weather were assessed throughout the sampling period. Wind speed and temperature data in ten-minute intervals collected from the on-site meteorological mast (measured at 80 m above ground level, which is the approximate hub height of modern wind turbines) were aligned with the counts of Leisler's bats in the same ten-minute intervals, and the results were grouped into categories. For the 2017 dataset the analysis was based only on the Leisler's activity in August, because the met mast was installed in July 2017. However, the 2018 dataset includes all three sampling months.

77.

78.

79. 

80. 

81. 

4.8.1 Effect of wind speed on bat activity (2017)

82. A breakdown of the number of Leisler's bat passes at different wind speeds in August 2017 is presented in **Table 9**, expressed both as counts and percentages. The proportion of sampling periods in each wind speed band is also provided in order to characterise the range and frequency of wind speeds during the month.

83. The mean wind speed during the sampling period was 8.5 m/s (± 3 SD), with a maximum of 16.7 m/s. It had a normal distribution around the mean, and the majority (71%) of sampling periods had average wind speeds of 4 – 11 m/s. When the relative proportions of wind speeds are compared to the relative proportions of bat passes for each species (Figure 10), it is clear that bat activity was skewed towards lower wind speeds. For example, 44% of Leisler's passes were recorded below 5 m/s, even though only 15% of wind records were below this speed. In a similar manner, 63% of Leisler's records were below 7 m/s, 75% were below 9 m/s, and 90% were below 11 m/s.

Table 9: Relationships between bat activity and wind speed in August 2017. The first column contains bands of wind speed in 1 m/s increments, and the second and third columns show the count and percentage of sampling periods in which the wind speed was between these values. The fourth and fifth columns show the count and percentages of Leisler's passes within each band, and the final column shows the cumulative percentage, i.e. how much activity is below the threshold.

Wind speed (m/s)	Frequency		Leisler's bat		
	Count	Percentage	Count	Percentage	Cumulative
0 - 1	0	0.0%	0	0.0%	0.0%
1 - 2	25	1.5%	790	10.3%	10.3%
2 - 3	44	2.6%	1606	21.0%	31.3%
3 - 4	58	3.4%	447	5.8%	37.1%
4 - 5	132	7.7%	546	7.1%	44.3%
5 - 6	136	8.0%	647	8.4%	52.7%
6 - 7	119	7.0%	812	10.6%	63.3%
7 - 8	194	11.4%	516	6.7%	70.0%
8 - 9	205	12.0%	429	5.6%	75.6%
9 - 10	224	13.1%	960	12.5%	88.2%
10 -11	204	12.0%	93	1.2%	89.4%
11 - 12	160	9.4%	373	4.9%	94.3%
12 - 13	95	5.6%	182	2.4%	96.6%
13 - 14	60	3.5%	205	2.7%	99.3%
14 - 15	48	2.8%	52	0.7%	100.0%

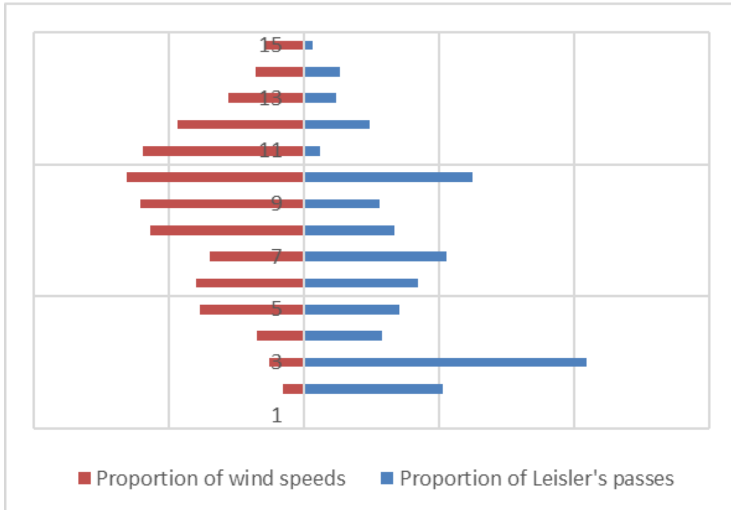


Figure 10: Comparing the relative proportions of wind speeds (m/s) and Leisler's passes in August 2017

4.8.2 Effect of wind speed on bat activity (2018)

84. A breakdown of the number of Leisler's bat passes at different wind speeds in May, July and September 2018 is presented in **Table 10**, expressed both as counts and percentages. Wind speeds were broadly similar to 2017, with an average of 8.8 m/s (± 3.9 SD), and a maximum of 23.8 m/s, but the majority (71%) of sampling periods had average wind speeds of 4 – 12 m/s. As noted above, it is clear that bat activity was skewed towards lower wind speeds, with 45% of Leisler's passes recorded below 5 m/s, 71% below 7 m/s, 92% below 9 m/s, and 99% below 11 m/s.

Table 10: Relationships between bat activity and wind speed in May, July and September 2018

Wind speed (m/s)	Frequency		Leisler's bat		
	Count	Percentage	Count	Percentage	Cumulative
0 - 1	11	0.5%	280	7%	7%
1 - 2	20	0.9%	462	12%	19%
2 - 3	41	1.8%	290	7%	26%
3 - 4	128	5.7%	443	11%	37%
4 - 5	148	6.6%	311	8%	45%
5 - 6	227	10.2%	622	16%	61%
6 - 7	294	13.2%	390	10%	71%
7 - 8	255	11.4%	253	6%	77%
8 - 9	197	8.8%	564	14%	92%
9 - 10	170	7.6%	223	6%	97%
10 -11	136	6.1%	66	2%	99%
11 - 12	144	6.4%	37	1%	100%
12 - 13	117	5.2%	1	0%	100%
13 - 14	98	4.4%	0	0%	100%
14 - 15	99	4.4%	0	0%	100%
15 - 16	48	2.1%	0	0%	100%
16 - 17	25	1.1%	0	0%	100%
17 - 18	16	0.7%	0	0%	100%
18 - 19	24	1.1%	0	0%	100%
19 - 20	21	0.9%	0	0%	100%
>20	14	0.6%	0	0%	100%

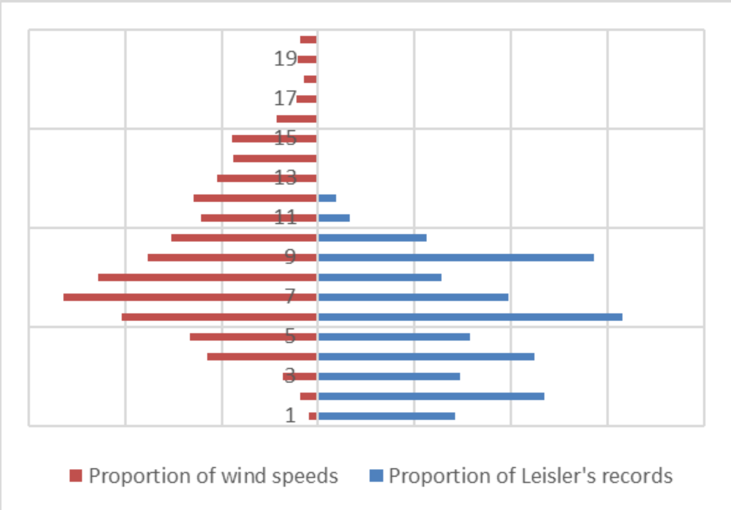


Figure 11: Comparing the relative proportions of wind speeds (m/s) and Leisler's passes in 2018

4.8.3 Effect of temperature on bat activity (both years)

85. A similar assessment of the relationship between bat activity and air temperature in each year is presented in **Tables 11 and 12**.

86. The average nightly temperature in August 2017 was 9.8 ºC (± 1.8 SD). August is a relatively warm month, and the majority (87%) of temperatures were between 7 and 12 m/s. The distribution of Leisler's bat passes was broadly similar (92% were recorded when temperatures were between 8 and 12 ºC), so there did not appear to be a strong relationship with temperature, at least in the month of August.

87. The average nightly temperature in May, July and September 2018 was 8.3 ºC (± 3.2 SD), but as the dataset covered multiple seasons, it also covered a much broader range of temperatures, with a minimum of 2.5 ºC in May and a maximum of 16 ºC in July. There was very little bat activity at the lower temperatures, with only 1.7% of Leisler's bat passes occurring below temperatures of 9 ºC, even though 52% of temperature records were below this threshold. 83% of all passes were recorded in a relatively narrow temperature band between 9 and 13 ºC.

88. Overall, it appears that bats were more active on nights with warmer temperatures, and that activity decreased significantly at lower temperatures (below 8 ºC in August 2017, and below 9 ºC in 2018). However, it is not clear whether this is a direct causal relationship, or whether it is an indirect relationship that is influenced by other factors, e.g. that bat activity is highest in summer months, when temperatures are coincidentally high. It is beyond the scope of this study to assess this variation in detail.

Table 11: Relationships between bat activity and temperature in August 2017. The first column contains bands of temperature in 1 ºC increments, the second and third columns show the count and percentage of sampling periods in which the temperature was between these values, and the fourth, fifth and sixth columns show the Leisler's activity within these temperature bands

Temp (ºC)	Frequency		Leisler's bat		
	Count	Percentage	Count	Percentage	Cumulative
5 - 6	0	0.0%	0	0.0%	0.0%
6 - 7	51	3.0%	6	0.1%	0.1%
7 - 8	252	14.7%	238	3.1%	3.2%
8 - 9	360	21.1%	1529	20.0%	23.1%
9 - 10	234	13.7%	1927	25.2%	48.3%
10 - 11	485	28.4%	2062	26.9%	75.2%
11 - 12	154	9.0%	1557	20.3%	95.5%
12 - 13	66	3.9%	230	3.0%	98.5%
13 - 14	59	3.5%	21	0.3%	98.8%
14 - 15	28	1.6%	92	1.2%	100.0%
15 - 16	20	1.2%	0	0.0%	100.0%
16 - 17	0	0.0%	0	0.0%	100.0%

Table 12: Relationships between bat activity and temperature in May, July and September 2018

Temp (ºC)	Frequency		Leisler's bat		
	Count	Percentage	Count	Percentage	Cumulative
2 - 3	31	1.4%	0	0.0%	0.0%
3 - 4	219	9.8%	4	0.1%	0.1%
4 - 5	293	13.1%	9	0.2%	0.3%
5 - 6	184	8.2%	5	0.1%	0.5%
6 - 7	79	3.5%	2	0.1%	0.5%
7 - 8	151	6.7%	0	0.0%	0.5%

Temp (°C)	Frequency		Leisler's bat		
	Count	Percentage	Count	Percentage	Cumulative
8 - 9	212	9.5%	47	1.2%	1.7%
9 - 10	301	13.4%	589	14.9%	16.6%
10 - 11	381	17.0%	1688	42.8%	59.5%
11 - 12	116	5.2%	728	18.5%	77.9%
12 - 13	67	3.0%	274	7.0%	84.9%
13 - 14	88	3.9%	75	1.9%	86.8%
14 - 15	72	3.2%	148	3.8%	90.5%
15 - 16	44	2.0%	373	9.5%	100.0%
16 - 17	0	0.0%	0	0.0%	100.0%

4.9 Spatial variation in bat activity

89. In order to assess any spatial variation in bat activity throughout the site, the average number of bat passes per night at each sampling location was calculated for the three months of highest activity (June and August in 2017, and July in 2018).

90. In June 2017, the average number of bat passes per night ranged from 10.2 to 64.2. The highest activity was at sampling point R3, which is located in the south-west of the site, and on the lower plateau of the hill. When all sampling points are compared, the highest activity levels appeared to be on the lower plateau, and the lowest activity on the top of the hill.

91. In August 2017, the average number of bat passes per night ranged from 17.1 to 79.7. The highest activity was at sampling point R1, which is located in the north-west of the site, and on the lower plateau of the hill. When all sampling points are compared, the highest activity levels were also on the lower plateau, and the lowest activity on the top of the hill.

92. In July 2018, the average number of bat passes per night ranged from 4.1 to 72.4. The highest activity was at sampling point B4, which is located in the centre of the site, and on the ridgeline of the hill. In contrast to the 2017 results, activity levels in the west of the site on the lower plateau of the hill were relatively low. When all sampling points are compared, the highest activity levels were on the ridgeline and in the centre of the site, while the lowest activity was on the crest of the hill and in the north of the site.

93. In summary, it appears that Leisler's bats use all parts of the site, and there was not a consistent focus of activity in a particular location. In 2017 most activity was on the lower plateau of the hill, and it was thought that this area may provide a sheltered foraging area. However, in 2018 most activity was recorded on the ridgeline of the hill, which is one of the most exposed locations. Therefore, there is no clear spatial pattern of activity at the site.

4.10 Overall conclusions

94. From an analysis of the data in 2017 and 2018 it appears that significant numbers of Leisler's bats use the site in the mid-summer period, so this species is considered to be a sensitive ecological receptor and will be included in the impact assessment for the bat report. Activity levels of this species appear to follow certain temporal patterns – both for months of the year, and for times of the night – and appear to be strongly influenced by weather conditions. However, there does not appear to be a consistent spatial pattern in its use of the site, so it is assumed to forage relatively evenly over all parts of the site. Activity levels at 45 m height and at ground level appeared to be relatively similar for this species, so there is no indication that bats were more abundant at height.

95. Common pipistrelle and soprano pipistrelle bats were rarely recorded on the site in significant numbers, and there did not appear to be a consistent temporal or spatial pattern in their activity. Therefore, these species are not considered to be sensitive ecological receptors and will not be included in the impact assessment for the bat report. No other species were recorded in significant numbers.

96. The ecological value of the Study Area can be categorised using the valuation system of the CIEEM Guidelines (refer to **Chapter 8: Ecology and Fisheries**). Considering the high levels of Leisler's bat activity at certain times of the year, the Study Area is considered to be of local ecological value for commuting / foraging bats.

5 Assessment of Potential Effects

5.1 Decommissioning/Construction phase

97. Site clearance works will involve the removal of low-growing vegetation and soils in the footprint of all decommissioning/ construction works. This will predominantly take place on heathland and grassland vegetation, which is of negligible value for feeding and commuting bats. A short section of low-quality hedgerow will be removed at the site entrance on the Terrydoo Road (it will be replaced in the short - medium term), but this is unlikely to sever or disturb any important commuting routes or feeding areas, as there is a similar hedgerow on the opposite site of the Terrydoo Road. No other trees, hedgerows or other linear habitats will be removed. Therefore, habitat loss during site clearance works will not cause any significant adverse effects on bats.

5.2 Operation phase

Background

98. Although bat fatalities have been reported from operational windfarms in North America and parts of Europe for almost twenty years, evidence from the British and Irish Isles has only begun to emerge in recent years. The key reference in this regard is a large-scale study by researchers at Exeter University that was published by Mathews et al. in 2016, which was based on bat activity and corpse searches at 46 operational wind farms throughout the British Isles. Bat corpses were found at two-thirds of these sites, of which 48% of fatalities were common pipistrelles, 40% were soprano pipistrelles and 10% were noctule bats (which are closely related to Leisler's bats). The estimated casualty rates, which correct for predator removals and the efficiency of the searches, ranged from 0 to 5.25 bats per turbine per month, and from 0-77 bats per site per month, during the period of the survey. A relationship between weather conditions and bat fatalities was found: most nights where casualties occurred (81.5%) had low mean wind speeds (≤5 m/s measured at the ground) and maximum night-time temperatures of >10°C. Formally, it was estimated that 95.3% of nights with mean wind speeds >5m/s would have no casualties.

99. However, there was not a clear relationship between recorded bat activity levels and the number of fatalities recorded at a site, as follows: "*Activity at the control locations [a proxy for pre-construction surveys] was not a useful predictor of the number of bat casualties, although it was a predictor of whether or not any casualties occurred (i.e. a binary yes/no categorisation)*". The nights of highest pipistrelle activity were considered to have the highest likelihood of casualties, although bat fatalities were only recorded in one third of these locations. In the Mathews et al. (2016) study, 'high activity' was defined as a night with more than 50 bat passes; which is used as the threshold for 'significant' levels of bat activity in this assessment.

100. Fatality research studies elsewhere in Europe have shown that, due to their different behaviour and flight style, bat species are affected differently by wind turbines (Rodrigues et al., 2014, Natural England, 2014). The species recorded in significant numbers at the proposed development site – Leisler's bats, and to a lesser extent common pipistrelles – have different flight styles, and consequently have different threat levels from wind turbines. Leisler's bats are considered to have a high risk of collision with wind turbines, and a high risk that collision-related mortalities could affect their populations (Natural England, 2014) (Natural England, 2014). In contrast, common pipistrelles are considered to have a medium risk of collision with wind turbines, but a low risk that collision-related mortalities could affect their populations. On this basis, the risk of impacts for each species are assessed below.

Site-specific risk assessment

101. Leisler's bats had negligible or low activity in spring (May) and autumn (September and October), but there were peaks of significant activity on 11% of the sampling nights, particularly during the mid-summer period (June to August, inclusive), and on the lower plateau. 36% of activity was below the standard cut-in speeds for modern wind turbines (3 m/s), but the remainder of passes were at wind speeds at which the turbine would be operational. Based on the frequency of significant activity levels, and the high risk posed to this species by wind turbines, it is possible that Leisler's bats will be killed at some of the proposed turbine locations, and it is possible that fatalities could significantly affect local populations of this species. It is not possible to make a prediction about the number of bats that may be killed, but in a worst-case scenario it is possible that casualties could have a significant impact on local populations of this species.

102. Common pipistrelles had negligible or infrequent activity on the vast majority of sampling nights, with significant activity on only 1.5% of the sampling nights. It is important to note that 48% of bat passes were recorded when wind speeds were below 3 m/s (the typical cut-in speed). Considering that this species was rarely recorded in significant numbers, that it has only a moderate risk from wind turbines, and that it typically flies at low heights and wind speeds, it is unlikely that any common pipistrelles will

be killed at any of the proposed turbine locations, and highly unlikely that fatalities would significantly affect local populations of this species.

103. All bat species receive strict protection under the *Conservation (Natural Habitats, etc.) Regulations (Northern Ireland)* 1995 (S.I. 1995/380, as amended), under which it is an offence to kill, injure or disturb any bat species. In accordance with policy NH 2 of the Department of the Environment's *Planning Policy Statement 2: Natural Heritage* (DOENI, 2013), planning permission will only be granted for a development that is not likely to harm any protected species (subject to suitable mitigation measures).

5.3 'Do nothing scenario'

104. If the proposed development does not proceed, the site is expected to remain in the baseline condition and to be used by common bat species at the levels recorded in 2017. The conservation status of all bat species in Northern Ireland is thought to be stable, so no decline in bat activity is predicted.

6 Proposed mitigation measures

6.1 Operational curtailment

105. Background

106. The curtailment of operational wind turbines - both by increasing the cut-in speed of turbines, and by feathering turbines below the cut-in speed - has been shown to significantly reduce the number of fatalities at wind farms in the USA (Arnett et al., 2013), and is widely implemented throughout Europe (Rodrigues et al., 2014). The following is noted in Mathews et al. (2016):

107. *"To minimise economic loss, it may be possible to undertake focused curtailment when the risk of collision has been shown to be highest, for example in warm weather, at low wind speeds, during migratory periods and/or when bat activity levels are high. Seasonal variation in risk, with a peak in fatalities in late summer and early autumn, is consistently reported in both Europe and North America, with a smaller peak sometimes being reported in late spring [primarily of migratory bats], and mitigation strategies therefore usually focus curtailment in these periods"*

108. In addition, the potential effectiveness of operational curtailment for British windfarms was addressed in the Mathews et al. (2016) report, as follows:

109. *"Weather conditions were also linked with bat fatalities, as had been expected from previous research in other countries. Most nights where casualties occurred (81.5%, 95% Confidence Interval* 69.2, 89.6) had low mean wind speeds (≤5 m/s measured at the ground) and maximum night-time temperatures of >10°C. It is possible to be confident that most nights with wind speeds >5m/s will have no casualties: formally, we can estimate that 95.3% (95% CI 91.5, 97.4) of nights with mean wind speeds >5m/s will have no casualties. However, it must be noted that most nights in the study had low wind speeds, and only 3.6% (95% CI 2.7-4.8) of these had casualties. It can therefore be concluded that whilst curtailing wind turbines in low winds would be extremely effective in minimising the collision risk to bats, it would also mean that turbines would be curtailed on most nights and, on average, only 3.6% of these nights would present a risk to bats."*

110. *"It may therefore be necessary to apply additional measures to identify that a substantial risk exists at a particular site or during a particular time-period (for example by finding casualties during post construction monitoring) before considering curtailment as a mitigation strategy. A simple strategy that should be considered at all sites where technically feasible is to restrict the rotation of turbine blades as much as possible below the cut-in speed (e.g. by feathering the blades). This will have a positive outcome for bats, as the amount of time the blades are turning at low wind speeds will be reduced, whilst also involving no loss of energy generation."*

111. Site-specific curtailment strategy

112. In recognition of the risk to Leisler's bats in the mid-summer period, all wind turbines will be curtailed on a precautionary basis during the operation of the Development. The curtailment strategy has been developed using the site-specific data discussed in Section 4, particularly the following findings:

- Significant Leisler's bat activity is only recorded during the months of June, July and August
- Peak activity occurs within circa. 2 hours of sunset
- A secondary peak occurs within circa. 1 hour of sunrise
- Activity overall is positively correlated with temperature and negatively correlated with wind speed

113. Using these parameters, and a model based on the bat activity and environmental parameters recorded in 2017 and 2018, a range of curtailment options were considered. The aim was to ensure that turbines were curtailed for 90% of the bat activity recorded in 2017 and 2018. On this basis, a curtailment strategy was developed using different wind-speeds at different times of the night, as outlined in **Table 13**. Further details regarding the selection of these thresholds is provided in **Technical Appendix A8.4: Bat Monitoring and Mitigation Strategy**.

Table 13: Site-specific curtailment strategy

Stage 1 (Post-sunset)	
Cut-in wind speed	13.3 m/s
Start after sunset	20 mins
Stop after sunset	110 mins
Stage 2 (Intervening period)	
Cut-in wind speed	5.5 m/s
Start after sunset	110 mins
Stop before sunrise	75 mins
Stage 3 (Pre-sunrise)	
Cut-in wind speed	10 m/s
Start before sunrise	75 mins
Stop before sunrise	30 mins
Global Parameter	
Minimum temperature	7.5 °C

114. The implementation of the curtailment will be via software which will automatically send a "pause" command to the relevant turbine when the parameters are met, initiating a 'feathering' of the blades to the fully open position using the pitch controls, and disengagement of the generator. This will slow the rotation speed of the blades to below 1 RPM (i.e. slower than the second hand of a clock). The emergency braking system shall not be used.

115. The wind speed and external temperature will be obtained from each turbine anemometry apparatus (on the nacelle) via the Supervisory Control and Data Acquisition (SCADA) interface. The control software will run within the proprietary SPR Centre of Operation of Renewable Energy (CORE) system.

7 Residual impacts

116. The curtailment strategy will substantially reduce the risk of fatalities for Leisler's bats at the Site. There is a high degree of confidence in the effectiveness of curtailment and feathering, as it has been demonstrated to reduce bat fatalities in peer-reviewed studies (e.g. Arnett et al. 2013), and is widely implemented elsewhere in Europe. Overall, these methods will avoid or minimise impacts on bats, and will ensure that the proposed development will not have a significant impact on bat populations.

8 Monitoring

117. In the Mathews et al (2016) report it is recommended that post-construction monitoring is carried out for all windfarms, both to confirm that proposed mitigation measures are effective, and to assess any changes in bat activity caused by the turbines. To achieve this objective, a detailed Bat Monitoring and Mitigation Strategy (BMMS) has been developed for this project by ScottishPower Renewables, which is provided in **Technical Appendix A8.4.**

118. The BMMS includes procedures for post-construction activity surveys and corpse searches, and of the methods that will be used to estimate actual mortality rates. If any further impacts are identified, additional mitigation will be proposed. An annual report covering the monitoring and mitigation activities will be prepared and submitted for the attention of NIEA Natural Environment Division and the Council.

9 References

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Appendix 1: Breakdown of automated detector survey results

Table A1.1. Detailed breakdown of bat records from May (Spring) 2017, expressed as the total numbers of bat passes per turbine per night

		May														
Location	**Species**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**Total**
R1	L	31	0	0	0	25	1	0	3	5	3	32	0	0	7	107
	CP	5	0	1	0	2	0	0	0	3	0	8	0	0	1	20
	UP	3	0	0	0	0	0	0	0	0	0	3	0	0	0	6
	SP	2	0	0	0	0	0	0	0	0	0	2	0	0	0	4
	UnID	2	0	0	0	0	0	0	0	0	1	0	0	0	0	3
	BLE	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1
	Total	43	0	1	0	27	1	0	3	8	4	46	0	0	8	141
R2	L	25	0	0	0	2	0	0	0	0	9	0	0	4	2	42
	CP	10	0	0	0	0	0	0	0	2	0	0	1	0	0	13
	Total	35	0	0	0	2	0	0	0	2	9	0	1	4	2	55
R3	L	17	0	0	0	23	0	0	2	2	7	5	0	0	27	83
	CP	0	0	0	0	0	0	0	2	2	3	0	0	0	0	7
	UP	1	0	0	0	0	0	0	0	0	0	1	0	0	0	2
	SP	2	0	0	0	0	0	0	0	0	0	0	0	0	0	2
	Total	20	0	0	0	23	0	0	4	4	10	6	0	0	27	94
R4	L	37	5	0	0	0	0	2	0	1	8	7	0	3	29	92
	CP	13	3	0	0	6	0	0	1	0	1	2	3	1	1	31
	SP	3	0	0	0	0	0	0	1	0	0	0	0	0	0	4
	UnID	4	0	0	0	2	0	0	0	0	0	0	0	0	0	6
	UP	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1
	BLE	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1
	Total	58	8	1	0	8	0	2	2	1	9	9	3	4	30	135
R5	L	15	1	0	0	9	0	0	0	0	1	3	3	7	45	84
	CP	16	5	1	0	0	0	0	0	0	0	0	0	0	5	27
	UnID	3	0	0	0	0	0	0	1	0	0	1	0	0	0	5
	SP	1	1	0	0	0	0	0	0	0	0	3	0	0	0	5
	UP	1	1	0	0	0	0	0	0	0	0	0	0	0	0	2
	Total	36	8	1	0	9	0	0	1	0	1	7	3	7	50	123
R8	L	16	0	0	0	8	1	0	3	0	5	2	0	0	1	36
	CP	8	0	0	0	0	0	0	0	1	0	0	3	0	0	12
	SP	1	1	0	0	0	0	0	0	0	0	0	0	0	0	2
	UnID	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1
	Total	25	1	1	0	8	1	0	3	1	5	2	3	0	1	51
Overall total		**217**	**17**	**4**	**0**	**77**	**2**	**2**	**13**	**16**	**38**	**70**	**10**	**15**	**118**	**599**

** Species codes are as follows: L – Leisler's bat; CP – common pipistrelle; SP – soprano pipistrelle; UP – Unidentified pipistrelle; NP – Nathusius' pipistrelle; MD – Daubenton's bat; MN – Natterer's bat; MY – unidentified Myotis species; BLE – brown long-eared bat; UnID – unidentified bat.*

Table A1.2. Detailed breakdown of bat records from June (Spring) 2017

		June																	
Location	**Species**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**	**25**	**Total**
R2	L	0	0	0	19	3	0	0	14	82	140	38	4	140	12	53	3	3	511
	CP	0	0	0	4	1	1	0	1	9	8	13	0	0	0	0	0	0	37
	SP	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	2
	UP	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1
	UnID	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	2
	Total	0	0	0	23	6	1	0	15	92	150	51	4	140	12	53	3	3	553
R3	L	0	12	0	56	28	25	0	239	216	117	122	0	67	4	17	188	0	1,091
	CP	0	1	3	0	2	0	0	3	5	5	2	0	0	0	0	0	0	21
	SP	0	0	0	0	1	0	0	0	0	0	2	0	0	0	0	0	0	3
	UP	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	2
	MN	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1
	BLE	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	6	8
	UnID	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	2
	Total	0	13	3	56	31	25	0	242	225	122	127	1	68	4	17	188	6	1,128
R4	L	0	0	0	15	3	0	3	6	30	61	40	0	13	2	0	0	0	173
	CP	0	0	0	1	3	0	0	0	4	1	5	0	0	0	0	0	0	14
	SP	0	0	0	0	0	0	0	2	2	1	1	0	0	0	0	0	0	6
	Total	0	0	0	16	6	0	3	8	36	63	46	0	13	2	0	0	0	193
R5	L	0	0	0	0	1	6	0	4	5	141	29	1	0	0	0	0	2	189
	CP	0	0	0	3	2	0	0	1	2	5	0	0	0	0	0	0	0	13
	SP	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1
	BLE	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1
	Total	0	0	0	3	3	6	0	5	7	146	29	1	0	0	0	1	3	204
R6	L	0	0	0	14	24	0	0	19	28	106	30	10	12	0	0	0	0	243
	CP	0	0	0	0	16	0	0	2	18	13	9	0	2	0	0	0	0	60
	SP	1	1	0	4	4	0	0	1	2	5	4	0	0	0	0	1	0	23
	UP	0	0	0	0	0	0	0	0	1	2	7	0	1	0	0	0	0	11
	BLE	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1
	Total	1	1	0	18	44	0	0	22	50	126	50	10	15	0	0	1	0	338
R8	L	0	3	0	18	14	3	0	1	28	119	18	6	0	1	0	0	1	212
	CP	0	0	0	1	2	0	0	0	3	1	2	0	1	0	0	0	0	10
	SP	0	1	0	0	2	0	0	0	0	1	0	0	0	0	0	0	0	4
	UP	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	2
	Total	0	4	0	19	18	3	0	1	31	121	22	6	1	1	0	0	1	228
Overall Total		**1**	**18**	**3**	**135**	**108**	**35**	**3**	**293**	**441**	**728**	**325**	**22**	**237**	**19**	**70**	**193**	**13**	**2,644**

Table A1.3. Breakdown of bat records from August (Summer) 2017

		Aug																														
Location	**Species**	**01**	**02**	**03**	**04**	**05**	**06**	**07**	**08**	**09**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**	**25**	**26**	**27**	**28**	**29**	**30**	**31**	**Total**
R1	L	50	18		4	110		160	473	191	79	25	12	4	174	38	78	20	114	54		2		94	186	82	235	20	8	1	203	36	2,471
	CP	1	1		4	2		35	107	5			4		40		10	2	11	6			1	11		11	38	5	16		6	10	326
	SP	5	2			2		5	28	8			2	5	11		1	2	1	7				9		3	17	2	16		2		128
	NP											3			3														1				7
	MY				2	4		3	2	4			3		7	2								1			1				3		32
	MN	5		1	1	5		1	6	5		1	1		2					2											1		31
	MD												1																				1
	UnID	1				2		1	3	2			1	1	18		2	2						1			1	2	1				38

		Aug																														
Location	**Species**	**01**	**02**	**03**	**04**	**05**	**06**	**07**	**08**	**09**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**	**25**	**26**	**27**	**28**	**29**	**30**	**31**	**Total**
	Total	62	21	1	11	125		205	619	215	79	29	24	10	255	40	91	26	126	69		2	1	116	186	96	292	29	42	1	215	46	3,034
R2	L	14	7		1	10		43	108	118	63	6	103	5	147	89	65	60	26	94	2	1	8	58	55	81	218	38	53		64	83	1,620
	CP	1				4		11	50			1	5		6	1	1	1	23	18			1	2		26	22		14		8		195
	SP				4		1	12	9	2		1	6		5	3	1			6				2		4	17	1	20	2	3		99
	NP										2				1					2									1				6
	MY	1			3	2		3		3					2	1													1				16
	MN	1				1									1	1	1										3						8
	UnID							2			2					5				1				4				1	1	1	3		20
	Total	17	7		8	17	1	71	167	123	67	8	114	5	162	100	68	61	49	121	2	1	9	66	55	111	260	40	90	3	78	83	1,964
R5	L	30			5	56	7	10	74	13	24		8	7	95	10	1	5		4				33		24	160	16	11	5	124	3	725
	CP	3				5	1	3	10				1	1	40	4	1	2		5				5		5	52	7	6	1	39	14	205
	SP	4	1		1	1		7	3	2	1		1	3	15	6	1	1		2				5			268	2	7	1	8	14	354
	NP													3			1																4
	MY																														4		4
	MN																										1						1
	UnID	6				1								1	8									3			2	1	1			6	29
	Total	43	1		6	63	8	20	87	15	25		10	15	158	20	4	8		11				46		29	483	26	25	7	175	37	1,322
R6	L	20	3	1		50	1	7	93	42	22	9	7	23	230	23		12		6	3	7		7	19	1	60	7	3		70	29	755
	CP	6	1		2	8		5	18	7	2		6	10	44	5	4	3		18				12	1	6	70	10	17	1	37	21	314
	SP	7	2		1	2	1	7	37	2		2	2	9	32	8	6		6	7				16	1	9	32	3	32		10	9	243
	NP		1										1	2																			4
	MY	1				1							1	1		1	1	1				1					1			2	1		12
	MN					1										1											1		1	3	2		9
	UnID								1	1				3	8	2								1			12	1	6	1	12	1	49
	Total	34	7	1	3	62	2	19	149	52	24	11	17	48	314	40	11	16	6	31	3	8		36	21	16	176	21	59	7	132	60	1,386
R7	L	35	1		7	24	1	9	13	12	37	2	10	12	44	22	7	9		16				25	5	3	141	18		1	105	3	562
	CP	2	1			3		9	2		1			1	34	5				4				4		4	84	1	1	3	30	14	203
	SP	4				2		3	4	4			2		10	3		1			1			10	1	1	49	1	1		2	3	102
	NP												1	2												2		1					6
	MY																	1															1
	MN																			1													1
	UnID														3		1										7		1		5	2	19
	Total	41	2		7	29	1	21	19	16	38	2	13	15	91	30	8	11		21	1			39	6	10	281	21	3	4	142	22	894
R8 G	L	42	29		1	64	7	13	8	21	19	52	7	23	82	30		24	8	26	3	8		29	24	32	178	6	9	3	134	5	887
	CP	9			1	8			4	1			3	3	63	3	3			1				4		10	115	4	1	1	55	17	306
	SP	5	2		1	3	1	3	5	1	2		2	4	34	4		2		1				3		3	68	2	7		15	7	175
	NP	1																									3	4					8
	MY																			1												1	2
	MN															1											1						2
	UnID	1													3	1											18	1		1	7		32
	Total	58	31		3	75	8	16	17	23	21	52	12	30	182	39	3	26	8	29	3	8		36	24	45	383	17	17	5	211	30	1,412
R8 H	L	36	9		1	59		7	9	13	7		19	11	52	29		1		24				21	3	9	130		5		189	8	642
	CP																										6				3	1	10
	SP															1																	1
	NP																											1					1
	UnID																										1						1
	Total	36	9		1	59		7	9	13	7		19	11	52	30		1		24				21	3	9	137	1	5		192	9	655
Overall Total		**291**	**78**	**2**	**39**	**430**	**20**	**359**	**1,067**	**457**	**261**	**102**	**209**	**134**	**1,214**	**299**	**185**	**149**	**189**	**306**	**9**	**19**	**10**	**360**	**295**	**316**	**2,012**	**155**	**241**	**27**	**1,145**	**287**	**10,667**

Table A1.4. Breakdown of bat records from the October (Autumn) 2017 surveys

		October																														
Location	**Species**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**	**25**	**26**	**27**	**28**	**29**	**30**	**31**	**Total**
R1	L				3	17		10	1							34												1					66
	CP					1		10								18							1				3						33
	SP					1		1								1							4			2	1			2			12
	UnID													1		6									1								8
	Total	0	0	0	3	19	0	21	1	0	0	0	0	1	0	59	0	0	0	0	0	0	5	0	1	2	4	1	0	2	0	0	119
R2	L															2											11						13
	CP				2	7		8	9							93							21	89	4	4	11			4	5		257
	SP				3	13		5	3							87							29	50		14	10		1	4	1		220
	UP					2																											2
	MN									1													1				1				3		6
	MY					1										6							2			1	2			1			13
	UnID					2										2							6	3			1						14
	Total	0	0	0	5	25	0	13	12	1	0	0	0	0	0	190	0	0	0	0	0	0	59	142	4	19	36	0	1	9	9	0	525
R5	L							12		1						5											14						32
	CP				9	17										22											8			2			58
	SP					3		1	1			1				6											4						16
	MN																										1						1
	MY																										1						1
	UnID					1																											1
	Total	0	0	0	9	21	0	13	1	1	0	1	0	0	0	33	0	0	0	0	0	0	0	0	0	0	28	0	0	2	0	0	109
R6	L															16							4										20
	CP								1							28																	29
	SP															4														2			6
	MY								1																								1
	UnID															2																	2
	Total	0	0	0	0	0	0	0	2	0	0	0	0	0	0	50	0	0	0	0	0	0	4	0	0	0	0	0	0	2	0	0	58
R7	L															23																	23
	CP															40							2	1									43
	SP							1						1		11							2			1	1			2			19
	NP								3						1																		4
	UnID															1																	1
	Total	0	0	0	0	0	0	1	3	0	0	0	0	1	1	75	0	0	0	0	0	0	4	1	0	1	1	0	0	2	0	0	90
R8 G	L								2							14							2			1	3						22
	CP															11							5	1			2						19
	SP															1							2				1						4
	UnID															13																	13
	Total	0	0	0	0	0	0	0	2	0	0	0	0	0	0	39	0	0	0	0	0	0	9	1	0	1	6	0	0	0	0	0	58
R8 H	L	0	0	0	0	0	0	0	2	0	0	0	0	0	0	4	0	0	0	0	0	0	16	2	0	1	9	0	0	0	0	0	4
Overall Total		**0**	**0**	**0**	**17**	**65**	**0**	**48**	**23**	**2**	**0**	**1**	**0**	**2**	**1**	**450**	**0**	**0**	**0**	**0**	**0**	**0**	**97**	**146**	**5**	**24**	**84**	**1**	**1**	**17**	**9**	**0**	**963**

Table A1.5. Breakdown of bat records from the Spring 2018 surveys

Location	Species	May 9	10	11	12	13	14	15	16	17	18	19	20	21	Total
A1	L						3				2	1			6
	CP						1	1		1					3
	SP										1				1
	Total						4	1		1	3	1			10
A2	L						1			10	6				17
	SP		1												1
	Total		1				1			10	6				18
A3	L			1			3		1	3	2				10
	CP										1			1	2
	Total			1			3		1	3	3			1	12
A4	L			2						1	5				8
	CP						1				4				5
	Total			2			1			1	9				13
A5	L		1				3		1	1	2				8
	SP										1				1
	BLE				1										1
	Total		1		1		3		1	1	3				10
A6	Total														0
A7	L									1					1
	CP							1							1
	SP				1		2			1	1				5
	Total				1		2	1		2	1				7
B1	L						3			2	1				6
	CP				2		1								3
	SP				1										1
	UnID									1					1
	Total				3		4			3	1				11
B2	L					3	1			2	55				61
	CP	1					2			1	2				6
	SP						1								1
	Total	1				3	4			3	57				68
B3	L	2					5			2					9
	CP				1										1
	Total	2			1		5			2					10
B4	L						9				12				21
	Total						9				12				21
B5	L										20				20
	Total										20				20
B6	L				5		8				23				36
	SP								1						1
	MN			1											1
	Total			1	5		8		1		23				38
B7	L						4				1				5
	Total						4				1				5
Overall Total		**3**	**2**	**4**	**11**	**3**	**48**	**2**	**3**	**26**	**139**	**1**	**0**	**1**	**243**

Table A1.6. Breakdown of bat records from the Summer 2018 surveys

Location	Species	July 11	12	13	14	15	16	17	18	19	20	21	22	23	24	Total
A1	L	2	5	7			3		9	4			2	14	8	54
	CP		1	2			1			1			1	1		7
	SP		2					1		1			3		2	9
	MY														1	1
	Total	2	8	9			4	1	9	6			6	15	11	71
A2	L	1	3	2			1	2	2	1			1	12	8	33
	CP									1				1	1	3
	SP								1				2			3
	MY			1												1
	Total	1	3	3			1	2	3	2			3	13	9	40
A3	L	3	12	7	4		2	46	5		1		3	63	13	159
	CP		1					1	2	1		1	3	15		24
	SP									1			5	3	2	11
	UnID														1	1
	Total	3	13	7	4		2	47	7	2	1	1	11	81	16	195
A4	L	4	18	4	6		14	51	14	10	10	36	81	66	48	362
	CP		1		1		1	14	1	9	1	1	11	14		54
	NP													1		1
	SP			1				1		1			1	1	1	6
	MY	12	1				20	5	16	17		7		16		94
	UnID							2								2
	Total	16	20	5	7		35	73	31	37	11	44	93	98	49	519
A5	L	2	7	8	33	26	14		14	17	10	21	42	43	46	283
	CP		1	5	3	5	2		1	16		1	16	5	1	56
	SP		1				1			1			7	1		11
	UnID													3		3
	Total	2	9	13	36	31	17		15	34	10	22	65	52	47	353
A6	L	1	5	3	15		6	37	11	5	5	6	10		7	111
	CP			1				7					1			9
	SP				1			1					4		1	7
	MY								1							1
	UnID								1							1
	Total	1	5	4	16		6	45	13	5	5	6	15		8	129
A7	L	5	9	1	3	6	2	1	2	9		6	3	5	5	57
	CP	1	3	1		1		1		2			2	1	1	13
	NP												1			1
	SP	2		1		1						1	4			9
	MY											1				1
	Total	8	12	3	3	8	2	2	2	11		8	10	6	6	81
B1	L	3	24	13	10	8	10	70	50	5	4		9	38	21	265
	CP			1		1	5	3					1	5	1	17
	SP	1						1		2			6			10

Location	Species	July 11	12	13	14	15	16	17	18	19	20	21	22	23	24	Total
	UnID							2		1			1			4
	Total	4	24	14	10	9	15	76	50	8	4		17	43	22	296
B2	L	2	6	3	3		5	28	41	2			2	13	8	113
	CP		2	1				1	2			1	1	3	1	12
	SP			1	1								3			5
	UnID												1	1		2
	Total	2	8	5	4		5	29	43	2		1	7	17	9	132
B3	L	8	23	24	4	6	10	103	25	25			9	67	21	325
	CP	1						4		6			1	4	1	17
	SP												2	1	1	4
	UnID							1						1		2
	Total	9	23	24	4	6	10	108	25	31			12	73	23	348
B4	L	9	61	28	34	1	55	375	80	114		4	122	54	77	1,014
	CP		4				6	3	2	7				6		28
	SP							2					5	2		9
	Total	9	65	28	34	1	61	380	82	121		4	127	62	77	1,051
B5	L		13	13	12		1	159	8	10			36	2	25	279
	CP							4	2				1	1	2	10
	SP		1					6						1		8
	MY	1														1
	Total	1	14	13	12		1	169	10	10			37	4	27	298
B6	L	15	51	12	11	8	8	123	16	7		2	31	139	90	513
	CP		6	2				2	1				2	4		17
	SP		1	1				1					6	2	1	12
	UnID												1			1
	Total	15	58	15	11	8	8	126	17	7		2	40	145	91	543
B7	L	1	21	27	13		6	18	5	11			22		23	147
	CP														2	2
	Total	1	21	27	13		6	18	5	11			22		25	149
Overall Total		**74**	**283**	**170**	**154**	**63**	**173**	**1,076**	**312**	**287**	**31**	**88**	**465**	**609**	**420**	**4,205**

Table A1.7. Breakdown of bat records from the Autumn 2018 surveys

Location	Species	Sept 12	13	14	15	16	17	18	19	20	21	22	23	Total
A1	L			1										1
	CP	1				1								2
	Total	1		1		1								3
A2	Total			0										0
A3	CP			1										1
	MY			2										2
	Total			3										3
A4	L					1								1
	CP			1										1
	MY			5		1				1				7
	Total			6		2				1				9
A5	CP	2												2
	SP	1												1
	Total	3		0										3
A6	L			1										1
	MY			1										1
	Total			2										2
A7	L					1								1
	CP					1				2				3
	MY			2						1				3
	Total			2		2				3				7
B1	L		1											1
	CP	1												1
	UnID					2								2
	Total	1	1			2								4
B2	L					1								1
	NP			2										2
	Total			2		1								3
B3	SP			1										1
	Total			1										1
B4	MY			1										1
	Total			1										1
B5	L										1		1	2
	NP	3												3
	Total	3									1		1	5
B6	L					13								13
	SP	1				1								2
	NP	1												1
	UnID												1	1
	Total	2				14							1	17
B7	Total			0										0
Overall Total		**10**	**1**	**18**	**0**	**22**	**0**	**0**	**0**	**4**	**1**	**0**	**2**	**58**

Appendix 2: Summary of weather conditions

Table A2.1. Summary of average nightly temperature and wind speed in 2017

Season	Date	Temperature (ºC)	Wind speed (m/s)
Spring 2017	09/05/17	7.2	0.8
	10/05/17	7.4	3.1
	11/05/17	9.7	2.9
	12/05/17	9.9	2.9
	13/05/17	7.1	3.9
	14/05/17	8.3	6.5
	15/05/17	13.6	6.9
	16/05/17	6.9	4.2
	17/05/17	5.5	2.2
	18/05/17	5.6	1.8
	19/05/17	7.2	1.0
	20/05/17	6.6	2.9
	21/05/17	9.2	6.8
	22/05/17	7.3	2.5
	23/05/17	12.7	6.5
	09/06/17	10.8	8.3
	10/06/17	11.1	10.6
	11/06/17	9.5	9.9
	12/06/17	10.6	5.4
	13/06/17	12.4	6.4
	14/06/17	11.2	9.9
	15/06/17	9.0	7.6
	16/06/17	13.1	6.9
	17/06/17	14.6	4.4
	18/06/17	14.7	2.2
	19/06/17	7.5	5.7
	20/06/17	15.0	5.6
	21/06/17	11.6	5.1
	22/06/17	10.7	13.6
	23/06/17	8.9	6.1
	24/06/17	8.1	4.9
	25/06/17	7.7	2.9
	26/06/17	7.7	5.4
Summer 2017	01/08/17	10.8	4.8
	02/08/17	12.0	6.1
	03/08/17	10.8	9.0
	04/08/17	7.6	5.2
	05/08/17	9.4	5.9
	06/08/17	9.0	8.9
	07/08/17	8.8	4.9
	08/08/17	10.9	3.8
	09/08/17	8.9	5.7
	10/08/17	11.5	11.7
	11/08/17	10.8	7.6
	12/08/17	7.9	4.0
	13/08/17	11.0	7.7

Season	Date	Temperature (°C)	Wind speed (m/s)
	14/08/17	10.3	4.3
	15/08/17	10.4	6.9
	16/08/17	11.1	9.5
	17/08/17	9.7	9.5
	18/08/17	9.3	11.2
	19/08/17	9.4	6.2
	20/08/17	11.5	8.2
	21/08/17	14.5	5.8
	22/08/17	13.6	7.9
	23/08/17	10.9	7.5
	24/08/17	11.9	9.2
	25/08/17	10.9	7.5
	26/08/17	11.4	4.1
	27/08/17	13.7	11.1
	28/08/17	8.5	7.9
	29/08/17	8.0	9.2
	30/08/17	8.5	2.7
	31/08/17	9.0	4.0
Autumn 2017	01/10/17	8.5	20.8
	02/10/17	7.1	14.6
	03/10/17	7.5	15.0
	04/10/17	8.3	12.7
	05/10/17	6.3	6.8
	06/10/17	9.7	14.5
	07/10/17	9.4	6.8
	08/10/17	9.0	8.3
	09/10/17	9.0	12.3
	10/10/17	9.8	15.5
	11/10/17	6.0	13.2
	12/10/17	14.3	17.8
	13/10/17	9.6	9.5
	14/10/17	12.1	15.4
	15/10/17	7.4	8.2
	16/10/17	8.9	20.8
	17/10/17	6.4	4.0
	18/10/17	9.3	11.6
	19/10/17	7.7	9.2
	20/10/17	8.5	12.4
	21/10/17	5.8	20.1
	22/10/17	8.7	10.9
	23/10/17	8.5	11.3
	24/10/17	7.3	13.0
	25/10/17	7.4	9.5
	26/10/17	6.8	4.6
	27/10/17	7.9	11.1
	28/10/17	8.9	13.6
	29/10/17	4.7	4.1
	30/10/17	9.2	10.0
	31/10/17	9.6	10.8

Table A2.2. Summary of average nightly temperature and wind speed in 2018

Season	Date	Temperature (°C)	Wind speed (m/s)
Spring 2018	09/05/18	3.5	11.9
	10/05/18	5.5	13.0
	11/05/18	4.0	5.9
	12/05/18	5.7	6.2
	13/05/18	8.0	8.0
	14/05/18	9.1	6.6
	15/05/18	4.7	8.1
	16/05/18	4.2	5.1
	17/05/18	7.7	6.9
	18/05/18	10.2	8.1
	19/05/18	9.6	11.3
	20/05/18	9.7	6.2
	21/05/18	4.7	8.1
Summer 2018	11/07/18	10.4	6.2
	12/07/18	10.3	3.8
	13/07/18	12.3	7.6
	14/07/18	14.6	9.7
	15/07/18	10.6	8.0
	16/07/18	9.5	6.2
	17/07/18	10.3	2.0
	18/07/18	9.5	3.6
	19/07/18	11.1	9.0
	20/07/18	9.9	7.0
	21/07/18	13.5	7.1
	22/07/18	13.0	7.1
	23/07/18	10.8	5.1
	24/07/18	11.2	6.6
Autumn 2018	12/09/18	8.0	11.7
	13/09/18	8.0	12.6
	14/09/18	6.4	8.6
	15/09/18	11.1	16.1
	16/09/18	9.7	10.0
	17/09/18	12.9	8.3
	18/09/18	9.0	16.2
	19/09/18	5.7	15.1
	20/09/18	4.4	8.9
	21/09/18	4.2	10.8
	22/09/18	3.8	5.4
	23/09/18	3.9	6.5

Rigged Hill Windfarm Repowering

Technical Appendix A.4: Bat Mitigation Plan

Volume 3 – Technical Appendix
July 2019

A8.4 Bat Mitigation Plan

1.1 Introduction

1. The assessment of bat activity at Rigged Hill Repowering Windfarm concluded that Leisler's bats are present in sufficient abundance that the Development is considered to pose a high risk to this bat population (**Technical Appendix A8.3**). As such mitigation measures are required to reduce the risk to Leisler's bats during windfarm operation. This document describes the mitigation measures, method of implementation, auditing and monitoring programme which will be implemented during the operational phase of the windfarm. It also describes the process by which any changes to mitigation measures will be made as part of feedback from monitoring data.

1.2 Mitigation Measures

2. The mitigation measures will comprise curtailment of the operation of the wind turbines to minimise turbine operation during conditions when Leisler's bats are likely to be present. This type of approach is made possible due to the distribution of activity being relatively predictable according to four key patterns (see also **Technical Appendix A8.3** for further analysis):

1. Significant Leisler's bat activity is only recorded during the months of June, July and August (Figure 1)
2. Peak activity occurs within circa. 2 hours of sunset (Figure 1)
3. A secondary peak occurs within circa. 1 hour of sunrise (Figure 1)
4. Activity overall is positively correlated with temperature and negatively correlated with wind speed (Figure 2)

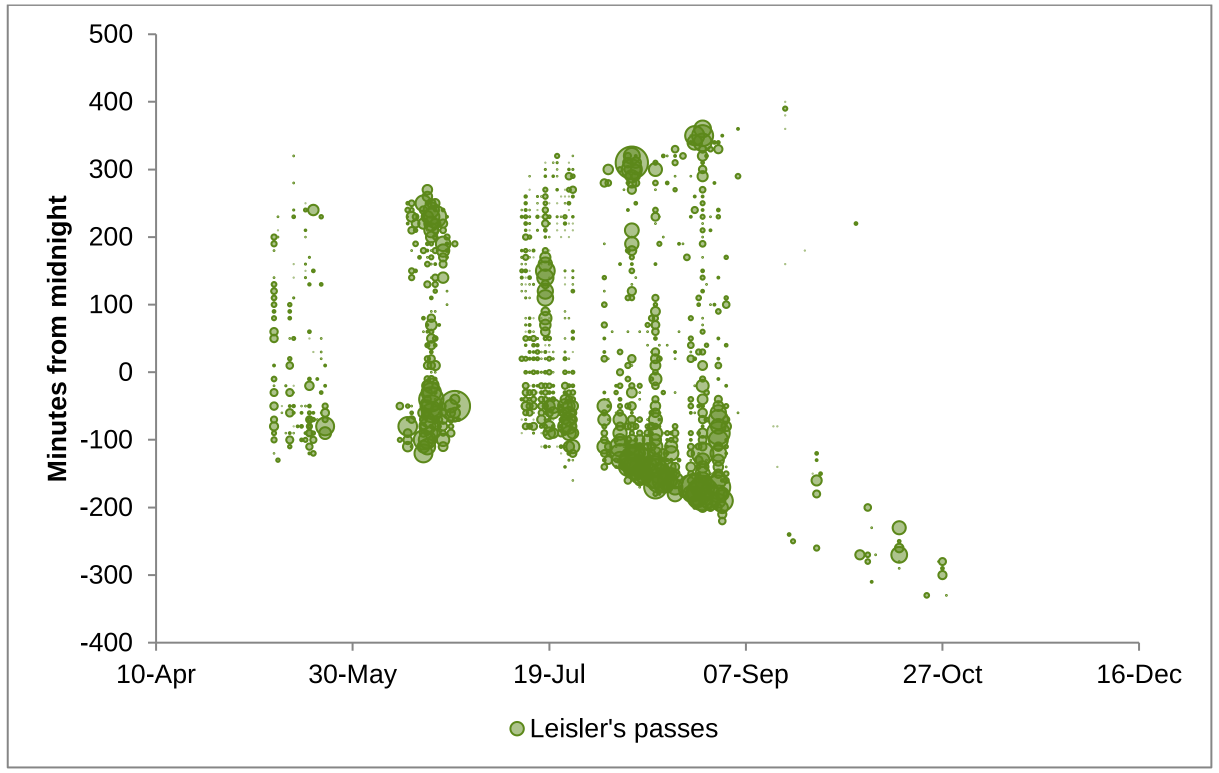

Figure 1: Composite plot of 2017 and 2018 survey data, with the relative size of each circle representing the number Leisler's bat passes recorded during a 10 minute period throughout each night.

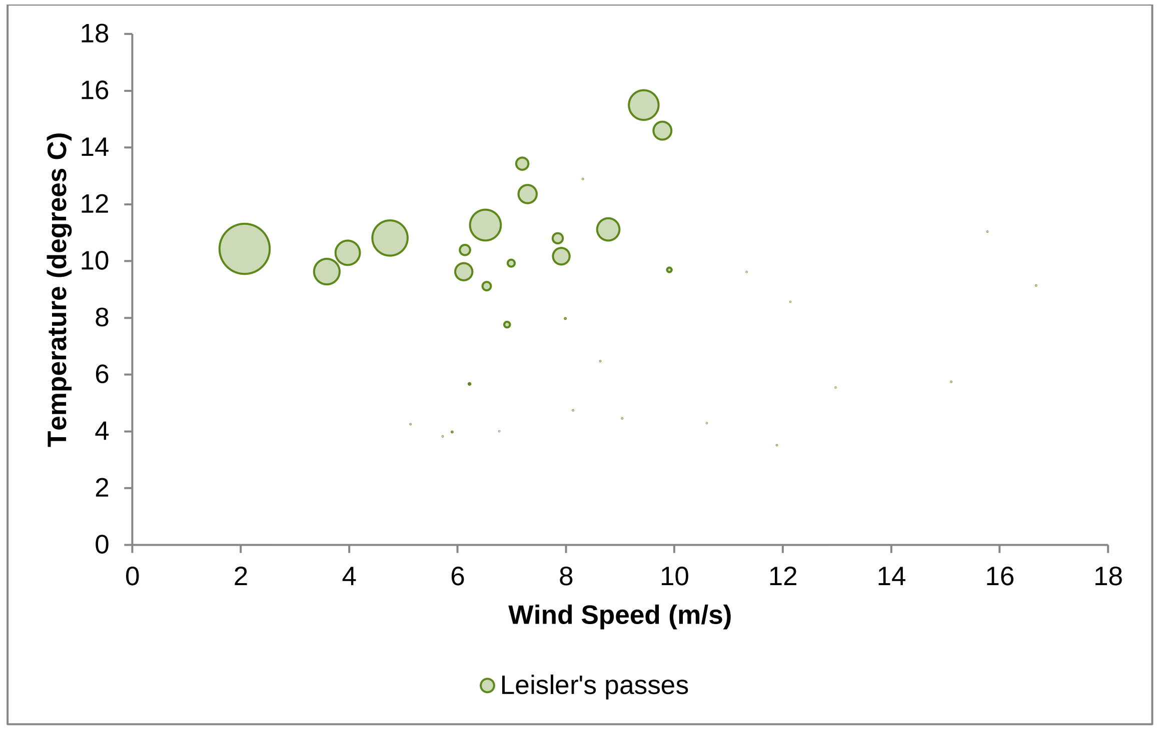

Figure 2: Relative number of recorded nightly Leisler's bat passes and the corresponding mean wind speed and temperature values. Virtually all activity is recorded when temperatures exceed 8 degrees C and wind speeds are below 10m/s.

3. Since the relationship between recorded activity and fatalities remains unclear, mitigation measures have been developed to avoid 90% of bat activity as a proxy for reducing collision risk. This approach was used at another SPR project in Scotland, and the resulting number of bat fatalities was below the rate of detection – effectively zero. Given this project remains the only commercial windfarm in the UK with curtailment measures in place, it provides the best source of confidence that this approach will be similarly successful at other projects.

4. The curtailment measures will be implemented at each turbine during the months of June, July, and August during each year for the lifetime of the Development unless monitoring results necessitate a change. During each night within this period, curtailment parameters will apply in 3 stages: post-sunset, between sunset and sunrise, and pre-sunrise. The initial parameters to be used for a curtailment strategy which will avoid 90% of activity are shown in Table 1.

Table 1: Initial parameters to be used in a 3 stage curtailment system during June, July and August

Stage 1 (Post-sunset)	
Cut-in wind speed	13.3 m/s
Start after sunset	20 mins
Stop after sunset	110 mins
Stage 2 (Intervening Period)	
Cut-in wind speed	5.5 m/s
Start after sunset	110 mins
Stop before sunrise	75 mins
Stage 3 (Pre-sunrise)	
Cut-in wind speed	10 m/s
Start before sunrise	75 mins
Stop before sunrise	30 mins
Global Parameter	
Minimum temperature	7.5 °C

5. Weather data which was available for bat data collected in 2018 (July and August, June bat data was from 2017 and no met mast data was available for this period) was used to simulate turbine operation using these parameters over the same 10 minute periods. When the parameters in Table 1 were met, the turbines would have been curtailed as shown in Figure 3. The combination of parameters proposed has been selected to avoid 90% of bat activity while minimising the losses of energetic yield (n=1435 passes, n=1291 passes avoided).

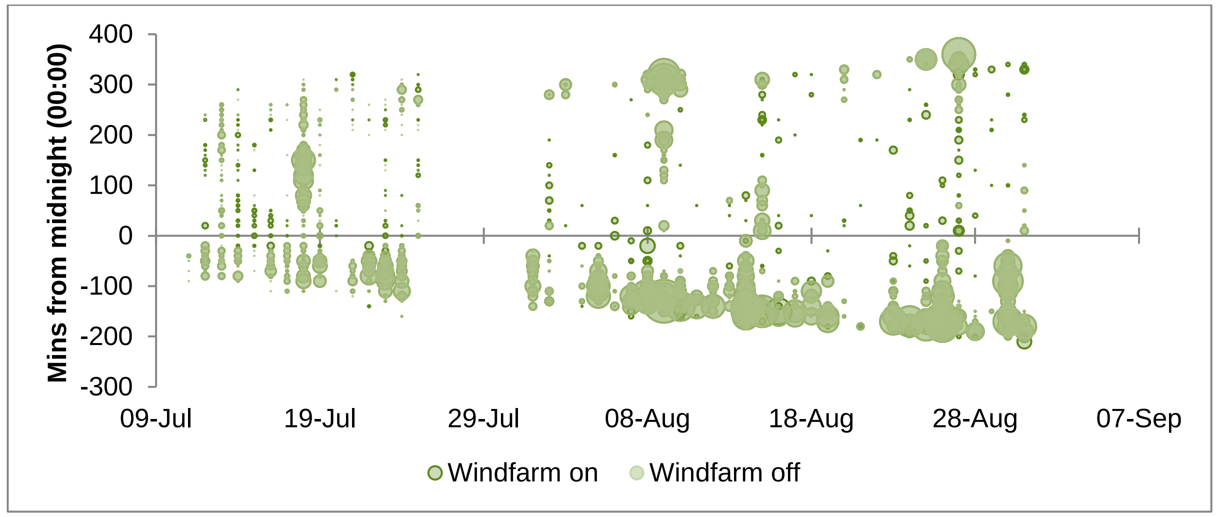

Figure 3: Plot of July and August 2018 survey data, with the relative size of each circle representing the number Leisler's bat passes recorded during a 10 minute period throughout each night. Where each circle is red indicates where turbines would have been curtailed using the parameters in Table 1.

1.3 Implementation

6. The implementation of the curtailment will be via software which will automatically send a "pause" command to the relevant turbine when the parameters are met, initiating a feathering of the blades to the fully open position using the pitch controls and disengagement of the generator. This will slow the rotation speed of the blades to below 1 RPM (i.e. slower than the second hand of a clock). The emergency braking system shall not be used.

7. The wind speed and external temperature will be obtained from each turbine anemometry apparatus (on the nacelle) via the Supervisory Control and Data Acquisition (SCADA) interface. The control software will run within the proprietary SPR Centre of Operation of Renewable Energy (CORE) system.

8. This method of control has already been established and is used for another SPR windfarm, Figure 4 is a screenshot of the parameter input window for this project within CORE. Note that the system currently only allows for a single stage curtailment, with a single set parameters for temperature and wind speed to apply between an offset from sunset and sunrise. This would be extended in the case of Rigged Hill Repowering to allow a 3 stage set of parameters to be incorporated.

9. Note that in the example of Figure 4 there is a "Speed Lo limit" of 5.5m/s, below which the turbine would enter a "pause" state, and a "Speed Hi Limit" of 5.6m/s above which the turbine would "run". The reason for this is to stop the turbine rapid cycling between "pause" and "run" when the wind speed was averaging 5.5m/s. In practice, the "Speed Hi Limit" is likely to be 0.5m/s higher than the selected curtailment speed to prevent this cycling damaging the turbine (which slightly increases the time which the turbine is curtailed).

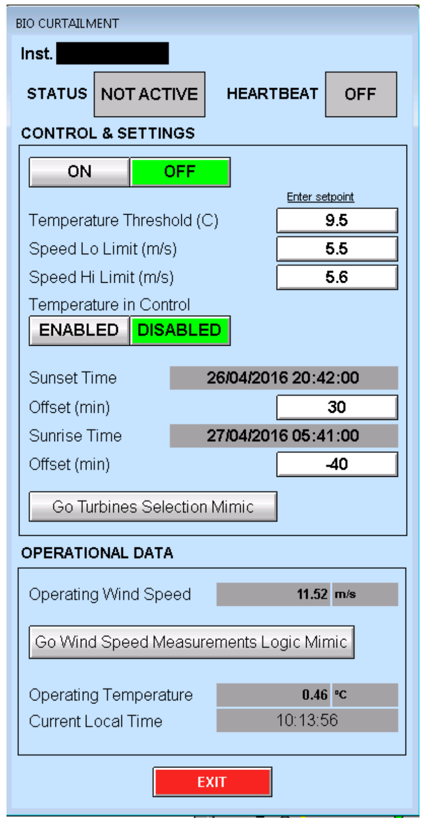

Figure 4: Screenshot of the curtailment parameter input window within CORE in use for another SPR windfarm.

1.4 Auditing

10. All turbine sensor data reported via SCADA is logged in a PI database[1]. This includes the wind speed and temperature data recorded at each turbine anemometry, as well as a TRUE/FALSE flag as to whether the curtailment system was in operation. As such it is a simple process to download the data over any period to validate that the system was operating according to the chosen parameters. An example of this output for another SPR windfarm is displayed in a graphical format in Figure 5. A similar output would be included in the annual report of the system operation for Rigged Hill Repowering.

[1] PI is a commercial product of OSISoft: https://www.osisoft.com/pi-system/

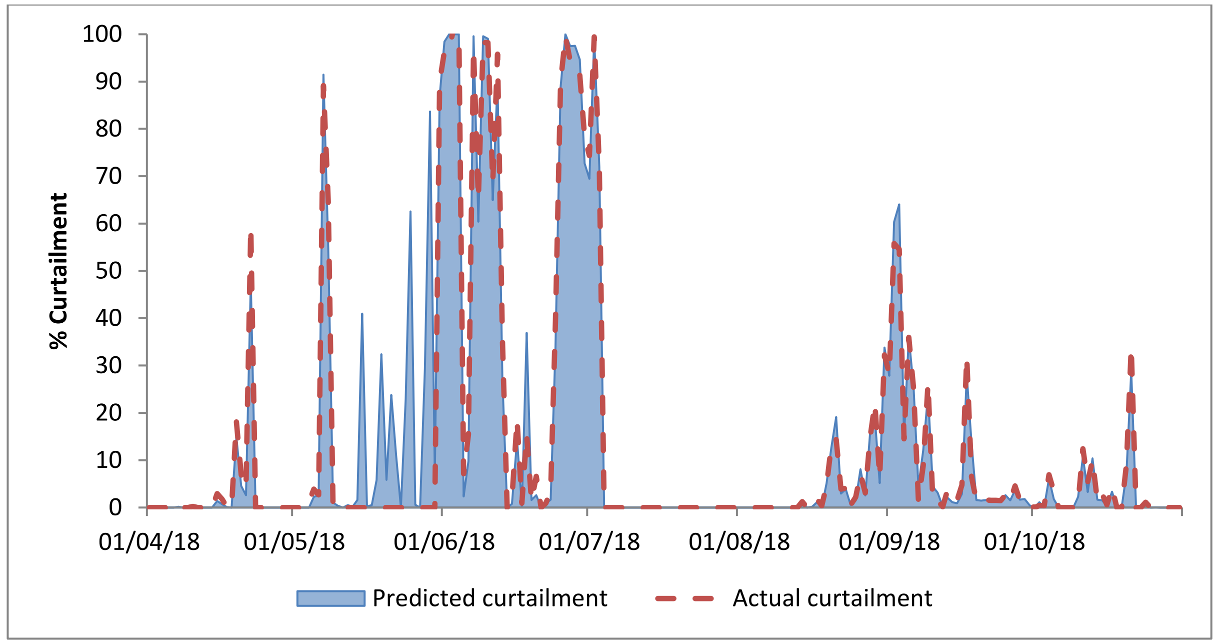

Figure 5: Example output of the auditing available from turbine SCADA data for another SPR windfarm in 2018. The blue shaded areas show the predicted curtailment (based on weather data) and the red dashed line shows the actual curtailment implemented during each night automatically by the CORE software. Data not available during two periods of site outage 9-29th May and 5th July – 12th August, when turbines were non-operational.

1.5 Monitoring

1.5.1 Rationale and Objective

11. Monitoring would comprise measurement of bat activity and fatality rates, and would be undertaken annually until validation of the initial parameters and any amendments was established in consultation with NIEA.

12. The maximum acceptable fatality rate will be 2 bats per turbine per year, a figure which has been established in Germany[2] and considered achievable without incurring excessive energetic losses, while being considered unlikely to have a significant impact on bat populations and thus deemed to be "incidental" levels of fatality. The basis of "incidental" levels of bat mortality arising from windfarm operation being criminal was considered in RWE vs Eaton 2012 in England, which ruled that a threshold of bat fatalities must exist enable legitimate activities to take place.

13. **The objective of the monitoring is to provide a robust estimate of the total number of bat fatalities, which will be used to determine whether the mitigation is effective**. There is no specific objective to determine the specific weather conditions under which a fatality may have occurred, since the hypothesis at Year 1 is that the mitigation would be effective. As such the proposed sampling approach varies from that suggested in Appendix 4 of the guidance[3].

1.5.2 Overview

14. The survey methodology will comprise static bat recorders at all 7 wind turbines during June – August inclusive. Omni-directional microphones will be mounted 2m height below the turbine nacelle and positioned horizontally facing away from turbine towers.

15. Carcass searching will be undertaken within a 50m radius at all 7 turbines every 2 weeks from 1st June until end of August i.e. 7 searches in total. An example search schedule, which was used for the worked example below, is shown in Table 2. It should be noted that since the number of turbines which can be searched by a single dog team is 6 per day, the schedule only searches 6 of the 7 turbines during each survey. This is taken into account during the analysis.

Table 2: Search schedule using 14 day search interval

Search Date	t1	t2	t3	t4	t5	t6	t7
01/06/2019	0	1	1	1	1	1	1
15/06/2019	1	0	1	1	1	1	1
29/06/2019	1	1	0	1	1	1	1
13/07/2019	1	1	1	0	1	1	1
27/07/2019	1	1	1	1	0	1	1
10/08/2019	1	1	1	1	1	0	1
24/08/2019	1	1	1	1	1	1	0

16. A worked example of the expected parameter estimation and resulting precision of estimates is described below.

17. The same order will follow for both Figures and Technical Appendices.

1.5.3 Estimates and Precision

18. All sampling methods are a pragmatic comprise, and an acceptable threshold for the precision of the estimates must be made. The precision of fatality estimates is based on four key factors: carcass persistence rate; observer efficiency rate; search interval and proportion of area searched.

19. The median carcass persistence rate for bats at other SPR sites has been estimated at 2.53 days[4]. This may vary at Rigged Hill Repowering, and as such will be estimated across the monitoring period by placing n=5 bat carcasses distributed randomly below the n=7 turbines to be searched during each survey (i.e. n=35 bat carcasses trials in total). Each carcass will also be paired with a motion activated camera-trap, which will provide the exact timing as to when a carcass is removed. The carcasses will then be checked manually on the following survey and left in-situ if remains are still visible for a maximum of 4 weeks (i.e. 2 survey periods) then retrieved.

20. The search methodology will aim to achieve an observer efficiency rate of >80% (i.e. 80% of carcasses which are present are detected) and will calculate this using integrated trials of the n=35 carcasses placed to determine carcass persistence. Previous work at SPR sites using trained dog teams (and for the DEFRA study[5]) has demonstrated that an observer efficiency rate of >0.81 is achievable. It is assumed that 100% of the area under the turbines will be searched since there are no ground conditions at Rigged Hill Repowering which would restrict access. Based on these parameters and a 14 day search interval (i.e. every 2 weeks), a median estimate of 20.6% (95% CI 13.4-29.8%)[6] of carcasses which exist will be detected.

21. Based on the above parameters, if 2 carcasses were found the adjusted median total fatality estimate would be 4.03, with a 90% confidence interval between 0 and 13.93[7]. An example of the distribution of estimates of total fatality from this survey schedule with n=2 carcasses detected is shown in Figure 6.

[2] Behr, O. (2015). 'Bat-friendly' operation of wind turbines – the current status of knowledge and planning procedures in Germany. Presentation at Wind Power and Wildlife Symposium, Stirling University.
[3] SNH (2019). Bats and Onshore Wind Turbines: Survey, Assessment and Mitigation.
[4] Calculated using GenEst "Carcass persistence" package, exponential model
[5] Understanding the Risk to European Protected Species (bats) at Onshore Wind Turbine Sites to Inform Risk Management (Defra, 2016)
[6] Calculated using GenEst "Detection Probability" package
[7] Calculated using GenEst "Mortality Estimation" package

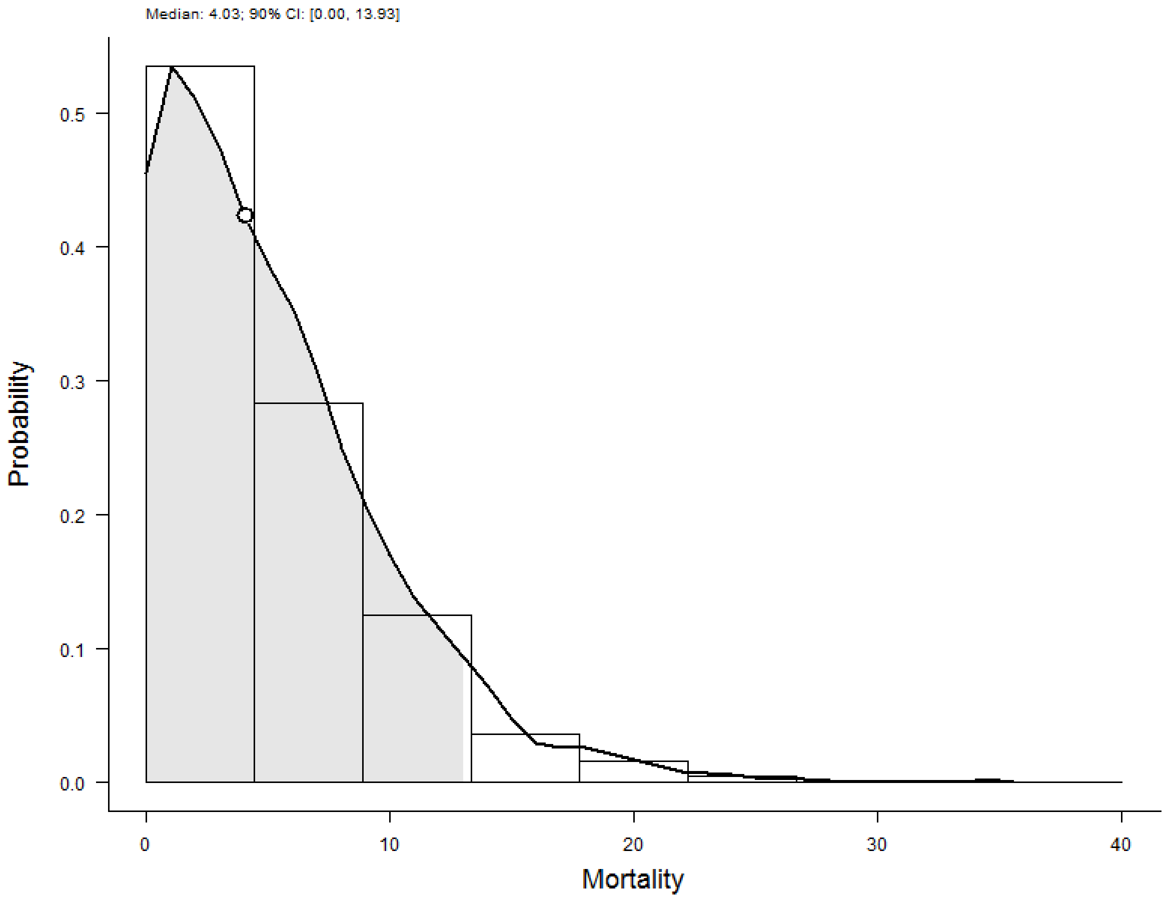

Figure 6: Output from GenEst "Mortality Estimation" using carcass persistence and observer efficiency data from previous SPR studies for a scenario where n=2 carcasses are detected.

22. Therefore, in order to be 90% confident that the true fatality rate is less than 2 bats per turbine per year (i.e. n=14 fatalities), fewer than 2 carcasses should be detected using the survey methodology outlined above.

1.5.4 Analysis

23. Detailed analysis of the results will be undertaken using the USGS developed Generalised Estimator software[8], which combines different accepted methods of calculating fatalities into a single tool and allows different models to be fitted to datasets depending on their distribution. It also combines the calculation of different sources of error around each parameter into an estimate of uncertainty around the final estimate.

1.6 Change Management

24. Following each annual monitoring period, if the number of bat fatalities is less than 2 bats per turbine per year, the operator shall be entitled to propose amendments to the curtailment parameters. If the number of bat fatalities is greater than 2 bats per turbine per year, the operator shall be obligated to propose amendments to the curtailment parameters. Any changes proposed will be consulted on with NIEA, and implemented the following year with repeated monitoring using the methods described above unless otherwise varied (e.g. to investigate condition in which fatalities are occurring).

[8] https://www.usgs.gov/software/genest-a-generalized-estimator-mortality

Rigged Hill Windfarm Repowering

Technical Appendix A.5: Fisheries & Aquatic Ecology

Volume 3 – Technical Appendix
July 2019

SCOTTISHPOWER RENEWABLES

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A8.5 Fisheries & Aquatic Ecology

1 Introduction

1. This Appendix to the Environmental Statement (ES) evaluates the effects of the Development on the Fisheries and Aquatic Ecology resource. This assessment was undertaken by Paul Johnston Associates. The assessment considers the potential effects of the Development during the following development stages:

- Decommissioning of the Operational Rigged Hill Windfarm (initial phase of the Development);
- Construction of the Development (likely to occur in tandem with the above phase);
- Operation of the Development; and
- Decommissioning of the Development (Final Phase).

2. The decommissioning of the Operational Rigged Hill Windfarm and the construction of the Development is likely to occur partly in tandem and would have a greater effect than if the two processes were to arise at different times. This represents a worst-case scenario for assessment purposes. Any effects arising as a result of the future decommissioning of the Development, are considered to be no greater than the effects arising when these two phases are combined. As a result, the final decommissioning phase has not been considered further in this assessment.

3. This Appendix includes the following elements:

- Legislation, Policy and Guidance;
- Assessment Methodology and Significance Criteria;
- Baseline Description;
- Assessment of Potential Effects;
- Mitigation and Residual Effects;
- Cumulative Effect Assessment;
- Summary of Effects;
- Statement of Significance; and
- Glossary.

2 Legislation, Policy and Guidance

4. With regard to fisheries administration and legislation, the footprint of the Development lies within the Loughs Agency's geographic area of responsibility.

5. Under Section 11 (6) of the Foyle Fisheries Act (Northern Ireland) 1952 and the Foyle Fisheries Act 1952 (Republic of Ireland) the Foyle Fisheries Commission was given the responsibility for "the conservation, protection and improvement of the Fisheries of the Foyle Area generally". Under the North/South Co-Operation (Implementation Bodies) (Northern Ireland) Order 1999 and the British Irish Agreement Act 1999 these functions were extended to include the Carlingford Area, and the Foyle Fisheries Commission transferred its functions to the Loughs Agency.

6. The Loughs Agency is an agency of the Foyle, Carlingford and Irish Lights Commission (FCILC), established under the 1998 Agreement between the Government of the United Kingdom of Great Britain and Northern Ireland and the Government of Ireland.

7. The following guidance, legislation and information sources have been considered in carrying out this assessment:

8. EU legislation relevant to fisheries and the water environment in member states:

- EC Habitats Directive (92/43/EEC)
- EU Water Framework Directive (2000/60/EC) (incorporating standards from the Fish Directive (Consolidated) (2006/44/EC); repealed in 2013)
- European Eel Regulation (EC) 1100/2007

9. Domestic legislation relevant to fisheries and the water environment in the Loughs Agency area of Northern Ireland:

- Fisheries (Northern Ireland) Act 1966
- Foyle Fisheries Act (Northern Ireland) 1952
- North/South Co-Operation (Implementation Bodies) (Northern Ireland) Order 1999
- Drainage (Northern Ireland) Order 1973 and The Drainage (Amendment) (Northern Ireland) Order 2005
- Environment (Northern Ireland) Order 2002
- Nature Conservation and Amenity Lands (Amendment) (Northern Ireland) Order 1989
- Water (Northern Ireland) Order 1999
- Water Environment (Water Framework Directive) (Northern Ireland) Regulations 2003
- Wildlife (Northern Ireland) Order 1985
- Wildlife and Natural Environment Act (Northern Ireland) 2011

10. Policy with regard to Atlantic salmon and European eel in this region is set out in the following:

- River Roe and Tributaries ASSI Citation;
- River Roe and Tributaries SAC Conservation Objectives;
- River Roe Local Management Area Plan;
- Atlantic Salmon Management Strategy for Northern Ireland and the Cross-Border Foyle and Carlingford catchments to meet the objectives of NASCO resolutions and agreements, 2013-18[1];
- North Western International River Basin District Eel Management Plan (Northern Regional Fisheries Board/Loughs Agency/DCAL).

11. Specific guidance relevant to the proposed Development includes:

- Guidelines for Fisheries Protection during Development Works (Foyle and Carlingford areas); Environmental Guidelines Series – No. 1[1] (Loughs Agency, 2011);
- Culvert Design and Operation Guide (C689) (CIRIA, 2010)
- Environment Agency Policy Regarding Culverts: Technical Guidance on Culverting Proposals (EA, 1999)
- PPG1: Understanding Your Environmental Responsibilities – Good Environmental Practices;
- GPP2: Above ground oil storage tanks;
- PPG3: Use and design of oil separators in surface water drainage systems;
- GPP4: Treatment and disposal of wastewater where there is no connection to the public foul sewer;
- GPP5: Works and maintenance in or near water;
- PPG6: Working at construction and demolition sites;
- PPG7: The safe operation of refuelling facilities;
- GPP8: Safe storage and disposal of used oils;
- GPP13: Vehicle washing and cleaning;
- PPG18: Managing fire water and major spillages;
- GPP21: Pollution incident response planning;
- GPP26: Safe storage - drums & intermediate bulk containers.

3 Assessment Methodology and Significance Criteria

3.1 Scoping Responses and Consultations

12. Consultation for this ES topic was undertaken with the organisations shown in **Table A8.5.1**.

[1] Loughs Agency (2011) Guidelines for Fisheries Protection during Development Works (Foyle and Carlingford areas); Environmental Guidelines Series – No. 1.

Table A8.5.1: Consultation Responses

Consultee	Type and Date	Summary of Consultation Response	Response to Consultee
Loughs Agency	Email 17/07/17	Section 69 authorisation issued to survey fish populations in stream draining the Site. No specific concerns/ issues raised with regard to the Development.	No direct response to this consultation required.
The Honourable The Irish Society	Email 13/09/17	Indicated that they have sporting rights within the Site Boundary. Also noted the possibility of pollution or run-off from the construction works that might affect the fishing rights in the Roe catchment, or result in loss of or damage to wildlife.	The Applicant is aware of the sporting and land rights across the Site. Points addressed at 7.2.1, 7.2.2, 8.1.1 & 8.1.2 in this document; also in Outline DCEMP for ES and Water DCEMP Technical Appendix A7.2

3.2 Scope of Assessment

13. The fisheries and aquatic ecology assessment involved desktop review of relevant information/data, field surveys, data processing, analysis and interpretation. Current fisheries data and relevant conservation information on the River Roe catchment is assimilated and supplemented through site specific fisheries and ecological surveys of the Development covering the principal watercourses within and downstream of the Site Boundary.

14. Field survey procedures consisted of walkover surveys of the principal watercourses, assessments of physical habitat conditions, measurement of basic chemistry parameters, collection of benthic invertebrate samples for assessment of biological quality, and a fish stock survey by electrofishing.

15. The key issues for the assessment of potential effects on fisheries and aquatic ecology relating to the Development are:

- Temporary effects arising from the initial decommissioning and construction phases such as the elevation of suspended sediments or the obstruction of fish passage;
- Permanent effects such as loss of habitat; and
- Indirect effects, including effects on fish and aquatic habitats outwith the Site Boundary due to waterborne sediments or other polluting materials.

3.3 Study Area / Survey Area

16. ES studies in the field of Fisheries and Aquatic Ecology primarily focus on the receptors (waterbodies) directly affected by a plan or project i.e. running waters and standing waters contained within a specific area subject to the proposed plan or project. However, due to the nature of flowing waters and the longitudinal dimension of river connectivity, a plan or project may have indirect effects downstream of the actual area subject to the proposed plan or project. It has therefore become standard practice for the study area in such cases to include extensive downstream reaches of watercourses, notably when these waterbodies may be of particular conservation significance whether subject to designated status or in terms of species of international or national importance. With regard to the Rigged Hill Windfarm Repowering, the study area included the streams draining the area within the Site Boundary and forming part of the Castle River catchment which subsequently connects to the River Roe. Field survey work was carried out on these streams both within the Site Boundary and downstream of the Site. The desk assessment includes an evaluation of fisheries in the wider catchment of the River Roe.

[2] Bain M., Finn J. and Brooke, H. (1985). Quantifying stream substrate for habitat analysis studies. N Am J Fish Manage 5, 499-500.

4 Baseline Survey Methodology

4.1 Desk Study

17. A desk study was carried out to assimilate baseline information relating to salmonid fisheries, ecological status (under Water Framework Directive (WFD)) and water quality (chemical and biological) for the study area. The following sources were consulted/used:

- Loughs Agency
- Northern Ireland Environment Agency (NIEA); Water Management Unit (WMU) (Rivers and Lakes Team) https://www.daera-ni.gov.uk/articles/water-framework-directive
- NIEA - Protected Areas https://www.daera-ni.gov.uk/topics/biodiversity-land-and-landscapes/protected-areas
- Joint Nature Conservation Committee (JNCC) www.jncc/defra.gov.uk

4.1.1 Environmental data

18. Environmental monitoring data for the River Roe and the Castle River was provided by DAERA Northern Ireland Environment Agency (NIEA).

4.1.2 Conservation status

19. Information on the conservation status of the River Roe was accessed through DAERA and JNCC web sources.

4.2 Field Survey: Stream Quality

20. Survey sites were selected on each of the five principal streams draining the Site. For each site, baseline water chemistry, physical habitat and aquatic ecology were assessed.

4.2.1 Chemical Water Quality: Basic Parameters

21. A series of basic water quality parameters were measured at each site using portable meters to provide an outline profile of chemical quality. Turbidity was measured using a EUTECH NT-100 turbidimeter, which records in Nephelometric Turbidity Units (NTU). pH was measured using a WTW 3110 pH meter, dissolved oxygen with a Hanna Oxy-Check oxygen meter, and conductivity with a Hanna HI86303 conductivity meter; temperature measurements were made with both the pH and oxygen meters.

22. Turbidity was used as a proxy indicator of suspended solids as it can be measured quickly in the field. However, there is no universal relationship between turbidity and suspended solids, and accurate computation of suspended solids concentrations from turbidity would require that a calibration exercise be carried out on a site-specific basis.

4.2.2 Physical Habitat

23. River physical habitat (substratum type, depth, flow velocity) was assessed based on the fully quantitative method developed by DAERA Inland Fisheries Division and the AgriFood and Biosciences Institute (AFBI). In each site, surveys consisted of a 40m stream reach with 25 sampling points across five equidistant cross-sectional transects except on very narrow (<0.3m width) and overgrown streams where it was difficult to observe the riverbed; on these streams, up to 12 transects (1-3 sampling points per transect) were surveyed in each reach.

24. At each sampling point, flow velocity was recorded at 60% depth using a Geopacks flow meter, with water depth measured using the meter's impeller stick; substrate was visually assessed using a bathyscope with the dominant substrate type recorded according to a modified Wentworth Scale[2] (**Table A8.5.2**).

Table A8.5.2: Substrate classification and scoring based on the Wentworth system[3]

Substrate type	Size Class (mm)	Score
Sand/silt	<2	1
Gravel	2-16	2
Pebble	17-64	3
Cobble	65-256	4

[3] Bain M., Finn J. and Brooke, H. (1985). Quantifying stream substrate for habitat analysis studies. N Am J Fish Manage 5, 499-500.

Substrate type	Size Class (mm)	Score
Boulder	>256	5
Irregular Bedrock	-	6

25. The following physical characteristics also were measured:

- Stream width at each transect
- Substrate composition (visually estimated[3]);
- Percentage of deposited fine sediment (<2mm grain) on the river bed[4] with the dominant fine sediment type (sand, silt, clays) determined by running the grain through the observer's fingers

26. The classification system[3] was used to summarise the composition of substrate in a reach based on two indices:

- Coarseness index (CI) – calculated as the mean dominant substrate score
- Heterogeneity (SD) – calculated as the standard deviation of the mean CI.

These indices show how coarse or smooth the substrate of a reach is and if it is comprised of a mixture or is dominated by a particular substrate class **(Table A8.5.3)**.

Table A8.5.3: Substrate description inferred from sample data[3]

Mean substrate score (CI)	Heterogeneity (SD)	Inferred substrate description
3.2	1.96	Heterogeneous, smooth and rough
5.0	0.00	Homogeneous, coarse
1.25	0.44	Nearly homogeneous, smooth
3.25	0.85	Heterogeneous, intermediate coarseness
5.05	0.69	Heterogeneous, coarse

4.2.3 Aquatic Ecology

27. Stream benthic communities are sensitive to a range of environmental conditions including fine sediment, and have taxa with relatively long lifespans that integrate stressor effects over longer timescales than may be indicated by physico-chemical parameters alone[5].

28. Baseline ecology of the streams within and draining the Site was assessed by sampling the benthic macroinvertebrate community during in October 2017 using a standard three minute kick sample (hand held 1mm mesh pole net); the method is recommended by the United Kingdom Technical Advisory Group (UK-TAG) for assessing the condition of the quality element "benthic invertebrates" for WFD reporting[6]. Sampling in autumn is a preferred season because of the greater expected abundance of larger instars, higher net retention, and the lower emergence of species with aerial stages.

29. Where possible, samples were collected from riffle/run habitats, fixed in 4% formalin for 1 week, followed by preservation in 70% ethanol prior to sorting and identification. In the laboratory, macroinvertebrates were spread across a 4 x 5, 20-square grid sorting tray to facilitate identification and to estimate relative abundance. Abundant taxa were counted in a subset of 5 squares and scaled to whole sample estimates[7]. Less abundant taxa were counted in all grid squares.

30. For each site, the baseline was summarised as the total number of taxa, total site BMWP-WHPT score, and average score per taxon (ASPT), using the abundance weighted sensitivity scores developed by Walley and Hawkes (1997) as recommended for the Water Framework Directive[6].

31. Sites were classified following the Water Framework Directive approach for assessing the condition of the quality element "benthic invertebrates". Environmental quality ratios (EQRs) were calculated for the number of taxa and ASPT by dividing observed by expected values **(Table A8.4.4)**. Both metrics were then assessed in a "worst of" approach to give an overall invertebrate classification[6].

Table A8.5.4: Environmental Quality Ratios used to classify test sites based on benthic invertebrates

Quality status/ condition	WHPT NTAXA EQR	WHPT ASPT EQR
High/Good	0.80	0.97
Good/ Moderate	0.68	0.86
Moderate/ Poor	0.56	0.72
Poor/ Bad	0.47	0.59

32. Expected (predicted) metric values were determined from site-specific physical and chemical data using the RIVPACS IV model incorporated in the online River Invertebrate Classification Tool (RICT: https://www.sepa.org.uk/environment/water/classification/river-invertebrates-classification-tool/).

33. Predictions require input of the following test site data: Altitude; distance from source; discharge category; percent substrate composition; electrical conductivity. Geographic environmental data were obtained from 1:50,000 ordnance surveys maps and from stream physical habitat assessments, whereas discharge category was determined first from daily mean flows for the 2005-2014 flow record to estimate mean annual discharge and comparison with discharge categories[7].

34. Samples from at least two seasons are recommended for site status classification, though classifications can be generated from single season samples. In RICT, the default RUN settings were selected with season set to autumn and the taxon end-group and predictive environmental variables both set for Northern Ireland

4.3 Field Survey: Fisheries Habitat

35. An outline assessment of the streams draining the Study Area was carried out in August 2017 and consisted of walkover surveys recording general characteristics to provide an outline assessment for these watercourses. This was then complimented through a fish stock survey by electrofishing.

36. The descriptive terminology used in the survey is based on the Life Cycle Unit method[8] currently used by DAERA Inland Fisheries and the Loughs Agency (see also DANI advisory leaflet No 1). In summary, habitat type is recorded as:

- Nursery (shallow rock/cobble riffle areas for juvenile fish - fry/parr)
- Holding (deeper pools/runs for adult fish)
- Spawning (shallow gravel areas for fish spawning)
- Unclassified (unsuitable for fish – shallow bedrock areas or heavily modified sections of channel)

4.4 Field Survey: Juvenile Fish Stocks

37. Monitoring of fish stocks by the Loughs Agency tends not to include sampling sites in the upper reaches of tributaries in most river systems. Therefore, this part of the fisheries assessment considered the principal streams draining the development site

[4] Clapcott, J.E., Young, R.G., Harding, J.S., Matthaei, C.D., Quinn, J.M. and Death, R.G. (2011) Sediment Assessment Methods: Protocols and guidelines for assessing the effects of deposited fine sediment on in-stream values. Cawthron Institute, Nelson, New Zealand.
[5] Extence C.A., Chadd R.P., England J., Dunbar M.J., Wood P.J. & Taylor E.D. (2013) The assessment of fine sediment accumulation in rivers using macro-invertebrate community response. River Research and Applications, 29,17–55.
[6] WFD-UKTAG (2014). UKTAG River Assessment Method: Benthic Invertebrate Fauna. Invertebrates (General Degradation): Walley, Hawkes, Paisley & Trigg (WHPT) metric in River Invertebrate Classification Tool (RICT).
[7] Murray-Bligh, J. (2002) *UK Invertebrate Sampling and analysis for EU-Star project*. EU- STAR(http://www.eu-star.at/pdf/RivpacsMacroinvertebrateSamplingProtocol.pdf)
[8] Kennedy GJA (1984) The ecology of salmon habitat re-instatement following river drainage schemes. IFM Annual Study Course, Magee College, Londonderry, 18pp.

and set out to obtain details on salmonid distribution in areas of the Castle River catchment not covered in routine sampling by the Loughs Agency.

38. A juvenile fish stock survey of the streams draining the site was carried out by electrofishing at selected locations in August 2017.

39. Electrofishing was carried out according to a semi-quantitative methodology[9]. The procedure involves two operators fishing continuously in an upstream direction for five minutes at each sampling location, using an E-Fish 500W single anode electrofishing backpack (EF-500B-SYS). The system operates on 24V input and delivers a pulsed DC output of 10 to 500W at a variable frequency of 10 to 100Hz. Output voltage and frequency are adjusted according to the electrical conductivity at the survey site.

40. All fish were caught using a dip net and retained for general inspection and length measurement before being returned to the water live. Any additional Age 0 salmonids observed but not captured were also recorded. This method is consistent with DAERA and Loughs Agency monitoring procedures.

41. The semi-quantitative electrofishing method has been calibrated separately for trout and salmon based on extensive studies in river reaches of known juvenile salmonid density. This has resulted in the development of an abundance classification system (Abundance Index) for salmon with five categories: Absent, Poor, Fair, Good, Excellent **(Table A8.5.5a)**. The Abundance Index for trout has six classifications: *Absent, Poor, Poor/Fair, Moderate, Good, Excellent* **(Table A8.5.5b)**.

Table A8.5.5a: Semi-quantitative abundance categories for age 0 salmon[9]

Fry (0+) nos.	Density (No/100m2)	Abundance/ quality category
0	0	Absent
1 – 4	0.1 – 41.0	Poor
5 – 14	41.1 – 69.0	Fair
15 – 24	69.1 – 114.6	Good
25+	114.6+	Excellent

Table A8.5.5b: Semi-quantitative abundance categories for age 0 trout as developed by Kennedy (*unpublished data*)

Fry (0+) nos.	Density (No/100m2)	Abundance/ quality category
0	0	Absent
0 – 1	0.1 – 7.0	Poor
2 – 3	7.1 - 16.5	Fair
4 – 8	17 - 31	Moderate
9 – 17	32 - 59.9	Good
18+	60+	Excellent

4.5 Methodology for the Assessment of Effects

42. The assessment of effects was derived from methodologies outlined by:

- the Design Manual for Roads and Bridges specifically with regard to Road Drainage and the Water Environment, Volume 11, Section 3, Part 10 HD45/09[10];
- Guidelines for Ecological Impact Assessment in the UK and Ireland (2018)[11].

43. The significance of the potential effects of the Development has been classified by professional consideration of the sensitivity of the receptor and the magnitude of the potential effect.

4.5.1 Sensitivity of Receptors

44. The sensitivity of the baseline conditions, including the importance of environmental features on or near to the Site or the sensitivity of potentially affected receptors, was assessed in line with best practice guidance, legislation, statutory designations and / or professional judgement.

45. Using the information assembled through the baseline assessment, the Fisheries Significance/Sensitivity of each watercourse was graded according to the generic methodology for environmental sensitivity outlined in the Design Manual for Roads and Bridges. **Table A8.5.6** details the framework applied in determining the sensitivity and this evaluation was used as the basis for the assessment of effects and the specification of any necessary mitigation requirements with regard to fisheries and the aquatic environment.

Table A8.5.6: Framework for Determining Sensitivity of Receptors

Sensitivity	Definition	Typical Examples
Very High	Attribute has a high quality and rarity on a regional or national scale	WFD Class 'High'. Site protected/designated under EC or UK habitat legislation (SAC, ASSI, salmonid water)/Species protected by EC legislation. Watercourse containing salmon and supporting a nationally important fishery or river ecosystem.
High	Attribute has a high quality and rarity on a local scale	WFD Class 'Good'. Species protected under EC or UK habitat legislation. Watercourse containing salmon or trout and supporting a locally important fishery or river ecosystem.
Medium	Attribute has medium quality and rarity on a local scale	WFD Class 'Moderate'. Watercourse containing trout and upstream of locally important fishery or river ecosystem.
Low	Attribute has low quality and rarity on a local scale	WFD Class 'Poor'. Watercourse without salmon or trout but upstream of locally important fishery or river ecosystem.
Negligible	Attribute has very low quality and rarity on a local scale	WFD Class 'Poor'/unspecified.

4.5.2 Magnitude of Effect

46. The magnitude of potential effects was identified through consideration of the Development, the degree of change to baseline conditions predicted as a result of the Development, the duration and reversibility of an effect and professional judgement, best practice guidance and legislation.

47. The criteria for assessing the magnitude of an effect are presented in **Table 8.7** which includes a consideration of the timescale of the effect (short, medium or long term).

[9] Crozier WW & Kennedy GJA (1994) Application of semi-quantitative electrofishing to juvenile salmonid stock surveys. Journal of Fish Biology 45, 159-164.
[10] DMRB (2009) Design Manual for Roads and Bridges. Road Drainage and the Water Environment, Volume 11, Section 3, Part 10 HD45/09.
[11] CIEEM (2018) Guidelines for Ecological Impact Assessment in the UK and Ireland.

Table A8.5.7 Framework for Determining Magnitude of Effects

Magnitude	Definition	Type and Scale of Effect
High	Results in loss of attribute and/or quality and integrity of the attribute	Loss or extensive change to a fishery. Loss or extensive change to a designated Nature Conservation Site. Major alteration to fish population levels in catchment as a whole, through fish mortality, habitat destruction or barrier to migration. Duration: long-term (>5 years).
Medium	Results in effect on integrity of attribute, or loss of part of attribute	Partial loss in productivity of a fishery. Appreciable alteration to fish population levels in specific sub-catchment or zone. Duration: medium-term (1-5 years).
Low	Results in some measurable change in attribute's quality or vulnerability	Minor loss in productivity of a fishery. Minor alteration to fish population levels in specific sub-catchment or zone. Duration: short-term (up to 1 year).
Negligible	Results in effect on attribute, but of insufficient magnitude to effect the use or integrity	Unlikely to affect the integrity of the water environment. No measurable alteration to fish population levels.

4.5.3 Significance of Effect

48. The sensitivity of the asset and the magnitude of the predicted effects was used as a guide, in addition to professional judgement, to predict the significance of the likely effects. The correlation of magnitude against the sensitivity of the receptor determines a qualitative expression for the significance of the effect. The standard matrix shown in **Table A8.5.8** summarises the guideline criteria for assessing the significance of effects. The greater the sensitivity or value of a receptor or resource, and the greater the magnitude of the impact, the more significant the effect.

Table A8.5.8: Framework for Assessment of the Significance of Effects

Magnitude of Effect	Sensitivity of Receptor				
	Very High	High	Medium	Low	Negligible
High	Major	Major	Moderate	Moderate	Minor
Medium	Major	Moderate	Moderate	Minor	Negligible
Low	Moderate	Moderate	Minor	Negligible	Negligible
Negligible	Minor	Minor	Negligible	Negligible	Negligible

49. Effects predicted to be of Major or Moderate significance are considered to be 'significant' in the context of the EIA Regulations (shaded light green in the above table), and will require mitigation. Those effects assessed as Low or Negligible are not considered to be significant in terms of the EIA, and will not require mitigation.

50. **Table A8.5.9** lists the five significance categories indicating a description of the typical effects in each case.

Table A8.5.9: Framework for Determining Sensitivity of Receptors

Significance category	Descriptor of effects
Major	These beneficial or adverse effects are generally, but not exclusively, associated with sites or features of international, national or regional importance that are likely to suffer a most damaging impact and loss of resource integrity. However, a major change in a site or feature of local importance may also enter this category.
Moderate	These beneficial or adverse effects may be important, but are not likely to be key decision-making factors. The cumulative effects of such factors may influence decision-making if they lead to an increase in the overall adverse effect on a particular resource or receptor.
Minor	These beneficial or adverse effects may be raised as local factors. They are unlikely to be critical in the decision-making process, but are important in enhancing the subsequent design of the project.
Negligible	No effects or those that are beneath levels of perception, within normal bounds of variation or within the margin of forecasting error.

5 Baseline Description

51. This element of the assessment consisted of:

- Desk studies to collate baseline information on fisheries, conservation designations, and ecological status of waterbodies hydrologically connected to the Site; and
- Field surveys focussed on the streams draining the Site to assess baseline physical habitat conditions, biological quality, salmonid habitat, and fish distribution. Field survey work was therefore carried out both within the Site Boundary and in the immediate downstream reaches of the drainage streams connecting to the Castle River and thence to the Roe.

5.1 Designated Sites

52. The Development is not located within the boundary of any statutory or non-statutory designated sites of international, national or local nature conservation importance. However, the Site drains into the Castle River which is hydrologically connected to the River Roe and Tributaries ASSI and SAC.

5.1.1 Legislative Context

53. The EC Habitats Directive (92/43/EEC) requires member states to designate Special Areas of Conservation (SACs) in order to protect habitats and species listed in Annex I and Annex II of the directive. The Habitats Directive was transposed into Northern Ireland legislation by the Conservation (Natural Habitats, etc) (Northern Ireland) Regulations 1995.

54. The Environment (Northern Ireland) Order 2002 provides the legislative basis for the protection of important nature conservation sites in Northern Ireland through the declaration of Areas of Special Scientific Interest. ASSIs are the major statutory mechanism for protecting nature conservation sites and generally provide the underpinning protection measure for the designation of European sites.

5.1.2 River Roe and Tributaries ASSI

55. The River Roe and Tributaries was declared an Area of Special Scientific Interest (ASSI) in 2007 (ASSI 246), due to the physical features of the river and its associated riverine flora and fauna.

56. The ASSI extends over approximately 87 km of watercourse and encompasses the main channel of the River Roe and several significant tributaries but not the Castle River which drains the Site. The ASSI is noted for the physical diversity and naturalness of the banks and channels, especially in the upper reaches. The richness and naturalness of its plant and animal communities are also significant features, in particular the population of Atlantic salmon, which is of international importance.

5.1.3 River Roe and Tributaries SAC

57. The River Roe and Tributaries was designated as a Special Area of Conservation (SAC) in 2007 (UK0030360) with Atlantic salmon noted as the Annex II species selected as the primary reason for designation of the site. The Roe SAC was also selected for the following Annex I habitat:

- Water courses of plain to montane levels with *Ranunculion fluitantis* and *Callitricho-Batrachion* vegetation.

58. Otter *Lutra lutra*, also listed in Annexe II, was identified as a qualifying feature but not a primary reason for site selection.

59. The conservation objectives for this SAC with regard to salmon are:

- Maintain and if possible expand existing population numbers and distribution (preferably through natural recruitment), and improve age structure of population.

- Maintain and if possible enhance the extent and quality of suitable Salmon habitat - particularly the chemical and biological quality of the water and the condition of the river channel and substrate.

60. Salmon is included in Annex II as a species of European importance, and other SACs in the Foyle catchment with salmon as the primary selection feature are:

- River Foyle and Tributaries
- River Faughan and Tributaries

5.2 EU Water Framework Directive
5.2.1 Local River Catchments

61. The Development is located in the Castle River sub-catchment of the River Roe. The Castle River flows in a north-westerly direction to join with the Roe near Limavady**;** the location of the Site within the Owenrigh sub-catchment and the River Roe catchment is shown in **Figure A8.5.1**. The Roe forms one of the major sub-catchments of the Foyle system **(Figure A8.5.2)**, which is assigned to the North Western International River Basin District (NWIRBD) under the Water Framework Directive.

62. The River Roe rises in the Sperrin Mountains and drains a catchment area of 385 km^2 through a river length of approximately 132 km including tributaries. The river flows in a general northerly direction to discharge into Lough Foyle near Limavady. Land use in the upper reaches is predominantly rough grazing for sheep with extensive conifer forestry plantation. In the middle reaches the river flows through a deep narrow gorge then emerges onto an alluvial flood plain to form a meandering channel between open grassy embankments.

63. The Roe is a top-quality salmon system with excellent quality habitats populated by sustainable stocks of salmon and trout. The river is particularly suited to a flourishing stock of Atlantic salmon and supports a popular recreational fishery. This is borne out in the accumulated data recorded by the Loughs Agency which indicates consistent levels of spawning by salmon and generally favourable densities of juvenile salmon.

5.2.2 Ecological Status

64. To achieve the ecological objectives of the Water Framework Directive (WFD), River Basin Management Plans (RBMPs) have been implemented through a series of Local Management Areas (LMA) during the initial 2010 to 2015 planning cycle and now extending into the subsequent 2016-21 cycle, with provision under WFD for a third cycle from 2022 to 2027.

65. The Development lies entirely within the Roe LMA, and specifically within the waterbody defined as Castle River (UKGBNI1NW020204061). Proceeding downstream from the Site there is sequential hydrological connection between the following waterbodies in the Roe LMA:

- Castle River (UKGBNI1NW020204061)
- Curly River (UKGBNI1NW020202013)
- River Roe (UKGBNI1NW020202024)

66. The ecological assessment for these waterbodies in 2015 is summarised in **Table A8.5.10** which indicates the overall classification and status with regard to each of the principal parameters monitored.

Table A8.5.10: Classification of individual quality elements contributing to overall WFD status of relevant water bodies in Roe LMA, 2015 (Source: NIEA).

Parameter	Castle River (Ref 4061)	Curly River (Ref 4060)	River Roe (Ref 2024)
Benthic Invertebrates	Good	Good	High
Macrophytes	High	High	Good
Phytobenthos	Good	Good	Good
Fish	-	-	Good
Biochemical Oxygen Demand	Good	High	High
Temperature*	High	High	High
Dissolved oxygen	High	High	High
pH	High	High	High
Soluble Reactive Phosphorus	Good	High	Good
Ammonia	Good/High	Good/High	Good/High
Hydrological regime	High	High	Good
Overall Status	**Good**	**Good**	**Good**

67. For the current planning cycle to 2021 NIEA has developed a series of RMBPs for each River Basin District including the North Western RBD. These documents set out the latest assessment of pressures and impacts on the water environment, describe the progress NIEA made towards achieving objectives for 2015, and explain the significant water management issues that still need to be addressed.

5.2.3 EC Fish Directive

68. The EC Freshwater Fish Directive (Consolidated) 2006/44/EC (FWFD) set physical and chemical water quality objectives for salmonid waters and cyprinid waters, specifically with regard to dissolved oxygen, ammonia, pH and total zinc.

69. The main stem channel of the River Roe was designated as “salmonid” under the Surface Waters (Fish Life Classification) Regulations (Northern Ireland) 1997, which implements the EC Freshwater Fish Directive. In 2003 this designation was extended to include several tributaries and extending the designation to the source of the Castle River.

70. The Fish Directive was repealed by the Water Framework Directive at the end of 2013, and the ecological status defined in the WFD sets the same protection to waterbodies designated for fish under the original directive. Areas designated under the Fish Directive have become areas designated for the protection of economically significant aquatic species under WFD and placed on a Register of Protected Areas.

5.3 Water Quality Monitoring

71. Chemical and biological quality of individual water bodies have been monitored by NIEA Water Management Unit on a monthly basis since 2009 to comply with statutory monitoring for Water Framework Directive reporting. There is a single monitoring station on the lower Castle River some distance downstream of the Development.

5.3.1 Chemical Quality

72. Summary results for a selection of chemical quality parameters at the Castle River monitoring site are presented in **Table A8.5.11**. It should be noted that this sampling location is approximately 6.5 km downstream of the Site.

Table A8.5.11: Selected Chemical Monitoring Data from the Castle River at Drummond Bridge, C688232, Site code 10176[14].

Year	Parameter	pH	Cond (µs/cm)	DO (mg/l)	DO (%sat)	BOD (mg/l)	NH3 (mg/l)	P-Sol (mg/l)	S.Solids (mg/l)
2009	Min	7.7	191	9.0	92	1.5	< 0.001	0.02	-
	Max	8.1	430	13.3	102	5.5	0.002	0.09	-
	Mean	8.0	332	11.0	98	2.6	0.001	0.05	-
2011	Min	7.6	212	9.5	84	1.0	< 0.001	< 0.01	-
	Max	8.5	434	13.2	112	5.4	0.015	0.11	-
	Mean	8.0	343	11.0	97	2.3	0.003	0.05	-
2012	Min	7.6	238	9.4	94	1.0	< 0.001	0.02	-
	Max	8.3	415	13.0	101	4.0	0.002	0.07	-
	Mean	8.0	305	11.1	97	1.8	0.001	0.04	-

Year	Parameter	pH	Cond (µs/cm)	DO (mg/l)	DO (%sat)	BOD (mg/l)	NH3 (mg/l)	P-Sol (mg/l)	S.Solids (mg/l)
2015	Min	7.3	165	10.1	94	2.0	< 0.001	0.02	3
	Max	7.8	293	12.8	100	6.6	0.001	0.08	84
	Mean	7.6	224	11.3	96	3.2	0.001	0.05	26

73. In general, pH appears to be relatively stable and remains within a range satisfactory for salmonid fisheries - the variation in pH is most likely related to flow conditions. The combination of consistently high dissolved oxygen and low biological oxygen reflects an absence of organic inputs.

74. Conductivity is an indication of the amount of dissolved salts in the water and typically increases in a downstream direction as a river flows through progressively richer lowland areas picking up different materials and receiving inputs from various tributaries and discharges. At this location the variation in conductivity is most likely related to flow conditions.

5.3.2 Biological Quality

75. Summary results for biological quality monitoring in the Castle River under the biological monitoring working party (BMWP) system are presented in **Table A8.5.12** (there has been no biological monitoring carried out at this location since 2012). Indicated are the total number of invertebrate taxa identified (No. taxa) at each site, total bioscore (BMWP bioscore), and average score per taxon (ASPT). In general terms these results reflect a Good standard of biological quality as was indicated in the WFD classifications for this waterbody in 2015 **(Table A8.5.10)**.

Table A8.5.12: Biological Monitoring Data from Castle River, 2008-12[14].

Site	Date	BMWP score	No. Taxa	ASPT
Castle River at Drummond Bridge C688232 Site code 10176	30/04/2008	79	15	5.27
	10/11/2008	114	21	5.43
	29/04/2009	128	23	5.57
	19/10/2009	92	18	5.11
	18/04/2011	110	20	5.50
	17/10/2011	125	24	5.21
	18/04/2012	123	22	5.59
	01/11/2012	93	17	5.47

5.4 WFD Fish Monitoring

76. Water Framework Directive compliant fish surveys at surveillance stations are required under national and European law. Annex V of the WFD stipulates that rivers should be included within monitoring programmes and that the composition, abundance and age structure of fish fauna should be examined (Council of the European Communities, 2000). Within the Roe catchment there are seven WFD fish monitoring stations which have each been subject to monitoring at least once over the last six years with fish classifications as noted in **Table A8.5.13[12][13][14].**

Table A8.5.13: Summary classifications of relevant sites under WFD fish monitoring[15].

Waterbody	2011	2012	2013	2014	2015
Owenalena River	-	-	-	High	High
River Roe (Limavady)	-	Good	Good	Good	High
Owenbeg River	Good	Good	Good	Good	Good
River Roe (Ballycarton)	Good	Good	Good	Good	Good
River Roe (Corick)	-	-	-	High	High

[12] Niven AJ (2010) Loughs Agency Water Framework Directive Fish Classification Report 2009. LA/WFDFISH/09.
[13] Niven, A.J. & Scott, R. (2013) Loughs Agency Water Framework Directive Fish in Rivers Northern Ireland Classification Report 2012. Loughs Agency, 22, Victoria Road, Derry-Londonderry.
[14] NIEA. Unpublished Data.

77. The following fish species are recorded as being present in the Roe catchment (Loughs Agency, 2010):

- Atlantic salmon (*Salmo salar*);
- Brown trout and Sea trout (*Salmon trutta*);
- Eel (*Anguilla anguilla*);
- Three-spined stickleback (*Gasterosteus aculeatus*);
- Minnow (*Phoxinus phoxinus*);
- Smelt (*Osmerus eperlanus*)
- River/Brook lamprey (*Lampetra* sp);
- Sea lamprey (*Petromyzon marinus*).

5.5 Significant Freshwater Species

78. This section outlines the current status of Annexe II freshwater species and other species of conservation interest.

5.5.1 Atlantic salmon

79. The salmon is an anadromous species having both a freshwater stage and a marine stage to its life cycle. The species is listed under Annexe II of the Habitats Directive and was added to the UK Biodiversity Action Plan (BAP) list in 2007 as a priority species for conservation action. More recently the salmon achieved an IUCN threat status of Vulnerable in the Irish Red List No 5[16].

80. Adult salmon mature at two to four years of age and spawning generally takes place in November or December notably in the upper reaches of suitable tributaries. The young fish remain in freshwater for one or two years before migrating to sea as smolts during April and May. After a phase of intense feeding and rapid growth in the sea, many salmon will return to freshwater in the following year as one sea-winter fish (grilse), while a proportion may remain at sea for another year to return as two sea-winter fish.

81. Northern Ireland's Atlantic salmon management strategy is aligned to the agreement reached by the North Atlantic Salmon Conservation Organisation (NASCO) and its Parties to adopt and apply a precautionary approach to the conservation, management and exploitation of the salmon resource and the environments in which it lives. Northern Ireland, through the UK and EU, is a Party to NASCO.

82. Atlantic salmon stocks in general are in serious decline and southern stocks, including some in North America and Europe, are threatened with extinction. As a conservation measure commercial netting for salmon was significantly reduced by the Loughs Agency in 2007, and has been suspended on an annual basis since 2009 due to the River Finn stock falling below its conservation limit.

83. Condition Assessments for the River Roe & Tributaries SAC, undertaken as part of Habitats Directive reporting requirements, indicate that the Atlantic salmon population was at Favourable status in both 2007 and 2011.

5.5.2 Lamprey

84. There are three species of lamprey in Northern Ireland:

- Brook lamprey (*Lampetra planeri*)
- River lamprey (*Lampetra fluviatilis*)

[15] Loughs Agency (2010) River Roe and Tributaries Catchment Status Report 2009. Loughs Agency of the Foyle Carlingford and Irish Lights Commission, LA/CSR/17/10.
[16] King, J.L., Marnell, F., Kingston, N., Rosell, R., Boylan, P., Caffrey, J.M., Fitzpatrick, Ú., Gargan,P.G., Kelly, F.L., O'Grady, M.F., Poole, R., Roche, W.K. & Cassidy, D. (2011) Ireland Red List No.5: Amphibians, Reptiles & Freshwater Fish. National Parks and Wildlife Service, Department of Arts, Heritage and the Gaeltacht, Dublin, Ireland.

- Sea lamprey (*Petromyzon marinus*)

85. Sea and River lampreys are parasitic and migrate between the freshwater and marine environments, returning to freshwater to breed. In contrast, Brook lamprey are resident freshwater throughout their life cycle and are non-parasitic. Brook lamprey are widely distributed in Northern Ireland but River and Sea lamprey have a more limited distribution (Goodwin *et al*, 2009).

86. All three species are designated under Annex II of the EU Habitats Directive (Directive 92/43/EEC) and there are five large river SACs designated in the Foyle area. None of the three species is listed as a site selection feature of the River Foyle and Tributaries SAC but River/Brook lamprey are known to be present.

87. The Loughs Agency carried out a baseline survey in 2013 to record the abundance and distribution of juvenile lamprey in the Roe SAC; it was found that River/Brook lamprey populations were at Favourable conservation status while Sea lamprey populations were Unfavourable[17]. The assessment also demonstrated the presence of River/Brook lamprey in the Castle River.

5.5.3 Eel

88. The European eel is not listed under Annexe II but has recently been added to the International Union for Conservation of Nature (IUCN) Red List of Threatened Species in the category of Critically Endangered[18].

89. The eel is a catadromous species, breeding in the sea and migrating to freshwater in order to grow before returning to the sea to spawn. It is believed that all European eels spawn in the Sargasso Sea in the middle of the North Atlantic Ocean.

90. The larvae drift in the plankton for up to three years towards the coasts of Europe. They then undergo metamorphosis into glass eels, subsequently elvers, which migrate up freshwater systems in large numbers. In freshwater they may take up to 20 years to reach sexual maturity as silver eels which then migrate back to sea.

91. The European eel is not listed in the EC Habitats Directive but the stock has been in rapid decline throughout its range since around 1980. This has led to the passing of the European Eel Regulation (EC) 1100/2007 which aims to establish measures for the recovery of the stock through action by Member States to implement Eel Management Plans in each eel river basin, in this case the North Western International River Basin District.

92. There is limited data available on the distribution of eel in the River Roe but the catchment status report for 2009 records the occurrence of the species during salmonid electrofishing surveys and indicates a regular distribution throughout the catchment, including the Castle River (Loughs Agency, 2010).

5.5.4 Brown/Sea trout

Brown trout are a priority species for conservation action in Northern Ireland, as required under the Wildlife and Natural Environment Act (Northern Ireland) 2011. The species is widely distributed in the River Roe catchment and a significant proportion of the stock migrates to sea and returns to freshwater to spawn. The Roe is one of the more significant Sea trout rivers in the Foyle system and the species is a popular target for anglers. However, there is little data available on the status of stocks in the Roe or in any Northern Ireland rivers - a major difficulty in assessing stock status is that juvenile trout do not exhibit any specific features which identify them as potential adult Sea trout.

5.6 Salmon & Trout Stock Data

93. Annual monitoring of salmon (and trout) stocks in the Foyle system is conducted by the Loughs Agency based on:

- Adult salmon runs;
- Salmon spawning;
- Juvenile fish stocks.

The River Roe and the Castle tributary support significant stocks of Atlantic salmon and brown trout.

[17] Niven, A.J. & McCauley, M. (2013) Lamprey Baseline Survey No3: River Foyle and Tributaries SAC. Loughs Agency, 22, Victoria Road, Derry~Londonderry.

5.6.1 Adult Salmon Runs and Conservation Limits

94. A key factor in assessing the status of salmon stocks is determination of Conservation Limits for individual river systems. The Conservation Limit for Atlantic salmon is defined by NASCO as: *the spawning stock level that produces long term average maximum sustainable yield as derived from the adult to adult stock and recruitment relationship*. In simpler terms the Conservation Limit for a river is the number of spawning salmon required to ensure that salmon are reproducing in sufficient quantities to produce the next generation of fish.

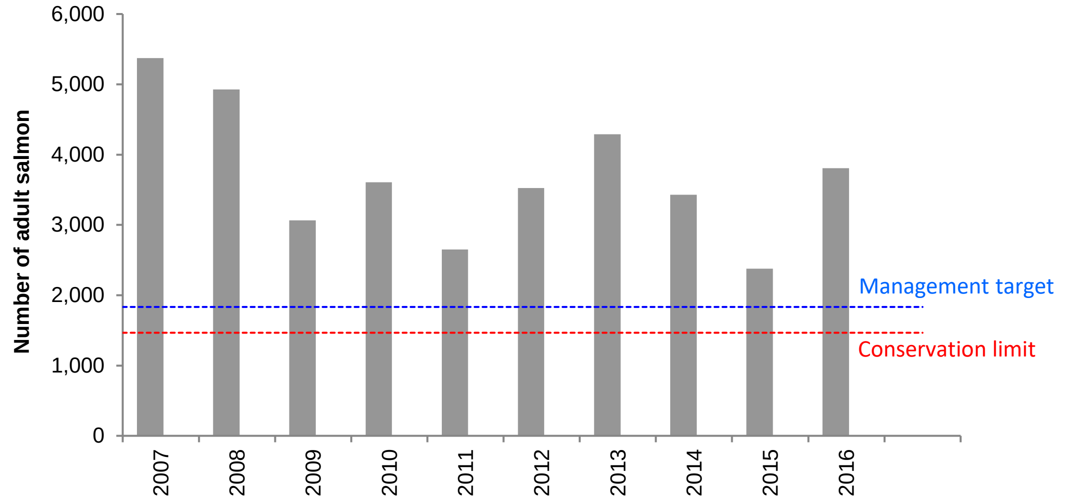
95. The Loughs Agency operates a “real time” management regime for the Foyle system which aims to manage salmon fisheries and spawning populations in a sustainable manner. Management targets and spawning targets are set for each river catchment with egg deposition levels are set according to the area and quality grading of each section of nursery habitat. 25% is deducted from the management target allowing for loss of salmon by angling (15%), and poaching and predation (10%). The remaining figure is referred to as the conservation limit/spawning target.

96. A management target of 1,833 adult Atlantic salmon has been set for the Roe Catchment, this equates to a conservation limit/spawning target of 1,466 or 2,062,125 eggs.

97. Adult salmon runs are now measured by electronic fish counters at six counting stations in the Foyle system; the Roe counter is located downstream of Limavady on a purpose-built crump weir spanning the full width of the river and has been in operation since 2001.

98. The numbers of adult fish returning to the river each year since 2007 are shown in **Figure A8.5.3** along with the conservation limit (CL) and management target (MT) for the river. There is some evidence of a decline in the stock but both CL and MT have been exceeded in each of the last 10 years.

Figure A8.5.3 Numbers of salmon ascending River Roe fish counter, 2007-16 (Source: Loughs Agency)



5.6.2 Juvenile Fish Stocks

99. Fry distribution and abundance are an indication of the distribution and level of spawning by adult fish. Trends in abundance of juvenile salmon and trout are monitored by the Loughs Agency through annual semi-quantitative electrofishing surveys[19]. Over 450 sites are sampled each year throughout the Foyle area with 60 in the Roe catchment including eight on the Castle River.

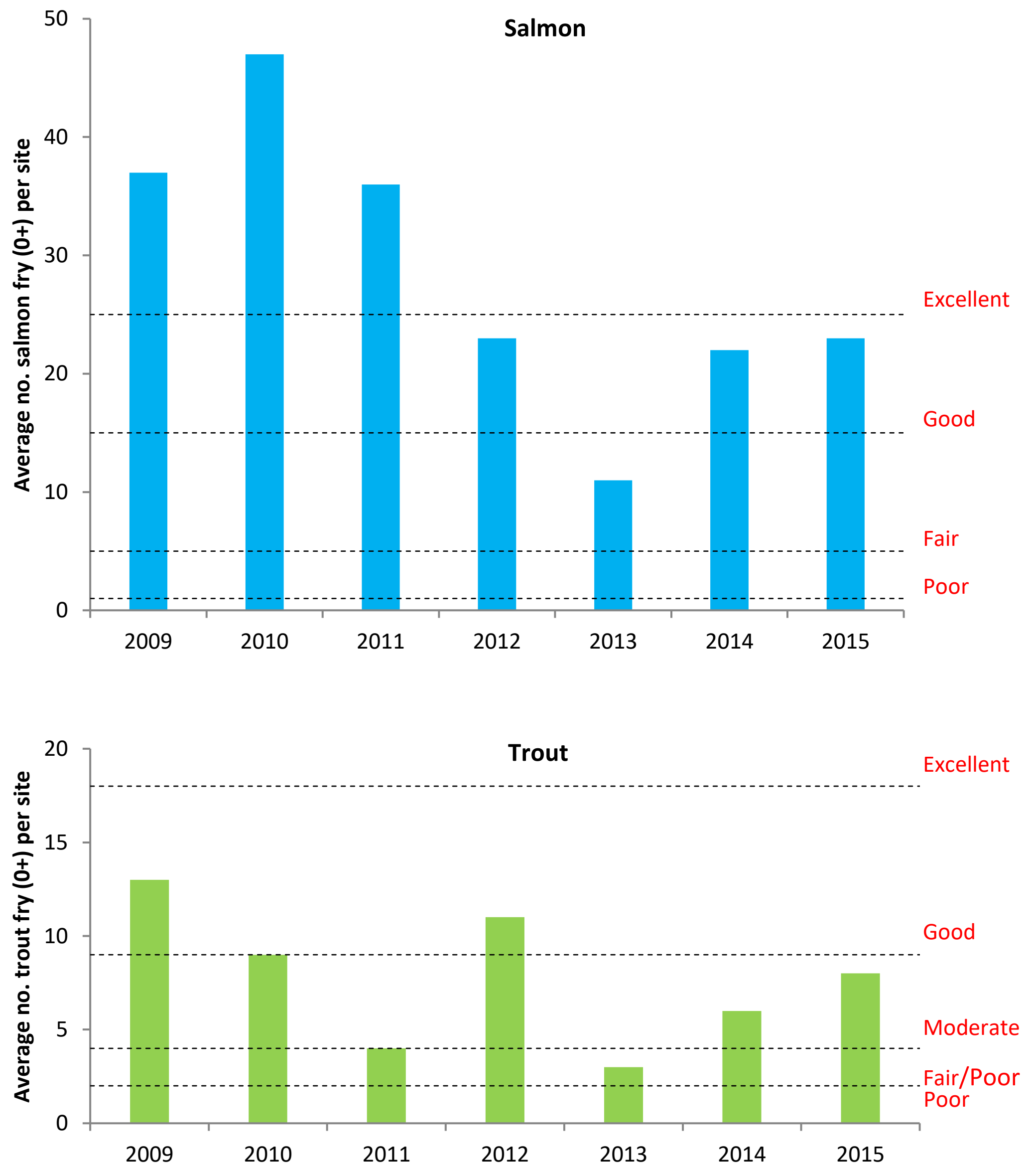
100. The semi-quantitative electrofishing method has been calibrated separately for trout and salmon based on extensive studies in river reaches of known juvenile salmonid density. This has resulted in the development of an abundance classification system

[18] King, J.L., Marnell, F., Kingston, N., Rosell, R., Boylan, P., Caffrey, J.M., Fitzpatrick, Ú., Gargan,P.G., Kelly, F.L., O’Grady, M.F., Poole, R., Roche, W.K. & Cassidy, D. (2011) Ireland Red List No.5: Amphibians, Reptiles & Freshwater Fish. National Parks and Wildlife Service, Department of Arts, Heritage and the Gaeltacht, Dublin, Ireland.

(Abundance Index) for salmon with five categories[19]: Absent, Poor, Fair, Good, Excellent. The Abundance Index for trout has six classifications: Absent, Poor, Poor/Fair, Moderate, Good, Excellent (Kennedy, unpublished).

101. **Figure A8.5.4** shows the average catch of salmon and trout fry at survey sites on the Roe over the most recent seven-year period with abundance categories indicated. Salmon fry are generally more abundant than trout and there is some evidence of a decline in both stocks during this period, consistent with the apparent decline in adult fish runs. However average salmon fry abundance remains in the Good category while trout abundance is Moderate.

Figure A8.5.4 Salmon and trout fry Abundance Indices based on mean fry numbers at electrofishing sites on the Roe, 2009-15 (Source: Loughs Agency)



102. The average numbers of trout and salmon (2009-15) detected at five Loughs Agency monitoring sites on the Castle River which are hydrologically connected to the Site are indicated in **Table A8.5.14**. The location of these sites is shown along with average Abundance Indices in **Figure A8.5.5**.

[19] Crozier WW & Kennedy GJA (1994) Application of semi-quantitative electrofishing to juvenile salmonid stock surveys. Journal of Fish Biology 45, 159-164.

Table A8.5.14: Average fry Abundance Indices at survey sites on the Castle River, 2005-15; listed upstream to downstream (Source: Loughs Agency)

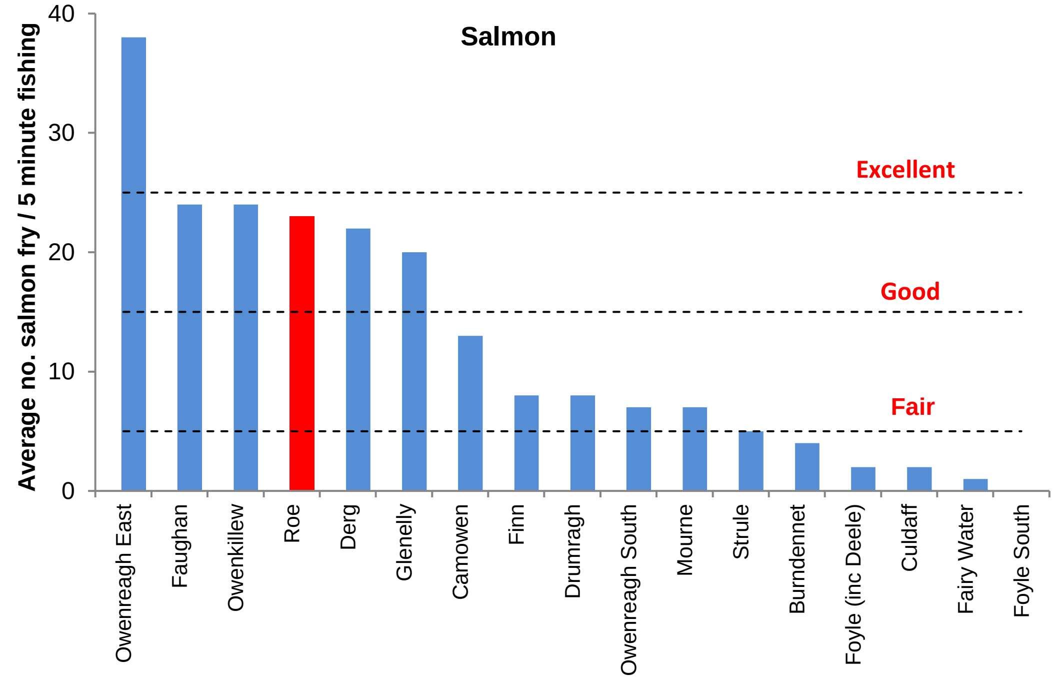
Site ID	Trout		Salmon	
	Age 0	Age 1	Age 0	Age 1
17_036	13	14	7	4
17_034	17	12	1	1
17_033	17	9	11	3
17_029	4	5	23	3
17_031	3	4	38	7

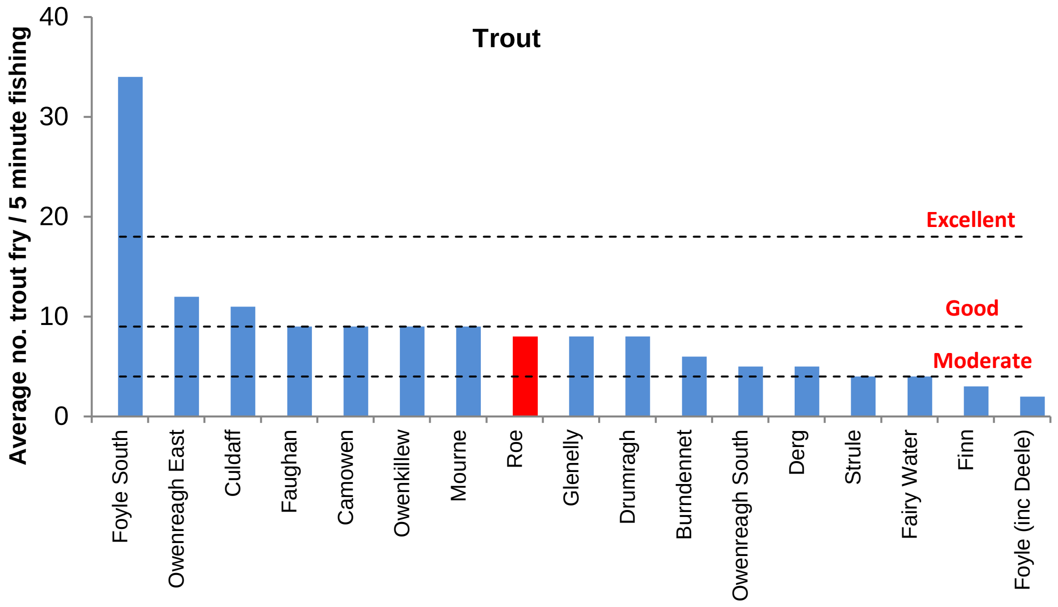
103. This data on the distribution of young fish in their first year demonstrates that:

- Adult trout spawn throughout the Castle River with greater abundance in upstream areas
- Adult salmon spawn in downstream reaches, although within 3 km of the Site.

104. Fry densities in the Roe for 2015 are compared with those from other leading catchments in the Foyle system in **Figure A8.5.6** (2015 is the most recent year with adequate data). This illustrates that for both salmon and trout the Roe is one of the most productive rivers in the region.

Figure A8.5.6: Salmon and trout fry index based on mean fry numbers in 17 principal catchments of the Foyle, 2015 (Source: Loughs Agency)





5.7 Angling

105. The Roe is one of the leading angling waters in the Foyle system providing a popular rod fishery for both the local population and visitors to the area. Fishing rights on the freshwater reaches of the main channel and tributaries are owned by The Honourable Irish Society while the tidal section is owned by the Loughs Agency. RES holds under Licence the necessary Sporting Rights from The Honourable Irish Society.

106. Angling is controlled and administered by the Roe Angling Ltd which leases the fishing rights on both the freshwater and tidal sections.

107. Details of angling activity and catches of salmon and sea trout are shown in **Table A8.5.15**. As these returns are based on incomplete licence/logbook returns, a raising factor is applied in line with Loughs Agency methodology which is based on an analysis[20]. Adjustment of the catch returns for 2009-15 would suggest an average annual catch of 379 salmon which would indicate a very productive fishery. Voluntary catch and release is now practised widely on the Foyle system reaching 58% in 2012.

Table A8.5.15: Salmon angling catches for the Roe indicating adjustment according to annual rate of licence/logbook returns, 2009-15 (Source: Loughs Agency)

Catch statistics	2009	2010	2011	2012	2013	2014	2015	Average
% licence/logbook return	44%	56%	46%	16%	10%	15%	38%	32%
Raising factor	1.38	1.24	1.35	2.58	3.70	2.70	1.49	2.06
Reported salmon catch	197	500	398	379	11	34	78	228
Adjusted salmon catch	273	619	538	976	41	92	116	379

108.

5.8 Habitat Improvement Works

109. Roe Angling Ltd has invested significant funds and labour in conducting fisheries enhancement works on various tributaries, notably the Owenbeg River, to upgrade spawning and nursery habitats. Grant funding has been obtained from ARC North West (NI Rural Development Programme), NGO Challenge Fund (NIEA) and the Lough Agency.

[20] Small, I. (1991) Exploring data provided by angling for salmonids in the British Isles. In: Catch Effort Sampling Strategies - their application in Freshwater Fisheries Management. I.G. Cowx (Ed.), Blackwell Scientific Publications Ltd.

110. The Loughs Agency has also carried out a series of habitat improvement measures in tributaries such as the Bovevagh River and the Wood Burn. The works were designed to improve in-channel flow and to introduce sequences of spawning, nursery and holding water.

5.9 Fisheries Habitat

5.9.1 Site Drainage and Local Hydrology

111. As noted above the Development lies entirely within the River Roe catchment and specifically within the Castle River sub-catchment. The Site area is drained by five streams flowing in a westerly direction and merging various points before discharging into the Castle River **(Figure A8.5.7)**. All of the streams are un-named and are referred to in this report as Streams A to E, with Stream A being the most southerly watercourse. Site drainage and hydrology are described in more detail in **Chapter 7, Hydrology, Hydrogeology, Geology, Soils and Peat**.

5.9.2 General Description / Observations

112. The following paragraphs give an outline description of habitat quality and fisheries significance of the six principal watercourses draining the Site (Streams A-F) and their subsequently merged channels downstream of the Site before discharging to the Castle River.

5.9.2.1 Stream A

113. Stream A flows along the southern section of the Site Boundary and drains the corresponding area of the Site. In general, this is a good quality stream of width 1.0-1.5 m channel width along the Site Boundary. Upstream reaches are characterised by a steep gradient with a substrate of cobble, boulder and gravel with some bedrock; extensive moss growth in this reach is indicative of substrate stability **(Plate A8.5.1)**. Fish habitat in this reach is excellent.

114. Approximately 2.25 km downstream of the Site Boundary at Terrydoo Road the channel is wider (2-3 m) and of significantly lower gradient with a substrate dominated by gravel, sand and silt, with a riffle/glide sequence **(Plate A8.5.2)**. This is likely to be a spawning area for trout.

Plate A8.5.1: Stream A

Plate A8.5.2: Stream A

115.

5.9.2.2 Stream B

116. Stream B is a significant channel and drains a substantial area of the Site. The main branch is 1.0-2.0 m wide within the Site Boundary where it is relatively fast-flowing with a bed of cobble, gravel, sand and some boulder, which forms a reasonable quality of nursery habitat for trout **(Plate A8.5.3)**. However, it is impacted to some degree by cattle poaching leading to an input of sediment to the channel.

117. Stream B is joined by a smaller tributary which also drains an area of the Site **(Plate A8.5.4)**; it is approximately 0.5-0.7 m wide with a bed composed of gravel, cobble and sand, but is very shallow and unlikely to be populated with fish. It merges with Stream B along the Site Boundary.

118. Emerging from the Site Boundary at Terrydoo Road Stream B is 2-3 m wide and, although substrate materials are of good quality, the baseflow is very low and likely to be a limiting factor in the distribution of trout stocks **(Plate A8.5.5)**.

Plate A8.5.3: Stream B

Plate A8.5.4: Stream B

119.

Plate A8.5.5: Stream B

120.

5.9.2.3 Stream C

121. Stream C is a very small channel 0.5-1.0 m wide and heavily overgrown with bankside vegetation along much of its length including along the Site Boundary **(Plate A8.5.6 & 7)**. However, there is a significant baseflow, substrate materials are of good quality and the stream carries a significant stock of juvenile trout within the Site Boundary and downstream of the Site.

Plate A8.5.6: Stream C

Plate A8.5.7: Stream C

122.

5.9.2.4 Merged Streams A-B-C

123. Approximately 1 km downstream of the Site Boundary Streams B and C merge **(Plate A8.5.8)**, and after a further 0.9 km, this channel joins with Stream A. The combined channel has a variable width of 2.0-5.0 m and is characterised by good quality habitat for juvenile salmonids **(Plate A8.5.9)**; the substrate consists largely of coarse materials with a prevalence of boulder/cobble along with some gravel and sand deposits. There is a disused weir approximately 500m upstream of the confluence with the Castle River - this structure would appear to be passable by migratory fish.

Plate A8.5.8: Streams B-C merged

Plate A8.5.9: Streams A-B-C merged

124.

5.9.2.5 Stream D

125. Stream D is comprised of two tributaries which drain a central portion of the Site and merge at the Site Boundary adjacent to Terrydoo Road. The smaller southern tributary **(Plate A8.5.10)**, is piped over a considerable distance within the Site and therefore without any value in terms of fisheries or aquatic ecology.

126. The larger tributary is also piped within the Site but over a shorter distance; although it retains some ecological significance within the Site **(Plate A8.5.11)**, it does not appear to be populated with fish.

Plate A8.5.10: Stream D

Plate A8.5.11: Stream D

5.9.2.6 Stream E

127. Stream E drains a significant area in the northern portion of the Site. It has an average width of 1.0 m, steep gradient and good quality substrate materials of cobble, gravel, sand and boulder forming moderate quality habitat for trout **(Plate A8.5.12 & 13**. Although eels were detected during the fish survey the reach within the Site was found to be devoid of trout and there was no obvious reason for this.

Plate A8.5.12: Stream E

Plate A8.5.13: Stream E

5.9.2.7 Stream F

128. Stream F flows along the northern limit of the Site Boundary within a deeply incised and overgrown gorge with a steep gradient. It is a small stream of channel width <1 m and after exiting the Site it follows a significantly reduced gradient with a low level of baseflow; habitat quality is at best moderate as there are extensive deposits of sandy silt **(Plate A8.5.14)**. Fish were not detected in the reach immediately downstream of Terrydoo Road.

129. Approximately 1.3 km downstream of Terrydoo Road the stream is wider at 1.0-1.5 m with the gradient further reduced; habitat quality is improved with greater prevalence of cobble/boulder materials, fine gravel and sand, although the channel is heavily overgrown **(Plate A8.5.15)**. Trout were found to be present in this reach.

Plate A8.5.14: Stream F

Plate A8.5.15: Stream F

5.9.2.8 Merged Streams D-E-F

130. After exiting the Site Streams D and E merge approximately 250 m to the west of the Site Boundary **(Plate A8.5.16).** Although habitat quality is good, fish were found to be absent from this reach; again, there was no obvious reason for this observation.

131. After a further 1.2 km Streams D-E joins with Stream F to form a 2-4 m wide channel with lower gradient and a sequence of riffles and long glides **(Plate A8.5.17).** This combined channel proceeds over a course of approximately 3.5 km to join with the Drummond River which then merges with the Castle River after another 1.3 km in the outskirts of Limavady.

Plate A8.5.16: Streams D-E merged

Plate A8.5.17: Streams D-E-F merged

5.10 Stream Quality

132. Five sites 1-5 were surveyed, each from one of the five small streams draining the Site; each survey site was located along the Site Boundary, Site 1 on Stream A, Site 2 on Stream B etc. as indicated in **Figure A8.5.7.**

5.10.1 Chemical Water Quality: Basic Parameters

133. The pH in all stream sites was generally circum-neutral (pH 7.4-7.9) except for site 1, which was marginally acidic **(Table A8.5.16)**. All streams had satisfactory dissolved oxygen levels with lower conductivity recorded in sites 1,2 and 5 **(Table A8.5.16)**. The lowest conductivity recorded in site 1 undoubtedly reflects the survey's location in the upper catchment at elevation 96m, where lower dissolved ion content would be expected. Turbidity was low at all stream sites and, as a proxy indicator, is consistent with suspended sediment concentrations well below the 25 mg/L upper threshold specified for salmonids in the Water Framework Directive.

134. It should be noted that spot measurements of physico-chemical parameters provide only a snapshot of stream water quality; consensus on overall quality should consider additional indicators such as those provided by stream macroinvertebrate communities (see below).

Table A8.5.16: Stream chemical parameters from baseline surveys conducted in October 2017.

Site no.	Stream	Grid ref		pH	Dissolved Oxygen (mg/L; % sat.)	Cond (µScm-1)	Turb (NTU)
		E	N				
1	A	274225	419257	7.4	9.5; 99%	65	1.1
2	B	272807	419906	6.6	11.4; 99%	95	1.38
3	C	273058	420367	7.6	11.4;100%	136	3.43
4	D	273297	420654	7.9	11.0; 98%	197	1.9
5	E	273408	420873	7.8	11.2; 97%	94	1.6

5.10.2 Physical Habitat Quality

135. All survey sites on the streams draining the Development were narrow with relatively shallow depths but good flows **(Table A8.5.17)**. Substratum was relatively complex at all sites, ranging from cobble/ pebble (sites 2-5) to cobble/ boulder (site 1), and with riverbed coarseness indices above or close to values in rivers with good salmonid habitat quality reported elsewhere in Northern Ireland (Johnston, 2012). All sites had low levels of fine sediment, well below the 20% threshold above which salmonid and benthic biodiversity can be compromised[4].

Table A8.5.17: Stream habitat quality at each site from baseline surveys conducted in October 2017.

Site no	Stream	Sediment cover (%) & type	Mean width	Mean water depth (m)	Mean flow velocity (ms^{-1})	Coarseness index (CI)	Substrate heterogeneity (SD)	Inferred substrate
1	A	2.4; sand	1.12	0.21	0.26	4.3	0.84	Mixture; coarse
2	B	6.2; sand	2.45	0.15	0.2	3.8	0.7	Mixture; intermediate coarseness
3	C	6.0; sand	1.5	0.12	0.21	3.9	0.92	Mixture; intermediate coarseness
4	D	6.6; sand, silt, clay	0.7	0.11	0.24	3.76	0.72	Mixture; intermediate coarseness
5	E	1.6; sand/ silt	1.12	0.12	0.2	3.84	0.62	Mixture; intermediate coarseness

5.10.3 Aquatic Ecology & WFD Ecological Status

136. Based on the benthic invertebrate indicator element, four sites (1-3 and 5) were indicated as having *High* WFD-based ecological quality with the remaining site 4 classed as *Good* ecological quality **(Table A8.5.18)**. It should be noted that quality classifications were the same whether using the predicted number of taxa (N-TAXA) or ASPT metric, reinforcing the robustness of these data. Although all streams had signs of erosion and riparian grazing by sheep, the slightly lower quality class at site 4 may be a consequence of slight enrichment or disturbance due to the presence of heavy grazing by dairy stock on the true right bank; this is further supported by that site's higher conductivity and the lower overall BMWP WHPT score than all others **(Tables A8.5.16 & 17)**. Nonetheless, site 4 was still indicated as having *Good* ecological quality. Overall, the quality classes for each stream site indicate high water quality and good physical habitat, with all streams supporting intermediate to coarse substrates across moderate to steep gradients with good flows.

Table A8.5.18: WFD-based ecological quality classes at each site derived from benthic invertebrate baseline surveys conducted in October 2017.

Site	Stream	BMWP WHPT score	Number of taxa	N-TAXA WFD-based invert. class	WHPT- ASPT	ASPT WFD-based invert. class
1	A	129.4	20	**HIGH**	6.47	**HIGH**
2	B	143.9	23	**HIGH**	6.25	**HIGH**
3	C	137.8	22	**HIGH**	6.4	**HIGH**
4	D	82.9	15	**GOOD**	5.52	**GOOD**
5	E	147.2	21	**HIGH**	7	**HIGH**

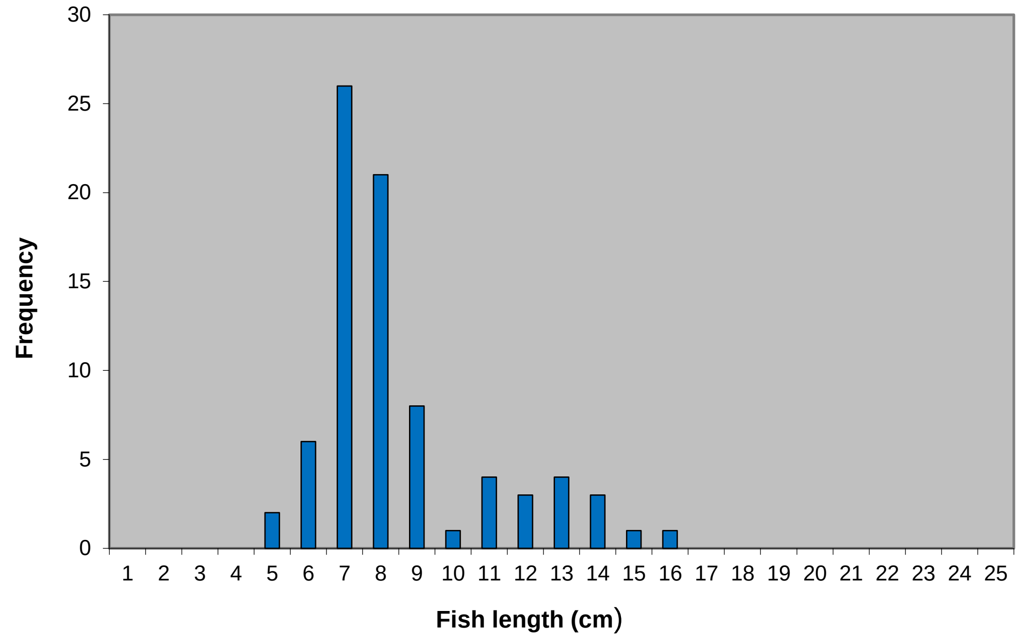
5.11 Juvenile Fish Stocks

137. A juvenile fish stock survey of the streams draining the Site was carried out on August 2017 at selected sampling sites along the Site Boundary and downstream of the Site **(Figure A8.5.7)**.

5.11.1 Population Age Structure

138. The age structure of the trout population in the tributary streams draining the Site was verified by constructing a fish length frequency distribution **(Figure A8.5.8)**. The trout population exhibits a bimodal distribution in size with the initial peak representing Age 0 fish (2017 hatch) in the size range 5-10 cm, and the second peak of Age 1 fish (2016 hatch) in the size range 120-16 cm.

Figure A8.5.8: Length frequency distribution of trout caught in the Castle River tributary streams.



139. The absence of larger fish suggests that mature adults migrate upstream into these streams to spawn, and that the juvenile fish remain until their third year before moving downstream into deeper waters as two-year-olds. A significant portion of the Roe trout stock migrates to sea in their second or third year and it is possible that the population of these streams forms part of this migration.

5.11.2 Distribution & Abundance

140. The results of the semi-quantitative survey are shown in **Table A8.5.19** with the numbers of trout caught at each site separated into Ages 0 and 1 based on observed fish length as outlined above. Applying the abundance indices outlined in **Table A8.5.4** shows trout fry (Age 0) densities ranging from *Absent* to *Excellent*, while salmon were absent from all sites; the only other species recorded was eel.

Table A8.5.19: Fish stock survey indicating numbers of juvenile trout (Age 0 and Age 1) recorded at each site; other species also noted.

Site	Stream	Grid Ref		Trout			Other species
		East	North	Age 0	Age 1	Abundance Index	
1	A	274226	419260	16	7	Good	
2	A	272141	419449	14	0	Good	
3	B	273437	419689	6	4	Moderate	1 eel (35 cm)
4	B	273417	419760	0	0	Absent	
5	C	273107	420287	12	3	Good	
6	A-B-C	271121	420521	8	5	Moderate	2 eel (20+ cm)
7	E	273399	420871	0	0	Absent	2 eel (~15 cm)
8	D-E	273022	421646	0	0	Absent	
9	F	273463	421829	0	0	Absent	
10	F	272315	421310	8	0	Moderate	1 eel (9.5 cm)
11	D-E-F	271465	421201	26	7	Excellent	

141. There was also a clear difference between the streams draining the southern portion of the Site (sites 1-5; streams A-B-C)) which were well populated with trout around the Site Boundary, and those draining the northern area (sites 7-9; streams D-E) which were largely devoid of fish around the Site Boundary. This may be indicative of a water quality issue in streams D-E. However, both groups of streams had *Good/Excellent* trout densities further downstream at site 6 (streams A-B-C) and at sites 10 and 11 (streams D-E).

6 Embedded Mitigation

142. Measures have been taken to eliminate, where possible, and minimise the potential for effects on fish and aquatic ecology through the design of the Development and the adoption of good practice, and general and site-specific management measures, as set out in **Chapter 4: Site Selection and Design** of the ES, and Technical appendix **A3.1: Outline Decommissioning and Construction Environment Management Plan** (DCEMP) and Technical Appendix A7.2: Water and Construction Environmental Management Plan (**WCEMP**). In particular, where possible, ground disturbance has been minimised through re-use of the existing infrastructure, watercourse crossings have been avoided, work within close proximity to watercourses has been avoided, and specific measures are proposed to minimise the effects on watercourses during the initial decommissioning and construction phases. The result of this is that effects on hydrology (reported in **Chapter 7** of the ES) are assessed as being not significant in terms of the EIA Regulations.

143. For the purposes of this document, however, the WCEMP has been considered as post-hoc mitigation in **Section 7** of this report. Potential effects considered in Section 6, below, are assessed on the basis that no management measures will be in place. Residual effects, following application of the proposed WCEMP measures, are set out in **Section 7**.

7 Assessment of Potential Effects

144. Potential effects were assessed for the decommissioning and construction, and operational phases of the Development. Decommissioning and construction effects cover the discharge of suspended solids, release of other pollutants and interruption of fish passage. Post-construction (operational) effects include habitat loss at watercourse crossings, obstruction of fish passage and surface water run-off.

7.1 Fisheries Significance/ Sensitivity

145. The assessments of Fisheries Significance/ Sensitivity for relevant watercourses draining the land within the Site Boundary as at Scoping stage are indicated in **Table A8.5.20**. A watercourse was deemed to have a High/ Very High sensitivity when the WFD class was at least Good and/or Annex II species were present (e.g. salmon, lamprey).

Table A8.5.20: Sensitivity of receiving watercourses within Site Boundary and downstream to River Roe main channel.

River/Stream	Location/key species	WFD class	ASSI/ SAC	Fisheries sensitivity
Stream A	Receiving watercourse; located within and downstream of the Site; Annexe II species unlikely; Brown trout present downstream of Site.	Good	-	Medium
Stream B	Receiving watercourse; located within and downstream of the Site; Annexe II species unlikely; Brown trout present within Site.	Good	-	Medium
Stream C	Receiving watercourse; located within and downstream of the Site; Annexe II species unlikely; Brown trout present within Site.	Good	-	Medium
Stream A-B-C	Receiving watercourse; located downstream of the Site; Annexe II species unlikely; Brown trout present.	Good	-	Medium
Stream D	Receiving watercourse; located within and downstream of the Site; Annexe II species unlikely.	Good	-	Low
Stream E	Receiving watercourse; located within and downstream of the Site; Annexe II species unlikely.	Good	-	Low
Stream F	Receiving watercourse; located within and downstream of the Site; Annexe II species unlikely; Brown trout present downstream of Site.	Good	-	Medium
Stream D-E-F	Receiving watercourse; located downstream of the Site; Annexe II species unlikely; Brown trout present.	Good	-	Medium
Castle River	Receiving watercourse located downstream of application area; Annexe II species: Atlantic salmon, River/Brook/Sea lamprey. Brown trout & European eel also present.	Good	-	High
River Roe	Receiving watercourse located downstream of application area; Annexe II species: Atlantic salmon, River/Brook/Sea lamprey. Brown trout & European eel also present.	Good	ASSI/SAC	Very High

[21] Newcombe, C.P. and Jensen, J.O.T. (1996). Channel suspended sediment and fisheries: A synthesis for quantitative assessment of risk and impact. North American Journal of Fisheries Management, 16, 4, 693-727.
[22] Turley, M. D., Bilotta, G. S., Extence, C. A., and Brazier, R. E. (2014). Evaluation of a fine sediment biomonitoring tool across a wide range of temperate rivers and streams. Freshwater Biology, 59, 2268-2277.

146. Streams A, B, C and F are assessed as of Medium sensitivity because they were of Moderate to Good habitat quality and are populated with brown trout. However, Streams D and E, also of Moderate to Good habitat quality, were devoid of any fish species. The downstream connected Castle River is assessed as of High sensitivity due the presence of Atlantic salmon, while the River Roe is of Very High sensitivity due to its designated SAC status.

7.2 Decommissioning and Construction Phase

147. The potential for effects on fisheries and aquatic habitats during the decommissioning and construction phases is mainly associated with ground disturbance and the entrainment of sediments in surface water drainage. There is also a potential effect from the accidental spillage of other hazardous substances (oil and fuel) used in the construction process, while construction of stream crossings could obstruct fish movements.

7.2.1 Sediment Run-off

148. The release of fine sediment (grain size <2mm) is potentially a major cause of environmental impacts and is associated with clearly defined negative impacts[21],[22]. Sensitive fish species such as brown trout and Atlantic salmon are highly vulnerable to suspended and deposited sediment in spawning and nursery habitats[25]. In spawning gravels, incubating salmonid eggs require good water circulation to provide oxygen and remove waste products. As deposited fine sediment content increases, gravels become embedded, resulting in restricted water circulation and reduced egg and alevin survival[23]. After emergence, juvenile salmonids (fry) disperse downstream to suitable nursery rearing habitat generally within 100m[8], often in faster flowing riffles/ runs, where they establish feeding territories and compete for food.

149. Suspended sediment can lower water clarity leading to reduce prey capture efficiency and may affect respiration rates by clogging of gills[25]. Deposited sediment can reduce habitat complexity and quality by in-filling of substrate, thus reducing territory size leading to increased aggression and ultimately lower carrying capacity. Deposited fine sediment can also indirectly affect growth and survival of juvenile salmonids by reducing the quality of habitat for preferred invertebrate prey species[24].

150. Although adult salmonids are prone to gill-clogging and visual impairment at high levels of suspended sediment, they are much less reliant on substrate complexity, tending to occupy deeper pools, particularly during the spawning season. Adult

[23] Cowx, I. and Welcomme, R.L. (1998). Rehabilitation of rivers for fish. A study undertaken by the European Inland Fisheries Advisory Commission of FAO. Fishing News Books.
[24] Suttle, K.B., Power, M. E., Levine, J. M., and McNeely, C. (2004). How fine sediment in riverbeds impairs growth and survival of juvenile salmonids. Ecological Applications, 14,4, 969-974.

salmonids are also more mobile than sessile eggs or juvenile stages, and thus more capable of avoiding adverse local conditions[25].

151. Freshwater benthic macroinvertebrates are also an important component of river ecosystems, acting both as sentinels of general water and habitat quality, and as an important food resource for higher trophic levels such as fish and birds. Pulses of fine sediment can cause behavioural drift, whereas excessive fine sediment can reduce the quality of physical habitat by smothering and blocking of interstitial spaces and water flow (Allan, 1999). As fine sediment infiltration increases, invertebrate abundance and community diversity is reduced, resulting in the replacement of sensitive taxa (mayfly, stonefly and caddis) by more tolerant types[26],[25] (worms, midge larvae, molluscs).

152. Sediment release and entrainment can also increase the risk of nutrient addition and alterations in channel morphology and hydrology[27],[28]. For example, excavated bank material or soils associated with the construction process could increase inputs of sediment bound phosphorus, which could negatively affect aquatic biota by causing excessive algal and macrophyte growth, and depressed oxygen levels.

153. Fine sediment is partly managed by the water quality objectives and standards of the EC Freshwater Fish Directive 2006/44/EC (FWFD), where a mean total suspended solids (TSS) concentration of 25 mg/L is specified for salmonid waters. While Article 6 of the Water Framework Directive has now repealed the FWFD, new standards that provide the same level of protection have been proposed (UKTAG, 2010). However, there is no national environmental standard or guideline for deposited fine sediment in the UK. Fine sediment cover above a threshold of 20% bed cover, based on recommendations in New Zealand[4], and published research[29],[25], provides a general indication of increasing risk for both invertebrates and salmonids.

- The discharge of suspended solids during construction of the windfarm:
- Excavations associated with construction of access tracks and turbine foundations
- Excavations associated with watercourse crossings
- Surface peat disturbance and subsequent erosion of the underlying soils
- Stockpiling of soils and excavated materials
- Run-off from access roads
- Landslide resulting from slippage of access roads or excavated materials.

154. The proposed site is hydrologically connected to watercourses of significant fisheries interest via on-site and off-site watercourses which are potential routes for suspended solids run-off. The River Roe is of particular significance due to its SAC status and stocks of Annexe II listed Atlantic salmon, while the Castle River, although not included in the SAC, is also populated by Atlantic salmon.

155. The un-mitigated impacts from the run-off of suspended solids have the potential to be of ***High Adverse Magnitude*** and of ***Moderate*** to ***Major Adverse Significance*** depending on the sensitivity of individual watercourses as noted in **Table A8.5.20**.

7.2.2 Release of other pollutants

156. As the development site drains into the Castle River and the River Roe, there is some potential for spillages or releases of diesel, oil or other polluting substances to reach any of these channels with consequences for resident fish together with invertebrate organisms.

157. During site construction when there is likely to be a high usage of plant fuel and oil, there will be an increased risk of accidental spillage and discharge to watercourses. Similarly, the application of concrete slurries in construction processes carries some risk of inadvertent discharge with the potential to impact on wild fish stocks.

158. In an extreme situation there is the potential for a ***High Adverse Impact*** arising from a pollution incident, and without mitigation, this would be of ***Moderate*** to ***Major Adverse Significance***.

7.2.3 Fish passage: temporary obstruction

159. Improperly managed instream or bank works at watercourse crossing points can result in the obstruction of stream channels during periods of upstream fish migration prior to spawning. The main access track from Terrydoo Road will require a series of watercourse crossings of streams draining the Site – none of these upper stream reaches are inhabited by fish, and there will therefore be no potential for obstruction of fish passage i.e. ***No Effect***.

7.3 Operational Phase

160. The potential for any effects will be significantly reduced during the operational phase with the initial decommissioning and construction processes complete, site infrastructure in place, and a reduced requirement for any potentially hazardous materials on-site.

7.3.1 Surface Water Run-off

161. Surface water run-off from hard surfaced areas (i.e., access tracks, hardstands, control building area) has the potential to lead to sediment-laden run-off to the receiving watercourses with effects on fish and other forms of aquatic life as outlined above.

162. Wash-out of storage areas of excavated peat/subsoil during or following periods of heavy rainfall also has the potential to result in run-off of sediment to the receiving watercourses with potential increases in sediment load impacting on fish stocks and aquatic habitats.

163. In the case of the Development, un-mitigated effects from surface water run-off has the potential to be of ***Medium Adverse Magnitude*** and of ***Minor*** to ***Major Adverse Significance*** depending of the sensitivity of individual watercourses as noted in **Table A8.5.20**.

8 Mitigation and Residual Effects

164. Potential effects of the Development on fisheries and aquatic ecology in the primary drainage streams along with the Castle River and the River Roe are assessed in light of proposed mitigation measures, to arrive at a conclusion of residual effects. It is the residual effects of the Development that represent the predicted (rather than potential) effects on fisheries and the aquatic environment during the decommissioning and construction, and operational phases.

8.1 Decommissioning and Construction Phase

165. Measures to protect the aquatic environment from disturbance and pollution are set out in the DCEMP and WCEMP.

8.1.1 Sediment Run-off

166. Mitigation measures to control sediment run-off are described in detail in the DCEMP. The potential for any significant peat soil instability and mass movement caused as a result of the Development has been determined as being insignificant in the Peat Slide Risk Assessment (**Technical Appendix A7.1**). Additional mitigation measures detailed in **Chapter 7** to reduce the potential for run-off of suspended solids are summarised as follows:

8.1.1.1 Management of Sediment and Surface Waters

167. The potential for pollution of watercourses by silt-laden runoff is addressed in **Chapter 7** with reference to the DCEMP which outlines the incorporation of a surface water management plan / site drainage design using the principles of Sustainable Drainage.

[25] Kemp, P, Sear, D., Collins, A, Naden, P., and Jones, I. (2011). The impacts of fine sediment on riverine fish. Hydrological Processes, 25, 11, 1800-1821.

[26] Matthaei C.D., Weller, F., Kelly, D.W. & Townsend, C.R. (2006) Impacts of fine sediment addition to tussock, pasture, dairy and deer farming streams in New Zealand. Freshwater Biology, 51, 2154-2172.

[27] Levesque, L.M. and Dube, M.G. (2007). Review of the effects of in-stream pipeline crossing construction on aquatic ecosystems and examination of Canadian methodologies for impact assessment. Environmental Monitoring and Assessment, 132, 395-409.

[28] Kelly, D.W. (2015). Water quality in Barkers Creek and its impact on the Waihi River. Environment Canterbury Technical Report No. R14/88.

[29] O'Connor WCK & Andrew TE (1998) The effects of siltation on Atlantic salmon, Salmo salar L, embryos in the River Bush. Fisheries Management and Ecology 5 (5), 393-401.

168. The management of sediment and surface water run-off generated during the decommissioning/construction phase of the Development is described in the WCEMP **(Technical Appendix A7.2)** which explains that this will be achieved through good practice construction techniques while major works will be minimised during heavy precipitation events.

169. Drainage from the site will include elements of Sustainable Drainage Systems (SuDS) design, where appropriate including:

- Silt traps, silt fencing and silt matting;
- Check dams; and settlement lagoons;
- Outflow monitoring from settlement lagoons; and
- Provision for storm events.

170. SuDS replicate natural drainage patterns and have a number of benefits:

- SuDS will attenuate run-off, thus reducing peak flow and any flooding issues that might arise downstream;
- SuDS will treat run-off, which can reduce sediment and pollutant volumes in run-off before discharging back into natural drainage network; and
- SuDS measures, such as lagoons or retention ponds, correctly implemented will produce suitable environments for wildlife.

8.1.1.2 Water Quality Monitoring

171. A surface water monitoring plan will be implemented as part of the final DCEMP. This will facilitate comparison of a range of water quality parameters against baseline water quality analysis of the principal site drainage streams undertaken prior to any decommissioning and construction works.

8.1.1.3 Timing of Instream Works

172. The Loughs Agency has produced Guidelines for Fisheries Protection during Development Works[1] (2011). This document recommends that instream river works should be avoided during the salmonid spawning season and egg incubation phases, 1 October – 30 April. The proposed watercourse crossings relating to this Development are relatively minor and may therefore proceed without this seasonal restriction. However, the Loughs Agency will be consulted if it proves necessary to deviate from the these guidelines.

8.1.2 Release of other pollutants

8.1.2.1 Site Management

173. All precautions will be taken to avoid spillages of diesel, oil or other polluting substances during the decommissioning and construction phases. This will be achieved through good site management practices as described in the Good Practice Guidance notes proposed by EA/SEPA/DAERA, including:

- PPG1: Understanding Your Environmental Responsibilities - Good Environmental Practices;
- GPP2: Above ground oil storage tanks;
- PPG3: Use and design of oil separators in surface water drainage systems;
- GPP4: Treatment and disposal of wastewater where there is no connection to the public foul sewer;
- GPP5: Works and maintenance in or near water;
- PPG6: Working at construction and demolition sites;
- PPG7: The safe operation of refuelling facilities;
- GPP8: Safe storage and disposal of used oils;
- GPP13: Vehicle washing and cleaning;
- PPG18: Managing fire water and major spillages;
- GPP21: Pollution incident response planning; and
- GPP26: Safe storage - drums & intermediate bulk containers.

174. The appointed contractor will also be required to include a Pollution Prevention Plan within the final DCEMP and a final DCEMP can be secured via the use of an appropriately worded planning condition. The site drainage system proposed for the Development will also facilitate the interception of diesel, oil or other polluting substances during the decommissioning and construction phases.

9 Cumulative Effect Assessment

175. This section considers other windfarm developments which, in combination with the Development, could give rise to the potential for cumulative effects on fisheries and the aquatic environment in local rivers. In this context, the potential for cumulative effects is only relevant with regard to existing or proposed developments that are either hydrologically connected or which drain to the same receiving environment. It is therefore more important to consider additional developments in the context of river catchments, both locally and on a wider river basin scale.

176. A total of 11 additional wind farm developments have been identified which are wholly or partly located within River Roe catchment and might therefore be considered to have the potential for cumulative effects on the river and the integrity of the SAC **(Table A8.5.21)**. Two of these sites, Smulgedon and Craiggore, are located within the immediate Castle River waterbody.

Table A8.5.21: Additional wind farm developments/proposals within the River Roe catchment indicating their location by WFD waterbody within the River Roe LMA.

Wind Farm	Planning Reference	WFD waterbody	Number of turbines	Status
Smulgedon	B/2009/0070/F	Castle River	7	Under Construction
Craiggore	B/2012/0268/F	Castle River	10	Consented
Altahullion I	B/2000/0118/F	Bovevagh River	20	Operational
Altahullion II	B/2004/0795/F	Bovevagh River	9	Operational
Glenconway	B/2011/0272/F	Bovevagh River	20	Operational
Dunbeg	B/2007/0560/F	Curly River	14	Operational
Dunmore	B/2007/0563/F	Curly River	7	Operational
Dunmore II	B/2013/0241/F	Curly River	8	Consented
Dunbeg Ext	LA01/2016/0061/F	Curly River	3	Consented
Dunbeg South	LA01/2018/0200/F	Curly River	9	In Planning
Evishagaran	B/2013/0120/F; LA01/2018/1151/F	Gelvin River	14	Consented

177. There is one documented incident relating to sediment run-off from a windfarm site, at Bin Mountain Wind Farm in Co Tyrone. However, there are no reports of similar problems have arisen in relation to other sites in Northern Ireland or specifically to the three sites (including Rigged Hill) in operation in the Castle River catchment, or indeed the eight sites currently operational in the overall River Roe catchment.

178. The greatest risk to fisheries and the aquatic environment is during the construction phase of these projects when the civil engineering works are carried out. It follows that it is vital for the highest standards to be maintained with regard to site preparation, temporary works and site drainage issues, and that full mitigation measures must be applied to remove any potential for this type of incident.

179. The likelihood of significant cumulative effects is increased if two or more windfarms are to be constructed or decommissioned at the same time. Craiggore, Dunmore II and Dunbeg Extension have been consented and construction is likely to proceed within the next three and five years. The low likelihood of any simultaneous windfarm construction with the Development further reduces the potential for any cumulative effects.

Implementation of the mitigation measures as described will ensure that the Development will not contribute to any cumulative impact on the SAC, in particular on Atlantic salmon as the primary feature of the site. Cumulative effects are therefore assessed as being ***Negligible***.

10 Summary of Effects

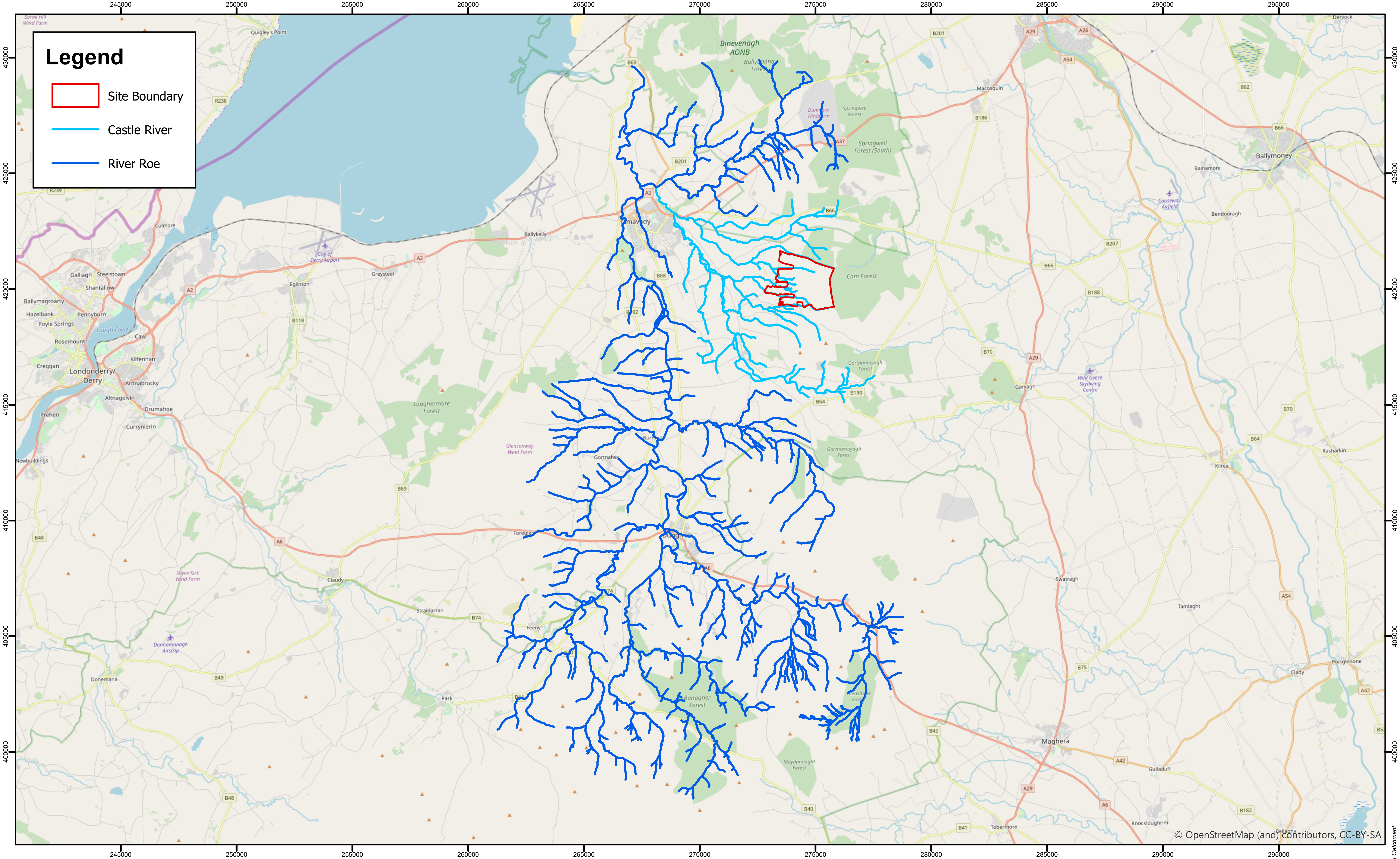
180. **Table A8.5.22** provides a summary of the effects detailed within this chapter.

Table A8.5.22: Summary of Effects

Receptor	Potential Effect	Significance of Effect	Mitigation Proposed	Residual Effect
Decommissioning / Construction Phase				
Streams A, B, C and F	Sediment Run-off	Moderate	• Buffer Zones • Site Drainage Management & SuDS • Water Quality Monitoring • Timing of Instream Works	Negligible
	Release of other pollutants	Moderate	• Site Management as detailed	Negligible
Streams D and E	Sediment Run-off	Moderate	• Buffer Zones • Site Drainage Management & SuDS • Water Quality Monitoring • Timing of Instream Works	Negligible
	Release of other pollutants	Moderate	• Site Management as detailed	Negligible
Castle River	Sediment Run-off	Moderate	• Buffer Zones • Site Drainage Management & SuDS • Water Quality Monitoring • Timing of Instream Works	Negligible
	Release of other pollutants	Moderate	• Site Management as detailed	Negligible
River Roe	Sediment Run-off	Major	• Buffer Zones • Site Drainage Management & SuDS • Water Quality Monitoring • Timing of Instream Works	Negligible
	Release of other pollutants	Major	• Site Management as detailed	Negligible
Operational phase				
Streams A, B, C and F	Sediment Water Run-off	Moderate	• SuDS Design	Negligible
Streams D and E	Sediment Water Run-off	Moderate	• SuDS Design	Negligible
Castle River	Sediment Water Run-off	Moderate/ Major	• SuDS Design	Negligible
River Roe	Sediment Water Run-off	Moderate	• SuDS Design	Negligible

11 Statement of Significance

181. This report has assessed the likely significance of effects of the Development on Fisheries and Aquatic Ecology. Without mitigation the effects are predicted to be of ***Moderate to Major Significance***, depending on specific effects and the sensitivity of individual receptors, i.e., watercourses. However, taking into account embedded mitigation in the form of careful design and the application of the final DCEMP, which will incorporate the WCEMP, the residual effects are predicted to be Negligible, and are ***Not Significant*** in terms of the EIA Regulations. Effects will be temporary during the initial decommissioning and construction phases, and permanent, yet reversible during the operational phase.



Rev	Date	By	Comment
A	27/06/2019	SC	First Issue.

SCOTTISHPOWER RENEWABLES

0 2 4 8 km

Rigged Hill Windfarm Repowering
River Roe Catchment
Figure A8.5.1

Drawing Number: 2606-REP-084

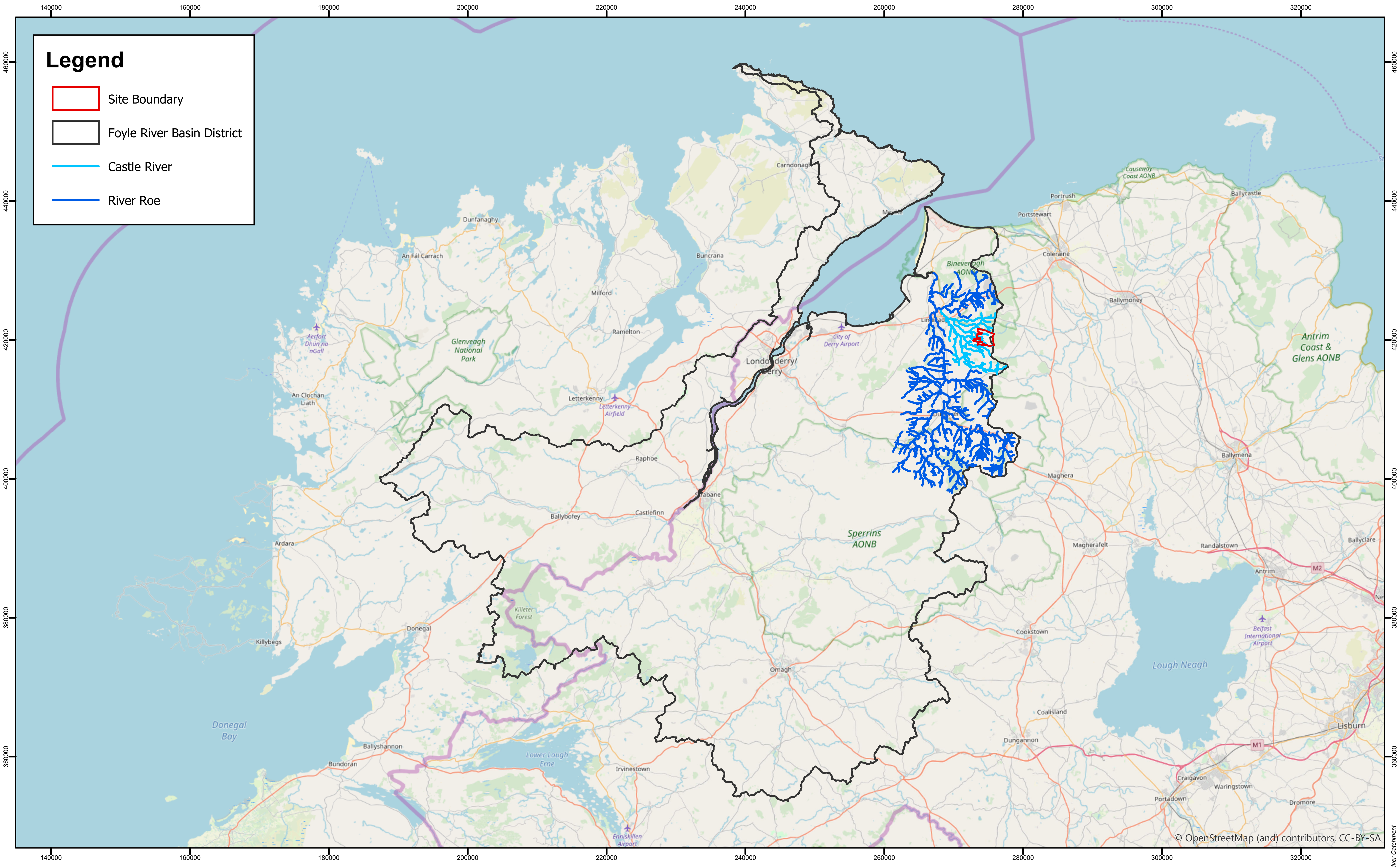
Datum TM65

Projection TM

Scale @ A3 1:150,000

Drawing produced by Arcus Consultancy Services

2607-REP-084 FigA8.5.1 River Roe Catchment



Rev	Date	By	Comment
A	27/06/2019	SC	First Issue.

0 5 10 20 km

Rigged Hill Windfarm Repowering

Foyle River Catchment

Figure A8.5.2

Drawing Number: 2606-REP-085

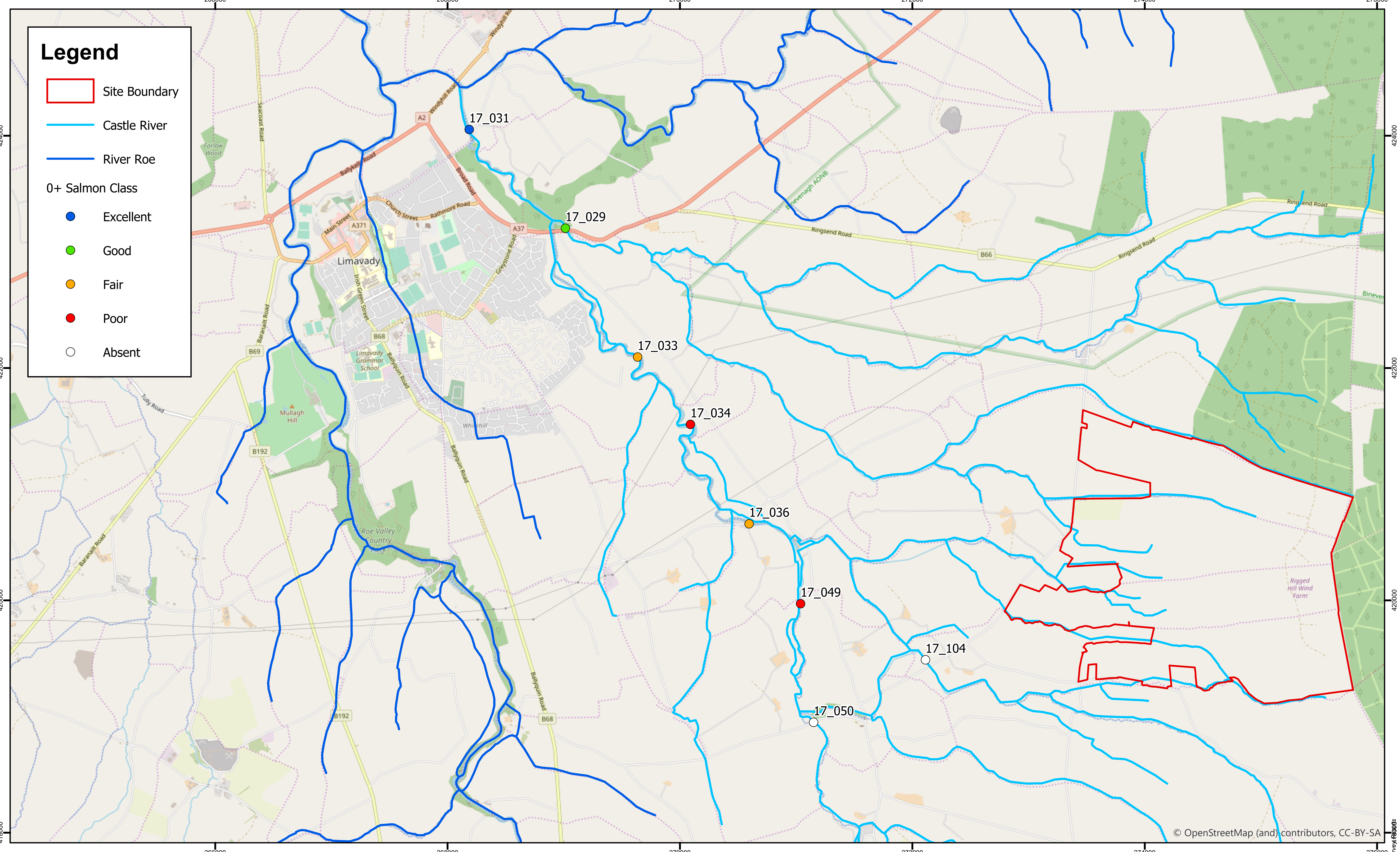
Datum TM65

Projection TM

Scale @ A3 1:500,000

Drawing produced by Arcus Consultancy Services

2607-REP-085 FigA8.5.2 Foyle River Catchment



SCOTTISHPOWER RENEWABLES

Rev	Date	By	Comment
A	27/06/2019	SC	First Issue.

km 0 0.4 0.8 1.6

Rigged Hill Windfarm Repowering

Salmon Survey Results

Figure A8.5.3

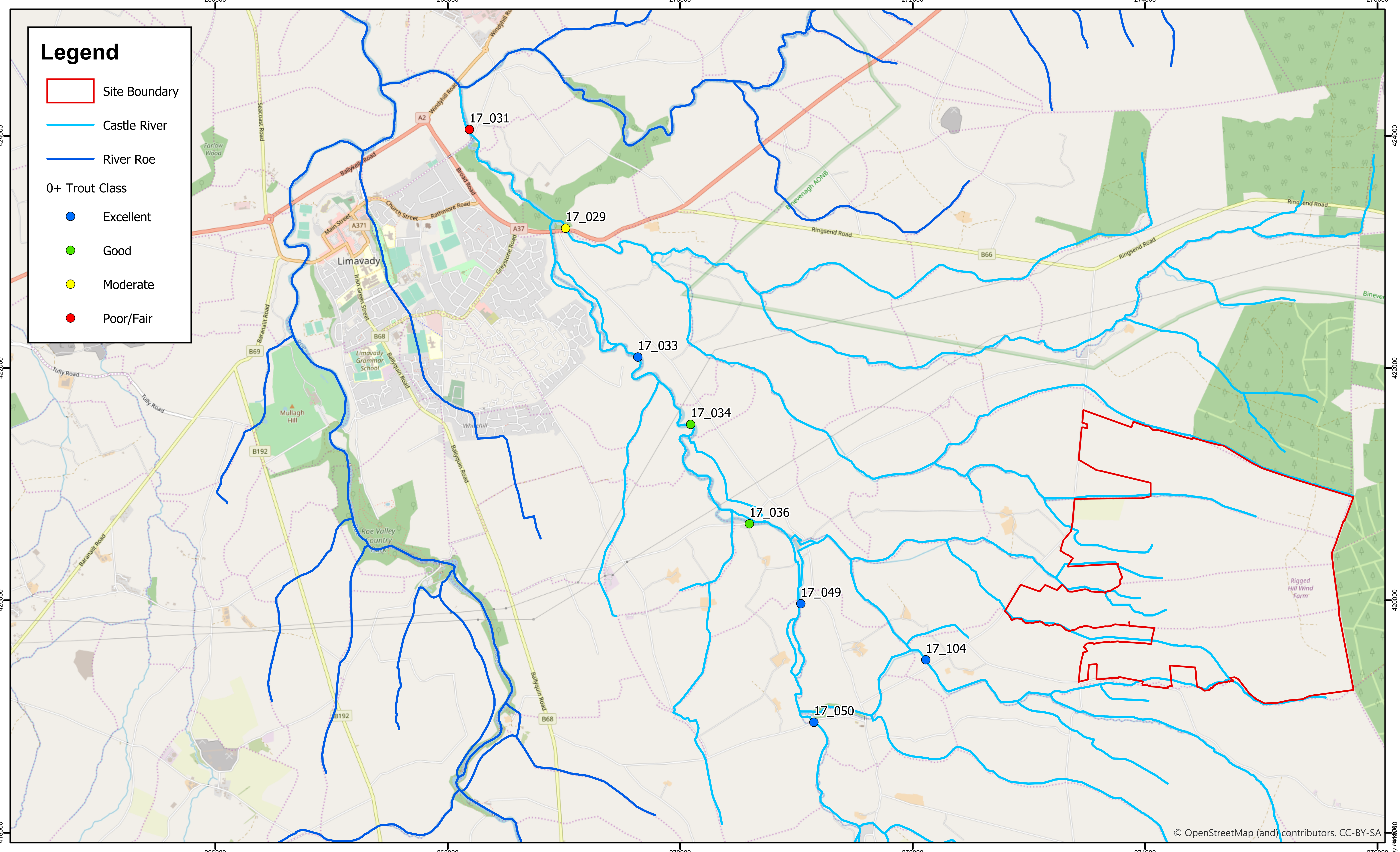
Drawing Number: 2606-REP-086

Datum TM65

Projection TM

Scale @ A3 1:30,000

Drawing produced by Arcus Consultancy Services



SCOTTISHPOWER RENEWABLES

Rev	Date	By	Comment
A	27/06/2019	SC	First Issue.

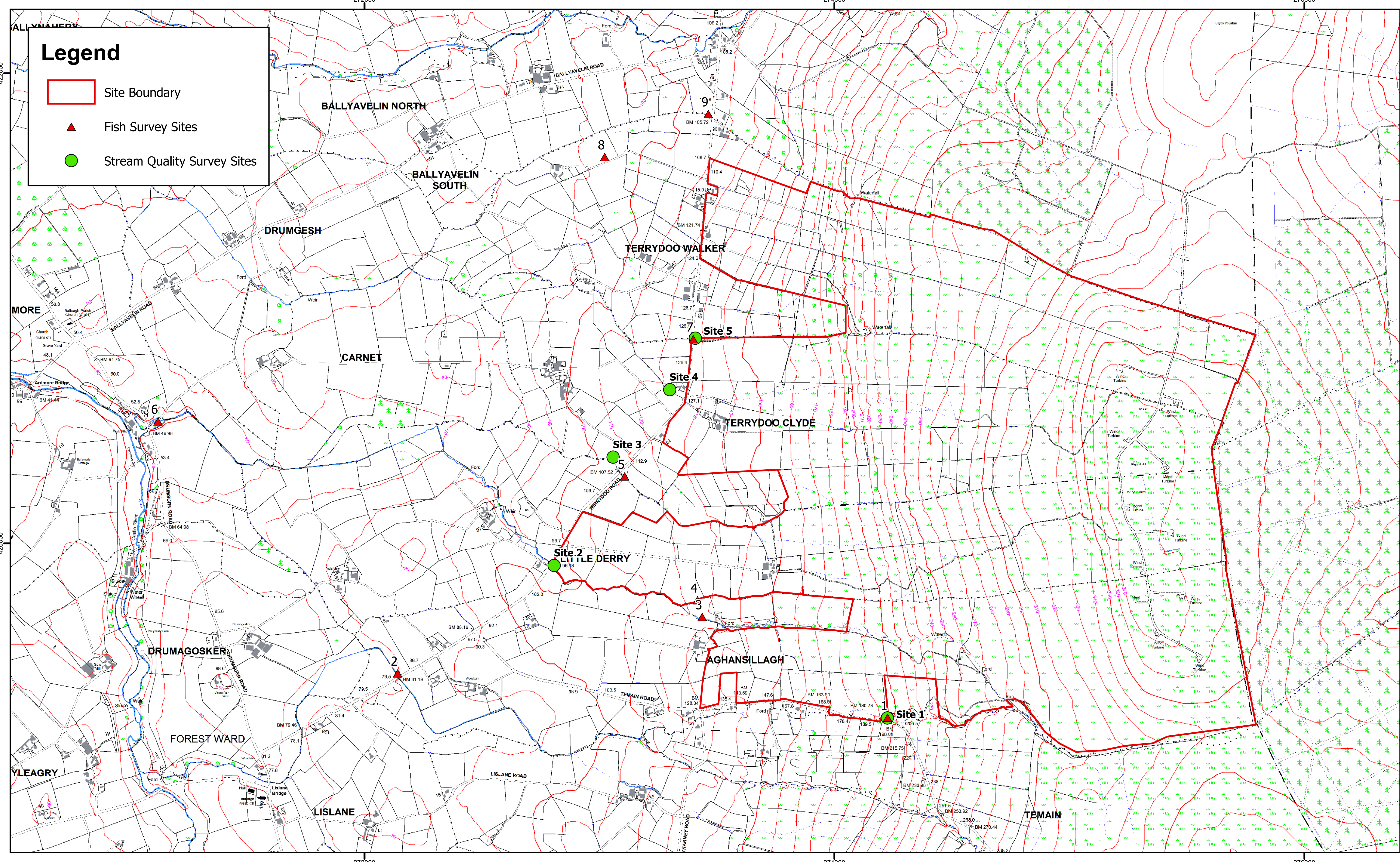
km 0 0.4 0.8 1.6

Rigged Hill Windfarm Repowering

Trout Survey Results

Figure A8.5.4

Drawing Number: 2606-REP-087	Datum TM65	Projection TM	
Scale @ A3 1:30,000	Drawing produced by Arcus Consultancy Services		



Rev	Date	By	Comment
A	27/06/2019	SC	First Issue.

0 0.2 0.4 0.8 km

SCOTTISHPOWER RENEWABLES

Rigged Hill Windfarm Repowering

Stream Quality Survey

Figure A8.5.5

Drawing Number: 2606-REP-088

Datum TM65

Projection TM

Scale @ A3 1:15,000

Drawing produced by Arcus Consultancy Services

2607-REP-088 FigA8.5.5 Stream Quality Survey