

Fisheries assessment for Carrig Renewables Wind Farm, Co. Tipperary



Prepared by Triturus Environmental Ltd. for MKO

September 2023

Please cite as:

Triturus (2023). Fisheries assessment for Carrig Renewables Wind Farm, Co. Tipperary. Report prepared by Triturus Environmental Ltd. for MKO. September 2023.

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1. Introduction

1.1 Background

Triturus Environmental Ltd. were commissioned by MKO to undertake a baseline fisheries assessment of numerous watercourses in the vicinity of the proposed Carrig Renewables Wind Farm project (formerly Sharragh wind farm), located approximately 7km west of Birr, Co. Offaly. (**Figure 2.1**).

The survey was undertaken to establish baseline fisheries data used in the preparation of the EIAR for the proposed project. In order to gain an accurate overview of the existing and potential fisheries value of the riverine watercourses within the vicinity of the proposed project, a catchment-wide electro-fishing survey across $n=14$ riverine sites was undertaken (**Table 2.1; Figure 2.1**). Electro-fishing helped to identify the importance of the watercourses as nurseries and habitats for salmonids, lamprey (*Lampetra* sp.) and European eel (*Anguilla anguilla*). Other species of lower conservation value were also recorded. The presence and or absence of fish populations and or associated supporting habitat would help inform impact assessment and any subsequent mitigation for the project. A fisheries appraisal was also undertaken at 1 no. lake site (Friar's Lough).

Triturus Environmental Ltd. made an application under Section 14 of the Fisheries (Consolidation) Act, 1959 as substituted by Section 4 of the Fisheries (Amendment) Act, 1962, to undertake a catchment-wide electro-fishing survey in the vicinity of the proposed Carrig Renewables Wind Farm. Permission was granted on the 20th July 2022 and the survey was undertaken on Friday 9th to Sunday 11th September 2022.

1.2 Fisheries asset of the survey area

The Holy Well Clohaskin River (also referred to as the Little Brosna (Carrig) River) is a tributary of the Little Brosna River known to support brown trout (*Salmo trutta*), European eel (*Anguilla anguilla*) and three-spined stickleback (*Gasterosteus aculeatus*) at the same location as survey site A7 (IFI 2015 data¹). The adjacent Faddan Beg Stream (also referred to as the Little Brosna (Carrig) River) is also known to support these fish species, including at the same location as survey site A3 (IFI data).

Friar's Lough, located on the Lorrha Stream (no data) is a coarse fishery and known to support a range of species such as pike (*Esox lucius*), perch (*Perca fluviatilis*), rudd (*Scardinius erythrophthalmus*), bream (*Abramis brama*), bream hybrids and tench (*Tinca tinca*) (pers. obs.). Given fluvial connectivity with the Lorrha Stream, the occurrence of brown trout in the lake is considered likely.

The Little Brosna River is known to support Atlantic salmon (*Salmo salar*), brown trout (*Salmo trutta*), European eel, lamprey (*Lampetra* sp.), minnow (*Phoxinus phoxinus*) and stone loach (*Barbatula barbatula*) (Kelly et al., 2010, 2015).

Fisheries data for the other watercourses surveyed was not available at the time of survey.

¹ IFI data available at <https://opendata-ifigis.hub.arcgis.com/datasets/IFIGIS::water-framework-directive-fish-ecological-status-2008-2021/>

2. Methodology

2.1 Fish stock assessment (electro-fishing)

A single anode Smith-Root LR24 backpack (12V DC input; 300V, 100W DC output) was used to electro-fish sites on watercourses in the vicinity of the proposed Carrig Renewables Wind Farm on Friday 9th to Sunday 11th September 2022 following notification to Inland Fisheries Ireland and under the conditions of a Department of the Environment, Climate and Communications (DECC) licence. Both river and holding tank water temperature was monitored continually throughout the survey to ensure temperatures of 20°C were not exceeded, thus minimising stress to the captured fish due to low dissolved oxygen levels. A portable battery-powered aerator was also used to further reduce stress to any captured fish contained in the holding tank.

Salmonids, European eel and other captured fish species were transferred to a holding container with oxygenated fresh river water following capture. To reduce fish stress levels, anaesthesia was not applied to captured fish. All fish were measured to the nearest millimetre and released in-situ following a suitable recovery period.

As three primary species groups were targeted during the survey, i.e., salmonids, lamprey, and eel, the electro-fishing settings were tailored for each species. By undertaking electro-fishing using the rapid electro-fishing technique (see methodology below), the broad characterisation of the fish community at each sampling reach could be determined as a longer representative length of channel can be surveyed. Electro-fishing methodology followed accepted European standards (CEN, 2003) and adhered to best practice (e.g., CFB, 2008).

2.1.1 Salmonids and European eel

For salmonid species and European eel, as well as all other incidental species, electro-fishing was carried out in an upstream direction for a 10-minute CPUE, an increasingly common standard approach for wadable streams (Matson et al., 2018). A total of approx. 50-100m channel length was surveyed at each site, where feasible, in order to gain a better representation of fish stock assemblages. At certain, more minor watercourse sites or sites with limited access, it was more feasible to undertake electro-fishing for a 5-minute CPUE. Discrepancies in fishing effort (CPUE) between sites are accounted for in the subsequent results section (**Table 3.1**).

Relative conductivity of the water at each site was checked in-situ with a conductivity meter and the electro-fishing backpack was energised with the appropriate voltage and frequency to provide enough draw to attract salmonids and European eel to the anode without harm. For the moderate to high conductivity waters of the sites (draining limestone) a voltage of 220-250v, frequency of 35-40Hz and pulse duration of 3.5-4ms was utilised to draw fish to the anode without causing physical damage.

2.1.2 Lamprey

Electro-fishing for lamprey ammocoetes was conducted by targeted quadrat-based electro-fishing (as per Harvey & Cowx, 2003) in objectively suitable areas of sand/silt, where encountered. As lamprey take longer to emerge from silts and require a more persistent approach, they were targeted at a lower frequency (30Hz) burst DC pulse setting which also allowed detection of European eel in

sediment, if present. Settings for lamprey followed those recommended and used by Harvey & Cowx (2003), APEM (2004) and Niven & McAuley (2013). Using this approach, the anode was placed under the water's surface, approx. 10-15cm above the sediment, to prevent immobilising lamprey ammocoetes within the sediment. The anode was energised with 100V of pulsed DC for 15-20 seconds and then turned off for approximately five seconds to allow ammocoetes to emerge from their burrows. The anode was switched on and off in this way for approximately two minutes. Immobilised ammocoetes were collected by a second operator using a fine-mesh hand net as they emerged.

Lamprey species were identified to species level, where possible, with the assistance of a hand lens, through external pigmentation patterns and trunk myomere counts as described by Potter & Osborne (1975) and Gardiner (2003).

2.2 Fisheries habitat

A broad appraisal / overview of the upstream and downstream habitat at each site was also undertaken to evaluate the wider contribution to salmonid and lamprey spawning and general fisheries habitat. River habitat surveys and fisheries assessments were also carried out utilising elements of the approaches in the River Habitat Survey Methodology (EA, 2003) and Fishery Assessment Methodology (O'Grady, 2006) to broadly characterise the riverine sites (i.e., channel profiles, substrata etc.).

2.3 Biosecurity

A strict biosecurity protocol following IFI (2010) and the Check-Clean-Dry approach was adhered to during surveys for all equipment and PPE used. Disinfection of all equipment and PPE before and after use with Virkon™ was conducted to prevent the transfer of pathogens or invasive propagules between survey sites. Surveys were undertaken at sites in a downstream order to minimise the risk of upstream propagule mobilisation. Cognisance was given towards preventing the spread or introduction of crayfish plague given the known historical distribution of white-clawed crayfish and previous outbreaks of crayfish plague in the wider survey area (i.e. Lorrha Stream). Furthermore, staff did not undertake any work in a known crayfish plague catchment for a period of <72hrs in advance of the survey. Where feasible, equipment was also thoroughly dried (through UV exposure) between survey areas. Any aquatic invasive species or pathogens recorded within or adjoining the survey areas were geo-referenced. All Triturus staff are certified in 'Good fieldwork practice: slowing the spread of invasive non-native species' by the University of Leeds.

Table 2.1 Location of $n=15$ electro-fishing & fisheries appraisal survey sites in the vicinity of Carrig Renewables Wind Farm, Co. Tipperary (* indicates fisheries appraisal only due to prohibitive depths)

Site no.	Watercourse	EPA code	Location	X (ITM)	Y (ITM)
A1	Faddan Beg Stream	25F29	Faddan More	598683	701971
A2	Faddan Beg Stream	25F29	Faddan More	600376	702329
A3	Faddan Beg Stream	25F29	L1071 road crossing, Doughkill	602492	700273
A4	Holy Well Clohaskin River	25H28	L5040 road crossing, Faddan More	599004	700303
A5	Holy Well Clohaskin River	25H28	Faddan More	599642	700200
A6	Faddan More Stream	25F57	Faddan More	600076	700869
A7	Holy Well Clohaskin River	25H28	L1071 road crossing, Lacka	601854	699579
A8	Little Brosna River	25L02	Riverstown Bridge	605240	703584
A9	Little Brosna River	25L02	New Bridge, R438	601660	709035
B1	Killenaule Stream	25Q34	R489 road crossing	600766	705583
B2	Killenaule Stream	25Q34	R438 road crossing	600613	707472
C1	Lissagadda Stream	25L44	L5057 road crossing	595483	703954
C2	Lorrha Stream	25L05	L1079 road crossing, Lorrha	592077	704502
C3*	Friar's Lough	25_175	1km west of Lorrha	590677	704709
C4*	Lorrha Stream	25L05	Ballyeiragh Bridge, N65	590677	704709

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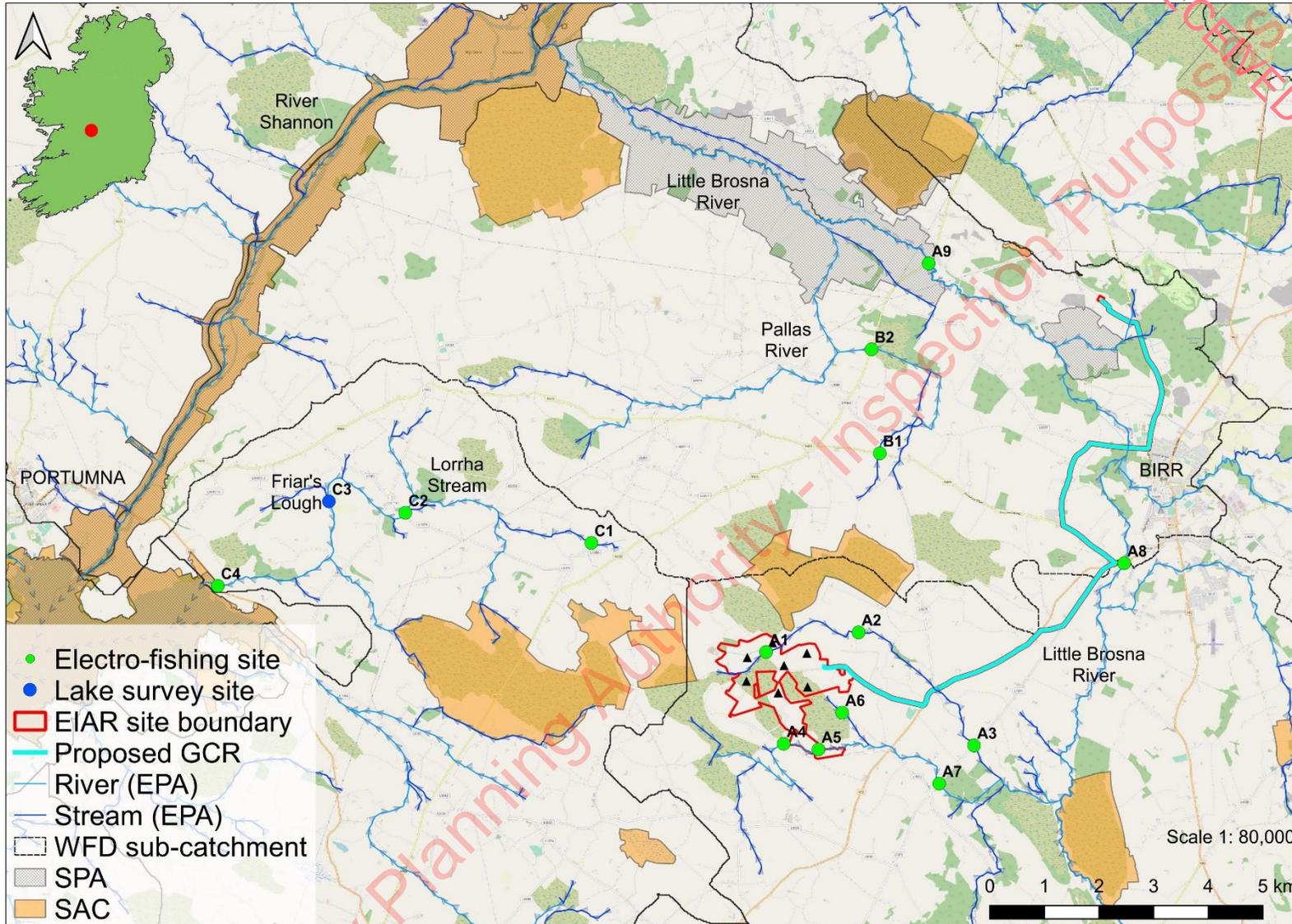


Figure 2.1 Overview of the n=15 electro-fishing & fisheries appraisal survey site locations for the proposed Carrig Renewables Wind Farm, Co. Tipperary

3. Results

A catchment-wide electro-fishing survey of $n=15$ riverine sites in the vicinity of the proposed Carrig Renewables Wind Farm was conducted on Friday 9th to Sunday 11th September 2022 following notification to Inland Fisheries Ireland. The results of the survey are discussed below in terms of fish population structure, population size and the suitability and value of the surveyed areas as nursery and spawning habitat for salmonids, European eel and lamprey species. Scientific names are provided at first mention only.

3.1 Fisheries assessment & appraisal

3.1.1 Site A1 – Faddan Beg Stream, Faddan More

Three-spined stickleback (*Gasterosteus aculeatus*) ($n=4$) was the only fish species recorded via electro-fishing at site A1 on the Faddan Beg Stream (**Figure 3.1**).

With the exception of three-spined (present in low densities), the historically modified site was not of fisheries value given heavy siltation, poor hydromorphology and poor connectivity with downstream habitats.

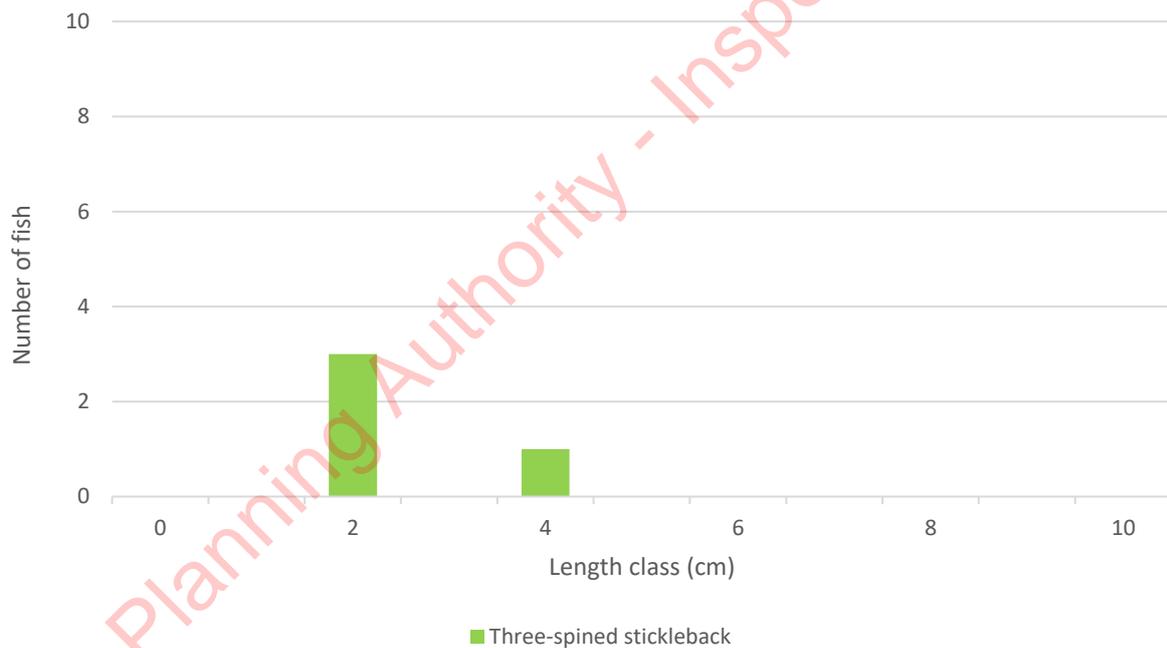


Figure 3.1 Length frequency distribution recorded via electro-fishing at site A1 on the Faddan Beg Stream, September 2022



Plate 3.1 Representative image of site A1 on the Faddan Beg Stream, September 2022

3.1.2 Site A2 – Faddan Beg Stream, Faddan More

Brown trout (*Salmo trutta*) ($n=3$) and three-spined stickleback ($n=3$) were recorded via electro-fishing at site A2 on the Faddan Beg Stream (**Figure 3.2**).

The historically modified site was of poor value for salmonids given gross siltation and poor hydromorphology, supporting only a very low density of brown trout. Spawning habitat was absent with the site also providing a poor quality nursery. Some moderate quality holding habitat (bank scours, deeper glide areas etc.) was present. The heavily silted site was of poor value for larval lamprey given the humic nature of the sediment and poor flows - none were recorded via targeted electro-fishing. Suitability for European eel was poor and none were recorded.

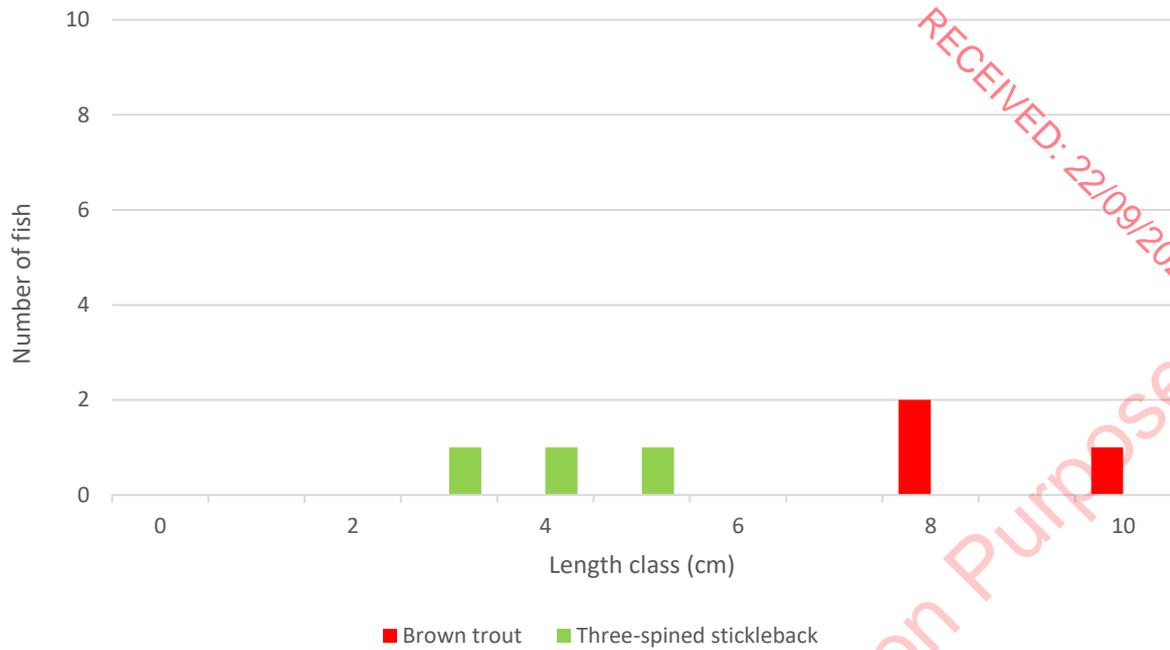


Figure 3.2 Length frequency distribution recorded via electro-fishing at site A2 on the Faddan Beg Stream, September 2022



Plate 3.2 Juvenile brown trout and three-spined stickleback recorded at site A2 on the Faddan Beg Stream, September 2022

3.1.3 Site A3 – Faddan Beg Stream, Doughkill

Brown trout ($n=6$) and three-spined stickleback ($n=5$) were recorded via electro-fishing at site A3 on the lower reaches of the Faddan Beg Stream (**Figure 3.3**).

The historically modified site was of moderate value to salmonids, supporting a low number of mixed-cohort brown trout. The site was considered a moderate quality salmonid nursery given evident siltation pressures which also significantly reduced the spawning value of the stream at this location. The small, narrow stream was of relatively poor value as a holding area for adult salmonids but some pools provided low suitability. Whist lamprey spawning habitat was present locally (fine gravels), the quality of the nursery habitat was poor given the typically shallow, flocculent nature of the soft sediment accumulations and no ammocoetes were recorded via targeted electro-fishing. Despite some suitability, no European eel were recorded.

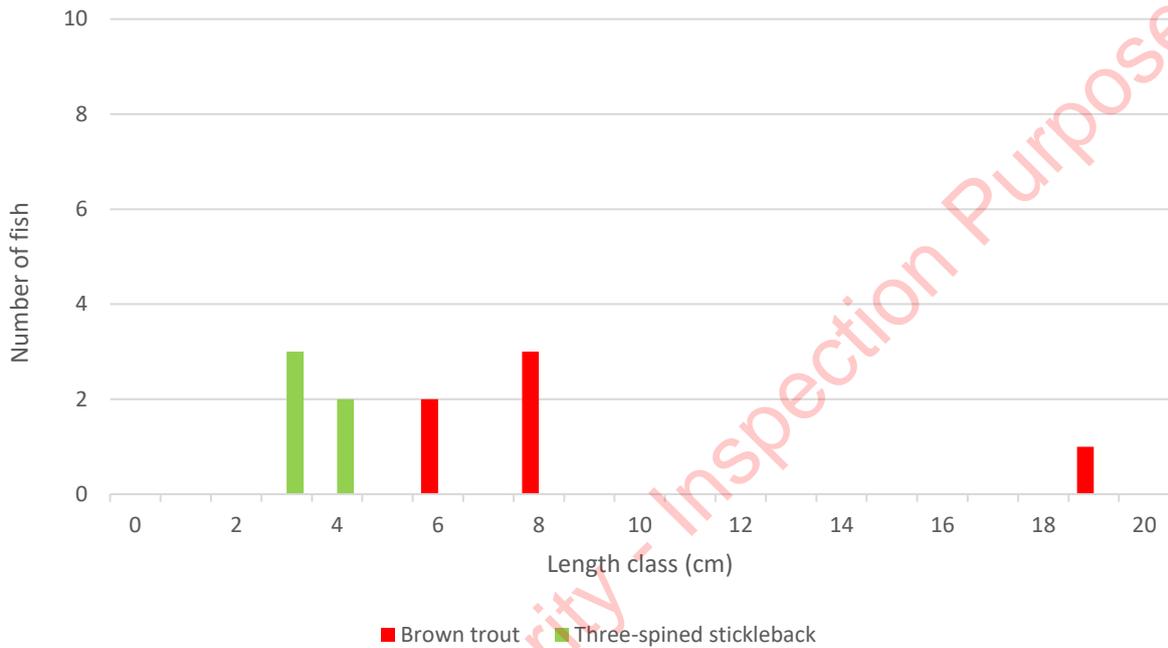


Figure 3.3 Length frequency distribution recorded via electro-fishing at site A3 on the Faddan Beg Stream, September 2022



Plate 3.3 Representative image of site A3 on the Faddan Beg Stream, September 2022 (downstream of road crossing)

3.1.4 Site A4 - Holy Well Clohaskin River, Faddan More

Three-spined stickleback ($n=40$) was the only fish species recorded via electro-fishing at site A4 on the Holy Well Clohaskin River (**Figure 3.4**).

With the exception of abundant stickleback, the historically modified site was not of fisheries value given heavy siltation, poor seasonal flows, poor hydromorphology and poor connectivity with downstream habitats. The accumulation of boulders at the box culvert/livestock access point was a significant barrier to fish migration at low flows. Under higher flows, there would be some improved but still poor quality salmonid and European eel habitat downstream of the culvert.

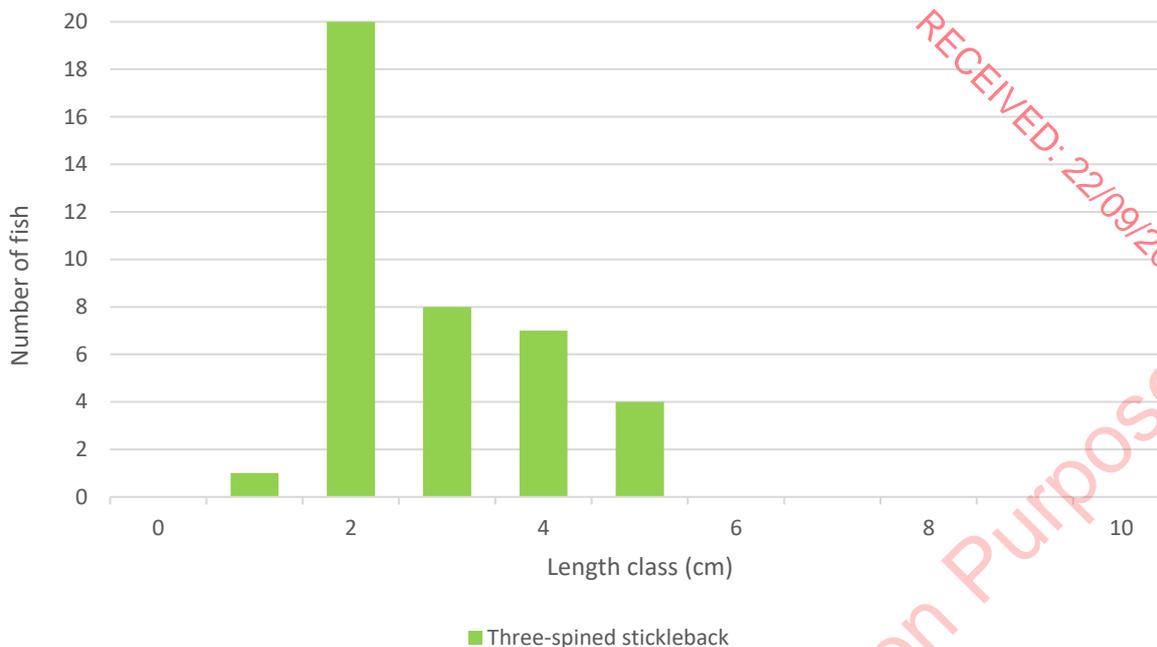


Figure 3.4 Length frequency distribution recorded via electro-fishing at site A4 on the Holy Well Clohaskin River, September 2022

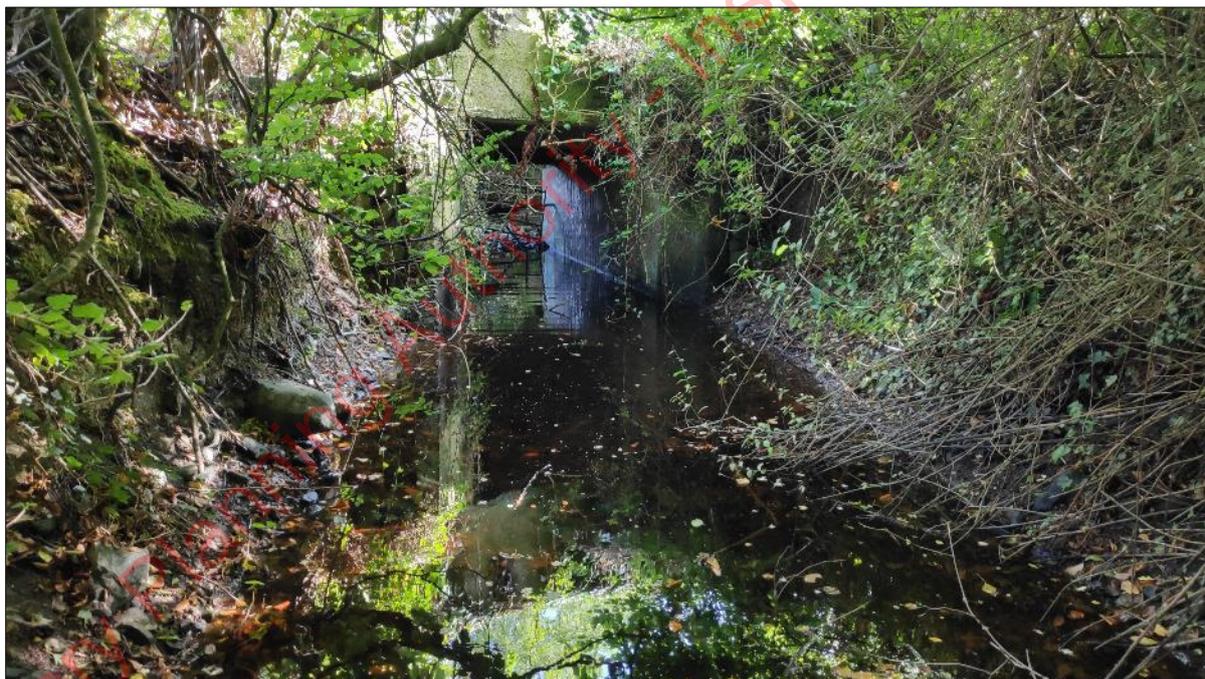


Plate 3.4 Representative image of site A4 on the Holy Well Clohaskin River, September 2022 (facing downstream to road crossing)

3.1.5 Site A5 – Holy Well Clohaskin River, Faddan More

Brown trout ($n=3$) and three-spined stickleback ($n=13$) were recorded via electro-fishing at site A5 on the Holy Well Clohaskin River (**Figure 3.5**).

The semi-natural site was of poor value for salmonids given poor seasonal flows, poor hydromorphology and evident siltation pressures. However, the site supported a low density of mixed-cohort brown trout. Nevertheless, the site provided poor quality spawning and nursery habitat with some moderate quality holding areas present. Despite some suitability, no European eel were recorded. Whilst some very limited poor-quality spawning habitat was present for lamprey, the flocculent nature of the soft sediment deposits precluded the presence of ammocoetes.

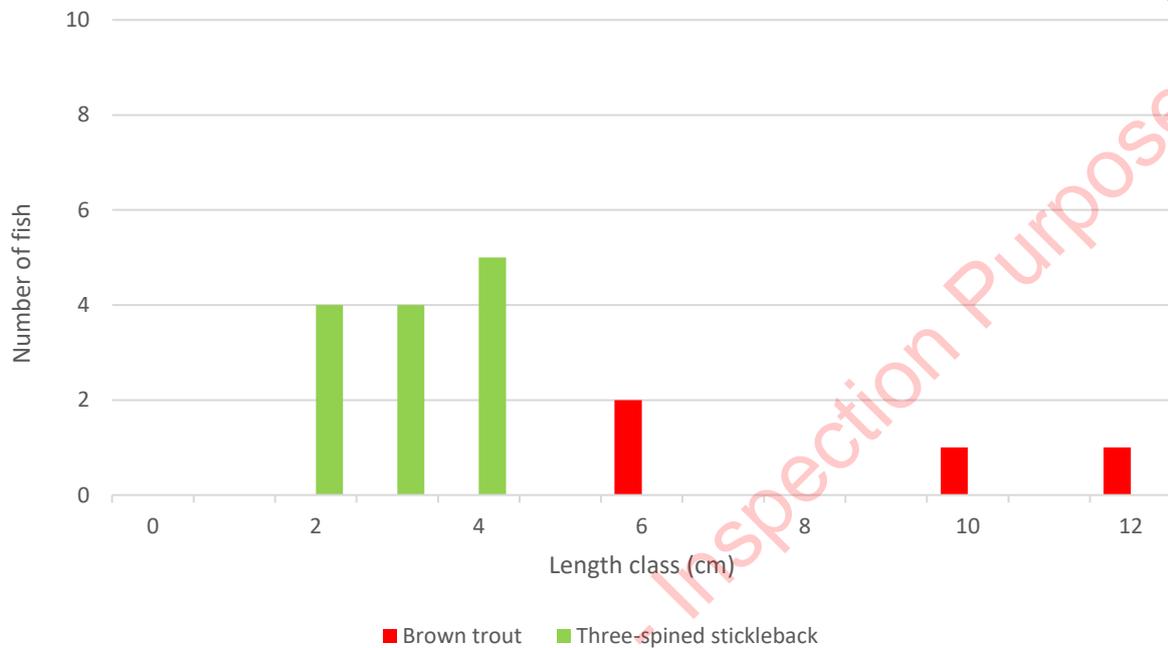


Figure 3.5 Length frequency distribution recorded via electro-fishing at site A5 on the Holy Well Clohaskin River, September 2022

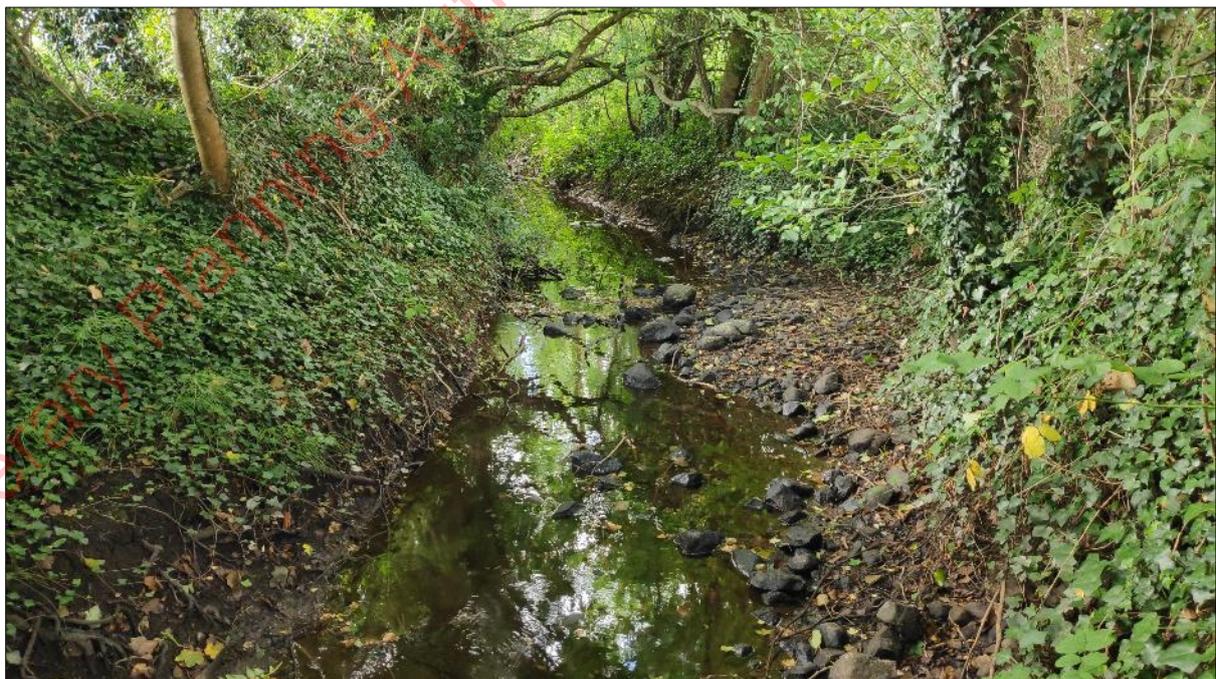


Plate 3.5 Representative image of site A5 on the Holy Well Clohaskin River, September 2022

3.1.6 Site A6 – Faddan More Stream, Faddan More

Site A6 was not of fisheries value given its dry/ephemeral nature and absence of aquatic habitats. It was not possible to undertake electro-fishing at this site.



Plate 3.6 Representative image of site A6 on the Faddan More Stream, September 2022 (dry channel)

3.1.7 Site A7 – Holy Well Clohaskin River, Lacka

Brown trout ($n=7$), lamprey (*Lampetra* sp.) ($n=57$) and three-spined stickleback ($n=2$) were recorded via electro-fishing at site A7 on the Holy Well Clohaskin River (**Figure 3.6**).

The semi-natural site was of good value for salmonids, supporting a small mixed-cohort population of brown trout. The site was of most value as a holding habitat for adult trout given an abundance of scoured banks, tree roots and macrophyte beds in addition to small pools. The site was of moderate value only as a salmonid nursery given the general paucity of hard substrata refugia and faster-flowing areas of glide and riffle. Whilst some spawning habitat for both salmonids and lamprey was present locally, the value was reduced considerably due to siltation pressures. Abundant soft sediment deposits on the littoral/marginal slopes provided excellent quality larval lamprey habitat which supported very high densities of *Lampetra* sp. ammocoetes (19 per m²). These areas were considered optimal for the species being a matrix of organic-rich flocculent silt, clay and sand. Despite high suitability, no European eel were recorded.

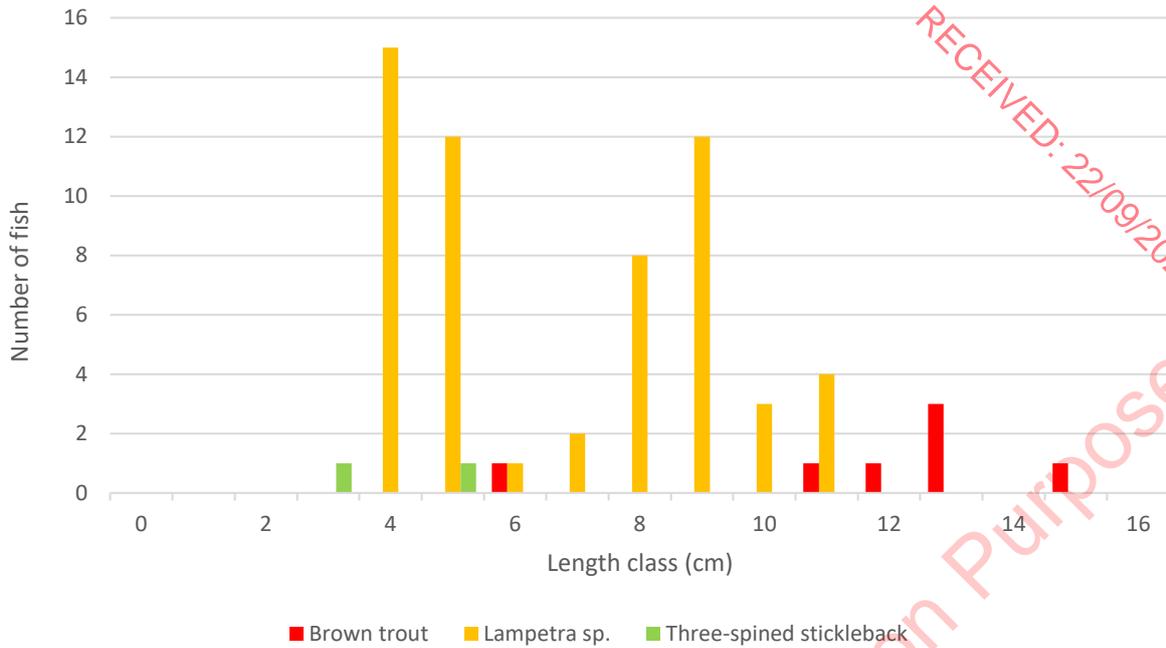


Figure 3.6 Length frequency distribution recorded via electro-fishing at site A7 on the Holy Well Clohaskin River, September 2022



Plate 3.7 Mixed cohort *Lampetra* sp. ammocoetes recorded at site A7 on the Holy Well Clohaskin River, September 2022

3.1.8 Site A8 – Little Brosna River, Riverstown Bridge

A total of 6 no. species were recorded at site A8 via electro-fishing on the Little Brosna River, namely Atlantic salmon (*Salmo salar*) ($n=1$), brown trout ($n=39$), European eel ($n=1$), minnow (*Phoxinus*

phoxinus) ($n=30$), stone loach (*Barbatula barbatula*) ($n=4$) and three-spined stickleback ($n=1$) (Figure 3.7). This was the highest species diversity recorded during the survey.

The large, swift-flowing lowland depositing site was of high value for salmonids, supporting a moderate density of mixed-cohort brown trout in addition to a low number of Atlantic salmon. The site provided good quality nursery habitat given the presence of abundant cobble and frequent boulder, in addition to macrophytes. Holding habitat was limited in extent but of good quality where present (e.g. small scours/undercuts). Better quality holding areas were present upstream. The site was of high value as a salmonid nursery despite the quality of habitat being reduced by siltation, enrichment and calcification pressures. Suitability for European eel was high although only a low density was recorded via electro-fishing.

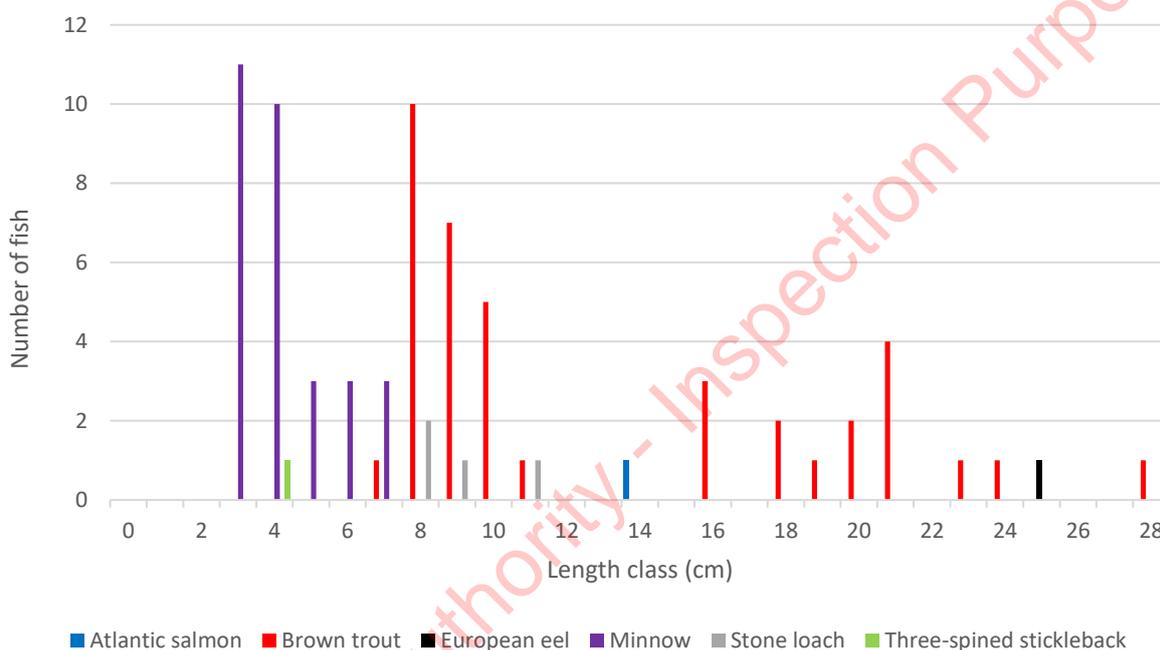


Figure 3.7 Length frequency distribution recorded via electro-fishing at site A8 on the Little Brosna River at Riverstown Bridge, September 2022



Plate 3.8 Atlantic salmon parr recorded at site A8 on the Little Brosna River, September 2022



Plate 3.9 Adult brown trout recorded at site A8 on the Little Brosna River, September 2022

3.1.9 Site A9 – Little Brosna River, New Bridge

Atlantic salmon ($n=4$), brown trout ($n=25$), lamprey (*Lampetra* sp.) ($n=9$), minnow ($n=2$) and invasive roach (*Rutilus rutilus*) ($n=7$) were recorded via electro-fishing at site A9 on the Little Brosna River (Figure 3.8).

The swift-flowing semi-natural site was of high value for salmonids, supporting a healthy population of mixed-cohort brown trout and low numbers of Atlantic salmon parr/smolts. The site was of excellent value as a holding area for adult salmonids (especially upstream of the bridge) given the presence of deeper glide and pool in addition to small bank scours and overhanging macrophyte vegetation. The site was of good value as a salmonid nursery given an abundance of instream refugia. The site also featured excellent quality spawning habitat for both salmonids and lamprey. Whilst lamprey ammocoetes were recorded in soft sediment areas, densities were relatively low overall (4.5 per m²) and optimal areas were highly localised (e.g. northernmost arch featured abundant soft sediments). Despite some good suitability, no European eel were recorded.

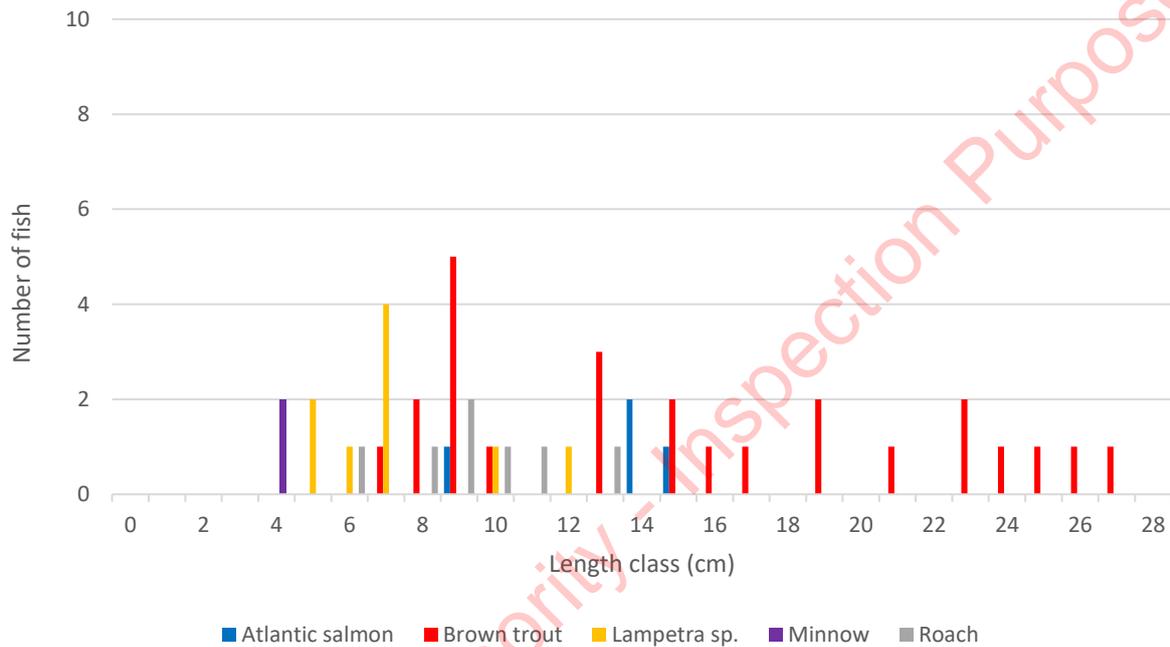


Figure 3.8 Length frequency distribution recorded via electro-fishing at site A9 on the Little Brosna River at New Bridge, September 2022



Plate 3.10 Roach and brown trout recorded at site A9 on the Little Brosna River at New Bridge, September 2022

3.1.10 Site B1 – Killenaule Stream, Clonmona

No fish were recorded via electro-fishing at site B1 on the Killenaule Stream. The site was not of fisheries value given it was an stream being dry at the time of the survey.



Plate 3.11 Representative image of site B1 on the Killenaule Stream, September 2022 (dry channel with rainwater pools)

3.1.11 Site B2 – Killenaule Stream, Gurteen

Three-spined stickleback ($n=9$) and ten-spined stickleback (*Pungitius pungitius*) ($n=11$) were the only fish species recorded via electro-fishing at site B2 on the Killenaule Stream (**Figure 3.9**).

With the exception of stickleback species, the heavily modified and heavily silted site was not of fisheries value given gross siltation, poor hydromorphology and poor connectivity with downstream habitats.

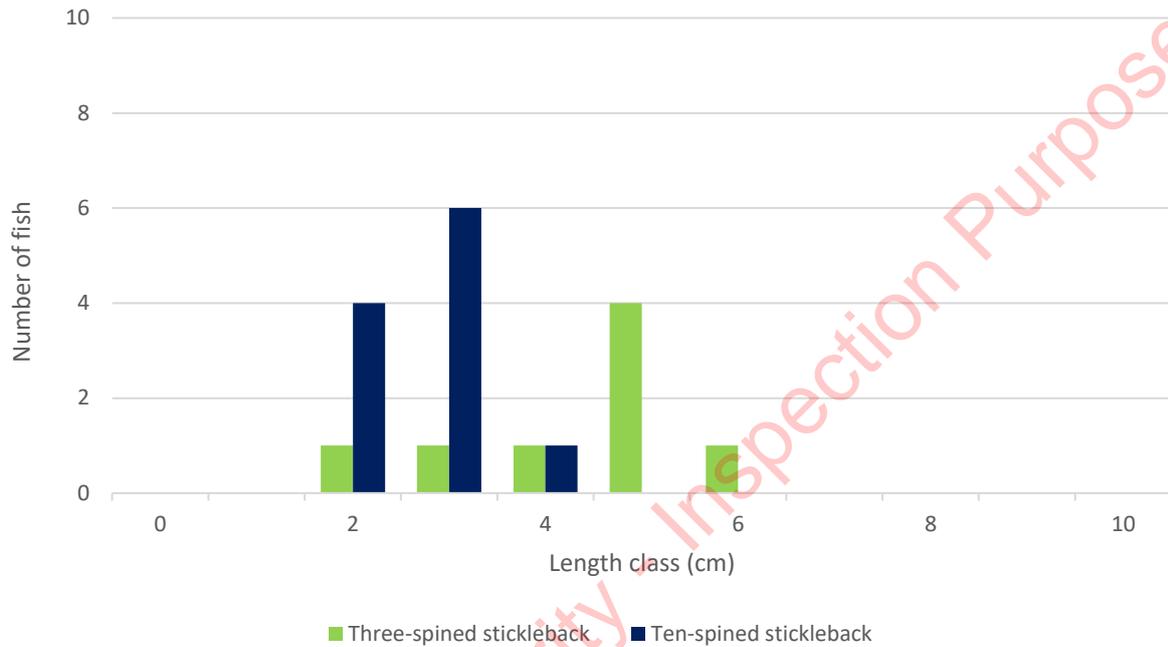


Figure 3.9 Length frequency distribution recorded via electro-fishing at site B2 on the Killenaule Stream, September 2022



Plate 3.12 Representative image of site B2 on the Killenaule Stream, September 2022 (upstream of the road crossing)

3.1.12 Site C1 – Lissagadda Stream, Abbeyville

Three-spined stickleback ($n=12$) was the only fish species recorded via electro-fishing at site C1 on the uppermost reaches of the Lissagadda Stream (**Figure 3.10**).

With the exception of low densities of stickleback, site C1 was not of fisheries value given gross siltation, low summer flows, poor hydromorphology and poor connectivity with downstream habitats. Whilst the channel is known to convey significantly higher water volumes seasonally, the poor hydromorphology would likely preclude fish of higher conservation value migrating from downstream connecting habitats.

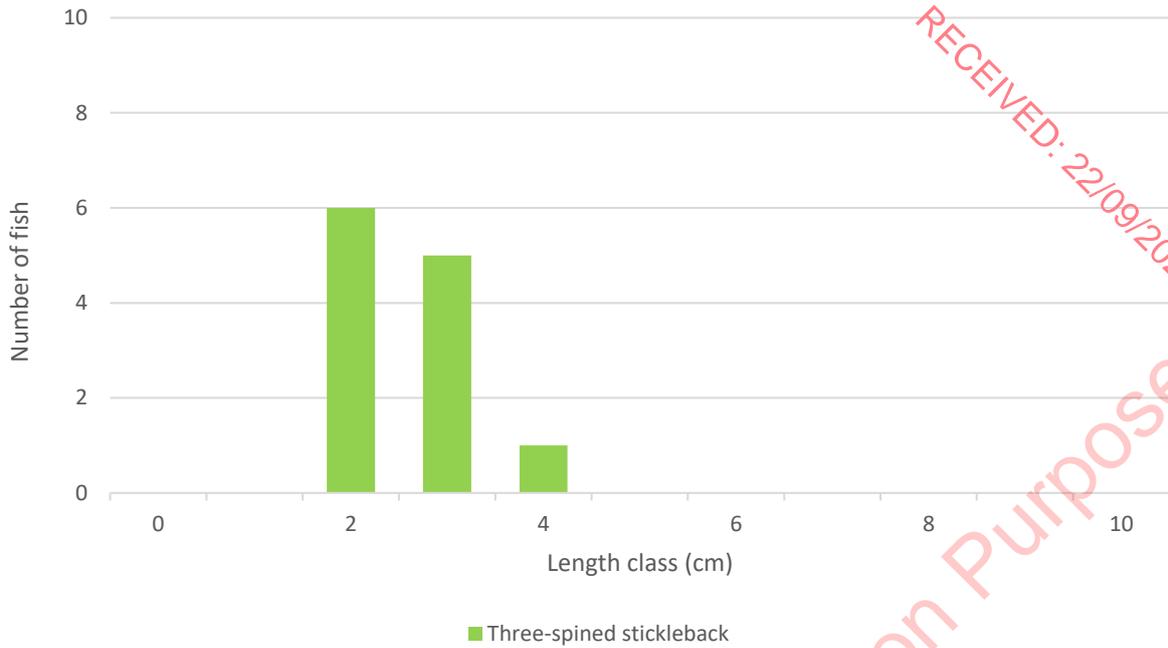


Figure 3.10 Length frequency distribution recorded via electro-fishing at site C1 on the Lissagadda Stream, September 2022



Plate 3.13 Representative image of site C1 on the upper Lissagadda Stream, September 2022 (facing downstream from road crossing)

3.1.13 Site C2 – Lorrha Stream, Lorrha

Brown trout ($n=46$), lamprey (*Lampetra* sp.) ($n=1$), European eel ($n=1$) and three-spined stickleback ($n=1$) were recorded via electro-fishing at site C2 on the Lorrha Stream (**Figure 3.11**).

Despite extensive modifications, the site was of high value for salmonids, supporting a high density of mixed-cohort brown trout. The site was of most value as a salmonid nursery with abundant juvenile (0+ and 1+) trout. Spawning habitat was of poor quality for both salmonids and lamprey given substrata compaction, siltation pressures and a predominance of larger substrata. Holding habitat for larger salmonids was largely absent (small, shallow pools only). Soft sediment accumulations were of poor suitability for larval lamprey given their flocculent, shallow nature and supported a very low density of *Lampetra* sp. ammocoetes (1 per m²). The site was of good value for European eel (frequent instream refugia) but only a low density were recorded.



Figure 3.11 Length frequency distribution recorded via electro-fishing at site C2 on the Lorrha Stream, September 2022



Plate 3.14 Mixed cohort brown trout recorded at site C2 on the upper reaches of the Lorrha Stream, September 2022

3.1.14 Site C3 – Friar’s Lough

A fisheries appraisal was undertaken at site C3 (i.e. no netting or electro-fishing). The 3ha linear lake, which the Lorrha Stream flows through, was of high value to a range of coarse fish species, with pike (*Esox lucius*), perch (*Perca fluviatilis*), rudd (*Scardinius erythrophthalmus*), European eel, bream (*Abramis brama*) and tench (*Tinca tinca*) known from the lake (pers. obs.). High quality spawning and nursery areas for these species were abundant. Given the lake is located on the Lorrha Stream, the occurrence of (adult) brown trout is likely. The site was also highly suitable as a European eel habitat.



Plate 3.15 Representative image of site C3 at Friar's Lough, September 2022

3.1.15 Site C4 – Lorrha Stream, Ballyeiragh Bridge

Electro-fishing was not undertaken at site C4 given prohibitive depths of >1.5m (i.e. fisheries appraisal only). The historically modified site was of high value for coarse fish species such as pike (captured via sweep netting), roach and perch in addition to European eel. The heavily vegetated site was of highest value as a coarse fish spawning and nursery area. There was some low suitability as an adult salmonid holding habitat (brown trout only).



Plate 3.16 Juvenile pike recorded via sweep netting at site C4 on the Lorrha River, September 2022

Table 3.1 Fish species densities per m² recorded at sites in the vicinity of the proposed Carrig Renewables Wind Farm via electro-fishing in September 2022 (values in **bold** represent the highest densities recorded for each species, respectively)

Site	Watercourse	CPUE (elapsed time)	Approx. area fished (m ²)	Fish density (per m ²)								
				Atlantic salmon	Brown trout	<i>Lampetra</i> sp.	European eel	Three-spined stickleback	Ten-spined stickleback	Stone loach	Minnow	Roach
A1	Faddan Beg Stream	5	65	0.000	0.000	0.000	0.000	0.062	0.000	0.000	0.000	0.000
A2	Faddan Beg Stream	5	70	0.000	0.043	0.000	0.000	0.043	0.000	0.000	0.000	0.000
A3	Faddan Beg Stream	5	100	0.000	0.060	0.000	0.000	0.050	0.000	0.000	0.000	0.000
A4	Holy Well Clohaskin River	5	120	0.000	0.000	0.000	0.000	0.333	0.000	0.000	0.000	0.000
A5	Holy Well Clohaskin River	10	187.5	0.000	0.016	0.000	0.000	0.069	0.000	0.000	0.000	0.000
A6	Faddan More Stream	n/a - dry channel		0.000	n/a	n/a	n/a	n/a	n/a	0.000	n/a	n/a
A7	Holy Well Clohaskin River	5	100	0.000	0.070	19.0 per m²	0.000	0.020	0.000	0.000	0.000	0.000
A8	Little Brosna River	10	240	0.004	0.163	0.000	0.004	0.004	0.000	0.017	0.125	0.000
A9	Little Brosna River	10	280	0.014	0.089	4.5 per m²	0.000	0.000	0.000	0.000	0.007	0.025
B1	Killenaule Stream	n/a dry channel		0.000	n/a	n/a	n/a	n/a	n/a	0.000	n/a	n/a
B2	Killenaule Stream	5	100	0.000	0.000	0.000	0.000	0.090	0.110	0.000	0.000	0.000
C1	Lissagadda Stream	5	100	0.000	0.000	0.000	0.000	0.120	0.000	0.000	0.000	0.000
C2	Lorrha Stream	10	125	0.000	0.368	1 per m²	0.008	0.008	0.000	0.000	0.000	0.000
C3	Friar's Lough	Lake site, no electro-fishing		0.000	n/a	n/a	n/a	n/a	n/a	0.000	n/a	n/a
C4	Lorrha Stream	n/a – too deep for electro-fishing		0.000	n/a	n/a	n/a	n/a	n/a	0.000	n/a	n/a

Table 3.2 Summary of fish species of higher conservation value and relative abundances (low, medium, high & very high) recorded via **electro-fishing** per survey site in the vicinity of the proposed Carrig Renewables Wind Farm, September 2022

Site	Watercourse	Relative abundance				
		Atlantic salmon	Brown trout	<i>Lampetra</i> sp.	European eel	Other species
A1	Faddan Beg Stream					Three-spined stickleback
A2	Faddan Beg Stream		Low			Three-spined stickleback
A3	Faddan Beg Stream		Low			Three-spined stickleback
A4	Holy Well Clohaskin River					Three-spined stickleback
A5	Holy Well Clohaskin River		Low			Three-spined stickleback
A6	Faddan More Stream	No fish recorded – dry channel				
A7	Holy Well Clohaskin River		Low	Very high		Three-spined stickleback
A8	Little Brosna River	Low	High		Low	Three-spined stickleback, minnow, stone loach
A9	Little Brosna River	Low	Medium	Low		Minnow, roach
B1	Killenaule Stream	No fish recorded – dry channel				
B2	Killenaule Stream					Three-spined stickleback, ten-spined stickleback
C1	Lissagadda Stream					Three-spined stickleback
C2	Lorrha Stream		High	Low	Low	Three-spined stickleback
C3	Friar's Lough	n/a – fisheries appraisal only due to prohibitive depths				
C4	Lorrha Stream	n/a – fisheries appraisal only due to prohibitive depths				

Conservation value: Atlantic salmon (*Salmo salar*), brook lamprey (*Lampetra planeri*) and river lamprey (*Lampetra fluviatilis*) are listed under Annex II of the Habitats Directive [92/42/EEC]. Atlantic salmon and river lamprey are also listed under Annex V of the Habitats Directive [92/42/EEC]. European eel are 'critically endangered' according to most recent ICUN red list (Pike et al., 2020) and listed as 'critically endangered' in Ireland (King et al., 2011). With the exception of the Inland Fisheries Acts 1959 to 2017, brown trout and coarse fish species have no legal protection in Ireland

4. Discussion

With the exception of the Little Brosna River, the surveyed watercourses in the vicinity of the proposed Carrig Renewables Wind Farm were typically small, modified channels which suffered from hydromorphological and siltation pressures. Some also suffered from very low summer flows at the time of survey (September 2022). Historical drainage pressures (straightening & deepening), eutrophication and siltation have significantly reduced the quality and heterogeneity of aquatic habitats in the vicinity of the proposed project. Historical straightening and deepening of watercourses removes habitat and hydromorphological heterogeneity, encourages sediment deposition and invariably results in an irreparable reduction in fisheries potential, particularly for salmonids but also other species such as European eel (O'Grady et al., 2017, O'Grady, 2006). Diffuse siltation is one of the greatest threats to salmonid populations, particularly in agricultural catchments such as that of the proposed development. Sediment not only blocks interstitial spaces in substrata (colmation) and limits oxygen supply to salmonid eggs (required for healthy embryonic development & successful hatching) but can also smother substrata, thus reducing available spawning habitat and impact macro-invertebrate communities on which salmonids feed (Kelly-Quinn et al., 2020; Davis et al., 2018; Conroy et al., 2016; Cocchiglia et al., 2012; Louhi et al., 2008, 2011; Walling et al., 2003; Soulsby et al., 2001). Sedimentation of salmonid habitat is a particular problem in Irish rivers flowing through agricultural catchments (Evans et al., 2006), such as that containing the proposed project.

Low summer water levels and ephemeral conditions were also evidently an issue for fish populations on selected channels such as the Holy Well Clohaskin River and Killenaule Stream. All wetted survey sites supported fish at the time of survey, although 4 no. sites (A1, A4, B2 & C1) contained three-spined and or ten-spined stickleback only given poor quality/ephemeral habitats. A total of ten fish species were recorded during the survey, namely Atlantic salmon, brown trout, *Lampetra* sp., European eel, stone loach, minnow, three-spined stickleback, ten-spined stickleback, pike and roach (the latter being an invasive species) (Table 3.2).

Brown trout were present at 7 no sites (A2, A3, A5, A7, A8, A9 & C2). Atlantic salmon parr were recorded at low density at two sites only, A8 and A9 on the Little River Brosna. Despite significant downstream barriers in the Shannon catchment, Atlantic salmon populations are still known from the Little Brosna² although numbers recorded during the current survey were low and significantly less than previous surveys, including at Riverstown Bridge (Kelly et al., 2010, 2015). Brown trout were typically present in low densities also, with the Little Brosna River and Lorrha Stream supporting the highest numbers (Table 3.1) and best quality salmonid habitat recorded during the current survey.

Lamprey ammocoetes (*Lampetra* sp.) were recorded from three sites during targeted electro-fishing across 13 no. survey sites in the vicinity of the proposed wind farm project (Table 3.1, 3.2). The highest density of ammocoetes (19.5 per m²) were recorded on the Holy Well Clohaskin River at site A7, where near-optimal settlement and burial conditions existed for the species. Low densities were also present at site A9 on the Little Brosna River (4.5 per m²) and the Lorrha Stream at site C2 (1 per m²) where sub-optimal conditions persisted. *Lampetra* spp. require fine gravels required for spawning (Dawson et al., 2015; Rooney et al., 2013; Lasne et al., 2010) and the deposition of fine, organic-rich sediment ≥5cm in depth generally (Aronsoo & Virkkala, 2014; Goodwin et al., 2008; Gardiner, 2003). Such

² Supported primarily by stocking from the ESB's Parteen hatchery (Ecofact, 2016)

characteristics were highly localised within the wider survey area due to historical drainage pressures (hydromorphology) and siltation issues. Furthermore, low summer flows contributed to a reduction in the quality of habitat for larval (nursery) and adult lamprey (spawning), respectively.

European eel are Red-listed in Ireland (King et al., 2011) and are classed as 'critically endangered' on a global scale (Pike et al., 2020). Despite widespread physical suitability, European eel were only recorded in low densities from sites A8 on the Little Brosna River and site C2 on the Lorrha Stream. The species is also known from Friar's Lough (pers. obs.) and is likely present in the lower reaches of the Lorrha Stream (site C4) where electro-fishing was not possible during the current survey due to prohibitive depths. As eel occurrence decreases significantly with increasing distance from the sea (Degerman et al., 2019), the paucity of eel observed in the the LittleBrosna_SC_020, Shannon[Lower]_SC_060 and LorrhaStream_SC_010 river sub-catchments can be partly explained by the distance between the survey area and marine habitats (Chadwick et al., 2007) (>100km nearest instream distance, with significant instream barriers). The absence of eel from many physically suitable sites also likely reflects the widespread low summer flow conditions which influence and restrict fish distribution.

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Aquatic baseline report for Carrig Renewables wind farm, Co. Tipperary

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Prepared by Triturus Environmental Ltd. for MKO

September 2023

Please cite as:

Triturus (2023). Aquatic baseline report for Carrig Renewables wind farm, Co. Tipperary. Report prepared by Triturus Environmental Ltd. for MKO. September 2023.

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1. Introduction

1.1 Background

Triturus Environmental Ltd. were commissioned by MKO to conduct baseline aquatic surveys to inform EIA preparation for the proposed Carrig Renewables Wind Farm project. The following report provides a baseline assessment of the aquatic ecology including fisheries and biological water quality, as well as protected aquatic species and habitats in the vicinity of the proposed project, located approximately 7km southwest of Birr, Co. Offaly.

Undertaken on a catchment-wide scale, the baseline surveys focused on the detection of freshwater habitats and species of high conservation value. These included surveys for white-clawed crayfish (*Austropotamobius pallipes*), macro-invertebrates (biological water quality) and fish of high conservation value, inclusive of supporting nursery and spawning habitat. The surveys also documented macrophyte and aquatic bryophyte communities including Annex I habitat associations in the vicinity of the project (**Figure 2.1**). Aquatic surveys were undertaken in September 2022, within the accepted optimal window for aquatic survey completion.

1.2 Project description

A full description of the proposed project is provided in Chapter 4 of the Environmental Impact Assessment Report (EIA).

2. Methodology

2.1 Selection of watercourses for assessment

All freshwater watercourses which could be affected directly or indirectly by the proposed wind farm project were considered as part of the current baseline. A total of $n=14$ riverine and $n=1$ lake sites were selected for detailed aquatic assessment (see **Table 2.1**, **Figure 2.1** below). The nomenclature for the watercourses surveyed is as per the Environmental Protection Agency (EPA). Aquatic survey sites were present on the Faddan Beg Stream (EPA code: 25F29), Holy Well Clohaskin River (25H28), Faddan More Stream (25F57), Little Brosna River (25L02), Killenaule Stream (25Q34), Lissagadda Stream (25L44), Lorrha Stream (25L05) and Friars Lough (**Table 2.1**). The aquatic survey sites were located within the LittleBrosna_SC_020, Shannon[Lower]_SC_060 and LorrhaStream_SC_010 river sub-catchments. A small portion of the proposed site boundary overlapped with the Ballyduff/Clonfinane Bog SAC (000641). There was also potential downstream hydrological connectivity between the proposed project and the River Shannon Callows SAC (000216) and Lough Derg, North-east Shore SAC (002241). With the exception of otter (*Lutra lutra*) in the River Shannon Callows SAC (NPWS, 2022), these European sites are designated for a range of terrestrial habitats only (NPWS, 2019, 2015).

Please note this aquatic report should be read in conjunction with Chapter 4 and Chapter 6 of the Environmental Impact Assessment Report (EIAR) prepared for the proposed project. More specific aquatic methodology is outlined below and in the appendices of this report.

2.2 Aquatic site surveys

Aquatic surveys of the watercourses within the vicinity of the proposed wind farm project were conducted on Friday 9th to Sunday 11th September 2022. Survey effort focused on both instream and riparian habitats at each aquatic sampling location (**Figure 2.1**). Surveys at each of these sites included a fisheries assessment (electro-fishing and or fisheries habitat appraisal), white-clawed crayfish survey, macrophyte and aquatic bryophyte survey and (where suitable) biological water quality sampling (Q-sampling) (**Figure 2.1**). This holistic approach informed the overall aquatic ecological evaluation of each site in context of the proposed project and ensured that any habitats and species of high conservation value would be detected to best inform mitigation for the wind farm project.

In addition to the ecological characteristics of the site, a broad aquatic and riparian habitat assessment was conducted utilising elements of the methodology given in the Environment Agency's 'River Habitat Survey in Britain and Ireland Field Survey Guidance Manual 2003' (EA, 2003) and the Irish Heritage Council's 'A Guide to Habitats in Ireland' (Fossitt, 2000). This broad characterisation helped define the watercourses' conformity or departure from naturalness. All sites were assessed in terms of:

- Physical watercourse/waterbody characteristics (i.e. width, depth etc.) including associated evidence of historical drainage
- Substrate type, listing substrate fractions in order of dominance (i.e. bedrock, boulder, cobble, gravel, sand, silt etc.)
- Flow type by proportion of riffle, glide and pool in the sampling area

- An appraisal of the macrophyte and aquatic bryophyte community at each site
- Riparian vegetation composition

Table 2.1 Location of $n=15$ aquatic survey sites in the vicinity of Carrig Renewables Wind Farm, Co. Tipperary

Site no.	Watercourse	EPA code	Location	X (ITM)	Y (ITM)
A1	Faddan Beg Stream	25F29	Faddan More	598683	701971
A2	Faddan Beg Stream	25F29	Faddan More	600376	702329
A3	Faddan Beg Stream	25F29	L1071 road crossing, Doughkill	602492	700273
A4	Holy Well Clohaskin River	25H28	L5040 road crossing, Faddan More	599004	700303
A5	Holy Well Clohaskin River	25H28	Faddan More	599642	700200
A6	Faddan More Stream	25F57	Faddan More	600076	700869
A7	Holy Well Clohaskin River	25H28	L1071 road crossing, Lacka	601854	699579
A8	Little Brosna River	25L02	Riverstown Bridge	605240	703584
A9	Little Brosna River	25L02	New Bridge, R438	601660	709035
B1	Killenaule Stream	25Q34	R489 road crossing	600766	705583
B2	Killenaule Stream	25Q34	R438 road crossing	600613	707472
C1	Lissagadda Stream	25L44	L5057 road crossing	595483	703954
C2	Lorrha Stream	25L05	L1079 road crossing, Lorrha	592077	704502
C3	Friar's Lough	25_175	1km west of Lorrha	590677	704709
C4	Lorrha Stream	25L05	Ballyeiragh Bridge, N65	590677	704709

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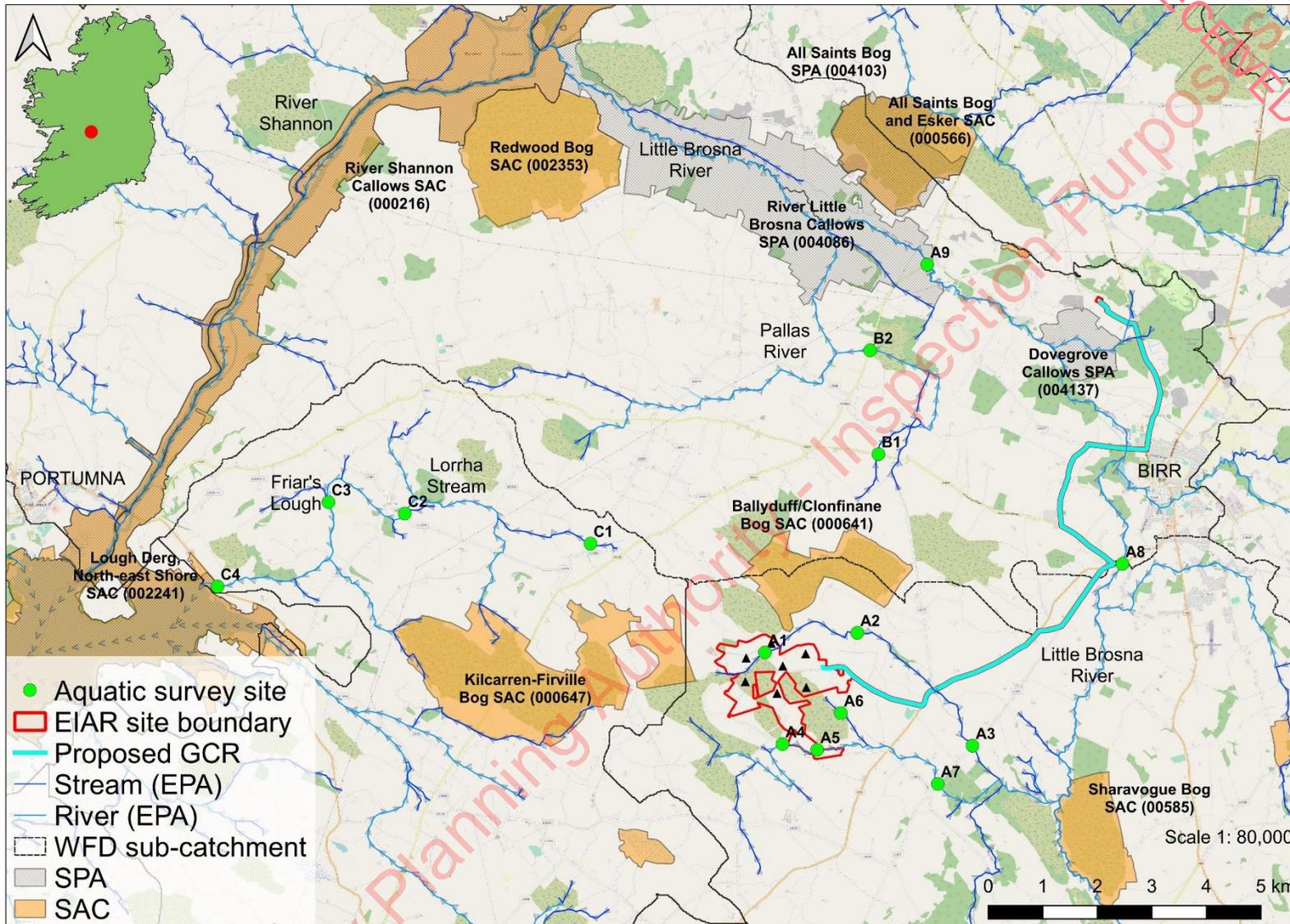


Figure 2.1 Overview of the $n=15$ aquatic survey site locations for the proposed Carrig Renewables Wind Farm, Co. Tipperary, September 2022

2.3 Fish stock assessment (electro-fishing)

A single anode Smith-Root LR24 backpack (12V DC input; 300V, 100W DC output) was used to electro-fish sites on watercourses in the vicinity of the proposed Carrig Renewables Wind Farm in September 2022 (**Table 2.1, Figure 2.1; Appendix A**), following notification to Inland Fisheries Ireland, under the conditions of a Department of the Environment, Climate and Communications (DECC) licence. The survey was undertaken in accordance with best practice (CFB, 2008; CEN, 2003) and Section 14 licencing requirements.

Furthermore, a fisheries habitat appraisal of the aquatic survey sites (**Figure 2.1**) was undertaken to establish their importance for salmonid, lamprey, European eel and other fish species. The baseline assessment also considered the quality of spawning, nursery and holding habitat for salmonids and lamprey within the vicinity of the survey sites. For detailed survey methodology, please refer to accompanying fisheries assessment report in **Appendix A**.

2.4 White-clawed crayfish survey

White-clawed crayfish surveys were undertaken at the aquatic survey sites in September 2022 under a National Parks and Wildlife (NPWS) open licence (no. C31/2022), as prescribed by Sections 9, 23 and 34 of the Wildlife Act (1976-2021), to capture and release crayfish to their site of capture, under condition no. 6 of the licence. As per Inland Fisheries Ireland recommendations, the crayfish sampling started at the uppermost site(s) of the wind farm catchment/sub-catchments in the survey area to minimise the risk of transferring invasive propagules (including crayfish plague) in an upstream direction.

Hand-searching of instream refugia and sweep netting was undertaken according to Reynolds et al. (2010). An appraisal of white-clawed crayfish habitat at each site was conducted based on physical channel attributes, water chemistry and incidental records in mustelid spraint. Additionally, a desktop review of crayfish records within the wider Carrig Renewables Wind Farm survey area was completed.

2.5 Biological water quality (Q-sampling)

The 14 no. riverine survey sites were assessed for biological water quality through Q-sampling in September 2022 (**Figure 2.1**). All samples were taken with a standard kick sampling hand net (250mm width, 500µm mesh size) from areas of riffle/glide utilising a 2-minute kick sample, as per Environmental Protection Authority (EPA) methodology (Feeley et al., 2020). Large cobble was also washed at each site for 1-minute (where present) to collect attached macro-invertebrates (as per Feeley et al., 2020). Samples were elutriated and fixed in 70% ethanol for subsequent laboratory identification. Samples were converted to Q-ratings as per Toner et al. (2005) and assigned to WFD status classes. Any rare invertebrate species were identified from the NPWS Red List publications for beetles (Foster et al., 2009), mayflies (Kelly-Quinn & Regan, 2012), stoneflies (Feeley et al., 2020) and other relevant taxa (i.e. Byrne et al., 2009; Nelson et al., 2011).

Table 2.2 Reference categories for EPA Q-ratings (Q1 to Q5) (Toner et al., 2005)

Q Value	WFD status	Pollution status	Condition
Q5 or Q4-5	High status	Unpolluted	Satisfactory
Q4	Good status	Unpolluted	Satisfactory
Q3-4	Moderate status	Slightly polluted	Unsatisfactory
Q3 or Q2-3	Poor status	Moderately polluted	Unsatisfactory
Q2, Q1-2 or Q1	Bad status	Seriously polluted	Unsatisfactory

2.6 Lake macro-invertebrate communities

Lake site L1 (Friar's Lough) was sampled for macro-invertebrates via sweep netting. A standard pond net (250mm width, mesh size 500µm) was used to sweep macrophytes to capture macro-invertebrates. The net was also moved along the lake/pond bed to collect epibenthic and epiphytic invertebrates from the substratum (as per Cheal et al., 1993). A 3-minute sampling period was employed. To ensure appropriate habitat coverage, the sampling period was also divided amongst the range of meso-habitats present at the survey site to get a representative sample for sub-habitats.

2.7 Macrophytes and aquatic bryophytes

Surveys of the macrophyte and aquatic bryophyte community were conducted by instream wading at each of the 14 no. riverine survey sites, with specimens collected (by hand, sweep nets or via grapnel) for on-site identification. An assessment of the aquatic vegetation community helped to identify any rare macrophyte species (Flora Protection Order or Wyse-Jackson et al., 2016) or habitats corresponding to the Annex I habitats, e.g., 'Water courses of plain to montane levels, with submerged or floating vegetation of the *Ranunculus fluitantis* and *Callitriche-Batrachion* (low water level during summer) or aquatic mosses [3260]' (more commonly referred to as 'floating river vegetation').

2.8 Otter signs

The presence of otter (*Lutra lutra*) at each aquatic survey site was determined through the recording of otter signs within 150m of each survey site. Notes on the age and location (ITM coordinates) were made for each otter sign recorded, in addition to the quantity and visible constituents of spraint (i.e. remains of fish, crustaceans, molluscs etc.).

2.9 Aquatic ecological evaluation

The evaluation of aquatic ecological receptors contained within this report uses the geographic scale and criteria defined in the 'Guidelines for Assessment of Ecological Impacts of National Road Schemes' (NRA, 2009).

2.10 Biosecurity

A strict biosecurity protocol following IFI (2010) and the Check-Clean-Dry approach was adhered to during surveys for all equipment and PPE used. Disinfection of all equipment and PPE before and after use with Virkon™ was conducted to prevent the transfer of pathogens or invasive propagules between survey sites. Surveys were undertaken at sites in a downstream order to minimise the risk of upstream propagule mobilisation. Cognisance was given towards preventing the spread or introduction of crayfish plague given the known historical distribution of white-clawed crayfish and previous outbreaks of crayfish plague in the wider survey area (i.e. Lorrha Stream). Furthermore, staff did not undertake any work in a known crayfish plague catchment for a period of <72hrs in advance of the survey. Where feasible, equipment was also thoroughly dried (through UV exposure) between survey areas. Any aquatic invasive species or pathogens recorded within or adjoining the survey areas were geo-referenced. All Triturus staff are certified in 'Good fieldwork practice: slowing the spread of invasive non-native species' by the University of Leeds.

3. Desktop review

3.1 Carrig Renewables Wind Farm catchment and survey area description

The proposed Carrig Renewables Wind Farm site boundary is located in a lowland area within the Co. Tipperary townlands of Lissernane, Sharragh, Faddan More, Coolderry, Cloncorrig, Arragh More and Clohaskin, approximately 7km west of Birr, Co. Offaly and 12km east of Portumna, Co. Galway (Figure 2.1). The proposed wind farm site is within the Shannon River Basin District and within hydrometric area 25 (Lower Shannon). The aquatic survey sites were located within the LittleBrosna_SC_020, Shannon[Lower]_SC_060 and LorrhaStream_SC_010 river sub-catchments. The proposed wind farm site is drained by the Faddan Beg Stream (EPA code: 25F29), Faddan More Stream (25F57) and the Holy Well Clohaskin River (25H28), tributaries of the Little Brosna River (Figure 2.1).

The watercourses and aquatic surveys sites in the vicinity of Carrig Renewables Wind Farm are typically small, historically modified lowland channels (FW2; Fossitt, 2000). Predominantly, the watercourses flow over areas of Visean limestone & calcareous shale and Tournaisian limestone (Geological Survey of Ireland data). Land use practices in the vicinity of the site boundary are transitional woodland scrub (CORINE 324), peat bogs (412), mixed forests (313) and pastures (231).

3.2 Fisheries asset of the survey area

The Holy Well Clohaskin River (also referred to as the Little Brosna (Carrig) River) is a tributary of the Little Brosna River known to support brown trout (*Salmo trutta*), European eel (*Anguilla anguilla*) and three-spined stickleback (*Gasterosteus aculeatus*) at the same location as survey site A7 from unpublished IFI data during 2015¹. The adjacent Faddan Beg Stream (also referred to as the Little Brosna (Carrig) River) is also known to support these fish species, including at the same location as survey site A3 in the current survey.

Friar's Lough, located on the Lorrha Stream (no data) is a coarse fishery and known to support a range of species such as pike (*Esox lucius*), perch (*Perca fluviatilis*), rudd (*Scardinius erythrophthalmus*), bream (*Abramis brama*), bream hybrids and tench (*Tinca tinca*) (pers. obs.). Given fluvial connectivity with the Lorrha Stream, the occurrence of brown trout in the lake is considered likely.

The Little Brosna River is known to support Atlantic salmon (*Salmo salar*), brown trout (*Salmo trutta*), European eel, lamprey (*Lampetra* sp.), minnow (*Phoxinus phoxinus*) and stone loach (*Barbatula barbatula*) (Kelly et al., 2010, 2015).

Fisheries data for the other watercourses surveyed was not available at the time of survey.

¹ IFI data available at <https://opendata-ifigis.hub.arcgis.com/datasets/IFigis::water-framework-directive-fish-ecological-status-2008-2021/>

3.3 Protected aquatic species

A comprehensive desktop review of available data (NPWS, NBDC & other data) for 10km grid squares adjoining the project (i.e. M90, M91, N00, R99 & S09) identified a number of records for a low number of rare and or protected aquatic species within the vicinity of the proposed wind farm.

There were a low number of contemporary (year 2000 onwards) records for otter (*Lutra lutra*) in the M80, M90, M91 & S09 grid squares, namely on the Carrigahorrig Stream, Pallas River, Little Brosna River, River Shannon and Lough Derg (**Figure 3.1**). Many historical records were also available for the 1980 to 1991 period (data not shown).

Whilst >40 records were available for white-clawed crayfish (*Austropotamobius pallipes*) in the wider survey area, the majority were historical only (1971 to 1999). Most of the contemporary records were on the Lorrha Stream (downstream of Lorrha), the Little Brosna River and the Carrigahorrig Stream (**Figure 3.1**). Environmental DNA analysis as part of the National Crayfish Plague Surveillance Programme confirmed the presence of white-clawed crayfish in the Lorrha Stream both upstream (Swords & Griffin, 2022) and downstream of Lorrha (White et al., 2019).

A high number of records (>50) for the Flora Protection Order species opposite-leaved pondweed (*Groenlandia densa*) were available for back channels of the River Shannon in the vicinity of Meelick near Eyrecourt, Co. Galway (grid square M91). These records ranged from 1991 to 2021.

A low number of records for the near threatened (Wyse-Jackson et al., 2016) macrophyte tubular water-dropwort (*Oenanthe fistulosa*) were available for the River Shannon Callows near Ballymacegan Island, Sallow Island and downstream of Portumna (NPWS & NBDC data, not shown). The species occupies a limited Irish distribution and is found in damp, often seasonally inundated wetland habitats (Stroh, 2015).

Common frog (*Rana temporaria*) records were widespread in the respective grid squares, although none overlapped with the proposed wind farm site (data not shown). A low number of contemporary records for smooth newt (*Lissotriton vulgaris*) were available but these also did not overlap with the proposed project (i.e. in the vicinity of Portumna and Birr).

3.4 EPA water quality data (existing data)

The following outlines the available water quality data for the watercourses in context of the proposed wind farm project. Only recent water quality is summarised below. There was no contemporary EPA biological monitoring data available for the majority of the surveyed watercourses.

Please note that biological water quality analysis was undertaken as part of this study, with the results presented in the **section 4** and **Appendix B** of this report.

3.4.1 Lorrha Stream

There were 2 no. contemporary EPA biological monitoring stations located on the Lorrha Stream (25L05). In Lorrha village (station RS25L050200, downstream of survey site C2), the river achieved **Q3-4 (moderate status)** in 2021. Some 2.6km downstream (downstream of Friar's Lough) at station RS25L050300 the river achieved **Q3 (poor status)** in 2019.

Upstream of Lorrha village, the Lorrha_010 river waterbody was of moderate status in the 2016-2021 period and was considered 'at risk' of failing to achieve good ecological status (WFD Risk 3rd cycle). Downstream of Lorrha, the Lorrha_020 river waterbody was of poor status in the same period and also considered 'at risk'. Agricultural pressures (including siltation) are the primary threat to water quality on the Lorrha Stream (EPA, 2019a).

3.4.2 Little Brosna River

There were a number of contemporary EPA biological monitoring stations located on the Little Brosna River (25L02) in the downstream vicinity of the project. At Riverstown Bridge (station RS25L020700, survey site A8) and station RS25L020810 the river achieved **Q3-4 (moderate status)** in 2021. At New Bridge (station RS25L021000, survey site A9) this elevated to **Q4 (good status)** in 2021.

The Little Brosna_040 river waterbody (also containing the Holy Well Clohaskin River and Faddan Beg Stream) was of moderate status in the 2016-2021 period and was considered 'at risk' of not achieving good ecological status (WFD Risk 3rd cycle). Downstream of Birr town (Little Brosna_050), the status was also moderate but 'not at risk' in the same period. The lower reaches of the river (Little Brosna_060) were of good status in the 2016-2021 period and not at risk of failing to achieving good ecological status. Peat extraction, agriculture and hydromorphology are the primary threats to water quality in the Little Brosna_040 river waterbody (EPA, 2019b).

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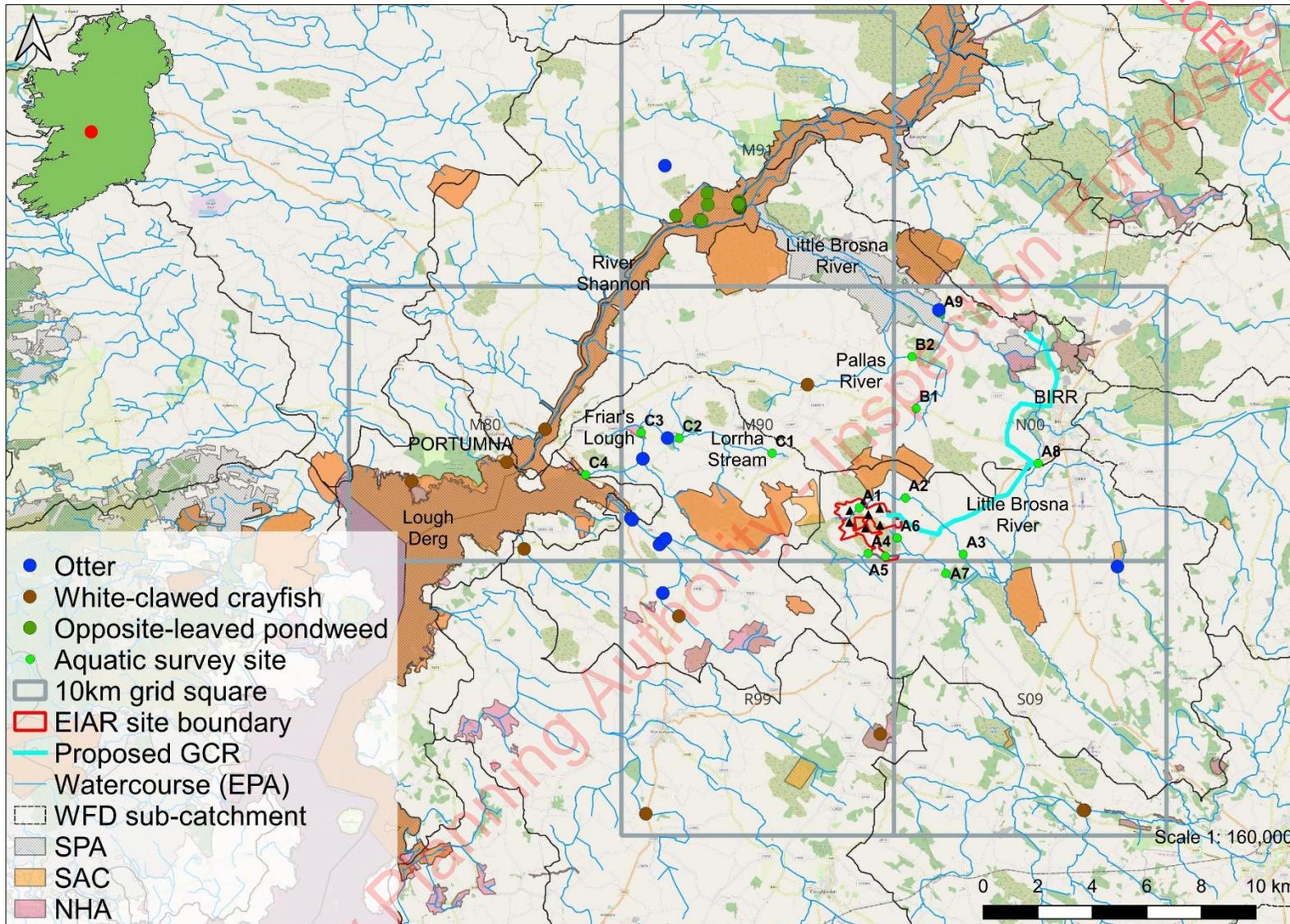


Figure 3.1 Selected protected aquatic species records in the vicinity of the proposed Carrig Renewables Wind Farm (source: NPWS & NBDC data, 2000-2021)

4. Results of aquatic surveys

The following section summarises each of the $n=15$ survey sites in terms of aquatic habitats, physical characteristics, fisheries, white-clawed crayfish and macrophyte/aquatic bryophyte communities. Biological water quality (Q-sample) results are also summarised for each riverine sampling site and in **Appendix B**. Habitat codes are according to Fossitt (2000). Scientific names are provided at first mention only. Sites were surveyed in September 2022. Please refer to **Appendix A** (fisheries assessment report) for more detailed fisheries results. A summary of the fish species recorded at each survey site is provided in **Table 4.1**. A summary of the aquatic species and habitats of high conservation concern recorded during the surveys is provided in **Table 4.2**. An evaluation of the aquatic ecological importance of each survey site based on these aquatic surveys is provided and summarised in **Table 4.3**.

4.1 Aquatic survey site results

4.1.1 Site A1 – Faddan Beg Stream, Faddan More

Site A1 was located on the upper reaches of the Faddan Beg Stream (25F29) in the centre of the proposed site boundary. The small stream (FW1) had been straightened and deepened historically and flowed in a trapezoidal peat-sided channel with bankfull heights of 1.5m. The stream averaged 1m wide and 0.1m deep, with very few deeper areas present. The profile was of very slow-flowing glide and occasional riffle, with infrequent small, shallow pool areas. The substrata comprised mixed gravels and occasional cobble and small boulder but these were heavily bedded in peat-dominated silt. Beds of sand were present locally. Shallow soft sediment accumulations (primarily peat-derived) were frequent in depositional areas. Given very high riparian shading and poor hydromorphology, the site did not support macrophytes with the exception of very occasional water mint (*Mentha aquatica*) in rare open areas of channel. Aquatic bryophytes were not recorded, with the liverwort *Pellia* sp. on exposed muddy sections of bank. The steep peaty banks supported abundant bramble (*Rubus fruticosus* agg.), gorse (*Ulex europaeus*) and bracken (*Pteridium aquilinum*) scrub with scattered grey willow (*Salix cinerea*) and downy birch (*Betula pubescens*). The stream was often completely tunnelled by scrub and herbaceous vegetation. The site was bordered by cutover bog (PB4) and scrub (WS1) to the south and coniferous afforestation (WD4) to the north.

Three-spined stickleback (*Gasterosteus aculeatus*) was the only fish species recorded via electro-fishing at site A1 (**Appendix A**). With the exception of three-spined stickleback (present in low densities), the site was not of fisheries value given heavy siltation, poor hydromorphology and poor connectivity with downstream habitats. There was no suitability for white-clawed crayfish. No otter signs were recorded in vicinity of the survey site.

Biological water quality, based on Q-sampling, was calculated as **Q2-3 (poor status) (Appendix B)**. No macro-invertebrate species of conservation value greater than 'least concern', according to national red lists, were recorded via Q-sampling.

Given the absence of aquatic species or habitats of higher conservation value, in addition to poor status water quality, the aquatic ecological evaluation of site A1 was of **local importance (lower value) (Table 4.3)**.



Plate 4.1 Representative image of site A1 on the Faddan Beg Stream, September 2022

4.1.2 Site A2 – Faddan Beg Stream, Faddan More

Site A2 was located on the upper reaches of the Faddan Beg Stream (25F29), approx. 2km downstream of site A1. The lowland depositing watercourse (FW2) had been extensively straightened and deepened historically with poor instream recovery evident. The stream averaged 2m wide and 0.6-0.8m deep, with locally deeper glide and pool to 1m. The profile was of very slow-flowing, depositional glide in a deep U-shaped channel with occasional pool often associated with large woody debris. Riffle areas were absent given historical modification (i.e. excavation). The bed was dominated by boulder and cobble that were heavily bedded in deep, peat-derived silt. Deep beds of humic silt were also present locally (up to 0.25m deep). Given poor hydromorphology and high riparian shading, macrophytes and aquatic bryophytes were absent. The liverwort species *Pellia* sp., *Riccardia chamedryfolia* and *Conocephalum conicum* were locally abundant on the wet peaty banks. The stream was very heavily shaded by a mature treeline of ash (*Fraxinus excelsior*) and blackthorn (*Prunus spinosa*) with abundant bramble scrub on the south bank, with a coniferous plantation (WD4) adjoining on the north bank. The site was bordered by improved pasture (GA1) to the south with only a narrow riparian buffer.

Brown trout (*Salmo trutta*) and three-spined stickleback were recorded via electro-fishing at site A2 (**Appendix A**). The site was of poor value for salmonids given gross siltation and poor hydromorphology, supporting only a very low density of brown trout. Spawning habitat was absent with the site also providing a poor quality nursery. Some moderate quality holding habitat (bank scours, deeper glide areas etc.) was present. The heavily silted site was of poor value for larval lamprey given the humic nature of the sediment and poor flows - none were recorded via targeted electro-fishing. Suitability for European eel and white-clawed crayfish was poor and none were recorded. No otter signs were recorded in vicinity of the site.

Biological water quality, based on Q-sampling, was calculated as **Q2-3 (poor status) (Appendix B)**. However, it should be noted that this is a tentative rating given poor flows and lack of suitable riffle areas for sampling (as per Toner et al., 2005). No macro-invertebrate species of conservation value greater than 'least concern', according to national red lists, were recorded via Q-sampling.

Given the presence of salmonids, the aquatic ecological evaluation of site A2 was of **local importance (higher value) (Table 4.3)**.



Plate 4.2 Representative image of site A2 on the Faddan Beg Stream, September 2022

4.1.3 Site A3 – Faddan Beg Stream, Doughkill

Site A3 was located on the Faddan Beg Stream (25F29) at the L1071 road crossing approx. 3.2km downstream of site A2. The lowland depositing stream (FW2) had been historically straightened and deepened in vicinity of the bridge crossing, with some instream recovery. The stream flowed in a heavily-tunnelled trapezoidal channel with bankfull heights of 2m. The stream averaged 2.5m wide and 0.2-0.3m deep with very few deeper areas present. The profile was of slow-flowing homogenous glide with occasional small pool and localised riffle areas. The stream had evidently suffered from low seasonal flows until recent rainfall. The substrata were dominated by mixed gravels with occasional boulder and cobble. Whilst loose (mobile), these were heavily silted. Soft sediment accumulations were occasional along channel margins and adjoining pool areas but were flocculent and often sand-dominated, where present. Siltation was high overall with significant plumes underfoot. Livestock poaching was evident. Given high shading, macrophytes were limited to watercress (*Nasturtium officinale*) and fool's watercress (*Apium nodiflorum*) in more open areas (abundant upstream of the bridge where the riparian zone had been cleared). Common duckweed (*Lemna minor*) was present but rare overall. Water mint was occasional along channel margins. Aquatic bryophyte coverage was low, with localised *Rhynchostegium riparioides* and *Leptodictyum riparium* (the latter being indicative of enrichment; Weekes et al., 2018). The stream was very heavily tunnelled downstream of the bridge,

with very dense hedgerows/treelines of hawthorn (*Crataegus monogyna*), willow, gorse and hazel (*Corylus avellana*) with abundant bramble-dominated scrub. The site was bordered by improved pasture (GA1).

Brown trout and three-spined stickleback were recorded via electro-fishing at site A3 (**Appendix A**). The site was of moderate value to salmonids, supporting a low number of mixed-cohort brown trout. The site was considered a moderate quality salmonid nursery given evident siltation pressures which also significantly reduced the spawning value of the stream at this location. The small, narrow stream was of relatively poor value as a holding area for adult salmonids but some pools provided low suitability. Whilst lamprey spawning habitat was present locally (fine gravels), the quality of the nursery habitat was poor given the typically shallow, flocculent nature of the soft sediment accumulations and no ammocoetes were recorded via targeted electro-fishing. Despite some suitability, no European eel or white-clawed crayfish were recorded. No other signs were recorded in vicinity of the site. The spraint site of an invasive mink (*Neovison vison*) was recorded under the bridge.

Biological water quality, based on Q-sampling, was calculated as **Q3-4 (moderate status) (Appendix B)**. No macro-invertebrate species of conservation value greater than 'least concern', according to national red lists, were recorded via Q-sampling.

Given the presence of salmonids, the aquatic ecological evaluation of site A3 was of **local importance (higher value) (Table 4.3)**.



Plate 4.3 Representative image of site A3 on the Faddan Beg Stream, September 2022 (downstream of road crossing)

4.1.4 Site A4 - Holy Well Clohaskin River, Faddan More

Site A4 was located on the Holy Well Clohaskin River (25H28) at the L5040 road crossing (box culvert). The small upland eroding river (FW1) had been historically straightened and deepened extensively in vicinity of the road crossing, with a deep trapezoidal channel and bankfull heights of up to 2.5m. The river suffered from low seasonal water levels at the time of survey (despite recent rainfall) and averaged 2m wide and 0.5m deep. The profile was of near stagnant glide/pool, with localised slow-flowing riffle areas (0.05m deep) immediately downstream of the bridge. The substrata were dominated by mixed gravels with abundant angular cobble and boulder. However, these were heavily bedded in silt (peat), with abundant leaf litter on the channel bed. Depositional glide areas featured silt deposits of up to 0.2m, which had been excavated to the clay/hard substrata layer. Siltation was very high overall (exacerbated by low seasonal flows). Given high riparian shading, macrophyte growth was limited to fool's watercress, common duckweed and ivy-leaved duckweed (*Lemna trisulca*) in localised open areas of channel. Branched bur-reed (*Sparganium erectum*) was abundant moving downstream in more open areas. Cover of aquatic bryophytes was also low, with only very occasional *Rhynchostegium riparioides* on larger cobble and boulder near the bridge. The river was heavily shaded (often tunnelled) by mature beech (*Fagus sylvatica*), ash and hawthorn with abundant bramble and ivy (*Hedera* sp.) scrub. The site was bordered by a residential property with amenity grassland (GA2, BL3) and improved pasture (GA1).

Three-spined stickleback was the only fish species recorded via electro-fishing at site A4 (**Appendix A**). With the exception of abundant stickleback, site A4 was not of fisheries value given heavy siltation, poor seasonal flows, poor hydromorphology and poor connectivity with downstream habitats. The accumulation of boulders at the box culvert/livestock access point was a significant barrier to fish migration at low flows. Under higher flows, there would be some improved but still poor quality salmonid and European eel habitat downstream of the culvert. Suitability for white-clawed crayfish was poor and none were recorded. No otter signs were recorded in vicinity of the site.

Biological water quality, based on Q-sampling, was calculated as **Q3 (poor status) (Appendix B)**. However, it should be noted that this is a tentative rating given poor flows and lack of suitable riffle areas for sampling (as per Toner et al., 2005). No macro-invertebrate species of conservation value greater than 'least concern', according to national red lists, were recorded via Q-sampling.

Given the absence of aquatic species or habitats of higher conservation value, in addition to poor status water quality, the aquatic ecological evaluation of site A4 was of **local importance (lower value) (Table 4.3)**.



Plate 4.4 Representative image of site A4 on the Holy Well Clohaskin River, September 2022 (facing downstream to road crossing)

4.1.5 Site A5 – Holy Well Clohaskin River, Faddan More

Site A5 was located on the Holy Well Clohaskin River (25H28) at a local track crossing, approx. 0.8km downstream of site A4. As per upstream, the river had been extensively straightened and deepened historically, with resulting poor hydromorphology in a steep trapezoidal channel with bankfull heights of 2-2.5m. The river suffered from low seasonal water levels at the time of survey, with only a slight flow and frequent ponding of water. The river averaged 2-2.5m wide and 0.2-0.4m deep at the time of survey. The profile comprised slow-flowing glide and frequent pool with only localised riffle areas. These often resulted from instream debris blockages and growth of tree roots across the narrow channel. The substrata were dominated by compacted boulder and cobble with interstitial mixed gravels (indicative of a high energy site under basal flows). However, these were heavily bedded in peat-dominated silt. Flocculent soft sediment deposits were abundant in depositional areas (exacerbated by low flows). Given high shading, macrophyte growth was limited to very occasional foal's watercress and common duckweed in open areas of channel. Aquatic bryophyte coverage was also low and limited to very occasional *Rhynchostegium riparioides* on larger boulder. Freshwater sponge (*Ephydatia* sp.) was occasional instream. The river at this location was heavily shaded by narrow but mature treelines of hazel, holly (*Ilex aquifolium*), sycamore (*Acer pseudoplatanus*) and ash with understories dominated by bramble and ivy. The site was bordered by heavily improved pasture (GA1).

Brown trout and three-spined stickleback were recorded via electro-fishing at site A5 (**Appendix A**). The site was of poor value for salmonids given poor seasonal flows, poor hydromorphology and evident siltation pressures. However, the site supported a low density of mixed-cohort brown trout. Nevertheless, the site provided poor quality spawning and nursery habitat with some moderate quality holding areas present. Despite some suitability, no European eel were recorded. Whilst some

very limited poor-quality spawning habitat was present for lamprey, the flocculent nature of the soft sediment deposits precluded the presence of ammocoetes. Suitability for white-clawed crayfish was low and none were recorded (few accessible refugia). No otter signs were recorded in the vicinity of the site.

Biological water quality, based on Q-sampling, was calculated as **Q3 (poor status) (Appendix B)**. However, it should be noted that this is a tentative rating given poor flows and lack of suitable riffle areas for sampling (as per Toner et al., 2005). No macro-invertebrate species of conservation value greater than 'least concern', according to national red lists, were recorded via Q-sampling.

Given the presence of salmonids, the aquatic ecological evaluation of site A4 was of **local importance (higher value) (Table 4.3)**.

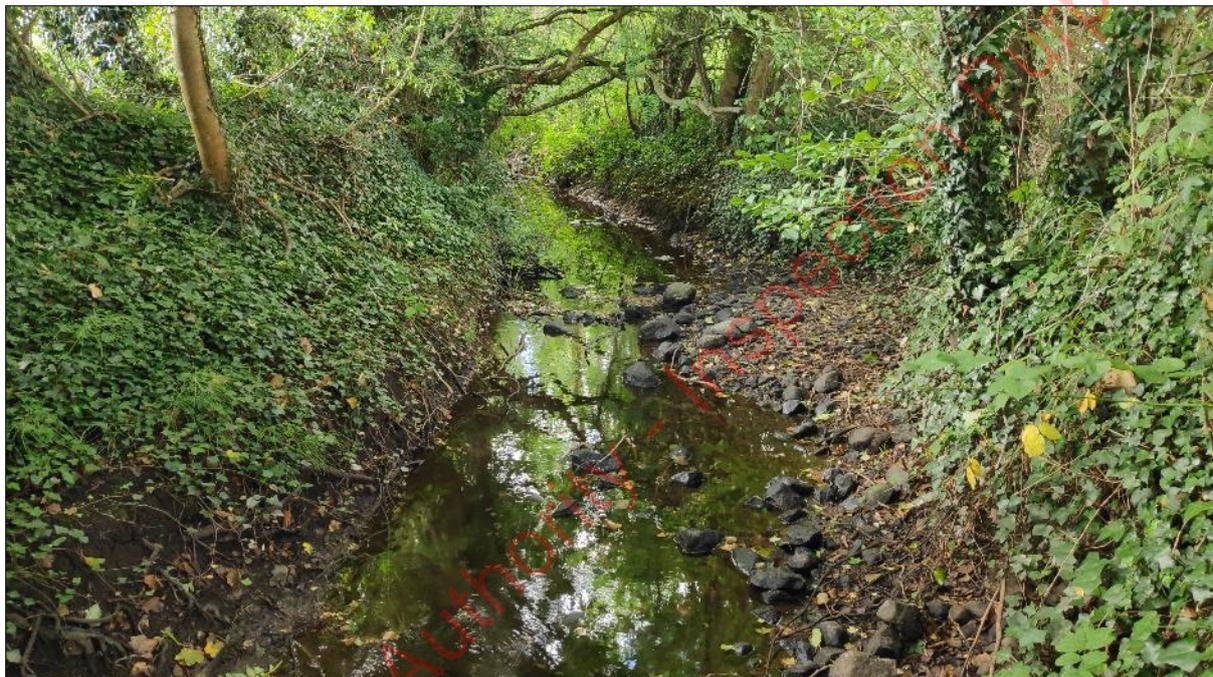


Plate 4.5 Representative image of site A5 on the Holy Well Clohaskin River, September 2022

4.1.6 Site A6 – Faddan More Stream, Faddan More

Site A6 was located on the Faddan More Stream (25F57) approx. 0.8km upstream of the Holy Well Clohaskin River confluence. The stream was dry at the time of survey with only the remnant of a drainage ditch-like channel present along the boundary of an extensive area of cutover bog (PB4). The channel had evidently been straightened and deepened historically but did not contain water, with no signs of recent flows. The bed comprised dry peat/mud with high levels of terrestrial encroachment (e.g. gorse scrub) and an absence of aquatic or wetland vegetation. The site was bordered by improved pasture (GA1).

Site A6 was not of fisheries value given its dry/ephemeral nature and absence of aquatic habitats. No otter signs were recorded in the vicinity of the site.

Given the dry nature of the site, it was not possible to collect a biological water quality sample at the time of survey.

Given the absence of aquatic habitats in the ephemeral channel, the aquatic ecological evaluation of site A6 was of **local importance (lower value)** (Table 4.3).



Plate 4.6 Representative image of site A6 on the Faddan More Stream, September 2022 (dry channel)

4.1.7 Site A7 – Holy Well Clohaskin River, Lacka

Site A7 was located on the Holy Well Clohaskin River (25H28) at the L1071 road crossing, approx. 2.8km downstream of site A5. The swift-flowing lowland depositing river (FW2) had been historically straightened and deepened in vicinity of the bridge, with trapezoidal banks of 2-2.5m in height. The river averaged 2.5-3m wide and 0.3-0.4m deep with occasional deeper areas to 0.6m. The profile was of heavily-vegetated, slow-flowing glide with occasional pool and very occasional riffle. The substrata comprised compacted cobble and interstitial gravels in faster-flowing areas with infrequent boulder. Depositional glide featured abundant silt and sand deposits (with high clay fractions). Siltation was moderate overall (high locally). Branched bur-reed was abundant instream (70% cover) with locally frequent water mint, fool's watercress and occasional watercress in less shaded areas. Common duckweed and ivy-leaved duckweed were also present but rare overall. Aquatic bryophyte coverage was low with *Rhynchostegium riparioides* confined to faster-flowing cobble dominated areas. The calcicolous liverwort *Pellia endiviifolia* was also present occasionally on more stable cobble and boulder. The immediate riparian zone supported reed canary grass (*Phalaris arundinacea*) with a nitrophilous community of great willowherb (*Epilobium hirsutum*), cleavers (*Galium aparine*), hedge bindweed (*Calystegia sepium*) and nettle (*Urtica dioica*). The channel was heavily shaded by mature alder (*Alnus glutinosa*), grey willow and hawthorn. The site was bordered by an oak (*Quercus* sp.) plantation (WS2) to the north and improved pasture (GA1) with narrow buffers upstream and to the south.

Brown trout, lamprey (*Lampetra* sp.) and three-spined stickleback were recorded via electro-fishing at site A7 (**Appendix A**). The site was of good value for salmonids, supporting a small mixed-cohort population of brown trout. The site was of most value as a holding habitat for adult trout given an abundance of scoured banks, tree roots and macrophyte beds in addition to small pools. The site was of moderate value only as a salmonid nursery given the general paucity of hard substrata refugia and faster-flowing areas of glide and riffle. Whilst some spawning habitat for both salmonids and lamprey was present locally, the value was reduced considerably due to siltation pressures. Abundant soft sediment deposits on the littoral/marginal slopes provided excellent quality larval lamprey habitat which supported very high densities of *Lampetra* sp. ammocoetes (19 per m²). These areas were considered optimal for the species being a matrix of organic-rich flocculent silt, clay and sand. Despite high suitability, no European eel or white-clawed crayfish were recorded. A regular otter spraint site (fish remains only) was recorded under the rendered bridge arch (ITM 601854, 699573)

Biological water quality, based on Q-sampling, was calculated as **Q3 (poor status)** (**Appendix B**). No macro-invertebrate species of conservation value greater than 'least concern', according to national red lists, were recorded via Q-sampling.

Given the presence of salmonids and *Lampetra* sp., in addition to utilisation by otter, the aquatic ecological evaluation of site A7 was of **local importance (higher value)** (**Table 4.3**).



Plate 4.7 Representative image of site A7 on the Holy Well Clohaskin River, September 2022

4.1.8 Site A8 – Little Brosna River, Riverstown Bridge

Site A8 was located on the Little Brosna River (25L02) at Riverstown Bridge, a 5-arch structure approx. 10km downstream (by water) of the proposed site boundary. The large, swift-flowing lowland depositing river (FW2) had been modified historically in vicinity of the bridge, with rendered bridge aprons and retaining walls present along the south bank. The river averaged >15m wide and 0.3-0.6m deep, with locally deeper pool and glide. Deeper glide was present upstream of the bridge. The river

flowed around a mature, well-vegetated island downstream of the bridge, with a side-channel flowing through the southernmost arch. The profile was dominated by glide habitat (typically swift-flowing) with frequent small pool areas and localised riffles (all downstream). The substrata comprised primarily cobble and localised mixed gravels, with frequent boulder in faster flowing areas. Compaction and calcification were high overall, with more mobile substrata present upstream of the bridge. Beds of coarse sands and finer gravels were frequent along channel margins and pool slacks. Soft sediment deposits were largely absent given high flow rates, with siltation moderate overall (plumes underfoot). The site supported frequent water crowfoot (*Ranunculus* sp.) and fool's watercress, with abundant ivy-leaved duckweed. Lesser water parsnip (*Berula erecta*), water starwort (*Callitriche* sp.), branched bur-reed and river water dropwort (*Oenanthe aquatica*) were occasional (mostly along margins). Channel margins often featured extensive beds of fool's watercress, watercress and water mint with localised water forget-me-not (*Myosotis scorpioides*). These graded into beds of reed canary grass with occasional bent grasses (*Agrostis* sp.). Small stands of yellow lily (*Nuphar lutea*) were present upstream of the bridge, with very occasional shining pondweed (*Potamogeton lucens*) downstream. Cover of aquatic bryophytes was low with occasional *Fontinalis antipyretica*, *Cinclidotus fontinaloides*, *Rhynchostegium riparioides* and *Leptodictyum riparium*. Despite the presence of several indicator species, the aquatic vegetation community was not extensive or contiguous enough to correspond with Annex I floating river vegetation habitat. Cover of filamentous algae was very high in open areas of channel, indicating significant enrichment (*Cladophora* & *Vaucheria* sp.). The river was lined by mature treelines supporting sycamore, ash, crack willow (*Salix fragilis*) and grey willow - these provided valuable thermal refugia and cover for fish (particularly downstream of the bridge). The non-native snowberry (*Symphoricarpos albus*) was locally abundant along the south bank downstream of the bridge. The site was bordered by buildings and artificial surfaces and residential properties (BL3, GA2).

A total of 6 no. species were recorded at site A8 via electro-fishing, namely Atlantic salmon (*Salmo salar*), brown trout, European eel, minnow (*Phoxinus phoxinus*), stone loach (*Barbatula barbatula*) and three-spined stickleback (**Appendix A**). This was the highest species diversity recorded during the survey. Site A8 was of high value for salmonids, supporting a moderate density of mixed-cohort brown trout in addition to a low number of Atlantic salmon. The site provided good quality nursery habitat given the presence of abundant cobble and frequent boulder, in addition to macrophytes. Holding habitat was limited in extent but of good quality where present (e.g. small scours/undercuts). Better quality holding areas were present upstream. The site was of high value as a salmonid nursery despite the quality of habitat being reduced by siltation, enrichment and calcification pressures. Suitability for European eel was high although only a low density was recorded via electro-fishing. Despite some good suitability, no white-clawed crayfish were recorded. A fresh otter spraint was recorded on the revetment immediately upstream of the bridge (605214, 703575). A very regular spraint site was also present on the mid-channel island (ITM 605244, 703649) with a well-worn trail (slide) to the river. Two individual kingfishers (*Alcedo atthis*) were observed during the survey.

Biological water quality, based on Q-sampling, was calculated as **Q3-4 (moderate status) (Appendix B)**. No macro-invertebrate species of conservation value greater than 'least concern', according to national red lists, were recorded via Q-sampling.

Given the presence of salmonids (including Atlantic salmon) and European eel, in addition to utilisation by otter, the aquatic ecological evaluation of site A8 was of **local importance (higher value)** (Table 4.3).



Plate 4.8 Representative image of site A8 on the Little Brosna River, September 2022 (facing downstream from bridge)

4.1.9 Site A9 – Little Brosna River, New Bridge

Site A9 was located on the Little Brosna River at New Bridge approx. 8.7km downstream of site A8. The lowland depositing river (FW2) had been historically straightened and deepened with trapezoidal banks of 3-4m in height. The river showed some good instream recovery and averaged 15-20m wide and 0.3-0.6m deep, with localised deeper glide and pool to >1.6m. The profile was dominated by deep glide and pool upstream of the bridge with shallower, fast glide and riffle downstream. Small pools were frequent throughout. The substrata of the high energy site were dominated by boulder and cobble with frequent interstitial mixed gravels. Due to high flow rates and calcification, these were invariably compacted. Large beds of mixed gravels were frequent in pool slacks and adjoining faster-flowing areas. Similarly, beds of sands were present marginally and in adjoining pools. Soft sediment accumulations (sand & silt), whilst present, were more localised. Siltation was low overall. The macrophyte community supported occasional water crowfoot (*Ranunculus* sp.) with frequent stands of water mint along channel margins. Water starwort (*Callitriche* sp.) was present in slacker areas of flow. Aquatic bryophyte coverage was relatively high with abundant *Leptodictyum riparium* and *Rhynchostegium riparioides* with more occasional *Fontinalis antipyretica*. *Cinclidotus fontinaloides* and *Fissidens* sp. mosses was present locally. The liverwort *Pellia* sp. and *Conocephalum conicum* were present on bridge abutments and muddy areas of bank. Despite a moderate bryophyte diversity, the aquatic vegetation community was not representative of Annex I floating river vegetation (3260). Filamentous algae (*Vaucheria* and *Cladophora* sp.) were present, indicating enrichment. Small mid-channel islands of reed canary grass were also present, with the poorly developed riparian zones

(including that of the island) dominated by reed canary grass with scattered grey willow, osier (*Salix viminalis*), hawthorn and ash. The site was bordered by improved pasture (GA1).

Atlantic salmon, brown trout, lamprey (*Lampetra* sp.), minnow and invasive roach (*Rutilus rutilus*) were recorded at site A9 via electro-fishing (**Appendix A**). The site was of high value for salmonids, supporting a healthy population of mixed-cohort brown trout and low numbers of Atlantic salmon parr/smolts. The site was of excellent value as a holding area for adult salmonids (especially upstream of the bridge) given the presence of deeper glide and pool in addition to small bank scours and overhanging macrophyte vegetation. The site was of good value as a salmonid nursery given an abundance of instream refugia. The site also featured excellent quality spawning habitat for both salmonids and lamprey. Whilst lamprey ammocoetes were recorded in soft sediment areas, densities were relatively low overall and optimal areas were highly localised (e.g. northernmost arch featured abundant soft sediments). Despite some good suitability, no European eel or white-clawed crayfish were recorded. Fresh otter prints were recorded on a marginal sand accumulation under the northernmost arch (ITM 601658, 709041) with a single spraint recorded on an old bank revetment downstream of the bridge (ITM 601655, 709049). A kingfisher was observed in flight during the site survey.

Biological water quality, based on Q-sampling, was calculated as **Q3-4 (moderate status) (Appendix B)**. No macro-invertebrate species of conservation value greater than 'least concern', according to national red lists, were recorded via Q-sampling.

Given the location of site A9 within the River Little Brosna Callows SPA (004086), the aquatic ecological evaluation of site A9 was of **international importance (Table 4.3)**. The site also supported salmonids (including Atlantic salmon) and *Lampetra* sp., in addition to otter.

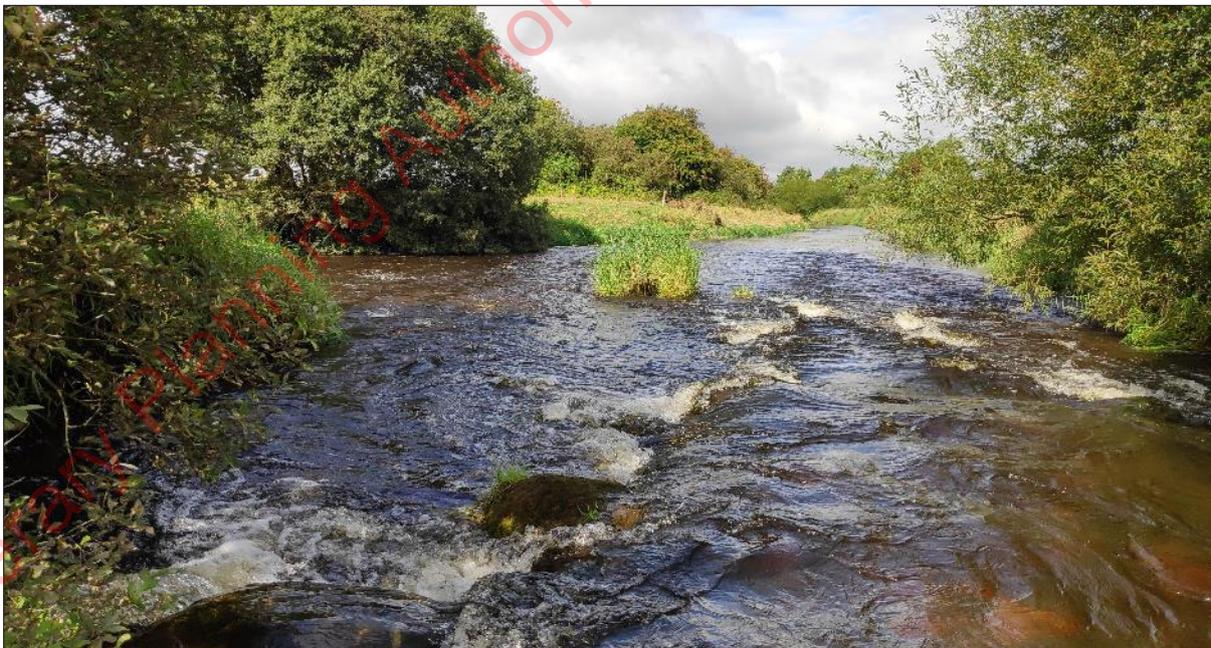


Plate 4.9 Representative image of site A9 on the Little Brosna River at New Bridge, September 2022

4.1.10 Site B1 – Killenaule Stream, Clonmona

Site B1 was located on the uppermost reaches of the Killenaule Stream (25Q34) at the R489 road crossing, >1km north-east of the proposed site boundary. The upland eroding stream (FW1) had been straightened, deepened and realigned historically, with the upper reaches culverted underground (upstream of the road crossing). Downstream of the pipe culvert, the stream was dry at the time of survey with only very shallow pools of rainwater present (following recent precipitation). The bed of the ephemeral stream was dominated by cobble and mixed gravels with occasional boulder, indicating it may convey water periodically. Furthermore, damp areas supported some localised water mint and fool's watercress. Aquatic bryophytes were not recorded. The dry channel averaged 1.5m wide with banks of up to 2.5m high. The channel was heavily tunnelled in dense hedgerows of hawthorn and bramble in improved pasture (GA1).

Site B1 was not of fisheries value given its dry/ephemeral nature and absence of aquatic habitats (rainwater pools only). No otter signs were recorded in the vicinity of the site.

Given the dry nature of the site, it was not possible to collect a biological water quality sample at the time of survey.

Given the ephemeral nature of the channel, the aquatic ecological evaluation of site B1 was of **local importance (lower value) (Table 4.3)**.



Plate 4.10 Representative image of site B1 on the Killenaule Stream, September 2022 (dry channel)

4.1.11 Site B2 – Killenaule Stream, Gurteen

Site B2 was located on the Killenaule Stream (25Q34) at the R438 road crossing, approx. 3.7km downstream of site B1. The lowland depositing stream (FW2) stream had been extensively realigned, straightened and deepened historically, with resulting very poor flows and hydromorphology. The

stream represented a peat drainage channel with an imperceptible flow that averaged a homogenous 4m wide and 0.2m deep. Downstream of the road crossing (old pipe culvert), the stream featured a slight flow over an increased gradient and averaged 2m wide and <0.1m deep. The substrata comprised exclusively deep anoxic peat (up to 0.3m deep). Given heavy siltation and high peat-staining, macrophyte coverage was low with common duckweed and very occasional bulrush (*Typha latifolia*). Bent grass (*Agrostis* sp.) was frequent along channel margins. Aquatic bryophytes were not recorded. The largely open (historically cleared) banks supported low-lying ferns and bindweed vegetation, with scattered willow and downy birch. The site was bordered by cutover bog (PB4) and improved pasture (GA1).

Three-spined stickleback and ten-spined stickleback (*Pungitius pungitius*) were the only fish species recorded via electro-fishing at site B2 (**Appendix A**). With the exception of stickleback species, site B2 was not of fisheries value given gross siltation, poor hydromorphology and poor connectivity with downstream habitats. There was no suitability for white-clawed crayfish. No otter signs were recorded in the vicinity of the site.

Biological water quality, based on Q-sampling, was calculated as **Q2-3 (poor status) (Appendix B)**. However, it should be noted that this is a tentative rating given poor flows and lack of suitable riffle areas for sampling (as per Toner et al., 2005). No macro-invertebrate species of conservation value greater than 'least concern', according to national red lists, were recorded via Q-sampling.

Given the absence of aquatic species or habitats of higher conservation value, in addition to poor status water quality, the aquatic ecological evaluation of site B2 was of **local importance (lower value) (Table 4.3)**.



Plate 4.11 Representative image of site B2 on the Killenaule Stream, September 2022 (upstream of the road crossing)

4.1.12 Site C1 – Lissagadda Stream, Abbeyville

Site C1 was located on the uppermost reaches of the Lissagadda Stream (25L44) at the L5057 road crossing, approx. 1.9km upstream of the Lorrha Stream confluence. The lowland depositing stream (FW2) emanated from an area of wet grassland (GS4) and flowed under the road via a pipe culvert. The stream had been historically straightened and deepened, resulting in very poor flows and hydromorphology. The stream represented a drainage channel and averaged 2-2.5m wide and 0.1m deep at the time of survey with an imperceptible flow. The substrata were dominated by cobble and mixed gravels with occasional boulder. However, these were compacted due to historical modifications and very heavily silted (mostly peat). The stream at this location was very heavily vegetated with abundant fool's watercress and frequent branched bur-reed instream (>90% cover). Water mint and iris (*Iris psuedacorus*) were also frequent instream. Common duckweed was occasional. Aquatic bryophytes were not recorded. The narrow, poorly-developed riparian zones supported herbaceous vegetation including great willowherb, nettle, iris, hedge bindweed, meadowsweet (*Filipendula ulmaria*), purple loosestrife (*Lythrum salicaria*) and wild angelica (*Angelica sylvestris*) in addition to scattered alder saplings, dog rose (*Rosa canina*) and bramble. The site was bordered by improved pasture (GA1) with mosaics of wet grassland (GS4) dominated by iris and rushes (*Juncus* spp.).

Three-spined stickleback was the only fish species recorded via electro-fishing at site C1 (**Appendix A**). With the exception of low densities of stickleback, site C1 was not of fisheries value given gross siltation, low summer flows, poor hydromorphology and poor connectivity with downstream habitats. Whilst the channel is known to convey significantly higher water volumes seasonally, the poor hydromorphology would likely preclude fish of higher conservation value migrating from downstream connecting habitats. There was poor suitability for white-clawed crayfish and none were recorded. No otter signs were recorded in the vicinity of the site.

Biological water quality, based on Q-sampling, was calculated as **Q3 (poor status) (Appendix B)**. However, it should be noted that this is a tentative rating given poor flows and lack of suitable riffle areas for sampling (as per Toner et al., 2005). No macro-invertebrate species of conservation value greater than 'least concern', according to national red lists, were recorded via Q-sampling.

Given the absence of aquatic species or habitats of higher conservation value, in addition to poor status water quality, the aquatic ecological evaluation of site C1 was of **local importance (lower value) (Table 4.3)**.



Plate 4.12 Representative image of site C1 on the upper Lissagadda Stream, September 2022 (facing downstream from road crossing)

4.1.13 Site C2 – Lorrha Stream, Lorrha

Site C2 was located on the Lorrha Stream (25L05) at the L1079 road crossing, approx. 3km downstream of site C1. The swift-flowing lowland depositing stream (FW2 with some eroding characteristics) at this location had been extensively straightened and deepened historically with steep near-vertical bankfull heights of up to 4m. The stream averaged 2.5m wide and 0.1-0.2m deep, with very few deeper areas. The profile comprised shallow glide and riffle with localised small pool. The substrata were dominated by compacted, angular cobble and boulder with frequent interstitial gravels. These were very heavily silted (flocculent deposits). Soft sediment accumulations (dominated by flocculent particles) were occasional along channel margins but these were shallow, where present. Due to high riparian shading, macrophyte cover was low with occasional fool's watercress, water starwort (*Callitriche* sp.) and water mint along the margins. Despite swift flows, common duckweed was frequent instream, indicating enrichment. Aquatic bryophyte coverage was also low with only occasional *Rhynchostegium riparioides*, *Leptodictyum riparium* and rare *Fontinalis antipyretica*. The calcicolous liverwort *Pellia endiviifolia* was present but rare overall. Filamentous algal cover was high in more open areas of channel, further indicating significant enrichment. The stream was heavily shaded by steep banks and mature treelines of ash and hawthorn with abundant bramble scrub. The site was bordered by mixed broad-leaved woodland (WD1), a residential property (GA2) and improved pasture (GA1).

Brown trout, lamprey (*Lampetra* sp.), European eel and three-spined stickleback were recorded via electro-fishing at site C2 (**Appendix A**). Despite extensive modifications, the site was of high value for salmonids, supporting a high density of mixed-cohort brown trout. The site was of most value as a salmonid nursery with abundant juvenile (0+ and 1+) trout. Spawning habitat was of poor quality for both salmonids and lamprey given substrata compaction, siltation pressures and a predominance of

larger substrata. Holding habitat for larger salmonids was largely absent (small, shallow pools only). Soft sediment accumulations were of poor suitability for larval lamprey given their flocculent, shallow nature and supported a very low density of *Lampetra* sp. ammocoetes. The site was of good value for European eel (frequent instream refugia) but only a low density were recorded. Despite only moderate suitability and the known outbreak of crayfish plague downstream in 2017 (NPWS, 2017), the site supported a low density (Peay, 2003) of white-clawed crayfish (30 refugia searched, 4 crayfish recorded; **Plate 4.14**). No other signs were recorded in vicinity of the site.

Biological water quality, based on Q-sampling, was calculated as **Q2-3 (poor status) (Appendix B)**. No macro-invertebrate species of conservation value greater than 'least concern', according to national red lists, were recorded via Q-sampling.

Given the presence of brown trout, *Lampetra* sp., European eel and white-clawed crayfish, the aquatic ecological evaluation of site C2 was of **local importance (higher value) (Table 4.3)**.

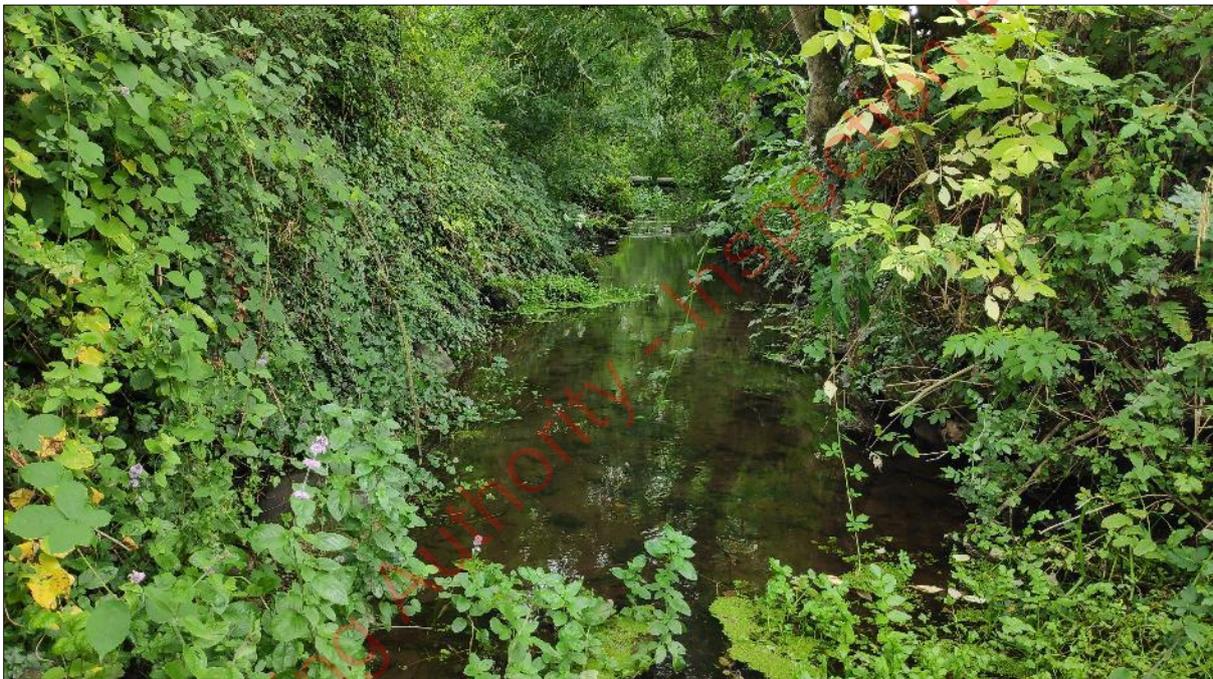


Plate 4.13 Representative image of site C2 on the upper reaches of the Lorrha Stream, September 2022



Plate 4.14 Juvenile and adult white-clawed crayfish recorded at site C2 on the Lorrha River, September 2022

4.1.14 Site C3 – Friar’s Lough

Site C3 was located at Friar’s Lough, a small 3ha linear lake which the Lorrha Stream flows through. The lake featured steeply shelving margins of >2m in depth that supported a narrow band of heterophyllus yellow lily. Beds of common reed (*Phragmites australis*) and common clubrush (*Schoenoplectus lacustris*) were abundant around the lake’s margins, with branched bur-reed occasional. The lake margins supported extensive reed swamp habitat (FS1) dominated by common reed, with frequent water mint, meadowsweet and occasional marsh marigold (*Caltha palustris*), water forget-me-not, blue water speedwell (*Veronica anagallis-aquatica*) and purple loosestrife. Bog bean (*Menyanthes trifoliata*), celery-leaved buttercup (*Ranunculus sceleratus*) and marsh bedstraw (*Galium palustre*) were all present in wetter areas but rare. The lake was fringed by mature oak-hazel woodland (WN2) and adjoined by semi-improved pasture (GA1) with frequent mosaics of wet grassland (GS4) (flood plains) to the south and north of the lake.

A fisheries appraisal was undertaken at site C3 (i.e. no netting or electro-fishing). The lake was evidently of high value to a range of coarse fish species, with pike (*Esox lucius*), perch (*Perca fluviatilis*), rudd (*Scardinius erythrophthalmus*), European eel, bream (*Abramis brama*) and tench (*Tinca tinca*) known from the lake (pers. obs.). High quality spawning and nursery areas for these species were abundant. Given the lake is located on the Lorrha Stream, the occurrence of (adult) brown trout is likely. The site was also highly suitable as a European eel habitat. The lake provided some good suitability for white-clawed crayfish. The species is known from the Lorrha Stream both upstream (Swords & Griffin, 2022) and downstream of Lorrha (White et al., 2019). No otter signs were recorded in vicinity of the survey site although the lake provided high-quality habitat for the species and their occurrence was considered likely. A kingfisher was observed in flight during the site survey.

No macro-invertebrate species of conservation value greater than ‘least concern’, according to national red lists, were recorded via sweep sampling. The non-native amphipod crustacean *Crangonyx* sp. was recorded in low numbers (**Appendix B**). A number of duck mussel (*Anodonta anatina*) (and dead shells) were recorded via sweep netting. Duck mussel are classed as a ‘vulnerable’ species in Ireland (Byrne et al., 2009).

Given the location of Friar’s Lough within Friar’s Lough NHA (000933), the aquatic ecological evaluation of site C3 was of **national importance (Table 4.3)**. The lake as also of high value for a range of coarse fish species and European eel and was of high suitability for white-clawed crayfish (known records both upstream and downstream of the lake).



Plate 4.15 Representative image of site C3 at Friar’s Lough, September 2022 (facing north from lake outflow)

4.1.15 Site C4 – Lorrha Stream, Ballyeiragh Bridge

Site C4 was located on the lowermost reaches of the Lorrha Stream (25L05) at Ballyeiragh Bridge on the N65 road, approx. 2.9km downstream of site C3 and 0.3km upstream of the Lough Derg confluence. The lowland depositing channel (FW2) at this location had been historically straightened (canalised) but not deepened. Boulder revetment was present in vicinity of the bridge with a rendered apron. The river averaged a homogenous 6-8m wide and 0.7 to 1.4m deep, with frequent deeper areas to >1.8m. The profile was of very slow-flowing depositional glide and pool with no riffle areas (i.e. a more lacustrine habitat). The substrata were dominated by 0.2-0.3m deep silt atop compacted cobble and boulder. The silt typically had a high clay fraction, with clay agglomerations occasional instream. Larger boulders were present in addition to occasional large woody debris. The site was very heavily vegetated with abundant frogbit (*Hydrocharis morsus-ranae*), arrowhead (*Sagittaria sagittifolia*) and common duckweed with frequent lesser water parsnip, fool’s watercress and watercress. Water mint, water forget-me-not, yellow lily and invasive Canadian pondweed (*Elodea canadensis*) were all occasional. Blue water speedwell and river water dropwort were present but rare overall. Aquatic

bryophytes were limited to very occasional *Fontinalis antipyretica* on marginal boulder. Filamentous algal cover was high (30%), indicating significant enrichment. The very narrow (often grazed) riparian zones supported sparse herbaceous vegetation and reed sweet grass (*Glyceria maxima*). The largely open banks supported only scattered grey willow and alder. The site was bordered by improved pasture (GA1) with extensive areas of wet grassland (GS4) downstream leading to Lough Derg.

Electro-fishing was not undertaken at site C4 given prohibitive depths of >1.5m (i.e. fisheries appraisal only). The site was of high value for coarse fish species such as pike (captured via sweep netting), roach (*Rutilus rutilus*) and perch in addition to European eel. The heavily vegetated site was of highest value as a coarse fish spawning and nursery area. There was some low suitability as an adult salmonid holding habitat (brown trout only). The site was also of suitability for white-clawed crayfish given abundant instream refugia. Despite high foraging suitability, no otter signs were recorded in vicinity of the site (few marking opportunities present).

Biological water quality, based on Q-sampling, was calculated as **Q3 (poor status) (Appendix B)**. However, it should be noted that this is a tentative rating given poor flows and lack of suitable riffle areas for sampling (as per Toner et al., 2005). No macro-invertebrate species of conservation value greater than 'least concern', according to national red lists, were recorded via Q-sampling.

Given the location of the site at the boundary of the Lough Derg, North-east Shore SAC (002241), the aquatic ecological evaluation of site C4 was of **international importance (Table 4.3)**.



Plate 4.16 Representative image of site C4 on the Lorrha River at Ballyeiragh Bridge, September 2022 (facing upstream from bridge)

4.2 White-clawed crayfish survey

White-clawed crayfish were recorded via hand-searching and sweep netting of instream refugia at site C2 on the upper reaches of the Lorrha Stream (30 refugia searched, 4 crayfish recorded). Low densities of both juveniles and adults were present (**Plate 4.14**).

No further live white-clawed crayfish or remains on mustelid spraint were recorded during the surveys in September 2022.

4.3 Otter signs

A total of 6 no. otter signs were recorded across 15 no. survey sites during the course of aquatic surveys undertaken in September 2022.

A regular otter spraint site (containing fish remains only) was recorded under the rendered bridge arch at site A7 on the Holy Well Clohaskin River (ITM 601854, 699573). A fresh spraint was recorded at site A8 on the Little Brosna River immediately upstream of the bridge (ITM 605214, 703575). A very regular spraint site was also present at this site on the mid-channel island downstream of the bridge (ITM 605244, 703649), with a well-worn trail (slide) to the river. Fresh otter prints were recorded under New Bridge on the Little Brosna River at site A9 (ITM 601658, 709041), with a single spraint recorded downstream of the bridge (ITM 601655, 709049).

No breeding (holts) or resting (couch) areas were identified in the vicinity of the survey sites in September 2022.

4.4 Invasive aquatic species

A regular spraint site of American mink (*Neovison vison*) was record at site A3 on the Faddan Beg Stream. This species is listed on the Third Schedule of the European Communities (Birds and Natural Habitats) Regulations 2011-2021 (S.I. 477/2011) and is considered a high-risk invasive species in Ireland (O' Flynn et al., 2014).

Non-native roach (*Rutilus rutilus*) were recorded at site A9 on the Little Brosna River and observed at site C4 on the Lorrha Stream. This is a medium impact fish species in Ireland (O'Flynn et al., 2014) and is also listed on the Third Schedule of the European Communities (Birds and Natural Habitats) Regulations 2011-2021 (S.I. 477/2011).

The invasive macrophyte Canadian pondweed (*Elodea canadensis*) was recorded at site C4 on the lowermost reaches of the Lorrha Stream. The species is relatively widespread in Ireland and is listed on the Third Schedule of the European Communities (Birds and Natural Habitats) Regulations 2011-2021 (S.I. 477/2011). It is considered a high-risk invasive species in Irish waters (O' Flynn et al., 2014).

The non-native amphipod crustacean *Crangonyx* sp. was recorded in low numbers at Friar's Lough (site C3) and the downstream-connecting Lorrha Stream (C4).

4.5 Biological water quality (macro-invertebrates)

No rare or protected macro-invertebrate species (according to national red lists) were recorded in the

biological water quality samples taken from 12 no. wetted sites in September 2022 (**Appendix B**). Duck mussel (*Anodonta anatina*), a vulnerable species in Ireland (Byrne et al., 2009) was recorded at Friar's Lough (site C3).

All sampling sites failed to meet the target good status ($\geq Q4$) requirements of the European Union Environmental Objectives (Surface Waters) (Amendment) Regulations 2019 and the Water Framework Directive (2000/60/EC) (**Figure 4.1**).

A total of 3 no. sites on the Faddan Beg Stream (site A3) and Little Brosna River (A8 & A9) achieved **Q3-4 (moderate status)** water quality (**Figure 4.1**). This was given the low numbers (<5%) of group A species, namely the mayflies *Ephemera danica* or *Ecdyonurus dispar*; low to moderate abundances of group B species such as the cased caddis *Agapetus fuscipes* and *Sericostoma personatum*, and a dominance of group C species such as the mayflies *Baetis rhodani*, freshwater shrimp (*Gammarus duebeni*) and black fly (Simuliidae) larvae (**Appendix B**).

The remaining 9 no. samples on the Faddan Beg Stream (A1, A2), Holy Well Clohaskin River (A4, A5 & A7), Killenaule Stream (B2), Lissagadda Stream (C1) and both sites on the Lorrha Stream (C2 & C4) achieved **Q2-3 (A1, A2, B2 & C2) or Q3 (poor status)** (all other sites). This was based on an absence of group A species; low numbers or absence of group B species and a dominance of group C species, particularly *Baetis rhodani*, *Elmis aenea* and *Gammarus duebeni* (**Appendix B**). Sites A1, A2, B2 and C2 supported higher proportions of group D and E taxa and thus were reduced to **Q2-3 (poor status)**. It should be noted that the ratings for sites A2, A4, A5, B1, C2 & C4 were tentative due to low summer flows and or a lack of suitable riffle areas for sampling (Toner et al., 2005).

Sites A6 on the Faddan More Stream and B1 on the Killenaule Stream were dry at the time of survey (September 2022) and thus no biological water quality sample could be collected.

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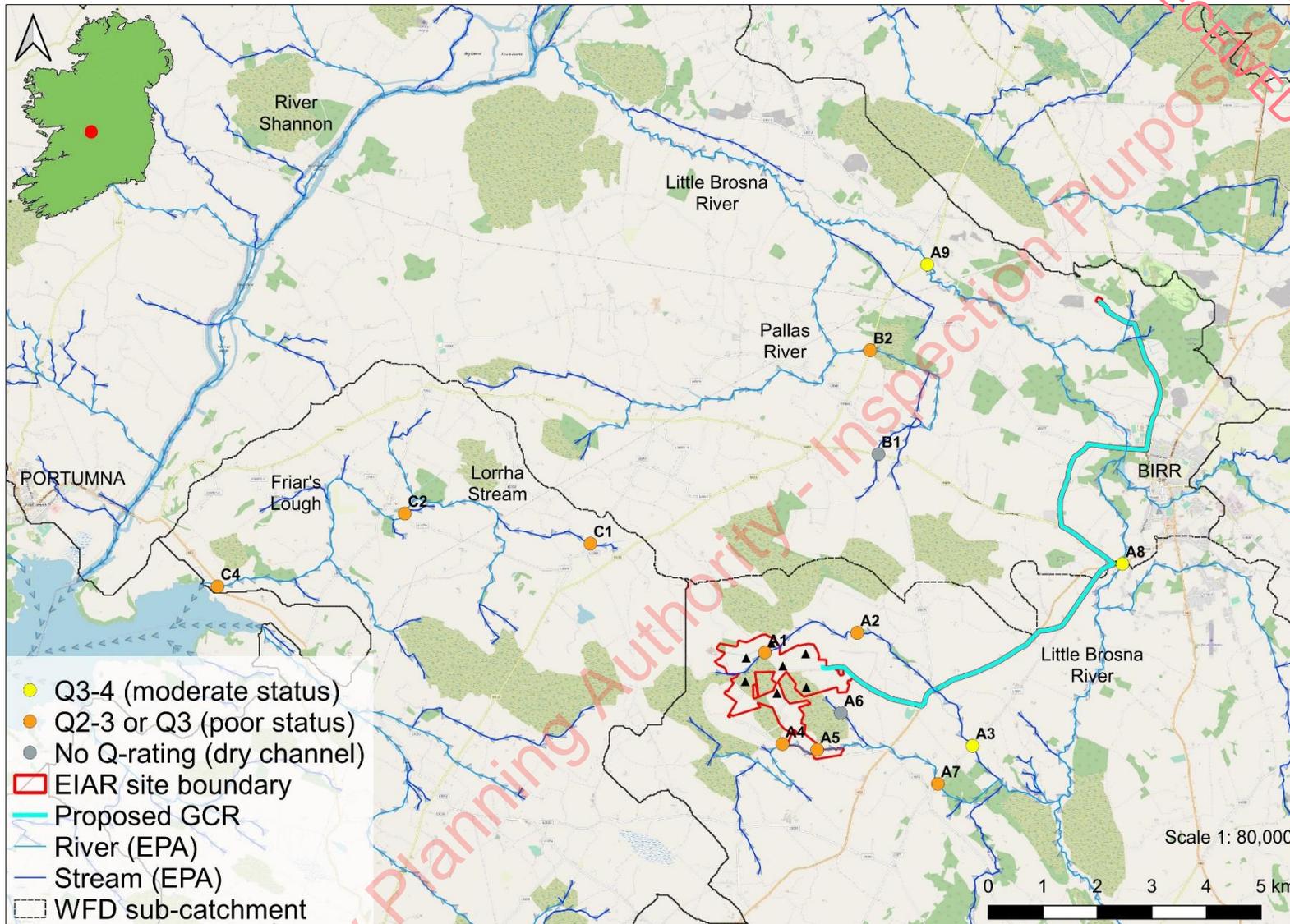


Figure 4.1 Biological water quality status in the vicinity of the proposed Carrig Renewables Wind Farm project, Co. Tipperary, September 2022

4.6 Macrophytes and aquatic bryophytes

No rare or protected macrophytes or aquatic bryophytes were recorded at the 15 no. survey sites in September 2022. Similarly, no examples of Annex I aquatic vegetation habitats were recorded during the surveys.

4.7 Aquatic ecological evaluation

An aquatic ecological evaluation of each survey site was based on the results of desktop review (i.e., presence of species of high conservation value), fisheries assessments and habitat assessments, the presence of protected or rare invertebrates (e.g. white-clawed crayfish), environmental DNA analysis, the presence of rare macrophytes and aquatic bryophytes and or associated representations of Annex I habitats. Furthermore, biological water quality status also informed the aquatic evaluation (**Table 4.3**).

Site A9 on the Little Brosna River was evaluated as **international importance** given the site was located within the River Little Brosna Callows SPA (004086). Site C4 on the Lorrha Stream was also evaluated as **international importance** given the site formed the boundary of the Lough Derg, North-east Shore SAC (002241).

Site C3 at Friar's Lough was evaluated as **national importance** given the site formed part of Friar's Lough NHA (000933).

A total of 6 no. sites on the Faddan Beg Stream (A2 & A3), Holy Well Clohaskin River (A5 & A7), Little Brosna River (A8) and the Lorrha Stream (C2) were evaluated as **local importance (higher value)** (**Table 4.3**).

The remaining 6 no. sites on the Faddan Beg Stream (A1), Holy Well Clohaskin River (A4), Faddan More Stream (A6), Killenaule Stream (B1 & B2) and the Lissagadda Stream (C1) were evaluated as **local importance (lower value)** in terms of their aquatic ecology given an absence of aquatic species or habitats of high conservation value and or less than Q4 (good status) water quality (**Table 4.3**).

Table 4.1 Summary of fish species of higher conservation value and relative abundances (low, medium, high & very high) recorded via **electro-fishing** per survey site in the vicinity of the proposed Carrig Renewables Wind Farm, September 2022

Site	Watercourse	Relative abundance				Other species
		Atlantic salmon	Brown trout	<i>Lampetra</i> sp.	European eel	
A1	Faddan Beg Stream					Three-spined stickleback
A2	Faddan Beg Stream		Low			Three-spined stickleback
A3	Faddan Beg Stream		Low			Three-spined stickleback
A4	Holy Well Clohaskin River					Three-spined stickleback
A5	Holy Well Clohaskin River		Low			Three-spined stickleback
A6	Faddan More Stream	No fish recorded – dry channel				
A7	Holy Well Clohaskin River		Low	Very high		Three-spined stickleback
A8	Little Brosna River	Low	High		Low	Three-spined stickleback, minnow, stone loach
A9	Little Brosna River	Low	Medium	Low		Minnow, roach
B1	Killenaule Stream	No fish recorded – dry channel				
B2	Killenaule Stream					Three-spined stickleback, ten-spined stickleback
C1	Lissagadda Stream					Three-spined stickleback
C2	Lorrha Stream		High	Low	Low	Three-spined stickleback
C3	Friar's Lough	n/a – fisheries appraisal only due to depth				
C4	Lorrha Stream	n/a – fisheries appraisal only due to depth				

Conservation value: Atlantic salmon (*Salmo salar*), brook lamprey (*Lampetra planeri*) and river lamprey (*Lampetra fluviatilis*) are listed under Annex II of the Habitats Directive [92/42/EEC]. Atlantic salmon and river lamprey are also listed under Annex V of the Habitats Directive [92/42/EEC]. European eel are 'critically endangered' according to most recent ICUN red list (Pike et al., 2020) and listed as 'critically endangered' in Ireland (King et al., 2011). With the exception of the Inland Fisheries Acts 1959 to 2017, brown trout and coarse fish species have no legal protection in Ireland.

Table 4.2 Summary of aquatic species & habitats of higher conservation value recorded in the vicinity of the proposed Carrig Renewables Wind Farm

Site	Watercourse	White-clawed crayfish	Otter signs ⁴	Annex I aquatic habitats	Rare or protected macrophytes/aquatic bryophytes	Rare or protected macro-invertebrates	Other species/habitats of high conservation value
A1	Faddan Beg Stream	None recorded	No signs	Not present	None recorded	None recorded	None recorded
A2	Faddan Beg Stream	None recorded	No signs	Not present	None recorded	None recorded	None recorded
A3	Faddan Beg Stream	None recorded	No signs	Not present	None recorded	None recorded	None recorded
A4	Holy Well Clohaskin River	None recorded	No signs	Not present	None recorded	None recorded	None recorded
A5	Holy Well Clohaskin River	None recorded	No signs	Not present	None recorded	None recorded	None recorded
A6	Faddan More Stream	None recorded	No signs	Not present	None recorded	None recorded	None recorded
A7	Holy Well Clohaskin River	None recorded	Regular spraint site	Not present	None recorded	None recorded	Lampetra sp.
A8	Little Brosna River	None recorded	2 no. spraint sites with slide	Not present	None recorded	None recorded	Atlantic salmon, European eel
A9	Little Brosna River	None recorded	Prints & spraint site	Not present	None recorded	None recorded	Atlantic salmon, Lampetra sp.
B1	Killenaule Stream	None recorded	No signs	Not present	None recorded	None recorded	None recorded
B2	Killenaule Stream	None recorded	No signs	Not present	None recorded	None recorded	None recorded
C1	Lissagadda Stream	None recorded	No signs	Not present	None recorded	None recorded	None recorded
C2	Lorrha Stream	Juveniles & adults recorded	No signs	Not present	None recorded	None recorded	Lampetra sp., European eel
C3	Friar's Lough	None recorded	No signs	Not present	None recorded	None recorded	Duck mussel (Anodonta anatina)
C4	Lorrha Stream	None recorded	No signs	Not present	None recorded	None recorded	None recorded

Conservation value: White-clawed crayfish (*Austropotamobius pallipes*) and Eurasian otter (*Lutra lutra*) are listed under Annex II and Annex V of the Directive on the Conservation of Natural Habitats of Wild Fauna and Flora (92/43/EEC) ('EU Habitats Directive') and all are protected under the Irish Wildlife Acts 1976-2021. White-clawed crayfish (Füreder et al., 2010) are also listed as 'Endangered' according to the IUCN Red List. The European Union (Invasive Alien Species) (Freshwater Crayfish) Regulations 2018 (SI 354/2018) affords further protection to native white-clawed crayfish by prohibiting the introduction and spread of five no. invasive 'Union concern' crayfish species listed under EU Regulation 1143/2014. Duck mussel are classed as a 'vulnerable' species in Ireland (Byrne et al., 2009). ⁴ Otter signs within 150m of the survey site

Table 4.3 Aquatic ecological evaluation summary of the Carrig Renewables Wind Farm survey sites according to NRA (2009) criteria

Site no.	Watercourse	EPA code	Evaluation of importance	Rationale summary
A1	Faddan Beg Stream		Local importance (lower value)	Small, shallow, historically modified, heavily silted upland eroding stream; three-spined stickleback recorded via electro-fishing; Q2-3 (poor status) water quality; no aquatic species or habitats of high conservation value
A2	Faddan Beg Stream		Local importance (higher value)	Small, historically modified lowland depositing stream with poor hydromorphology & siltation pressures; brown trout & three-spined stickleback recorded via electro-fishing; Q2-3 (poor status) water quality (tentative rating)
A3	Faddan Beg Stream		Local importance (higher value)	Small, historically modified lowland depositing stream with poor flows, poor hydromorphology & siltation pressures; brown trout & three-spined stickleback recorded via electro-fishing; Q3-4 (moderate status) water quality
A4	Holy Well Clohaskin River		Local importance (lower value)	Small, historically modified lowland depositing stream with poor flows (near stagnant), poor hydromorphology & siltation pressures; three-spined stickleback recorded via electro-fishing; Q3 (poor status) water quality (tentative rating); no aquatic species or habitats of high conservation value
A5	Holy Well Clohaskin River		Local importance (higher value)	Small, historically modified lowland stream with some semi-natural features but low summer flows & poor hydromorphology; brown trout & three-spined stickleback recorded via electro-fishing; Q3 (poor status) water quality (tentative rating)
A6	Faddan More Stream		Local importance (lower value)	Small, historically modified channel that was dry at the time of survey (no ephemeral characteristics) with an absence of aquatic species or habitats
A7	Holy Well Clohaskin River		Local importance (higher value)	Small, semi-natural, heavily vegetated swift-flowing lowland stream; brown trout, <i>Lampetra</i> sp. & three-spined stickleback recorded via electro-fishing; regular otter spraint site recorded; Q3 (poor status) water quality
A8	Little Brosna River		Local importance (higher value)	Large, swift-flowing lowland river of high aquatic & fisheries value but with enrichment pressures; Atlantic salmon, brown trout, European eel, minnow, stone loach & three-spined stickleback recorded via electro-fishing; regular otter spraint site recorded; Q3-4 (moderate status) water quality
A9	Little Brosna River		International importance	Located within the River Little Brosna Callows SPA (004086); large, high-energy historically modified lowland river with some good instream recovery of high aquatic & fisheries value; Atlantic salmon, brown trout, <i>Lampetra</i> sp., minnow & roach; otter prints & spraint recorded; Q3-4 (moderate status) water quality
B1	Killenaule Stream		Local importance (lower value)	Small, historically modified ephemeral channel that was dry at the time of survey with an absence of aquatic species or habitats
B2	Killenaule Stream		Local importance (lower value)	Small, very heavily modified lowland stream with gross siltation (peat), poor flows & very poor hydromorphology; three-spined & ten-spined stickleback recorded via electro-fishing; Q2-3 (poor status) water quality (tentative rating); no aquatic species or habitats of high conservation value

Site no.	Watercourse	EPA code	Evaluation of importance	Rationale summary
C1	Lissagadda Stream		Local importance (lower value)	Small, historically modified, heavily vegetated lowland stream with poor flows, poor hydromorphology & siltation pressures; three-spined stickleback recorded via electro-fishing; Q3 (poor status) water quality (tentative rating); no aquatic species or habitats of high conservation value
C2	Lorrha Stream		Local importance (higher value)	Small, historically modified, swift-flowing lowland stream with heavy siltation; brown trout, <i>Lampetra</i> sp., European eel & three-spined stickleback recorded via electro-fishing; low density of white-clawed crayfish recorded; Q2-3 (poor status) water quality
C3	Friar's Lough		National importance	Located within Friar's Lough NHA (000933); small 3ha mesotrophic to eutrophic lake with high aquatic & fisheries value; of high value as a coarse fish, European eel, white-clawed crayfish & otter habitat; Red-listed duck mussel recorded
C4	Lorrha Stream		International importance	Lower reaches of heavily vegetated, historically modified, canalised lowland river with poor flows & poor hydromorphology; of high value as a coarse fish (pike recorded via sweep netting), European eel, white-clawed crayfish & otter habitat; Q3 (poor status) water quality (tentative rating);

Conservation value: Atlantic salmon (*Salmo salar*), *Lampetra* spp. and otter (*Lutra lutra*) are all listed under Annex II of the Habitats Directive [92/42/EEC]. Furthermore, Atlantic salmon, *Lampetra* spp. are also listed under Annex V of the Habitats Directive [92/42/EEC] while otter are also listed on under Annex IV of the Habitats Directive [92/42/EEC]. Otters (along with their breeding and resting places) are also protected under provisions of the Irish Wildlife Acts 1976 to 2021. European eel are 'critically endangered' according to most recent ICUN red list (Pike et al., 2020) and listed as 'critically engendered' in Ireland (King et al., 2011). With the exception of the Inland Fisheries Acts 1959 to 2017, brown trout and coarse fish species have no legal protection in Ireland.

5. Discussion

5.1 Most valuable areas for aquatic ecology

Site A9 on the Little Brosna River was evaluated as **international importance** given the site was located within the River Little Brosna Callows SPA (004086). The site also supported Atlantic salmon, lamprey (*Lampetra* sp.) and otter. Site C4 on the Lorrha Stream was also evaluated as **international importance** given the site formed the boundary of the Lough Derg, North-east Shore SAC (002241).

Site C3 at Friar's Lough was evaluated as **national importance** given the site formed part of Friar's Lough NHA (000933). The lake was of high value as a coarse fish and European eel habitat with suitability for otter and white-clawed crayfish.

A total of 6 no. sites on the Faddan Beg Stream (A2 & A3), Holy Well Clohaskin River (A5 & A7), Little Brosna River (A8) and the Lorrha Stream (C2) were evaluated as **local importance (higher value)** (Table 4.3). This was due to the presence of higher conservation value species such as salmonids (all 6 of these sites), *Lampetra* sp. (2 no. sites), European eel (2 no. sites), white-clawed crayfish (1 no. sites) and or otter (2 no. sites) (Table 4.3).

The remaining 6 no. sites on the Faddan Beg Stream (A1), Holy Well Clohaskin River (A4), Faddan More Stream (A6), Killenaule Stream (B1 & B2) and the Lissagadda Stream (C1) were evaluated as **local importance (lower value)** in terms of their aquatic ecology given an absence of aquatic species or habitats of high conservation value and or less than Q4 (good status) water quality (Table 4.3).

5.1.1 Fish species of high conservation value

Brown trout were present at seven no sites in total (A2, A3, A5, A7, A8, A9 & C2; Table 4.1). Atlantic salmon parr were present at two sites only (i.e. A8 and A9) on the Little River Brosna where the species was present at low densities. Brown trout were typically present at low densities also, with the Little Brosna River (A8) and Lorrha Stream (C2) supporting the highest numbers and best quality salmonid habitat recorded during the current survey (Appendix A). Low summer water levels were evidently an issue for salmonid populations on channels such as the Holy Well Clohaskin River and Killenaule Stream. In such streams with lower summer water volumes thermal stress can impact juvenile salmonids causing mortality and recruitment problems.

Lamprey ammocoetes (*Lampetra* sp.) were recorded from three sites (A7, A9 & C2) during targeted electro-fishing across 13 no. survey sites in the vicinity of the proposed wind farm project (Table 3.1, 3.2). The highest density of ammocoetes (19.5 per m²) were recorded on the Holy Well Clohaskin River at site A7, where near-optimal settlement and burial conditions existed for the species. Low densities were also present at site A9 on the Little Brosna River (4.5 per m²) and the Lorrha Stream at site C2 (1 per m²) where sub-optimal conditions persisted. Lamprey were highly localised within the wider survey area due to historical drainage pressures (hydromorphology) and siltation issues (Appendix A).

European eel are Red-listed in Ireland (King et al., 2011) and are classed as 'critically endangered' on a global scale (Pike et al., 2020). Despite widespread physical suitability, European eel were only recorded in low densities from sites A8 on the Little Brosna River and site C2 on the Lorrha Stream (Table 4.1; Appendix A). The species is also known from Friar's Lough (pers. obs.) and is likely present

in the lower reaches of the Lorrha Stream (site C4). The absence of eel from many physically suitable sites reflects the significant barriers to fish passage present in the downstream Shannon catchment, as well as widespread low summer flow conditions (**Appendix A**).

5.1.2 Otter

Despite some suitability at numerous survey locations, otter signs (spraints & prints) were only recorded at sites on the Holy Well Clohaskin River (A7) and Little Brosna River (A8 & A9). This paucity of signs was considered to mainly reflect the influence of low summer flows and historical instream modifications on the health and distribution of fish populations, the key prey resource of otter (Krawczyk et al., 2016; Ruiz-Olmo & Jiménez, 2009). Otters are food-limited and prey availability is a crucial factor in determining mortality, breeding success and the status of local populations (Sittenthaler et al., 2019; Ruiz-Olmo et al., 2002). Furthermore, otter sign marking is routinely associated with prominent features such as large instream boulders and tree root systems (Almeida et al., 2012). Historical drainage significantly reduces habitat heterogeneity and the availability or marking areas (outposts), which therefore results in the deposition and detection of fewer otter signs such as spraints, irrespective of watercourse utilisation (e.g. for foraging).

No breeding (holt) or couch (resting) areas were identified in the vicinity of the survey sites in September 2022.

5.1.3 Invasive aquatic species

American mink (*Neovison vison*) (site A3), roach (*Rutilus rutilus*) (sites A9 & C4) and Canadian pondweed (*Elodea canadensis*) (site C4) were recorded during the survey. All three species are listed on the Third Schedule of the European Communities (Birds and Natural Habitats) Regulations 2011-2021 (S.I. 477/2011). These species are widespread in Ireland and are considered medium-risk (roach) and high-risk invasive species (mink, Canadian pondweed) in Ireland, respectively (O' Flynn et al., 2014).

The non-native amphipod crustacean *Crangonyx* sp. was recorded in low numbers at Friar's Lough (site C3) and the downstream-connecting Lorrha Stream (C4). Whilst *Crangonyx pseudogracilis* has been known in Ireland since 1969 (Phoenix Park, Dublin; Holmes, 1975) its range has expanded in recent years and it is well established, including in the Shannon system (Minchin et al., 2013). Furthermore, *Crangonyx floridanus* has recently been confirmed in the Liffey and Barrow catchments (Baars et al., 2021). Speciation within the *Crangonyx* genus has proven difficult (Mauvisseau et al., 2018). The ecological impacts of either *Crangonyx* species in Ireland remains uncertain (Baars et al., 2021).

5.1.4 White-clawed crayfish

White-clawed crayfish were recorded via hand-searching and sweep netting of instream refugia at site C2 on the upper reaches of the Lorrha Stream (30 refugia searched, 4 crayfish recorded). Low densities of both juveniles and adults were present (**Plate 4.14**), indicating a sustaining population. The occurrence of crayfish at this location is encouraging in light of an outbreak of crayfish plague (*Aphanomyces astaci*) in the Lorrha River at Lorrha village in August 2017 (NPWS, 2017). Crayfish were also detected via environmental DNA analysis at this same location and 0.5km downstream in August

2020 (Swords & Griffin, 2022). The species is also known from the Lorrha Stream downstream of Friar's Lough (White et al., 2019). Crayfish plague was not detected at these sites during the same sampling period.

5.1.5 Macro-invertebrates & biological water quality

Duck mussel (*Anodonta anatina*) were recorded from the well-vegetated littoral zone of Friar's Lough (site C3). The species is listed as vulnerable in Ireland (Byrne et al., 2009). In contrast to freshwater pearl mussel (*Margaritifera margaritifera*) which require salmonids as obligate intermediate hosts to complete their life cycle (Wacker et al., 2019; Taeubert & Geist, 2017), *Anodonta* sp. glochidia may develop in a wide range of fish species, including brown trout as well as cyprinids (Dias et al., 2020; Huber & Geist, 2019; Chowdhury et al., 2018) (both are likely present in Friar's Lough). Duck mussels demonstrate a relatively high plasticity and tolerance to different abiotic conditions and can thus be found from fast-flowing streams to lentic habitats (such as Friar's Lough) (Zieritz & Aldridge, 2011). With the exception of duck mussel and white-clawed crayfish, no other rare or protected macro-invertebrate species (according to national red lists) were recorded in the biological water quality samples taken from 12 no. wetted sites in September 2022 (**Appendix B**).

All sampling sites failed to meet the target good status ($\geq Q4$) requirements of the European Union Environmental Objectives (Surface Waters) (Amendment) Regulations 2019 and the Water Framework Directive (2000/60/EC), i.e. water quality of less than or equal to **Q3-4 (moderate status)**.

The biological water quality of the survey area was generally poor, with the majority of watercourses significantly impacted via eutrophication, siltation and or historical modifications (hydromorphology). The widespread low summer flows further reduced the water quality within the survey area in September 2022. Peat extraction, agriculture and hydromorphology are the primary threats to water quality within the survey area (EPA, 2019a, 2019b) and this was observed during the site surveys.

5.2 Aquatic ecology summary

With the exception of the Little Brosna River, the surveyed watercourses in the vicinity of the proposed Carrig Renewables Wind Farm were typically small, modified channels which suffered from considerable hydromorphological and siltation pressures. Some also suffered from very low summer flows at the time of survey (September 2022). Historical drainage pressures (straightening & deepening), eutrophication and siltation have significantly reduced the quality and heterogeneity of aquatic habitats in the vicinity of the proposed project. The majority of survey sites (9 no.) were of at least **local importance (higher value)** given the presence of aquatic species or habitats of high conservation value or their location within designated national and European sites.

Salmonids were relatively widespread within the LittleBrosna_SC_020 river sub-catchment, with European eel and *Lampetra* sp. showing a much more restricted distribution in the wider survey area. Atlantic salmon were recorded from the Little Brosna River only (a tributary of the River Shannon). Other fish species recorded were minnow, gudgeon, stone loach, three-spined stickleback, ten-spined stickleback, pike and non-native, invasive roach (the latter in the Little Brosna River only but also likely present in Friar's Lough). White-clawed crayfish were recorded from the Lorrha Stream upstream of Lorrha village. With the exception of duck mussel at Friar's Lough (listed as vulnerable by Byrne et al., 2009) and white-clawed crayfish, no rare or protected macro-invertebrates were recorded. A low

number of otter signs were recorded in vicinity of the project (no holts or couches) during the Friday 9th to Sunday 11th September 2022 survey period. No rare or protected macrophytes or aquatic bryophytes were recorded and no examples of Annex I aquatic habitats were present. Biological water quality was less than satisfactory (<Q4) at all sampled sites. Broadly speaking, the highest value watercourses within vicinity of the project in terms of aquatic ecology were the Lorrha Stream and Friar's Lough (east of the project) and, to a lesser extent, the Holy Well Clohaskin River (draining east of the site boundary).

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7. Appendix A – fisheries assessment report

Please see accompanying fisheries assessment report

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8. Appendix B – Q-sample results (biological water quality)

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Table 8.1 Macro-invertebrate Q-sampling results, September 2022

Group	Family	Species	A1	A2	A3	A4	A5	A7	A8	A9	B2	C1	C2	C4	EPA class
Ephemeroptera	Ephemeridae	<i>Ephemera danica</i>							1	2					A
Ephemeroptera	Heptageniidae	<i>Ecdyonurus dispar</i>			1										A
Ephemeroptera	Baetidae	<i>Alainites muticus</i>			1	2	7	2	1	2			5		B
Ephemeroptera	Baetidae	<i>Cloeon dipterum</i>												1	B
Plecoptera	Leuctridae	<i>Leuctra hippopus</i>	1							6					B
Trichoptera	Cased caddis pupa	sp. indet.					1	2	1			1			B
Trichoptera	Glossosomatidae	<i>Agapetus fuscipes</i>			11	15		3							B
Trichoptera	Goeridae	<i>Silo pallipes</i>				1									B
Trichoptera	Lepidostomatidae	<i>Lepidostoma basale</i>								1					B
Trichoptera	Leptoceridae	<i>Athripsodes sp.</i>												2	B
Trichoptera	Limnephilidae	<i>Limnephilus lunatus</i>		16											B
Trichoptera	Limnephilidae	<i>Potamophylax cingulatus</i>							10				10		B
Trichoptera	Limnephilidae	sp. indet.	1												B
Trichoptera	Sericostomatidae	<i>Sericostoma personatum</i>	1				8	1	26	10					B
Odonata	Coenagrionidae	sp. indet.												3	B
Ephemeroptera	Ephemerellidae	<i>Serratella ignita</i>			2			2		3					C
Ephemeroptera	Baetidae	<i>Baetis rhodani</i>	5		56		10	32	41	2			29		C
Ephemeroptera	Caenidae	<i>Caenis rivulorum</i>							4						C
Trichoptera	Hydropsychidae	<i>Hydropsyche instabilis</i>						3		34			21		C
Trichoptera	Hydropsychidae	<i>Hydropsyche siltalai</i>					2								C
Trichoptera	Polycentropodidae	<i>Holocentropus dubius</i>											1		C
Trichoptera	Polycentropodidae	<i>Plectrocnemia conspersa</i>	1					1				2	1		C
Trichoptera	Polycentropodidae	<i>Polycentropus kingi</i>			1			1	2	3			3		C
Trichoptera	Rhyacophilidae	<i>Rhyacophila dorsalis</i>			1		3	5	1						C
Coleoptera	Dytiscidae	<i>Acilius canaliculatus</i>									1				C

Group	Family	Species	A1	A2	A3	A4	A5	A7	A8	A9	B2	C1	C2	C4	EPA class
Coleoptera	Dytiscidae	<i>Colymbetes fuscus</i>									1				C
Coleoptera	Dytiscidae	<i>Hyphydrus ovatus</i>												2	C
Coleoptera	Dytiscidae	<i>Ilybius ater</i>										1			C
Coleoptera	Dytiscidae	<i>Nebrioporus depressus</i>			1										C
Coleoptera	Elmidae	<i>Elmis aenea</i>	17		9	46	25	7		2			8		C
Coleoptera	Elmidae	<i>Limnius volckmari</i>						46	1						C
Coleoptera	Gyrinidae	Gyrinidae larva			1										C
Coleoptera	Haliplidae	<i>Brychius elevatus</i>								1					C
Coleoptera	Haliplidae	<i>Halipus ruficollis group</i>												1	C
Coleoptera	Scirtidae	sp. indet.		1											C
Diptera	Chironomidae	Non-chironomus spp.	8	1		1	10	4	2	2			2		C
Diptera	Pediciidae	Dicranota sp.	2			3	2	1		1					C
Diptera	Dixidae	sp. indet.		1											C
Diptera	Culicidae	sp. indet.							1						C
Diptera	Limoniidae	<i>Antocha sp.</i>											1		C
Diptera	Simuliidae	sp. indet.			7			57	4	22			1		C
Diptera	Tipuliidae	sp. indet.							2				1		C
Hemiptera	Aphelocheiridae	<i>Aphelocheirus aestivalis</i>								3					C
Hemiptera	Corixidae	<i>Hesperocorixa linnaei</i>												16	C
Hemiptera	Corixidae	<i>Callicorixa praeusta</i>												1	C
Hemiptera	Gerridae	Gerridae nymph				2									C
Hemiptera	Gerridae	<i>Gerris sp.</i>	8			10					1	3			C
Hemiptera	Hydrometridae	<i>Hydrometra stagnorum</i>										1			C
Hemiptera	Veliidae	<i>Velia caprai</i>		2											C
Hemiptera	Notonectidae	<i>Notonecta glauca</i>									6				C
Hirudinidae	Piscicolidae	<i>Piscicola sp.</i>	1	1		1									C
Gastropoda	Planorbidae	<i>Ancylus fluviatilis</i>			2		24		1						C

Group	Family	Species	A1	A2	A3	A4	A5	A7	A8	A9	B2	C1	C2	C4	EPA class
Gastropoda	Planorbidae	<i>Gyraulus albus</i>	1												C
Gastropoda	Planorbidae	<i>Planorbis planorbis</i>				1			12		1			8	C
Gastropoda	Bithyniidae	<i>Bithynia tentaculata</i>							7					6	C
Gastropoda	Tateidae	<i>Potamopyrgus antipodarum</i>	29									24	10		C
Gastropoda	Planorbidae	<i>Planorbarius corneus</i>												2	C
Crustacea	Gammaridae	<i>Gammarus duebeni</i>	10	11	152	35	64	107	79	4		92	51		C
Arachnida	Hydrachnidiae	sp. indet.							1					2	C
Platyhelminthes	Tricladida	sp. indet.												1	C
Hirudinidae	Erpobdellidae	sp. indet.							2						D
Hirudinidae	Glossiphoniidae	sp. indet.			3	1			3			2			D
Crustacea	Asellidae	<i>Asellus aquaticus</i>	45	21	1	10	9	11				18		67	D
Megaloptera	Sialidae	<i>Sialis lutaria</i>	2											2	D
Gastropoda	Lymnaeidae	<i>Lymnaea stagnalis</i>							5					10	D
Gastropoda	Lymnaeidae	<i>Ampullacaena balthica</i>							26						D
Gastropoda	Sphaeriidae	sp. indet.	12			2				3	10		1		D
Annelida	Naididae (Tubificidae)	sp. indet.		12		1									E
Diptera	Chironomidae	Chironomus spp.	4	1	3				2		12	1	35	2	E
Crustacea	Crangonyctidae	<i>Crangonyx</i> sp.												1	n/a
Annelidae	Oligochaeta	sp. indet.			1		6			1					n/a
Abundance			148	67	253	131	171	285	235	102	32	145	180	127	
Q-rating			Q2-3	Q2-3*	Q3-4	Q3*	Q3*	Q3	Q3-4	Q3-4	Q2-3*	Q3*	Q2-3	Q3*	
WFD status			Poor	Poor	Mod	Poor	Poor	Poor	Mod	Mod	Poor	Poor	Poor	Poor	

*tentative Q-rating due to poor flows and or lack of suitable riffle areas for sampling (Toner et al., 2005)

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