

Appendix 9D
Aquatic Survey Reports

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Aquatic baseline report for Derrygreenagh Power, Co Offaly & Co. Westmeath



Prepared by Triturus Environmental Ltd. for Bord na Móna Powergen Limited

February 2023

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1. Introduction

1.1 Background

Triturus Environmental Ltd. were commissioned by Bord na Móna Powergen Limited to conduct baseline aquatic surveys to inform EIA preparation for the proposed Derrygreenagh Power gas-fired development, inclusive of potential grid connection and gas pipeline routes. 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 near Rhode, Co. Offaly and Rochfortbridge, Co. Westmeath.

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 during August-September 2022.

1.2 Project description

The development comprises a power station consisting of two units, a flexible mid merit combined cycle gas turbine unit (CCGT) and a reserve / peaking open cycle gas turbine unit (OCGT) with a proposed site power generation capacity of 600 MW.

A full description of the proposed project will be provided in any Environmental Impact Assessment Report used to support consenting applications.

2. Methodology

2.1 Selection of watercourses for assessment

All freshwater watercourses which could be affected directly or indirectly by the proposed development were considered as part of the current baseline. A total of $n=31$ riverine 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) system of identification. Aquatic survey sites were present on the Rochfortbridge Stream (EPA code: 07R04), Castlejordan River (07C04) and unnamed tributary, Kiltonan Stream (07K04), Milltownpass River (07M04), Kinnegad River (07K01), Hightown River (07H16), Yellow River (07Y02), Coolcor Stream (07C08), Clonin Stream (07C74), Road River (14R53) and unnamed tributary, Esker Stream (14E03), Rochfort Demesne Stream (25R11), Gallstown River (07G36), Derry River (07D28), Toberdaly Stream (14T28) and the Grand Canal (**Table 2.1**).

The aquatic survey sites were located within the Yellow[Castlejordan]_SC_010, Boyne_SC_030, Figile_SC_020 and Brosna_SC_010 river sub-catchments. The proposed development and associated infrastructure was not located within a European site although there was downstream hydrological connectivity (via several watercourses) with the Lough Ennell SAC (000685), Lough Ennell SPA (004044) and the River Barrow and River Nore SAC (002162). Hydrological connectivity also existed with the River Boyne and Blackwater SAC (002299) and River Boyne and River Blackwater SPA (004232).

Please note this aquatic report should be read in conjunction with the final 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 development were conducted on Wednesday 31st August and Thursday 1st, Friday 2nd, Thursday 22nd, Friday 23rd 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**).

Habitat suitability for white-clawed crayfish and presence was assessed at each survey site in conjunction with environmental DNA (eDNA) sampling undertaken for the species at $n=4$ strategically chosen riverine locations within the vicinity of the project. These water samples were also analysed for crayfish plague (*Aphanomyces astaci*). 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 development.

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

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 Derrygreenagh Power development in August-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 (*Lampetra* sp.), European eel (*Anguilla anguilla*) 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 August-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 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 Derrygreenagh survey area was completed.

Table 2.1 Location of $n=31$ aquatic survey sites in the vicinity of the proposed Derrygreenagh Power development, Co. Offaly & Co. Westmeath (* denotes eDNA sampling)

Site no.	Watercourse	EPA code	Location	X (ITM)	Y (ITM)	Potential associated infrastructure (watercourse crossing)
A1	Rochfortbridge Stream	07R04	R400 road crossing, Castlelost West	644392	741635	Gas pipeline route option 1
A2	Castlejordan River	07C04	R400 road crossing, Farthingstown	646879	740315	Gas pipeline route option 1 & 2
A3	Kiltonan Stream	07K04	Mongagh Bridge	648553	738867	Gas pipeline route option 1 & 2
A4	Kiltonan Stream	07K04	Farthingstown, east of R400 road crossing	649613	739013	Gas pipeline route option 1 & 3
A5	Unnamed stream	n/a	Carrick	652197	739948	Gas pipeline route option 1 & 3
A6	Castlejordan River	07C04	Carrick	652484	741375	Gas pipeline route option 1 & 3
A7	Unnamed stream	n/a	Milltown	652487	742166	Gas pipeline route option 1 & 3
A8	Milltownpass River	07M04	Milltown	652497	742393	Gas pipeline route option 1 & 3
B1	Kinnegad River	07K01	Rattin	653352	744648	Gas pipeline route option 1 & 3
B2	Hightown River	07H16	R446 road crossing, Rattin	653436	744861	Gas pipeline route option 1 & 3
*B3	Kinnegad River	07K01	Killaskillen	658163	744354	n/a
C1	Yellow River	07Y02	Derrygreenagh	649916	736283	Electricity GCR option 2
C2	Yellow River	07Y02	R400 road crossing, Derryiron	651801	735983	Electricity GCR option 3
C3	Coolcor Stream	07C08	Barrysbrook	650625	733333	Electricity GCR option 1 & 2
C4	Coolcor Stream	07C08	Coolcor	651310	734459	Electricity GCR option 2
C5	Coolcor Stream	07C08	R400 road crossing, Coolcor	652286	735536	Electricity GCR option 3
C6	Clonin Stream	07C74	R400 road crossing, Coolcor	652408	735420	Electricity GCR option 3
*C7	Yellow River	07Y02	Clongall Bridge	659381	737570	n/a
D1	Unnamed stream	n/a	Rathcobican	653388	732740	Electricity GCR option 3
D2	Road River	14R53	Rathcobican	652986	731991	Electricity GCR option 3
*D3	Esker Stream	14 E03	Newtown Bridge	652952	728554	n/a

Site no.	Watercourse	EPA code	Location	X (ITM)	Y (ITM)	Potential associated infrastructure (watercourse crossing)
E1	Rochfort Demesne Stream	25R11	Kilbrennan	642171	742741	Gas pipeline route option 1
*E2	Rochfort Demesne Stream	25R11	Stoneford Bridge	641792	744109	n/a
X1	Gallstown Stream	07G36	R400 road crossing, Gortumly	645879	742809	Gas pipeline route option 2
X2a	Derry River	07D28	R400 road crossing, Castlelost	646378	741569	Gas pipeline route option 2
X2b	Rochfortbridge Stream	07R04	Castlelost	646370	741537	Adjacent to gas pipeline route option 2
X3	Yellow River	07Y02	Derrygreenagh	649706	736462	Electricity GCR option 1 & 2
X4	Grand Canal	n/a	Coole	650889	730911	Electricity GCR option 1
X5	Grand Canal	n/a	Toberdaly	651780	731377	Electricity GCR option 1
X6	Toberdaly Stream	14T28	Toberdaly	651751	731394	Electricity GCR option 1
X7	Toberdaly Stream	14T28	Toberdaly	651791	731158	Electricity GCR option 1

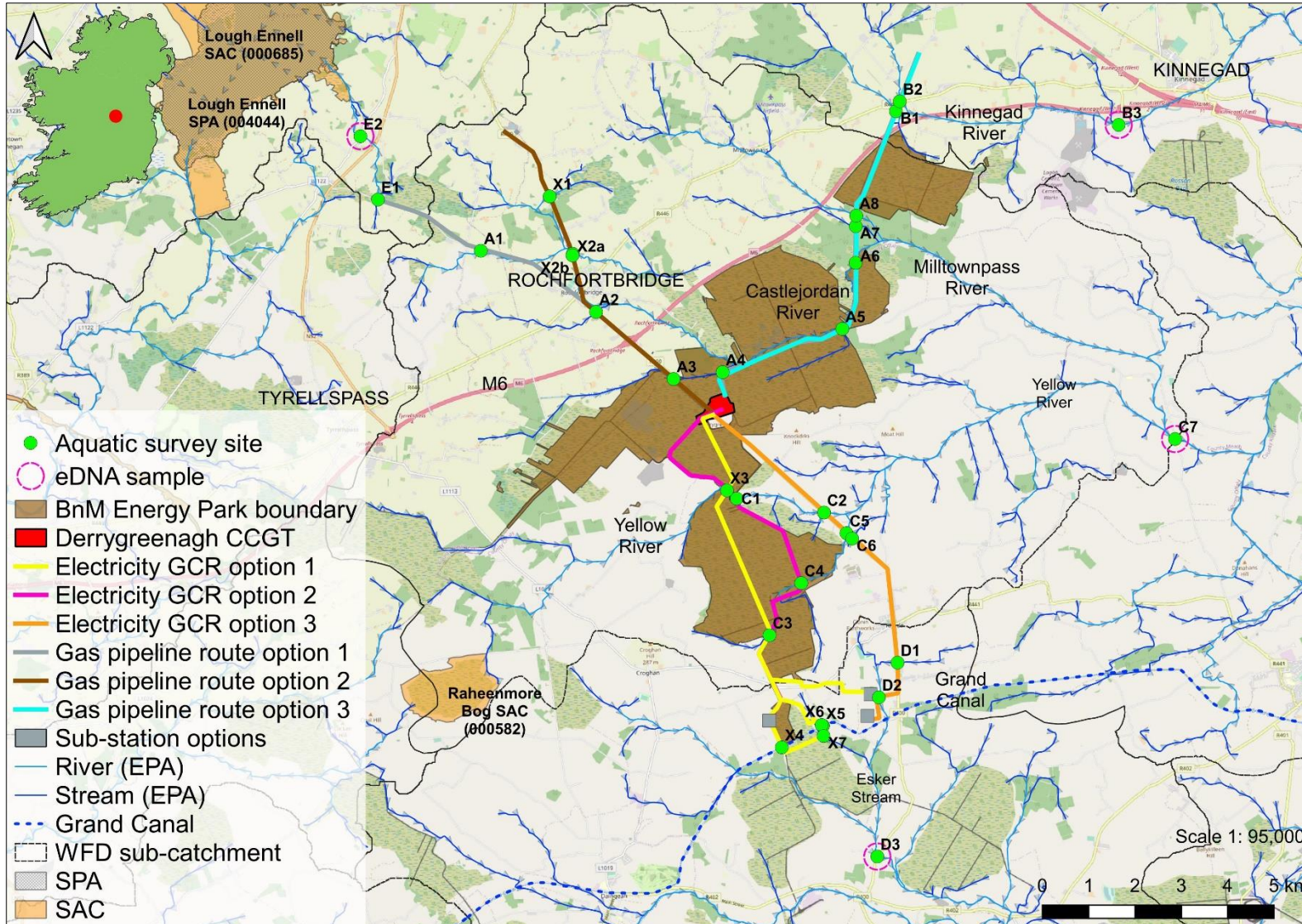


Figure 2.1 Overview of the $n=31$ aquatic survey site locations for the proposed Derrygreenagh Power development, Co. Offaly & Co. Westmeath, July 2022

2.5 eDNA analysis

To validate site surveys and to detect potentially cryptically low populations within the study area, $n=4$ composite water samples were collected from the Kinnegad River (site B3), Yellow River (C7), Esker River (D3) and Rochfort Demesne Stream (E2) and analysed for white-clawed crayfish eDNA (**Figure 2.1**). This would help to validate the site surveys. Samples were also analysed for crayfish plague. The water samples were collected on Friday 2nd September 2022, with the sites strategically chosen to maximise longitudinal (instream) coverage within the catchment (i.e. facilitating a greater likelihood of species detection).

In accordance with best practice, a composite (500ml) water sample was collected from the sampling point, maximising the geographic spread at the site (20 x 25ml samples at each site), thus increasing the chance of detecting the target species' DNA. The composite sample was filtered on-site using a sterile proprietary eDNA sampling kit. The fixed sample was stored at room temperature and sent to the laboratory for analysis within 48 hours of collection. A total of $n=12$ qPCR replicates were analysed for the site. Given the high sensitivity of eDNA analysis, a single positive qPCR replicate is considered as proof of the species' presence (termed qPCR No Threshold, or qPCR NT). Whilst an eDNA approach is not currently quantitative, the detection of the target species' DNA indicates the presence of the species at and or upstream of the sampling point. Please refer to **Appendix D** for full eDNA laboratory analysis methodology.

2.6 Biological water quality (Q-sampling)

The 31 no. riverine survey sites were assessed for biological water quality through Q-sampling in July 2022 (**Figure 2.1**). Sites A7 (unnamed stream), C6 (Clonin Stream), D1 (unnamed stream) and X7 (Toberdaly Stream) were dry at the time of sampling and sites X4 and X5 on the Grand Canal were unsuitable for Q-sampling and thus a three-minute sweep from marginal macrophyte mesohabitat was undertaken. Thus, biological water quality samples were collected from a total of 27 no. riverine sites. All samples were taken with a standard kick sampling hand net (250mm width, 500 μ m 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)

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

2.7 Physiochemical water quality

Physiochemical water quality samples were collected from a subset of 14 no. sites on the Castlejordan River (site A2 & A6), Kiltonan Stream (A3), Milltownpass River (A8), Kinnegad River (B3), Yellow River (C2, C7 & X3), Esker Stream (D3), Rochfort Demesne Stream (E2), Rochfortbridge Stream (X2b) and the Grand Canal (X4 & X5) (**Figure 2.1**). Samples were collected in September 2022 and delivered to the laboratory on the same day for analysis. In order to collate a broad water quality baseline for the study area, a range of physio-chemical parameters for each site were laboratory-tested, namely;

- pH
- Total alkalinity (mg CaCO₃/l)
- Total oxidised nitrogen (mg N/l)
- Total ammonia (mg N/l)
- Total phosphorus (mg P/l) (canal sites only)
- Molybdate Reactive Phosphorus (MRP) (mg P/l)
- Chloride (mg Cl/l)
- Biochemical Oxygen Demand (BOD) (mg O₂/l)
- Chemical Oxygen Demand (COD) (mg O₂/l)
- Suspended solids (mg/L)
- Chlorophyll a (µg/l) (canal sites only)

2.8 Macrophytes and aquatic bryophytes

Surveys of the macrophyte and aquatic bryophyte community were conducted by instream wading at each of the $n=29$ riverine and $n=2$ canal 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 *Ranunculon fluitantis* and *Callitricho-Batrachion* (low water level during summer) or aquatic mosses [3260]’ (more commonly referred to as ‘floating river vegetation’).

2.9 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.).

2.10 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).

2.11 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. Specific consideration was given to highly virulent crayfish plague given known historical outbreaks in connecting downstream catchments. Surveys were undertaken at sites in a downstream order to minimise the risk of upstream mobilisation of pathogens and invasive species. 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. Receiving environment

3.1 Derrygreenagh catchment and survey area description

The proposed Derrygreenagh Power development (CCGT & OCGT) is located in an area of cutover bog at Derrygreenagh, Co. Offaly approx. 4km south-east of Rochfortbridge, Co. Westmeath (**Figure 2.1**). The proposed development is within hydrometric areas 07 (Boyne), 25 (Lower Shannon) and 14 (Barrow). The aquatic survey sites were located within the Yellow [Castlejordan]_SC_010, Boyne_SC_030, Figile_SC_020 and Brosna_SC_010 river sub-catchments.

The watercourses and aquatic surveys sites in the vicinity of Derrygreenagh are small, historically modified lowland depositing (FW2; Fossitt, 2000) and drainage channels (FW4). Predominantly, watercourses flow over areas of Visean limestone & calcareous shale with localised Tournaisian limestone (Geological Survey of Ireland data). Land use practices in the wider survey area are dominated by peat bogs (CORINE 412) with localised transitional woodland scrub (CORINE 324), coniferous forest (CORINE 312) and extensive adjoining pastures (CORINE 231).

3.2 Fisheries asset of the survey area

The Kinnegad River, Yellow River and the Castlejordan River (aka Mongagh River) are known to support *Lampetra* sp. (O'Connor, 2006). These rivers are also known to support good stocks of small-sized brown trout (*Salmo trutta*) (O'Reilly, 2009). The Kinnegad River and Castlejordan (Mongagh) River support a genetically distinct sub-population of trout within the Boyne catchment (Massa-Gallucci & Mariani, 2011).

The Grand Canal is known to support a range of coarse fish species, including perch, pike (*Esox lucius*), bream (*Abramis brama*), roach (*Rutilus rutilus*), rudd (*Scardinius erythrophthalmus*) and their respective hybrids, European eel (*Anguilla anguilla*), tench (*Tinca tinca*), highly localised common carp (*Cyprinus carpio*) and brown trout (IFI data; McLoone, 2011; Tierney et al., 1999; pers. obs.). *Lampetra* sp. lamprey have also been recorded at a low number of locations, e.g. 11th lock, ROD, 2016; 7th lock, Caffrey et al., 2006; 5th lock, MKO, 2019).

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

3.3 Protected aquatic species

A comprehensive desktop review of available data (NPWS, NBDC, BSBI & other data) for 10km grid squares containing and adjoining the project (i.e. N43, N44, N52, N53, N54, N63 & N64) identified records for a low number of rare and or protected aquatic species within the vicinity of the proposed development, although most did not overlap directly with the survey area (**Figure 3.1**).

Records for white-clawed crayfish were widespread within the wider survey area (45 records), primarily on the on the Kinnegad River but also the Yellow River, Castlejordan River and Lough Ennel (**Figure 3.1**). These records ranged from 1971-2018 (the most recent being from the Yellow River).

There were a very high number of records available for otter (*Lutra lutra*) records in the relevant grid squares (>80 records). Whilst many were historical (1980-1991), the majority were contemporary records (2005-2018) (**Figure 3.1**). Records were available for several watercourses and waterbodies including the Rochfortbridge Stream, Kinnegad River, Kiltonan Stream, Castlejordan (Mongagh) River, Yellow River and Esker Stream and numerous settlement ponds in vicinity of the proposed development.

A low number of records were available for smooth newt (*Lissotriton vulgaris*) in grid squares N44, N52 and N63. Common frog (*Rana temporaria*) were widespread throughout the respective 10km grid squares (>60 records).

3.4 EPA water quality data (existing data)

The following outlines the available water quality data for the watercourses in context of the proposed development. Only recent water quality is summarised below (i.e. since 2015). There was no contemporary EPA biological monitoring data available for several watercourses in vicinity of the survey area, namely the unnamed Castlejordan River tributary, Kiltonan Stream (07K04), Hightown River (07H16), Coolcor Stream (07C08), Clonin Stream (07C74), Road River (14R53) and unnamed tributary, Esker Stream (14E03), Rochfort Demesne Stream (25R11), Gallstown River (07G36), Derry River (07D28) or the Toberdaly Stream (14T28).

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 Rochfortbridge Stream

There was a single contemporary EPA biological monitoring station located on the Rochfortbridge Stream (07R04). At station RS07R040300 (survey site X2b) the river achieved Q3-4 (moderate status) in 2020.

Upstream of survey site X2b, the Rochfortbridge Stream (Rochfortbridge Stream_010 river waterbody) was of moderate status in the 2016-2021 period and was 'at risk' of failing to achieve good WFD status (WFD Risk 3rd cycle). Downstream of this point, the Castlejordan_010 river waterbody was of poor status in the 2016-2021 period and also considered 'at risk'. Peat extraction is the major risk to the Rochfortbridge Stream within these two river waterbodies (EPA, 2018a).

3.4.2 Castlejordan River

There were three contemporary EPA biological monitoring station located on the Castlejordan River (07C04). However, at Baltinoran Bridge (station RS07C040100), halfway between survey sites A6 and A7, the river achieved Q4 (good status) in 2020. The river also achieved Q4 (good status) at station RS07C040190, Castlejordan Bridge) in 2020.

The Castlejordan River upstream of Rochfortbridge (Castlejordan_010 river waterbody) was of moderate status in the 2016-2021 period and was 'at risk' of failing to achieve good ecological status (WFD Risk 3rd cycle). However, downstream the Castlejordan_020 and _030 river waterbodies were of good status and were 'under review' and 'not at risk', respectively. Peat extraction (including elevated

ammonia levels) and diffuse agriculture are the main risk to water quality in these river waterbodies (EPA, 2018a).

3.4.3 Milltownpass River

There was a single contemporary EPA biological monitoring station located on the Milltownpass River (07M04). At station RS07M040400 (c.3km upstream of survey site A8) the river achieved Q3-4 (moderate status) in 2020.

The middle and lower reaches of the river are located within the Castlejordan_020 river waterbody which was of good status in the 2016-2021 period and 'not at risk' of failing to achieve good WFD status (WFD Risk 3rd cycle). Peat extraction (including elevated ammonia levels) and diffuse agriculture are the main risk to water quality in these river waterbodies (EPA, 2018a).

3.4.4 Kinnegad River

Two contemporary EPA biological monitoring stations were located on the Kinnegad River (07K01) in vicinity of the survey area. At station RS07K010060 (downstream of survey site B1) and station RS07K010070 (survey site B3) the river achieved Q3 (poor status) in 2020.

Upstream of Kinnegad, the Kinnegad River (within the Kinnegad_010 and Kinnegad_020 river waterbodies) was of poor status in the 2016-2021 period and was considered 'at risk' of failing to achieve good WFD status and 'under review', respectively (WFD Risk 3rd cycle). Agriculture, peat extraction and hydromorphology are the biggest risks to water quality within these river waterbodies (EPA, 2018b).

3.4.5 Yellow River

Three contemporary EPA biological monitoring stations were located on the Yellow River (07Y02) in vicinity of the survey area. At station RS07Y020070 (survey site X3) the river achieved Q3 (poor status) in 2020. However, at Garr Bridge (station RS07Y020100), the river achieved Q4 (good status) in 2020. The river also achieved Q4 (good status) at station RS07Y020300 (Clongall Bridge, survey site C7) in 2020.

In vicinity of the proposed development, the Yellow River (within Yellow (Castlejordan)_020 and _030 river waterbodies) was of good status in the 2016-2021 period and was considered 'not at risk' of failing to achieve good WFD status (WFD Risk 3rd cycle).

3.4.6 Coolcor Stream

There were two contemporary EPA biological monitoring stations located on the Coolcor Stream (07C08). At station RS07C080020 (0.5km downstream of survey site C4) the river achieved Q3-4 (moderate status) in 2020. The stream also achieved Q3-4 (moderate status) at station RS07C080190 (survey site C5) in 2020.

The stream is located within the Castletown tara Stream_010 river waterbody which was of moderate status in the 2016-2021 period and 'at risk' of failing to achieve good WFD status (WFD Risk 3rd cycle). Peat extraction is the main risk to water quality in this river waterbody (EPA, 2018a).

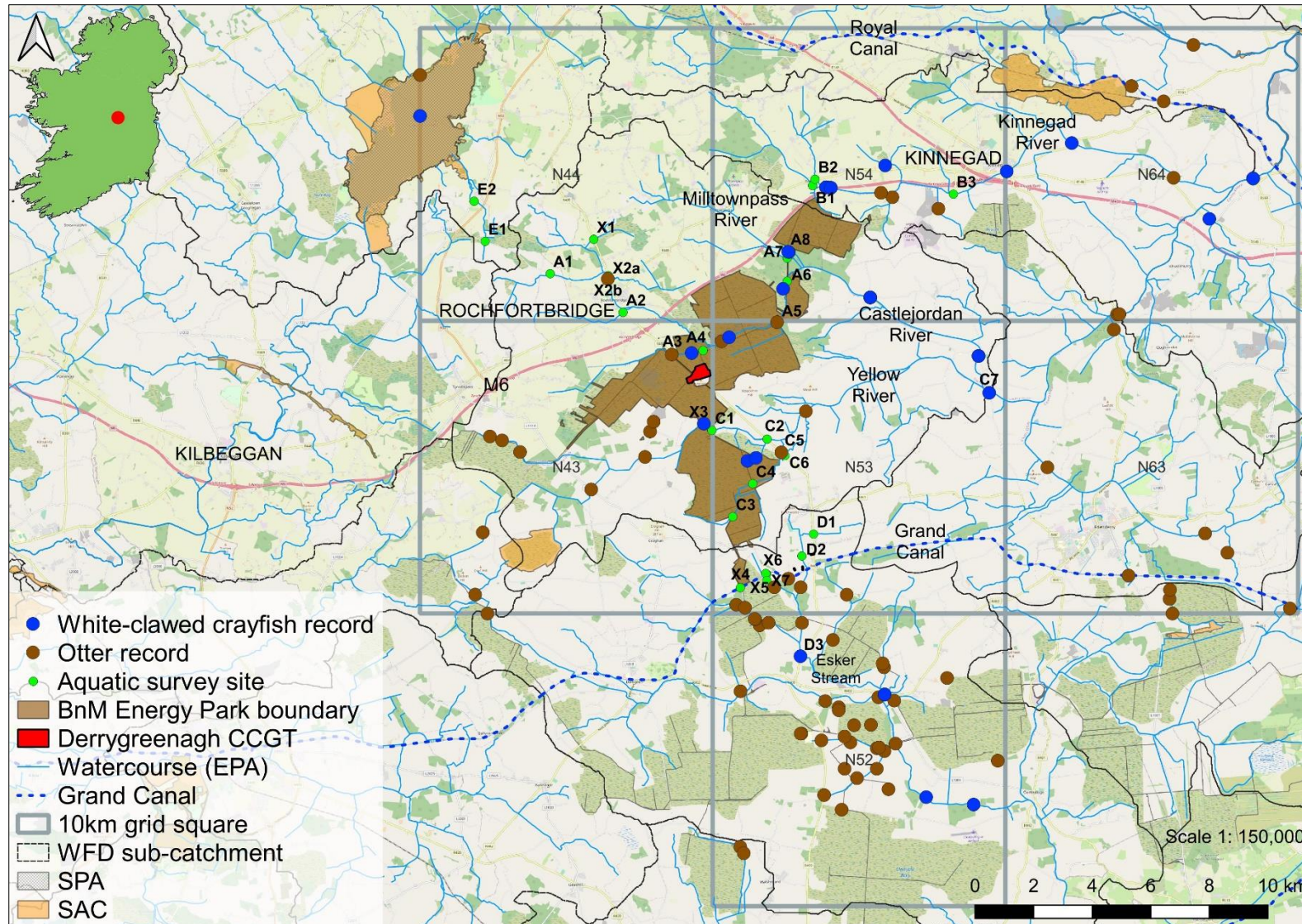


Figure 3.1 Selected protected aquatic species records in the vicinity of the proposed Derrygreenagh Power Project (source: NPWS & NBDC data, 2000-2018)

4. Results of aquatic surveys

The following section summarises each of the $n=31$ survey sites in terms of physical characteristics to broadly establish their hydromorphological condition. Furthermore, each survey site was assessed in terms of its fisheries habitats, inclusive of electro-fishing data compiled. Surveys for white-clawed crayfish and macrophyte/aquatic bryophyte communities were also undertaken. Biological water quality (Q-sample) results were also summarised for each riverine sampling site inclusive of species lists. Please refer to **Appendix A** (fisheries assessment report) for more detailed fisheries results and **Appendix B** for invertebrate species lists and biological Q sampling summaries for each survey site. Habitat codes are presented according to Fossitt (2000) and scientific names are provided at first mention only. The surveys were carried out between July and September 2022 during low water to best observe aquatic species and habitats. High level summaries of the fish species recorded at each survey site is provided in **Table 4.2**. Additionally, a summary of the aquatic species and habitats of high conservation concern recorded during the surveys is provided in **Table 4.3**. An evaluation of the aquatic ecological importance of each survey site based on these aquatic surveys is provided and summarised in **Table 4.4**.

4.1 Aquatic survey site results

4.1.1 Site A1 – Rochfortbridge Stream, Castlelost West

Site A1 was located on the Rochfortbridge Stream (07R04) at the R400 road and potential gas pipeline route option 1 crossing. The heavily modified lowland depositing watercourse (FW2) had been historically deepened and straightened with resulting poor hydromorphology in a U-shaped channel. The stream averaged 3-4m wide and 0.1-0.3m deep. The profile was dominated by very slow flowing shallow glide with localised riffle and shallow pool. The substrata comprised scattered cobble and mixed gravels that were heavily bedded and heavily silted. Livestock poaching was evidently contributing to the siltation of the channel. The site supported abundant cover of watercress (*Nasturtium officinale*) and fool's watercress (*Apium nodiflorum*). Common duckweed (*Lemna minor*) was locally abundant and covered c.10% of the stream's surface. Aquatic bryophytes were not recorded. Filamentous algal cover was moderate (20%) with abundant floc¹. The stream margins supported frequent great willowherb (*Epilobium hirsutum*), hedge bindweed (*Calystegia sepium*), bramble (*Rubus fruticosus* agg.), meadowsweet (*Filipendula ulmaria*) and iris (*Iris pseudacorus*). The riparian areas supported scattered mature grey willow (*Salix cinerea*), hawthorn (*Crataegus monogyna*) and ash (*Fraxinus excelsior*) with scrub in the understories. The site was bordered by heavily improved pasture (GA1).

Three-spined stickleback (*Gasterosteus aculeatus*) and lamprey (*Lampetra* sp.) were the only fish species recorded via electro-fishing at site A1 (**Appendix A**). The site was a poor quality salmonid nursery being degraded due to historical drainage, poor flow rates, heavy siltation and evident enrichment. The quality of spawning habitat was also poor (for both salmonids and lamprey) being

¹ floc is defined as an aggregation of (mostly dead) organic material, mainly from algae and diatoms, but also with potential origins from decaying macrophytes and associated decomposers (bacteria and fungi). The floc can form a layer at the surface of the substrate, or infiltrate the substrate, generally where there is insufficient flow to keep the material in suspension (Moorkens & Killeen, 2020)

reduced by the deterioration of the bed from algae and sedimentation. Holding water for adult salmonids was also poor given very limited deeper areas. However, the site was of moderate value for lamprey ammocoetes with localised shallow silt deposits supporting a low density population. There was some suitability for European eel and white-clawed crayfish given the presence of dense macrophyte refugia but the poor flows and more limited cobble and boulder refugia reduced the overall value (none 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)**. 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 lamprey (*Lampetra* sp.), the aquatic ecological evaluation of site A1 was of **local importance (higher value) (Table 4.4)**.



Plate 4.1 Representative image of site A1 on the Rochfortbridge Stream, August 2022

4.1.2 Site A2 – Castlejordan River, Farthingstown

Site A2 was located on the Castlejordan River (07C04) at the R400 road and potential gas pipeline route 1 and 2 crossing. The heavily modified lowland depositing watercourse (FW2) had been historically deepened and straightened with resulting poor hydromorphology in a U-shaped channel. The bank heights were 2.5-3m. The river averaged 2-2.5m wide and 0.1-0.4m deep. The profile was dominated exclusively by very slow flowing glide. The substrata comprised scattered cobble and mixed gravels that were heavily bedded in silt. The site featured >95% coverage of fool's watercress with no areas of open water. Aquatic bryophytes were not recorded. The riparian areas supported scattered mature ash with dry grassy understories and scattered great willowherb, thistles (*Cirsium* sp.) and nettle (*Urtica dioica*). The site was bordered by heavily improved pasture (GA1).

With the exception of three-spined stickleback, recorded in low densities (**Appendix A**), the site was not of fisheries value given historical modifications, poor hydromorphology, low flows and heavy siltation. There was no suitability for white-clawed crayfish. 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 A2 was of **local importance (lower value) (Table 4.4)**.



Plate 4.2 Representative image of site A2 on the Castlejordan Stream, August 2022

4.1.3 Site A3 – Kiltonan Stream, Mongagh Bridge

Site A3 was located on the Kiltonan Stream (07K04) (also known as the Mongagh River) at Mongagh Bridge, a potential gas pipeline route 1 and 2 crossing. The heavily modified lowland depositing watercourse (FW2) had been extensively deepened and straightened with resulting poor hydromorphology in a deep U-shaped/trapezoidal channel. Over-deepening had resulted in banks of 8-10m in height. The stream averaged 2-3m wide (in a wider 4-6m channel) and 0.3-0.6m deep. The profile was of slow-flowing glide with accelerated flows in vicinity of the road culvert only. The substrata comprised deep silt with very limited hard substrata present (localised boulder only). Fool's watercress was abundant with the channel lined by abundant reed canary grass (*Phalaris arundinacea*). Cover of filamentous algae was high, indicating enrichment. The riparian areas supported dense bramble, gorse (*Ulex europaeus*), hedge bindweed, great willowherb, wild angelica (*Angelica sylvestris*) and grey willow. The site was bordered to the north by improved pasture (GA1) with cutover bog (PB4) and quarrying areas (ED2, ED3, ED4) present downstream.

Brown trout (*Salmo trutta*) and three-spined stickleback were the only fish species recorded via electro-fishing at site A3 (**Appendix A**). The site was considered a moderate quality salmonid nursery given the historical drainage, slower flow, heavy sedimentation and dense macrophyte growth. The spawning quality was poor due to the heavy sedimentation of the channel. Holding habitat was

moderate overall due to the heavy macrophyte growth and the limited pool habitat. The channel had high suitability for lamprey ammocoetes given the soft organic rich sediment. However, very limited spawning habitat was present given heavy sedimentation and an absence of hard substrata (no lamprey were recorded). European eel habitat was moderate overall given the presence of dense macrophyte growth and pockets of deeper glide, although no eel were recorded. There was some moderate suitability for white-clawed crayfish given abundant instream refugia. However, whilst none were recorded during targeted crayfish surveys, crayfish remains were identified in otter spraint downstream of the R400 road culvert (ITM 648570, 738859).

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, in addition to otter utilisation, the aquatic ecological evaluation of site A3 was of **local importance (higher value) (Table 4.4)**.



Plate 4.3 Representative image of site A3 on the Kiltonan Stream, September 2022

4.1.4 Site A4 – Kiltonan Stream, Farthingstown

Site A4 was located on the Kiltonan Stream (07K04) adjacent to Derryarkin Sand & Gravel Quarry, approx. 0.25km upstream of the Castlejordan River confluence and 1km downstream of site A3. The river, also known as the Mongagh River at this location, had been historically straightened and over-deepened with a very deep, steep trapezoidal channel and bankfull heights of up to 8m. The river averaged 1.5-2m wide in a heavily vegetated two-stage channel of up to 8m wide. The depth was a homogenous 0.5m. The profile comprised deep slow-flowing depositional glide with no riffle or pool areas. The substrata, given historical excavation, comprised compacted clay with very localised boulder and superficial gravels. Macrophyte cover was very high (>95%) with abundant fool's watercress, watercress and water mint (*Mentha aquatica*). Branched bur-reed (*Sparganium erectum*) was frequent instream and along channel margins. Broad-leaved pondweed (*Potamogeton natans*) and common duckweed were locally frequent with occasional water starwort (*Callitriche* sp.) and water plantain (*Alisma plantago-aquatica*). Aquatic bryophytes were not recorded. Filamentous algae

were present (10% cover), further indicating significant enrichment. The riparian zones (mostly GS2 habitat) supported abundant reed canary grass, great willowherb, purple loosestrife (*Lythrum salicaria*), creeping bent grass (*Agrostis stolonifera*) with scattered bramble and gorse scrub (WS1). The site was bordered by an active quarry to the south (ED3) and scrub and cutover bog (PB4) to the north.

Brown trout, lamprey, roach (*Rutilus rutilus*) and three-spined stickleback were recorded via electro-fishing at site A4 (**Appendix A**). The site was of poor value to salmonids (single adult trout recorded) given poor flows, poor hydromorphology and evident siltation and enrichment pressures. Spawning habitat was not present and the site was not of value as a salmonid nursery. Despite the presence of frequent soft sediment accumulations, the site only supported a very low density of *Lampetra* sp. ammocoetes. This was considered to reflect the poor flows/hydromorphology and clay-dominated substrata. Despite some good suitability for European eel and white-clawed crayfish, none were recorded. While some foraging habitat existed for otter 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 was a tentative rating given poor flows and an absence of suitable riffle areas for sampling (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 and lamprey (*Lampetra* sp.), the aquatic ecological evaluation of site A4 was of **local importance (higher value) (Table 4.4)**.



Plate 4.4 Representative image of site A4 on the Kiltonan Stream, August 2022

4.1.5 Site A5 – unnamed stream, Carrick

Site A5 was located on the lowermost reaches of an unnamed stream at the potential gas pipeline route option 1 and 3 crossing, immediately upstream of the Castlejordan River confluence and downstream of a mature peat settlement pond. The lowland depositing channel (FW2) had been historically straightened and over-deepened, with a steep trapezoidal channel featuring bankfull heights of up to 5m. The channel flowed under the track crossing via a pipe culvert with a 0.3m fall on the downstream side at low summer flows. Downstream of the culvert, the modified river channel averaged 2.5-3.5m wide and 0.3-0.6m deep. A deeper plunge pool below the culvert was up to 1.6m in depth. The profile comprised very slow-flowing glide with localised pool (no riffle). The substrata were dominated by silt with a high clay fraction although some superficial (excavated) gravels were also present nearer the culvert (heavily bedded in silt). More organic-rich soft sediment accumulations were present along the steeply sloping channel margins. The site supported frequent invasive Nuttall's pondweed (*Elodea nuttallii*) with occasional common water starwort blue water speedwell (*Veronica anagallis-aquatica*), water plantain and broad-leaved pondweed. Branched bur-reed was rare in stream and common along the margins. Macrophyte coverage was very high (>95%) in the main river, with Nuttall's pondweed and broad-leaved pondweed dominant. Aquatic bryophytes were not recorded. The margins of the channel supported abundant reed canary grass with frequent hedge bindweed, willowherb species and occasional bottle sedge (*Carex rostrata*). The scrubby riparian zones also supported these species with occasional bramble scrub and scattered gorse and willow. The site was adjoined by cutover bog on the south bank and coniferous afforestation (WD4) on the north bank.

A total of six fish species were recorded via electro-fishing at site A5, namely lamprey (*Lampetra* sp.), roach, minnow (*Phoxinus phoxinus*), perch (*Perca fluviatilis*), gudgeon (*Gobio gobio*) and pike (**Appendix A**). The site was primarily of value as a coarse fish nursery. The site was of poor value to salmonids given poor flows, poor hydromorphology and evident siltation pressures. No salmonids were recorded via electro-fishing. However, the plunge pool at the culvert provided some low potential as an adult holding habitat (as did the downstream-connecting Castlejordan River). Spawning habitat was almost entirely absent and the site was not of value as a salmonid nursery. Despite the presence of frequent soft sediment accumulations, the site only supported a low density of *Lampetra* sp. ammocoetes. This was considered to reflect the poor flows/hydromorphology and clay-dominated substrata. Despite some good suitability for European eel and white-clawed crayfish, 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 presence of lamprey (*Lampetra* sp.), the aquatic ecological evaluation of site B1 was of **local importance (higher value) (Table 4.4)**.



Plate 4.5 Representative image of site A5 on an unnamed Castlejordan River tributary, August 2022 (facing downstream to river confluence)

4.1.6 Site A6 – Castlejordan River, Carrick

Site A6 was located on the Castlejordan River (07C04) (aka Mongagh River) at a livestock access bridge and potential gas pipeline route option 1 and 3 crossing, approx. 4.5km downstream of site A4. As per upstream, the river had been historically straightened and deepened, with old embankments present. The lowland depositing watercourse (FW2) was 4-5m wide and >1.2m deep, with a short section near the cattle bridge 0.2-0.4m deep. The profile was of slow-flowing depositional glide with only a short section of faster glide/riffle in the immediate vicinity of the bridge. Given low summer flows, much of the deeper glide habitat resembled pool habitat. The substrata were dominated by deep silt (with a high clay content given historical excavation). However, the short faster-flowing section near the bridge featured mixed gravels with occasional cobble and boulder. These were heavily silted and partially bedded. Soft sediment accumulations were abundant and siltation was very high overall. The slow-flowing site was very heavily vegetated (>90% cover) with abundant branched bur-reed, broad-leaved pondweed and invasive Nuttall's pondweed. Marginal (floating) stands of watercress and fool's watercress were frequent. Blue water speedwell, water plantain, water mint and water starwort (*Callitriche* sp.) were occasional, with common duckweed, ivy-leaved duckweed (*Lemna trisulca*) and small pondweed (*Potamogeton pusillus*) recorded as rare. Aquatic bryophytes were limited to *Fontinalis antipyretica* and *Leptodictyum riparium* on rare cobble and boulder. Filamentous algae was abundant instream (30% cover), further indicating significant enrichment. The narrow riparian zones supported a typical nitrophilous community of great willowherb, reed canary grass, broad-leaved dock (*Rumex obtusifolius*), nettle, thistles (*Cirsium* spp.), bent grass (*Agrostis* sp.) and rank grasses. The site was bordered by dry meadows and grassy verges (GS2) and improved pasture to the west (GA1). Peat settlement ponds adjoined the channel upstream.

Brown trout, lamprey, pike, perch and stone loach (*Barbatula barbatula*) were recorded via electro-fishing at site A6 (**Appendix A**). The site was of moderate value for salmonids given considerable hydromorphological and siltation pressures, supporting a very low density of brown trout. Except for the short section near the bridge (moderate value), the site was not of value as a salmonid spawning or nursery habitat. However, given the predominance of deeper glide areas, good holding opportunities were present. Given the poor hydromorphological condition of the channel the site was primarily of value as a coarse fish habitat. Despite some good suitability for European eel and white-clawed crayfish (abundant instream refugia), none were recorded. No otter signs were recorded in vicinity of the site.

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 and lamprey in addition to otter utilisation, the aquatic ecological evaluation of site A6 was of **local importance (higher value) (Table 4.4)**.



Plate 4.6 Representative image of site A6 on the Castlejordan River, August 2022

4.1.7 Site A7 – unnamed stream, Milltown

Site A7 was located on an unnamed stream at the potential gas pipeline route option 1 and 3 crossing, approx. 0.6km upstream of the Castlejordan River (Mongagh River) confluence. Despite being present on EPA mapping, no riverine channel was identified during the survey, with a dry peat-base drainage ditch present alongside the mapped route of the stream. The Castlejordan River tributary was likely realigned historically as part of land drainage works. Site A7 was not of fisheries value given an absence of any permanent water. Furthermore, given the dry nature of the site, it was not possible to collect a biological water quality sample at the time of survey.

In light of the absence of permanent water in the ephemeral channel, the aquatic ecological evaluation of site A7 was of **local importance (lower value) (Table 4.4)**.



Plate 4.7 Representative image of site A7 on an unnamed Castlejordan River tributary, August 2022 (no channel or aquatic habitats present)

4.1.8 Site A8 – Milltownpass River, Milltown

Site A8 was located on the Milltownpass River (07M04) at a Bord na Móna rail and potential gas pipeline route option 1 and 3 crossing, approx. 0.8km upstream of the Castlejordan River confluence. The lowland depositing watercourse (FW2) had been historically straightened and deepened throughout, with bank modifications (gabion baskets including twin bore culvert) in the vicinity of the bridge crossing. The river flowed in a trapezoidal channel with bankfull heights of 2-3m. The river averaged 3m wide with a wider section in vicinity of the bridge of up to 6-7m. The depth ranged from 0.3-0.5m in glide habitat to 1.8m in pool areas underneath the bridge. The profile was of slow-flowing glide with deep pool in vicinity of the bridge only. The substrata were dominated by silt with a high clay fraction although a short section (10m) downstream of the bridge featured loose mixed gravels. Cobble and small boulder were present but localised in the upstream and downstream vicinity of the culverts. Soft sediment accumulations were abundant, particularly underneath the bridge adjoining deep glide and pool. Apart from the bridge area (open water), the river at this location was very heavily vegetated. Upstream, macrophyte cover exceeded 95% with abundant branched bur-reed and broad-leaved pondweed. Downstream of the bridge supported abundant watercress, lesser water parsnip (*Berula erecta*) and fool's watercress, with frequent mare's-tail (*Hippuris vulgaris*), branched bur-reed and less frequent unbranched bur-reed (*Sparganium emersum*). Water starwort (*Callitriche* sp.), ivy-leaved duckweed and small pondweed were occasional. Aquatic bryophytes were limited to very localised greater water-moss (*Fontinalis antipyretica*), Kneiff's feather-moss (*Leptodictyum riparium*) and jagged germanderwort (*Riccardia chamedryfolia*) on cobble and boulder (the latter a calcareous indicator). The sloping riparian zone supported abundant reed canary grass and hedge bindweed with

great willowherb and other herbaceous species such as common valerian (*Valeriana officinalis*). The site was bordered by historical clear-fell (WS5; now recolonising with abundant rosebay willowherb (*Chamaenerion angustifolium*) and scrubby areas with scattered willow species.

Brown trout, lamprey (*Lampetra* sp.) and pike were recorded via electro-fishing at site A8 (**Appendix A**). Site A8 was of high value for salmonids, despite hydromorphological, enrichment and siltation pressures, supporting a moderate density of primarily adult brown trout. The site as of highest value as a holding area for adult salmonids (excellent quality pool habitat under the bridge. Good quality spawning habitat for both salmonids and lamprey was present downstream of the aforementioned pool (mobile mixed gravels). The site was of relatively poor value as a salmonid nursery. However, the site was an excellent quality lamprey nursery (abundant soft sediment accumulations) and supported a moderate density of ammocoetes. Despite high suitability for European eel and white-clawed crayfish, none were recorded. The site was also of good value for coarse fish species such as pike, perch and roach given the deeper vegetated channel (although the latter two species were not recorded during the current survey). A very regular spraint site, complete with two slides and a latrine, was recorded under the bridge (north bank) on soft peat-clay bank (ITM 652521, 742386). The observed spraints did not contain crayfish remains. A couch site was also identified at the latrine area.

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 A8 was of **local importance (higher value) (Table 4.4)**.



Plate 4.8 Representative image of site A8 on the Milltownpass River, August 2022

4.1.9 Site B1 – Kinnegad River, Rattin

Site B1 was located on the upper reaches of the Kinnegad River (07K01) at the potential gas pipeline route option 1 and 3 crossing. The lowland depositing river (FW2) had been historically deepened and straightened along field boundaries but showed some good recovery instream. The river averaged 4-5m wide and 0.1m deep with localised areas up to 0.3m. The banks heights were 2-5m (a sign of over-deepening). The site had a deep U-shaped profile dominated by very slow-flowing glide with riffle habitat upstream adjoining the R446 road crossing. The substrata comprised mixed small boulder, cobble and gravels with silt becoming more frequent moving downstream from the R446. Livestock poaching was present locally. The potential pipeline crossing area featured abundant fool's watercress which covered the majority of the channel's width. Aquatic bryophytes were not recorded. The riparian areas were more open with low lying scrub and rank grasses on the west bank and a mature treeline of ash, sycamore (*Acer pseudoplatanus*), and hawthorn on the east bank. The site was bordered by heavily improved pasture (GA1).

Brown trout and three-spined stickleback were the only fish species recorded via electro-fishing at site B1 (**Appendix A**). The site was considered a moderate quality salmonid nursery, despite moderate to heavy siltation. Whilst some areas of good quality spawning habitat were present locally, the overall value was reduced due to historical drainage and sedimentation pressures. Holding habitat was of poor quality given a paucity of deeper glide and pool habitat. The site provided some good quality lamprey spawning habitat. Despite some suitability locally in soft sediment accumulations, no larval lamprey were recorded. Whilst the site was of moderate suitability for European and white-clawed crayfish (ample refugia), 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)**. 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 B1 was of **local importance (higher value) (Table 4.4)**.



Plate 4.9 Representative image of site B1 on the Kinnegad River, August 2022

4.1.10 Site B2 – Hightown River, Rattin

Site B2 was located on the Hightown River (07H16) at the R446 road and potential gas pipeline route option 1 and 3 crossing, approx. 0.3km upstream of the Kinnegad River confluence. The heavily modified lowland depositing river (FW2) had been historically deepened and straightened along field boundaries but retained some semi-natural characteristics, including a hard bed and areas of riffle and glide. The river averaged 2-4m wide and 0.2-0.4m, with bank heights of 2-3m. The deep U-shaped channel featured a profile of swift flowing glide with more localised riffle and pool. The substrata were dominated by mixed medium and fine gravels which were heavily silted and bedded. Exposed clay was also present locally. The site supported abundant fool's watercress and localised water mint. In terms of aquatic bryophytes, the star-headed liverwort (*Marchantia polymorpha* subsp. *Polymorpha*) was abundant instream. The riparian areas comprised of dense scrub with scattered sycamore and ash. The site was bordered by heavily improved pasture (GA1).

Brown trout, minnow and three-spined stickleback were recorded via electro-fishing at site B2 (**Appendix A**). The site was considered a moderate quality salmonid nursery given the presence of localised riffle and slow flowing glide, despite moderate to heavy siltation and compaction. The spawning value for salmonids and lamprey was locally good but moderate overall given historical drainage and siltation pressures. Holding habitat quality was moderate overall due to a paucity of deeper pool habitat. Whilst some suitable soft sediment areas for lamprey ammocoete was present locally, none were recorded during targeted electro-fishing. Despite some moderate suitability, no European eel or white-clawed crayfish 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)**. 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 B2 was of **local importance (higher value) (Table 4.4)**.



Plate 4.10 Representative image of site B2 on the Hightown River, August 2022

4.1.11 Site B3 – Kinnegad River, Killaskillen

Site B3 was located on the Kinnegad River (07K01) at the L8021 road crossing, approx. 5km downstream of site B1. The lowland depositing river (FW2) had been extensively straightened and deepened historically resulting in a trapezoidal channel with poor hydromorphology. The heavily modified channel averaged 4-6m wide and 1.3-1.8m deep with bank heights of 4-6m. The profile was of deep slow-flowing glide with a bed dominated by soft silt. The site was heavily vegetated with abundant fool's watercress, branched bur-reed and broad-leaved pondweed which restricted flows. Watercress and water mint were also present locally. The riparian areas supported abundant reed canary grass, great willowherb, meadowsweet and thistles with scattered grey willow and hawthorn. The site was bordered by heavily improved pasture (GA1).

Electro-fishing was not undertaken at site B3 given prohibitive depths of >1.3m and a soft riverbed (deep silt). The Kinnegad River at this location was considered a poor quality salmonid nursery given the poor flows, heavy sedimentation and dense macrophyte growth. The spawning quality was also poor due to the absence of even moderate flows. The site was of some value as a holding area for adult salmonids. The site was more suited to coarse fish species. The site could theoretically support ammocoetes given the abundant soft sediment accumulations but the very low flows reduced the suitability for the species in addition to the absence of suitable spawning habitat. European eel habitat was moderate overall given the presence of dense macrophyte growth and deep pools. There was also moderate suitability for white-clawed crayfish given the presence of abundant macrophyte refugia although none were recorded during the survey. Environmental DNA analysis also failed to detect the species (**Table 4.1**). Despite some foraging suitability, 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 some suitability for aquatic species of higher conservation value such as European eel and otter, the aquatic ecological evaluation of site B3 was of **local importance (higher value)** (**Table 4.4**).



Plate 4.11 Representative image of site B3 on the Kinnegad River, August 2022

4.1.12 Site C1 – Yellow River, Derrygreenagh

Site C1 was located on the upper reaches of the Yellow River (07Y02) at a potential electricity GCR option 2 crossing in an area of peatland. The lowland depositing river (FW2) had been extensively deepened historically, resulting in an over-deepened trapezoidal channel with 8-10m bank heights and poor hydromorphology. The river averaged 6m wide and 0.3-1.2m deep. The profile comprised deep, slow-flowing glide and localised pool (no riffles). The substrata were dominated by mixed coarse gravels bedded in deep silt and peat, with occasional boulder. The gravels were also moderately compacted. The site supported abundant branched bur-reed and broad-leaved pondweed with occasional fool's watercress and water mint. Occasional boulders supported the thalloid liverwort *Pellia endiviifolia*. No filamentous green algae were present but localised red algae (rhodophytes) were present. The riparian areas supported dense bramble and gorse scrub (WS1) with hedge bindweed, great willowherb, wild angelica, reed canary grass and grey willow. The site was bordered by cutover bog (PB4) and a peat settlement pond.

Brown trout, perch, pike (*Esox lucius*) and three-spined stickleback were recorded via electro-fishing at site C1 (**Appendix A**). The heavily vegetated channel of the Yellow River was considered a good habitat for coarse fish and supported pike and perch. The site was considered a poor to moderate quality salmonid nursery given the historical drainage, slower flow, heavy sedimentation and dense macrophyte growth. The spawning quality was poor due to the heavy siltation of the channel. Holding habitat was moderate overall due to the heavy macrophyte growth despite the presence of deeper glide and localised pools. The channel had moderate suitability for lamprey ammocoetes given the presence of soft sediment, but the peat influences and very limited spawning habitat reduced the potential for the species and none were recorded. Despite some moderate suitability for European eel and white-clawed crayfish, none were recorded. No otter signs were recorded in the vicinity of the site although a spraint site was recorded c.0.3km upstream at site X3 (see section 4.1.27).

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 C1 was of **local importance (higher value) (Table 4.4)**.



Plate 4.12 Representative image of site C1 on the Yellow River, September 2022

4.1.13 Site C2 – Yellow River, Derryiron

Site C2 was located on the upper reaches of the Yellow River (07Y02) at the R400 and potential electricity GCR option 3 crossing. The lowland depositing river channel (FW2) had been extensively deepened and straightened with a deep U-shaped profile but exhibited good recovery with semi-natural characteristics. The river averaged 6-7m wide and 0.3-0.6m deep with bank heights of 6-8m. The profile was dominated by swift-flowing glide with localised riffles and pools associated with large woody debris dams and overhanging willow. The substrata comprised boulder, cobble and coarse gravels with moderate to heavy siltation. The site was heavily vegetated locally with abundant branched bur-reed and broad-leaved pondweed with occasional fool's watercress, water mint and water forget-me-not (*Myosotis scorpioides*). Endive pellia was occasional on scattered boulder. The riparian areas supported dense bramble, hedge bindweed and purple loosestrife. The site was bordered by improved pasture (GA1).

Brown trout and stone loach were the only fish species recorded via electro-fishing at site C2 (**Appendix A**). The site was a good quality salmonid habitat supporting relatively high numbers of mixed-cohort brown trout. Good quality nursery habitat was present although this was reduced by evident siltation and enrichment pressures. Localised deeper glide and pool, in addition to macrophyte beds, provided some good quality holding habitat for adult salmonids. Some good quality spawning habitat for salmonids and lamprey was present but again the value was reduced by siltation. The site was of poor suitability for lamprey ammocoetes given the dominance of hard substrata and none were recorded. Despite some good suitability (abundant refugia), no European eel or white-clawed crayfish were recorded. No otter signs were recorded in the vicinity of the site.

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 and relatively high value as a salmonid spawning and nursery habitat, the aquatic ecological evaluation of site C2 was of **local importance (higher value) (Table 4.4)**.



Plate 4.13 Representative image of site C2 on the Yellow River, September 2022

4.1.14 Site C3 – Coolcor Stream, Barrysbrook

Site C3 was located on the upper reaches of the Coolcor Stream (07C08) at a bog access track and potential electricity GCR option 1 and 2 crossing (pipe culvert). The lowland depositing stream (FW2) had been extensively straightened and over-deepened historically, with resulting very steep trapezoidal banks (5m bankfull heights) and poor hydromorphology. The canalised stream averaged 2m and 0.5m deep at the time of survey. The profile comprised very slow flowing glide and pool (seasonally stagnant). Peat staining was very high at the time of survey (draining peatland). The substrata were 100% deep peat with slumping of the steep banks evident. Macrophyte cover was high with abundant fool's watercress and occasional watercress and common duckweed. Filamentous algae were present (5%), indicating enrichment. Terrestrial encroachment was also high with abundant bent grass (*Agrostis* sp.) and great willowherb. The steep sloping banks supported gorse, bramble and bracken (*Pteridium aquilinum*) scrub (WS1) with scattered immature downy birch (*Betula pubescens*) and rank grasses. The site was bordered by extensive areas of cutover bog (PB4).

With the exception of three-spined stickleback and ten-spined stickleback² (*Pungitius pungitius*) (recorded at moderate densities), site C3 was not of fisheries value given poor hydromorphology, heavy siltation and poor connectivity with superior downstream habitats. There was no suitability for salmonids given low seasonal flows and heavy siltation pressures. There was some low suitability for European eel although connectivity issues would likely preclude the species. Suitability for white-clawed crayfish was low (none recorded). Whilst no otter signs were recorded in vicinity of the site, an otter holt was recorded at the top of the peaty embankment adjoining the pipe culvert (ITM 650601, 733322; **Plate 4.15**). The presence of cobwebs at the entrance to this burrow would indicate a lack of recent utilisation.

² The species is highly tolerant of low oxygen conditions and is often found in very shallow channels exposed to seasonal flow pressures (Lewis et al., 1972).

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 an otter holt (potential breeding/resting area), the aquatic ecological evaluation of site C3 was of **local importance (higher value) (Table 4.4)**.



Plate 4.14 Representative image of site C3 on the Coolcor Stream, September 2022



Plate 4.15 Otter holt excavated in sloping peat bank at site C3 on the Coolcor Stream, September 2022

4.1.15 Site C4 – Coolcor Stream, Coolcor

Site C4 was located on the Coolcor Stream (07C08) at a bog access track and potential electricity GCR option 2 crossing at a pumping station approx. 1.6km downstream of site C3. The lowland depositing stream (FW2) stream had been extensively straightened and deepened historically, with resulting steep trapezoidal banks (3m bankfull heights) and poor hydromorphology. The heavily modified, canalised stream averaged 5-6m and >1.5m deep at the time of survey. Deep glide and pool predominated with bidirectional flows regulated by a pumping station. As a result, the site was typically representative of a pond habitat with no flows. Deep areas near the pumping station exceeded 1.8m. Peat staining was very high at the time of survey. The bed comprised 100% deep peat with slumping of banks evident. This slumping contributed some mixed gravels and clay to the channel margins. Given high peat staining, macrophyte growth was limited with only very occasional water plantain and watercress. Aquatic bryophytes were not recorded. The steep margins supported narrow fringes of reed canary grass which often formed overhangs. The loose peaty loam banks were dominated by purple moor grass (*Molinia caerulea*), silverweed (*Potentilla anserina*), purple loosestrife, tormentil (*Potentilla erecta*) and scattered grey willow. The site was bordered by extensive areas of cutover bog (PB4).

Electro-fishing was not undertaken at site C4 given prohibitive depths of >1.5m and a soft bed (deep silt). With the exception of three-spined stickleback and ten-spined stickleback (recorded via sweep netting), site C4 was not of fisheries value given poor hydromorphology, heavy siltation and poor connectivity with superior downstream habitats. There was no suitability for salmonids given regulated flows and siltation pressures. There was some low suitability for European eel although connectivity issues would likely obstruct the species from passing upstream (west) of the pumping station. Suitability for white-clawed crayfish was low 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 **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 C4 was of **local importance (lower value) (Table 4.4)**.



Plate 4.16 Representative image of site C4 on the Coolcor Stream, September 2022

4.1.16 Site C5 – Coolcor Stream, Coolcor

Site C5 was located on the Coolcor Stream (07C08) at the R400 road and potential electricity GCR option 3 crossing, approx. 1.7km downstream of site C4. The lowland depositing stream (FW2) stream had been extensively straightened historically, with resulting poor hydromorphology. The heavily modified, canalised stream averaged 2-2.5m wide and 0.4-0.6m deep with banks of 1.5m in height. Peat staining was high at the time of survey. The U-shaped channel had a deep silt base with high levels of terrestrial encroachment. The site featured abundant fool's watercress and intermittent stands of branched bur reed. No aquatic bryophytes were recorded. The scrubby channel margins supported purple loosestrife, hedge bindweed, reed canary grass and nettle. The channel was bordered by heavily improved pasture (GA1).

With the exception of three-spined stickleback, recorded in low densities (**Appendix A**), the site was not of fisheries value given historical modifications, poor hydromorphology, low flows and heavy siltation. There was no suitability for white-clawed crayfish 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 C5 was of **local importance (lower value) (Table 4.4)**.



Plate 4.17 Representative image of site C5 on the Coolcor River, September 2022

4.1.17 Site C6 – Clonin Stream, Coolcor

Site C6 was located on the uppermost reaches of the Clonin Stream (07C74) at the R400 road and potential electricity GCR option 3 crossing. The Castlejordan River tributary was dry at the time of survey with no aquatic species or habitats present. The ephemeral stream represented a historically straightened and deepened U-shaped drainage channel (FW4), 2m wide and with 1m bank heights. The site was bordered by heavily improved pasture (GA1). Site C6 was not of fisheries value given the ephemeral nature of the channel. For this reason 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 C6 was of **local importance (lower value) (Table 4.4)**.



Plate 4.18 Representative image of site C6 on the Clonin Stream (dry, ephemeral channel)

4.1.18 Site C7 – Yellow River, Clongall Bridge

Site C7 was located on the Yellow River (07Y02) at Clongall Bridge, >9km downstream of site C2. The lowland depositing river (FW2) had been extensively deepened and straightened historically with a resulting trapezoidal profile and bank heights of 6-8m. Nonetheless, the river retained some good semi-natural characteristics. The river averaged 8-10m wide and 0.6-1.3m deep. The profile was of deep swift-flowing glide with localised riffle and deep pool. The substrata were dominated by small boulder, cobble and gravels which were heavily bedded. Siltation was moderate. The site supported abundant branched bur-reed, common club rush (*Schoenoplectus lacustris*) and lesser water-parsnip along river margins. Fool's watercress was frequent and occasional water mint was also present. The liverwort species endive pellia was frequent on submerged boulder and cobble. The moss species *Fontinalis antipyretica* and *Leptodictyum riparium* were recorded as occasional. The riparian areas supported abundant reed canary grass, great willowherb, meadowsweet, iris, hedge bindweed and thistles with scattered grey willow, white willow (*Salix alba*) and hawthorn. The site was bordered by heavily improved pasture (GA1) with narrow riparian zones.

A total of six fish species were recorded via electro-fishing at site C7, namely Atlantic salmon (*Salmo salar*), brown trout, lamprey (*Lampetra* sp.), European eel, stone loach and minnow (**Appendix A**). This was the only survey site found to support Atlantic salmon. The site was a good salmonid nursery with swift flowing glide habitat and abundant boulder and cobble refugia. Spawning habitat was of moderate quality overall given limited gravels and dominance of boulder and cobble. Good quality holding habitat was present given abundant deep glide and pool in addition to overhanging vegetation and scoured banks. Whilst some good quality lamprey nursery habitat was present, soft sediment areas only supported a very low density of ammocoetes. Suitability for European eel was very high given abundant refugia, with a single adult recorded. Despite some high suitability for white-clawed crayfish, none were recorded. However, eDNA sampling detected the species at this site, alongside crayfish plague (*Aphanomyces astaci*) (**Table 4.1**). No otter signs were recorded in vicinity of the site although this likely reflected a paucity of marking opportunities.

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 (including Atlantic salmon), lamprey (*Lampetra* sp.) and European eel, the aquatic ecological evaluation of site C7 was of **local importance (higher value) (Table 4.4)**.



Plate 4.19 Representative image of site C7 on the Yellow River at Clongall Bridge, September 2022

4.1.19 Site D1 – unnamed stream, Rathcobican

Site D1 was located on an unnamed stream at the R400 road and potential electricity GCR option 3 crossing, approx. 0.5km upstream of the Road River confluence. The stream was dry at the time of survey with no aquatic species or habitats present. The ephemeral stream represented a historically straightened and deepened U-shaped drainage channel (FW4), 1m wide and with 1m bank heights. The mud-based channel was lined by mature hedgerows of hawthorn and blackthorn (*Prunus spinosa*). The site was bordered by residential properties and heavily improved pasture (GA1). Site D1 was not of fisheries value given an absence of aquatic habitats.

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

Due to the ephemeral nature of the channel, the aquatic ecological evaluation of site D1 was of **local importance (lower value) (Table 4.4)**.



Plate 4.20 Representative image of site D1 on an unnamed stream, August 2022 (dry channel)

4.1.20 Site D2 – Road River, Rathcobican

Site D2 was located on the Road River (14R53) at a potential electricity GCR option 3 crossing. The lowland depositing river (FW2) had been extensively straightened historically with resulting poor hydromorphology. The canalised channel averaged 1-1.5m wide with stagnant pools of 0.2-0.4m deep at the time of survey (i.e. no flows). The substrata comprised exclusively deep silt and the channel was very heavily vegetated. Fool's watercress and invasive least duckweed (*Lemna minuta*) were abundant. Terrestrial encroachment of herbaceous vegetation was high with abundant purple loosestrife, great willowherb, hedge bindweed and reed sweet grass (*Glyceria maxima*) in the channel. The riparian areas were predominantly open with scattered willow. The site was bordered by heavily improved pasture (GA1).

Apart from three-spined stickleback (recorded at low densities), site D2 was not of fisheries value given poor hydromorphology, heavy siltation and poor connectivity with superior downstream habitats. There was no suitability for white-clawed crayfish and the species was not recorded during the survey. No otter signs were recorded in vicinity of the site.

Biological water quality, based on Q-sampling, was calculated as **Q2 (bad 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 bad status water quality, the aquatic ecological evaluation of site D2 was of **local importance (lower value) (Table 4.4)**.



Plate 4.21 Representative image of site D2 on the Road River, August 2022

4.1.21 Site D3 – Esker Stream, Newtown Bridge

Site D3 was located on the Esker Stream (14E01) at Newtown Bridge. The semi-natural lowland depositing watercourse (FW2) had been historically widened and averaged 4-7m wide (10m wide channel) and 0.1-0.3m deep. The profile was dominated by shallow glide with no riffle habitat present due to very low summer flows at the time of survey. Pool habitat was localised and associated with meanders. The substrata were dominated by small boulder, cobble and coarse gravels which were moderately bedded and heavily silted. Macrophyte cover was high with abundant common duckweed and ivy-leaved duckweed. The site also supported frequent narrow fruited-watercress (*Nasturtium microphyllum*) and lesser water parsnip with occasional blue water-speedwell. The site also supported occasional water starwort (*Callitriche* sp.), broad-leaved pondweed and yellow water lily (*Nuphar lutea*). The moss *Fontinalis antipyretica* was occasional on larger boulder. Filamentous algal cover was also high with c.70% of the bed covered by *Cladophora glomerata*. The riparian areas supported mature ash, grey willow and blackthorn with bramble understories. The site was bordered by heavily improved pasture (GA1).

Brown trout, minnow, stone loach and invasive dace (*Leuciscus leuciscus*) were recorded via electro-fishing at site D3 (**Appendix A**). The site was a moderate quality salmonid nursery, being degraded due to historical drainage, siltation and enrichment. Some moderate quality spawning habitat (for both salmonids and lamprey) was present but was also reduced in quality due to filamentous algae and sedimentation. Holding habitat for adult salmonids was present but localised. Although some suitability existed for larval lamprey, none were recorded via targeted electro-fishing of soft sediment deposits. Despite good suitability for European eel and white-clawed crayfish, none were recorded. Environmental DNA analysis did not detect crayfish at this site (**Figure 4.1**). Despite some foraging suitability, 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**). 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 a brown trout population and semi-natural supporting habitat, the aquatic ecological evaluation of site D3 was of **local importance (higher value)** (Table 4.4).



Plate 4.22 Representative image of site D3 on the Esker Stream at Newtown Bridge, September 2022

4.1.22 Site E1 – Rochford Demesne Stream, Kilbrennan

Site E1 was located on the upper reaches of the Rochford Demesne Stream (25R11) at the L1127 road and potential gas pipeline route option 1 crossing, approx. 3.6km upstream of the Lough Ennell confluence. The lowland depositing watercourse (FW2) had been heavily modified (straightened and deepened) resulting in a canalised channel more representative of a U-shaped drainage channel than a stream. The channel averaged 2-3m wide and 0.2-0.4m deep with a near imperceptible flow at the time of survey. The profile was of very slow-flowing homogenous glide. The substrata comprised scattered, superficial gravels heavily bedded in deep peat. Common duckweed was abundant and covered >75% of the water's surface. Branched bur-reed was occasional. No aquatic bryophytes were recorded. The riparian areas were predominantly open but supported scattered gorse, bramble, grey willow, ash and hazel (*Corylus avellana*). The site was bordered by improved pasture (GA1).

With the exception of three-spined stickleback, recorded in low densities (**Appendix A**), the site was not of fisheries value given historical modifications, poor hydromorphology, poor connectivity with downstream habitats, low flows and very heavy siltation. There was no suitability for white-clawed crayfish. 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 absence of aquatic species or habitats of higher conservation value, in addition to poor status water quality, the aquatic ecological evaluation of site E1 was of **local importance (lower value)** (Table 4.4).



Plate 4.23 Representative image of site E1 on the Rochford Demesne Stream, September 2022

4.1.23 Site E2 – Rochfort Demesne Stream, Stoneford Bridge

Site E2 was located on the Rochford Demesne Stream (25R11) at Stoneford Bridge, approx. 1.6km downstream of site E1 and 2km upstream of the Lough Ennell confluence. The lowland depositing watercourse (FW2) had been heavily modified (straightened and deepened) resulting in a deep U-shaped profile. The channel averaged 4m wide and 0.2-0.2m deep. The profile was of slow-flowing glide with very localised riffle and pool. The substrata were dominated by cobble and mixed gravels which were heavily bedded and silted. Common duckweed was locally abundant (10% cover). Watercress and fool's watercress were frequent. No aquatic bryophytes were recorded. Filamentous algal was also low due to riparian shading. The margins supported frequent reed canary grass and great willowherb. The riparian areas supported mature sycamore and hawthorn with dense bramble in the understories. The site was bordered by heavily improved pasture (GA1).

Brown trout and three-spined stickleback were the only fish species recorded via electro-fishing at site E2 (**Appendix A**). The site was a moderate quality salmonid nursery, supporting a moderate density of juvenile trout, with some moderate quality spawning habitat also present. However, the value was considerably reduced due to historical drainage, siltation and enrichment pressures. The shallow site was a poor quality holding habitat for adult salmonids. The site was also of poor quality for lamprey ammocoetes in terms of burial habitat given limited areas of organic-rich silt and limited suitable spawning areas. Despite some moderate suitability for European eel and white-clawed crayfish, none were recorded. 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 E2 was of **local importance (lower value)** (Table 4.4).



Plate 4.24 Representative image of site E2 on the Rochford Demesne Stream, September 2022

4.1.24 Site X1 – Gallstown River, Gortumly

Site X1 was located on the Gallstown Stream (07G36) at the R400 and potential gas pipeline route option 2 crossing. The lowland depositing river channel (FW2) had been historically straightened and deepened resulting in a trapezoidal channel with poor hydromorphology. The stream averaged 2m wide and 0.1-0.2m deep with 1.5m high banks and was stagnant at the time of survey (i.e. no flows). Peat staining was high. The substrata comprised deep, humic silt (peat derived) with no hard substrata. The site was very heavily vegetated with abundant fool's watercress. No aquatic bryophytes were recorded. The channel margins supported mature ash, sycamore, hawthorn and downy birch with bramble, ivy and nettle in the understories. The site was bordered by heavily improved pasture (GA1).

With the exception of three-spined stickleback, recorded in low densities (**Appendix A**), the site was not of fisheries value given historical modifications, poor hydromorphology, poor connectivity with downstream habitats, low flows and very heavy siltation. There was no suitability for white-clawed crayfish. 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 absence of aquatic species or habitats of higher conservation value, in addition to poor status water quality, the aquatic ecological evaluation of site X1 was of **local importance (lower value)** (Table 4.4).



Plate 4.25 Representative image of site X1 on the Gallstown River, September 2022

4.1.25 Site X2a – Derry River, Rahanine

Site X2a was located on the Derry River (07D28) at the R400 and potential gas pipeline route option 2 crossing. The lowland depositing river channel (FW2) had been historically straightened and deepened resulting in a trapezoidal channel with poor hydromorphology. The heavily modified river averaged 2-2.5m wide and 0.1-0.2m deep with 2-3m high banks. The channel was stagnant at the time of survey (i.e. no flows). Peat staining was high. The substrata comprised deep, humic silt (peat derived) with superficial mixed gravels. The river was heavily tunnelled and this precluded the presence of macrophytes and aquatic bryophytes. The channel was lined by mature lime (*Tilia* sp.), hawthorn and grey willow with a dense bramble understory. The site was bordered by heavily improved pasture (GA1) and amenity grassland (GA2) of a residential property. There was no visible connection with the Rochfortbridge Stream west of the R400 (site X2b), albeit the drainage connection could be overgrown with vegetation and likely runs perpendicular under the R400.

Site X2a was not suitable for electro-fishing due to seasonal flows (**Appendix A**). The site was not of fisheries value given historical modifications, poor hydromorphology, poor connectivity with downstream habitats, very limited water and heavy siltation. There was no suitability for white-clawed crayfish. No otter signs were recorded in vicinity of the site.

Biological water quality, based on Q-sampling, was calculated as **Q2 (bad 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 bad status water quality, the aquatic ecological evaluation of site X2a was of **local importance (lower value)** (Table 4.4).



Plate 4.26 Representative image of site X2a on the Derry River, September 2022

4.1.26 Site X2b – Rochfortbridge Stream, Rahanine

Site X2b was located on the Rochfortbridge Stream (07R04) adjoining the R400 road and potential gas pipeline route option 2 crossing, approx. 2.1km downstream of site A1. The lowland depositing river (FW2) had been historically realigned along the border of the R400 and adjoining improved grassland (GA1), resulting in a U-shaped channel with poor hydromorphology. Bank heights were 3m. The river averaged 3m wide and 0.5-1m deep with an imperceptible flow at the time of survey (i.e. stagnant). The profile was of stagnant glide and pool (no riffle). The substrata comprised soft silt with superficial mixed gravels. The channel had a bed of soft silt and mixed gravels. The site was very heavily vegetated with abundant fool's watercress, branched bur-reed, great willowherb and very localised water mint. The channel was lined by an intermittent treeline of hawthorn, downy birch and grey willow. The site was bordered by heavily improved pasture (GA1).

With the exception of three-spined stickleback, recorded in low densities (**Appendix A**), the site was not of very poor fisheries value given historical modifications, poor hydromorphology, poor connectivity with downstream habitats, low flows and very heavy siltation. However, there was some low suitability for European eel and white-clawed crayfish (none 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 absence of aquatic species or habitats of higher conservation value, in addition to poor status water quality, the aquatic ecological evaluation of site X2b was of **local importance (lower value)** (Table 4.4).



Plate 4.27 Representative image of site X2b on the Derry River, September 2022

4.1.27 Site X3 – Yellow River, Derrygreenagh

Site X3 was located on the Yellow River (07Y02) at a potential electricity GCR option 1 crossing approx. 0.3km upstream of site C1. The lowland depositing river (FW2) had been extensively deepened historically, resulting in an over-deepened U-shaped channel with 4-6m bank heights and poor hydromorphology. The river averaged 6m wide (but up to 10m in places) and 0.3-1m deep, with locally deeper pool to 1.5m. The profile comprised deep, slow-flowing glide and localised deep pool (no riffles). The substrata were dominated by sand with localised gravel and small boulder. Branched bur-reed was frequent with more localised watercress and fool's watercress. The site also supported occasional bog pondweed (*Potamogeton polygonifolius*) and frequent small pondweed. The moss species *Leptodictyum riparium* was present locally alongside the liverwort species endive pellia. The margins supported dense scrub comprised of bramble, gorse, thistle, meadowsweet and rosebay willowherb on steep embankments. The site was bordered by extensive cutover bog (PB4).

Brown trout, minnow and pike were recorded via electro-fishing at site X3 (**Appendix A**). The site was a moderate quality salmonid nursery, supporting a low density of juveniles. This reflected the hydromorphological modifications. However, some moderate quality spawning habitat was present for both salmonids and lamprey. The site of good value as an adult salmonid holding habitat with deeper pools and glide being abundant. Soft sediment accumulations were humic in nature and

unsuitable for lamprey ammocoetes (none recorded). Despite some moderate suitability for European eel and white-clawed crayfish, none were recorded. However, crayfish remains were identified in otter spraint at the culvert crossing upstream of the survey area (ITM 649643, 736505).

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 salmonids and utilisation by otter, the aquatic ecological evaluation of site X3 was of **local importance (higher value) (Table 4.4)**.



Plate 4.28 Representative image of site X3 on the Yellow River, September 2022

4.1.28 Site X4 – Grand Canal, Coole

Site X4 was located on the Grand Canal at a Bord na Móna lifting bridge and a potential electricity GCR option 1 crossing. The canal (FW3) averaged 15m wide and 1-1.5m deep with a slightly deeper central (navigation) channel. The bed comprised soft silt (with a high clay fraction). Boulder and cobble was present occasionally along the margin. Although the canal in vicinity of the bridge had been recently cleared of vegetation (for navigation purposes), the site supported a high cover of macrophytes with frequent invasive Nuttall's pondweed, stonewort (*Chara* sp.) and yellow lily. Spiked water-milfoil (*Myriophyllum spicatum*) and ivy-leaved duckweed was occasional. The invasive macrophyte New Zealand pygmyweed (*Crassula helmsii*) was recorded as occasional in the shallow margins alongside water plantain. Mare's-tail was present but rare. Linear stands of branched bur-reed and common reed (*Phragmites australis*) lined the margins. Filamentous algal mats were also present. Aquatic bryophytes were not recorded. The narrow riparian fringes supported bracken, bramble, meadowsweet, scattered willow and downy birch with rank grasses. The site was bordered by cutover bog (PB4) with localised areas of improved grassland (GA1) and willow-dominated woodland (WN7).

Electro-fishing was not undertaken at site X4 given prohibitive depths and inherent unsuitability (i.e. canal site). However, a fisheries appraisal was undertaken. Site X4 was of high value for coarse fish species with abundant nursery and spawning habitat present given abundant macrophyte cover. Species such as roach and perch were visibly abundant in vicinity of the bridge. The site was also highly suitable as a European eel habitat and provided high quality otter foraging habitat. Suitability for white-clawed crayfish in this area was high although the species is not known from the western extent of the waterway.

The canal site was not suitable for biological water quality assessment via Q-sampling. However, a composite sweep sample was taken to gain a representation of the macro-invertebrate community. No macro-invertebrate species of conservation value greater than 'least concern', according to national red lists, were recorded (**Appendix B**).

Given the location of the site within the Grand Canal pNHA (002104), the aquatic ecological evaluation of site X4 was of **national importance (Table 4.4)**. The site was also of high value for Red-listed European eel and a range of coarse fish species.



Plate 4.29 Representative image of site X4 on the Grand Canal, September 2022

4.1.29 Site X5 – Grand Canal, Toberdaly

Site X5 was located on the Grand Canal at a potential electricity GCR option 1 crossing, approx. 0.8km downstream of site X4. The canal (FW3) averaged 15-18m wide and 1.2-1.6m deep with a slightly deeper central (navigation) channel. The bed comprised soft silt (with a high clay fraction). Boulder and cobble was present occasionally along the margin. Although the canal had been recently cleared of vegetation (for navigation), the site supported a high cover of macrophytes with abundant invasive Nuttall's pondweed and frequent spiked-water milfoil. The invasive macrophyte New Zealand

pygmyweed was recorded as occasional. Yellow lily and water plantain were also occasional, with rare broad-leaved pondweed, bulrush (*Typha latifolia*), amphibious bistort (*Persicaria amphibia*), fennel pondweed (*Stuckenia pectinata*) and water horsetail (*Equisetum fluviatile*). Linear stands of branched bur-reed and common reed lined the margins. Filamentous algal mats were also present. Aquatic bryophytes were not recorded. The narrow riparian fringes supported herbaceous species such as purple loosestrife, meadowsweet, common reed and scattered alder with a mature sycamore, alder, ash, grey willow, downy birch and hawthorn treeline on the south bank.

Electro-fishing was not undertaken at site X4 given prohibitive depths and inherent unsuitability (i.e. canal site). However, a fisheries appraisal was undertaken. Site X4 was of high value for coarse fish species with abundant nursery and spawning habitat present given abundant macrophyte cover. Species such as roach and perch were visibly abundant in vicinity of the bridge. The site was also highly suitable as a European eel habitat and provided high quality otter foraging habitat. Suitability for white-clawed crayfish in this area was high although the species is not known from the western extent of the waterway.

The canal site was not suitable for biological water quality assessment via Q-sampling. However, a composite sweep sample was taken to gain a representation of the macro-invertebrate community. The diving water beetle dinghy skipper (*Laccophilus hyalinus*) was recorded in the sweep sample. This species is listed as 'vulnerable' in Ireland (Foster et al., 2009). No other macro-invertebrate species of conservation value greater than 'least concern', according to national red lists, were recorded (**Appendix B**).

Given the location of the site within the Grand Canal pNHA (002104), the aquatic ecological evaluation of site X5 was of **national importance (Table 4.4)**. The site was also of high value for Red-listed European eel, otter and supported the IUCN vulnerable dinghy skipper diving beetle.



Plate 4.30 Representative image of site X5 on the Grand Canal, September 2022

4.1.30 Site X6 – Toberdaly Stream, Toberdaly

Site X6 was located on the Toberdaly Stream (14T28) at a potential electricity GCR option 1 crossing adjacent to the Grand Canal (site X5). The lowland depositing stream (FW2) had been extensively realigned, straightened and deepened, flowing parallel to the Grand Canal Greenway, resulting in a trapezoidal channel with very poor hydromorphology. The stream averaged 2m wide and 0.5m deep with homogenous slow-flowing glide. The substrata comprised compacted clay and cobble that was heavily silted (peat-derived). The channel was heavily vegetated with abundant fool's watercress with occasional watercress and branched bur-reed with rare water starwort (*Callitriche* sp.). The margins supported narrow fringes of common reed. The trapezoidal slopes supported abundant reed canary grass, great willowherb, hedge bindweed and nettle with scattered bramble. The site was bordered by the Grand Canal and improved pasture (GA1).

With the exception of three-spined stickleback, recorded in low densities (**Appendix A**), the site was not of fisheries value given historical modifications, poor hydromorphology, low flows and heavy siltation. There was low suitability for white-clawed crayfish but 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 absence of aquatic species or habitats of higher conservation value, in addition to poor status water quality, the aquatic ecological evaluation of site X6 was of **local importance (lower value) (Table 4.4)**.



Plate 4.31 Representative image of site X6 on the Toberdaly Stream, September 2022

4.1.31 Site X7 – Toberdaly Stream, Toberdaly

Site X7 was located on the Toberdaly Stream (14T28) south of the Grand Canal at the potential electricity GCR option 1 crossing. As outlined above, the stream had been evidently realigned and the section south of the channel did not appear hydrologically connected with that surveyed at site X6. The stream at this location was dry at the time of survey. The ephemeral U-shaped channel had been extensively straightened and deepened, with a 2m wide channel and banks of up to 1.5m high. The channel was heavily shaded by birch-willow woodland (WN7) and bramble-dominated scrub (WS1) and did not support macrophytes or aquatic bryophytes. The site was bordered by semi-improved pasture with mosaics of species-poor wet grassland (GS4).

Site X7 was not of fisheries value given an absence of water in the channel (i.e. ephemeral nature). 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 X7 was of **local importance (lower value) (Table 4.4)**.



Plate 4.32 Representative image of site X7 on the Toberdaly Stream, September 2022 (dry, ephemeral channel)

4.2 White-clawed crayfish survey

No white-clawed crayfish were recorded via hand-searching or sweep netting of instream refugia during the survey in August-September 2022. However, crayfish remains were identified in otter spraint recorded on the Kiltonan River (aka. Mongagh River) at site A3 and the Yellow River at site X3.

White-clawed crayfish eDNA was also detected in the water sample collected from the Yellow River at Clongall Bridge (site C7) (section 4.3 below).

4.3 eDNA analysis

White-clawed crayfish eDNA was only detected in the composite water sample collected from the Yellow River at Clongall Bridge (site C7) (1 positive qPCR replicates out of 12, respectively) (**Table 4.1; Appendix D**). This result was considered as evidence of the species' presence at and or upstream of the sampling location. White-clawed crayfish were not detected in samples from the Kinnegad River sample (site B3), Esker River (site D3) or Rochfort Demesne Stream (site E2).

Site C7 on the Yellow River also tested positive for crayfish plague (*Aphanomyces astaci*) (10 positive qPCR replicates out of 12) (**Table 4.1**). Crayfish plague was not detected at the Kinnegad River, Esker River or Rochfort Demesne Stream sampling sites.

Table 4.2 eDNA results in the vicinity of the proposed Derrygreenagh Power development, Co. Westmeath (positive qPCR replicates out of 12 in parentheses)

Sample	Watercourse	White-clawed crayfish	Crayfish plague
FK769	Kinnegad River (site B3)	Negative (0/12)	Negative (0/12)
FK783	Yellow River (site C7)	Positive (1/12)	Positive (10/12)
FK781	Esker Stream (site D3)	Negative (0/12)	Negative (0/12)
FK768	Rochfort Demesne Stream (site E2)	Negative (0/12)	Negative (0/12)

4.4 Otter signs

A total of $n=8$ otter signs were recorded across 4 no. survey sites during aquatic surveys undertaken in August and September 2022. Spraint sites were recorded on the Kiltonan Stream (site A3), Yellow River (X3) and Milltownpass River (A8).

Site A8 also supported a heavily used latrine and couch (ITM 652521, 742386). An otter holt was recorded at the top of the peaty embankment adjoining the pipe culvert at site C3 on the Coolcor Stream (ITM 650601, 733322).

4.5 Invasive aquatic species

The invasive macrophyte New Zealand pigmyweed (*Crassula helmsii*) was abundant at sites X4 and X5 on the Grand Canal. The plant is considered a high-risk invasive species in Ireland (O' Flynn et al., 2014)

and is listed on the Third Schedule of the European Communities (Birds and Natural Habitats) Regulations 2011-2021 (S.I. 477/2011). This species is known from the Grand Canal (NBDC data).

The invasive macrophyte Nuttall's pondweed (*Elodea nuttallii*) was recorded at sites on the Castlejordan River (A6) and an unnamed tributary (A5), as well as the Grand Canal at sites X4 and X5. The species is widespread in Ireland (naturalised) and is listed on the Third Schedule of the European Communities (Birds and Natural Habitats) Regulations 2011-2021 (S.I. 477/2011). Nuttall's pondweed is considered a high-risk invasive species in Ireland (O' Flynn et al., 2014)

Least duckweed (*Lemna minuta*) was recorded (abundant) at site D2 on the Road River. The floating macrophyte is considered a medium impact species (O'Flynn et al., 2014).

Dace (*Leuciscus leuciscus*) are an invasive cyprinid species in Ireland (O'Flynn et al., 2014) and have been present in the River Barrow since 1992 (Caffrey et al., 2007). The species is now firmly established throughout the River Barrow catchment including the upper reaches and was recorded (via electro-fishing) at site D3 on the Esker Stream.

Roach (*Rutilus rutilus*) is a widespread medium impact invasive fish species in Ireland (O'Flynn et al., 2014) listed on the Third Schedule of the European Communities (Birds and Natural Habitats) Regulations 2011-2021 (S.I. 477/2011). It was recorded via electro-fishing at site A4 on the Kiltonan Stream and A5 on an unnamed stream (both tributaries of the Castlejordan/Mongagh River). Roach are also known to be present in the Grand Canal and were observed at sites X4 and X5 during the survey.

Environmental DNA analysis detected the non-native pathogen crayfish plague (*Aphanomyces astaci*) in the Yellow River at site C7 (Clongall Bridge) (**Table 4.1**; see section 4.3 above).

4.6 Biological water quality (macro-invertebrates)

The diving water beetle dinghy skipper (*Laccophilus hyalinus*) was recorded in the sweep sample from site X5 on the Grand Canal. This species is listed as 'vulnerable' in Ireland (Foster et al., 2009). No rare or protected macro-invertebrate species (according to national red lists) were recorded in the biological water quality samples taken from the remaining sampling sites in July 2022 (**Appendix A**).

None of the 27 no. sample sites achieved **Q4 (good status)** water quality and thus all 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 4.2**). This was given the absence of at least one pollution-sensitive group A taxa in fair numbers (5% of total abundance) (**Appendix B**).

A total of 3 no. sites on the Kiltonan Stream (A3), Castlejordan River (A6) and Yellow River (C2) achieved **Q3-4 (moderate status)** water quality. This was given the low numbers (<5%) of group A species, namely the stoneflies *Nemurella picteti* (A3), *Protonemura meyeri* (C2) and Heptageniidae mayfly (A6). These sites also supported a low number of group B species such as the mayfly *Alainites muticus* in addition to a dominance of pollution-tolerant group C species such as the mayflies *Baetis rhodani* and *Seratella ignita* and freshwater shrimp (*Gammarus duebeni*) (**Appendix B**).

A total of 20 no. sites on the Rochfortbridge Stream (A1, X2b), Castlejordan River (A2) and unnamed

tributary (A5), Kiltonan Stream (A4), Milltownpass River (A8), Kinnegad River (B1, B3), Hightown River (B2), Yellow River (C1, C7, X3), Coolcor Stream (C3, C4, C5), Esker Stream (D3), Rochfort Demesne Stream (E1, E2), Gallstown River (X1) and Toberdaly Stream (X6) achieved **Q2-3 or Q3 (poor status)** based on an absence of group A species; low numbers or an absence of group B species and a dominance of group C species, particularly *Baetis rhodani*, *Gammarus duebeni* and Corixid species (**Appendix B**). Sites were reduced to the intermediate **Q2-3** rating where there was a greater proportion of pollution-tolerant group D species such as freshwater hoglouse (*Asellus aquaticus*) and the wandering snail (*Ampullacaena balthica*) (**Appendix B**). It should be noted that half of these ratings (i.e. sites A4, B3, C3, C4, C5, E1, E2, X1, X2b & X6) were tentative due to low summer flows and or a lack of suitable riffle areas for sampling (Toner et al., 2005).

Sites D2 on the Road River and X2a on the Derry River achieved **Q2 (bad status)** given a dominance of group D taxa. However, both ratings were also tentative due to poor flows (i.e. absence of riffle-glide habitat).

4.7 Physiochemical water quality

Physiochemical water quality samples were collected from a subset of 14 no. sites in September 2022 (i.e. sites A2, A3, A6, A8, B3, C2, C4, C7, D3, E2, X2b, X3, X4 & X5). The results of the laboratory analysis are summarised below and provided in full in **Appendix C**.

The pH levels of the sample sites ranged from 7.53 to 8.14, reflecting the calcareous influences within the survey area. Similarly, calcareous influences resulted in high alkalinity (>100mg CaCO₃) at all sites, with the exception of the heavily modified site C4 on the Coolcor Stream (moderate alkalinity).

Apart from sites A6 (Castlejordan River), A8 (Milltownpass River) and C4 (Coolcor Stream) all sampling sites met the good status targets for total ammonia (i.e. ≤0.040 mg N/l) as set out under the European Union Environmental Objectives (Surface Waters) (Amendment) Regulations 2019 (S.I. No. 77/2019). Total ammonia levels at sites A6 (0.41mg N/l) and A8 (0.421mg N/l) were elevated with the level at site C4 especially high (1.668 mg N/l) (**Appendix C**).

Levels of total oxidised nitrogen (TON) were typically moderate at the riverine sites sampled, ranging from 0.978 to 2.670mg N/l. Levels were low (<0.010mg N/l) on both Grand Canal sites (A4 & X5) (**Appendix C**). TON is comprised mainly of nitrate (N as NO₃) given that the concentration of nitrite is typically negligible (O'Boyle et al., 2019). The European Union Environmental Objectives (Surface Waters) (Amendment) Regulations 2019 (S.I. 77 of 2019) sets no specific boundary conditions for nitrate. However, EPA assessment of high-quality water sources has set boundary conditions of 0.8mg/l NO₃-N (nitrate as nitrogen) for high quality waters and 1.8mg/l NO₃-N for good quality waters. Thus, with the exception of sites A2 (Castlejordan River) and A3 (Kiltonan Stream) (both >2mg N/l), all sampling sites fell within accepted parameters for good quality water based on TON levels.

The majority of riverine sampling sites showed low levels of Levels of Molybdate Reactive Phosphorus (MRP) (the amount of phosphorus bioavailable for plant uptake) (i.e. ≤0.0239 mg P/l) and thus complying with the Surface Water Regulations (S.I. 77 of 2019) good status target for rivers i.e. ≤0.035 mg P/l. However, sites A2 (0.050mg P/l), D3 (0.052mg/l) and X2b (0.050mg P/l) exceeded this threshold (**Appendix C**). Both Grand Canal sites (X4 and X5) met the good status target (<0.025mg P/l) for total phosphorus (**Appendix C**).

Biochemical oxygen demand (BOD) levels were typically low across the riverine sampling sites, with most sites meeting the good status threshold of $\leq 1.5 \text{ mg O}_2/\text{l}$ as set out under the European Union Environmental Objectives (Surface Waters) (Amendment) Regulations 2019 (S.I. No. 77/2019). However, BOD was significantly elevated at sites B3 (6.8 mg O₂/l) and C4 (5.8 mg O₂/l) (**Appendix C**). Higher BOD levels are indicative of some form of pollution and reduce the dissolved oxygen available for aquatic biota. However, slow-flowing waters (such as modified watercourses) often feature higher BOD levels for a given volume of organic and inorganic material than in faster-flowing, highly aerated waters.

Apart from sites B3 (50.5mg/l) and C4 (14.0mg/l), suspended solids were low across the sampling sites (**Appendix C**). Both of these sites had been historically modified and were heavily silted.

4.8 Macrophytes and aquatic bryophytes

No rare or protected macrophytes or aquatic bryophytes were recorded at the $n=31$ survey sites in August-September 2022. Similarly, no examples of Annex I aquatic vegetation habitats were recorded during the surveys.

4.9 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 4.4**).

Sites X4 and X5 on the Grand Canal were evaluated as **national importance** given their location within the Grand Canal pNHA (002104).

None of the remaining aquatic survey sites were evaluated as greater than **local importance (higher value)**. Of the remaining 29 no. survey sites, fifteen were evaluated as **local importance (higher value)**. These sites were present on the Rochfortbridge Stream (site A1), Kiltonan Stream (A3 & A4), unnamed stream (A5), Castlejordan River (A6), Milltownpass River (A8), Kinnegad River (B1, B3), Hightown River (B2), Yellow River (C1, C2, C7, X3), Coolcor Stream (C3) and the Esker Stream (D3). The **local importance (higher value)** evaluation was primarily due to the presence of salmonids, lamprey (*Lampetra* sp.) or other species of high conservation value such as otter (**Table 4.4**).

The remaining 14 no. sites were evaluated as **local importance (lower value)**. These sites of limited aquatic ecological value were situated on the Castlejordan River (A2), unnamed stream (A7), Coolcor Stream (C4, C5), Clonin Stream (C6), unnamed stream (D1), Road River (D2), Rochfort Demesne Stream (E1, E2), Gallstown Stream (X1), Derry River (X2a), Rochfortbridge Stream (X2b) and the Toberdaly Stream X6 & X7). Primarily their low aquatic ecological evaluation related to poor hydromorphology because of historical drainage pressures, their small size, poor flow regimes and the absence of aquatic species including fish and or habitats of high ecological value.

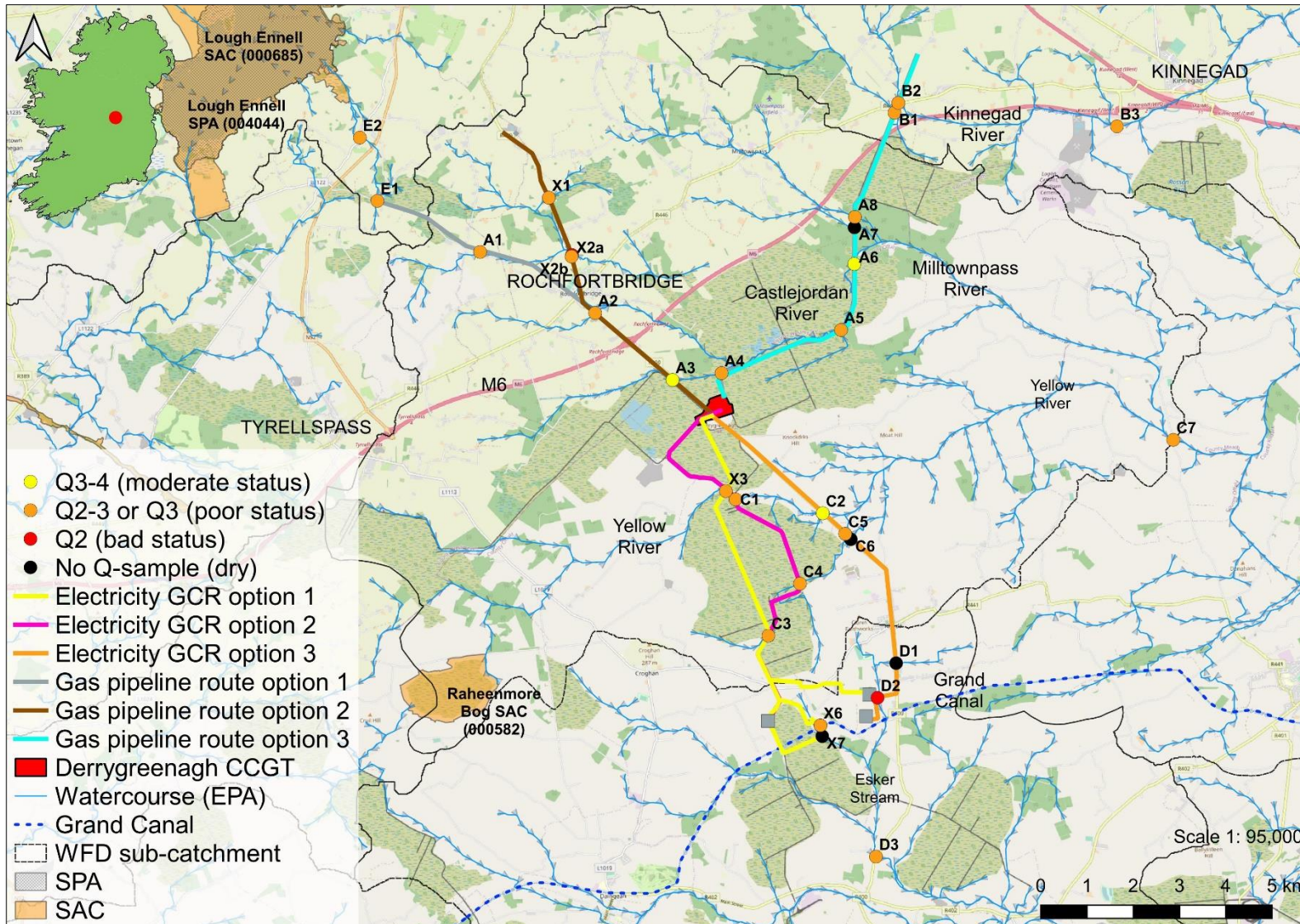


Figure 4.1 Overview of the biological water quality status in the vicinity of the proposed Derrygreenagh Power development, Co. Westmeath, Aug-Sept 2022

Table 4.2 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 Derrygreenagh Power development, August-September 2022

Site	Watercourse	Relative abundance				Other species
		Atlantic salmon	Brown trout	<i>Lampetra</i> sp.	European eel	
A1	Rochfortbridge Stream			Low		Three-spined stickleback
A2	Castlejordan River					Three-spined stickleback
A3	Kiltonan Stream			Low		Three-spined stickleback
A4	Kiltonan Stream		Low	Low		Three-spined stickleback, roach
A5	Unnamed stream			Low		Roach, perch, pike, gudgeon, minnow
A6	Castlejordan River		Low	Low		Stone loach, perch, pike
A7	Unnamed stream	No fish recorded (dry channel)				
A8	Milltownpass River		Medium	Medium		Pike
B1	Kinnegad River		Medium			Three-spined stickleback
B2	Hightown River		Medium			Three-spined stickleback, minnow
B3	Kinnegad River	No electro-fishing undertaken (too deep)				
C1	Yellow River		Low			Three-spined stickleback, pike, perch
C2	Yellow River		High			Stone loach
C3	Coolcor Stream					Three-spined stickleback, ten-spined stickleback
C4	Coolcor Stream	No electro-fishing undertaken (too deep)				
C5	Coolcor Stream					Three-spined stickleback
C6	Clonin Stream	No fish recorded (dry channel)				
C7	Yellow River	Medium	Medium	Low	Low	Stone loach, minnow
D1	Unnamed stream	No fish recorded (dry channel)				
D2	Road River					Three-spined stickleback
D3	Esker Stream		Medium			Dace, minnow, stone loach
E1	Rochfort Demesne Stream					Three-spined stickleback
E2	Rochfort Demesne Stream		Medium			Three-spined stickleback
X1	Gallstown Stream					Three-spined stickleback

Site	Watercourse	Relative abundance				Other species
		Atlantic salmon	Brown trout	<i>Lampetra</i> sp.	European eel	
X2a	Derry River	No fish recorded				
X2b	Rochfortbridge Stream					Three-spined stickleback
X3	Yellow River		Medium			Pike, minnow
X4	Grand Canal	n/a – fisheries appraisal only				
X5	Grand Canal	n/a – fisheries appraisal only				
X6	Toberdaly Stream					Three-spined stickleback
X7	Toberdaly Stream	No fish recorded (dry channel)				

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 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.

Table 4.3 Summary of aquatic species (**excluding fish**) and habitats of higher conservation value recorded in the vicinity of the proposed Derrygreenagh Power development, Co. Offaly & Co. Westmeath

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	Rochfortbridge Stream	None recorded	No signs	Not present	None recorded	None recorded	None recorded
A2	Castlejordan River	None recorded	No signs	Not present	None recorded	None recorded	None recorded
A3	Kiltonan Stream	None recorded but remains in otter spraint	Regular spraint site	Not present	None recorded	None recorded	None recorded
A4	Kiltonan Stream	None recorded	No signs	Not present	None recorded	None recorded	None recorded
A5	Unnamed stream	None recorded	No signs	Not present	None recorded	Dinghy skipper (<i>Laccophilus hyalinus</i>) (vulnerable; Foster et al., 2009)	None recorded
A6	Castlejordan River	None recorded	No signs	Not present	None recorded	None recorded	None recorded
A7	Unnamed stream	None recorded	No signs	Not present	None recorded	None recorded	None recorded
A8	Milltownpass River	None recorded	Regular spraint site, latrine & couch	Not present	None recorded	None recorded	None recorded
B1	Kinnegad River	None recorded	No signs	Not present	None recorded	None recorded	None recorded
B2	Hightown River	None recorded	No signs	Not present	None recorded	None recorded	None recorded
B3	Kinnegad River	None recorded; negative eDNA result at site	No signs	Not present	None recorded	None recorded	None recorded
C1	Yellow River	None recorded	No signs	Not present	None recorded	None recorded	None recorded
C2	Yellow River	None recorded	No signs	Not present	None recorded	None recorded	None recorded
C3	Coolcor Stream	None recorded	Holt	Not present	None recorded	None recorded	None recorded

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
C4	Coolcor Stream	None recorded	No signs	Not present	None recorded	None recorded	None recorded
C5	Coolcor Stream	None recorded	No signs	Not present	None recorded	None recorded	None recorded
C6	Clonin Stream	None recorded	No signs	Not present	None recorded	None recorded	None recorded
C7	Yellow River	None recorded but positive eDNA result at site	No signs	Not present	None recorded	None recorded	None recorded
D1	Unnamed stream	None recorded	No signs	Not present	None recorded	None recorded	None recorded
D2	Road River	None recorded	No signs	Not present	None recorded	None recorded	None recorded
D3	Esker Stream	None recorded; negative eDNA result at site	No signs	Not present	None recorded	None recorded	None recorded
E1	Rochfort Demesne Stream	None recorded	No signs	Not present	None recorded	None recorded	None recorded
E2	Rochfort Demesne Stream	None recorded; negative eDNA result at site	No signs	Not present	None recorded	None recorded	None recorded
X1	Gallstown Stream	None recorded	No signs	Not present	None recorded	None recorded	None recorded
X2a	Derry River	None recorded	No signs	Not present	None recorded	None recorded	None recorded
X2b	Rochfortbridge Stream	None recorded	No signs	Not present	None recorded	None recorded	None recorded
X3	Yellow River	None recorded but remains in otter spraint	Regular spraint site	Not present	None recorded	None recorded	None recorded
X4	Grand Canal	None recorded	No signs	Not present	None recorded	None recorded	None recorded
X5	Grand Canal	None recorded	No signs	Not present	None recorded	None recorded	None recorded
X6	Toberdaly Stream	None recorded	No signs	Not present	None recorded	None recorded	None recorded
X7	Toberdaly 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) is 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.

⁴ Otter signs within 150m of the survey site

Table 4.4 Aquatic ecological evaluation summary of the Derrygreenagh Power development survey sites according to NRA (2009) criteria

Site no.	Watercourse	EPA code	Evaluation of importance	Rationale summary
A1	Rochfortbridge Stream	07R04	Local importance (higher value)	Heavily modified, heavily silted lowland depositing stream with poor flows; <i>Lampetra</i> sp. & three-spined stickleback recorded via electro-fishing; Q3 (poor status) water quality
A2	Castlejordan River	07C04	Local importance (lower value)	Heavily modified, heavily silted lowland depositing stream with abundant aquatic vegetation, poor flows & poor aquatic value; three-spined stickleback recorded via electro-fishing; Q3 (poor status) water quality (tentative rating); no aquatic species or habitats of high conservation value
A3	Kiltonan Stream	07K04	Local importance (higher value)	Heavily modified, heavily silted & over-deepened lowland depositing river with evident enrichment; brown trout & three-spined stickleback recorded via electro-fishing; otter spraint site (with white-clawed crayfish remains) recorded; Q3-4 (moderate status) water quality
A4	Kiltonan Stream	07K04	Local importance (higher value)	Heavily modified, heavily vegetated & over-deepened lowland depositing river with evident enrichment; brown trout, <i>Lampetra</i> sp., roach & three-spined stickleback recorded via electro-fishing; Q2-3 (poor status) water quality
A5	Unnamed stream	n/a	Local importance (higher value)	Heavily modified, heavily silted & over-deepened lowland depositing stream with evident enrichment but of good value as coarse fish nursery; <i>Lampetra</i> sp., roach, minnow, perch, gudgeon & pike recorded via electro-fishing; Q3 (poor status) water quality (tentative rating)
A6	Castlejordan River	07C04	Local importance (higher value)	Semi-natural, historically modified lowland depositing river with heavy siltation and abundant aquatic vegetation; brown trout, <i>Lampetra</i> sp., perch, pike & stone loach recorded via electro-fishing; Q3-4 (moderate status) water quality
A7	Unnamed stream	n/a	Local importance (lower value)	Historically realigned channel with no aquatic species or habitats in vicinity of the survey site; no aquatic species or habitats of high conservation value
A8	Milltownpass River	07M04	Local importance (higher value)	Historically straightened and deepened lowland depositing river with abundant aquatic vegetation with evident enrichment & siltation pressures; brown trout, <i>Lampetra</i> sp. & pike recorded via electro-fishing; otter spraint site, latrine & couch recorded with potential holt area under bridge; Q3 (poor status) water quality
B1	Kinnegad River	07K01	Local importance (higher value)	Historically modified lowland depositing river with some good instream recovery; brown trout & three-spined stickleback recorded via electro-fishing; Q3 (poor status) water quality
B2	Hightown River	07H16	Local importance (higher value)	Historically modified lowland depositing river with some good instream recovery; brown trout, minnow & three-spined stickleback recorded via electro-fishing; Q3 (poor status) water quality
B3	Kinnegad River	07K01	Local importance (higher value)	Heavily modified, heavily silted, heavily vegetated & over-deepened lowland depositing river with evident enrichment & poor hydromorphology; electro-fishing not undertaken due to prohibitive depths (>1.3m) but of some value for European eel & coarse fish species; Q3 (poor status) water quality (tentative rating)

Site no.	Watercourse	EPA code	Evaluation of importance	Rationale summary
C1	Yellow River	07Y02	Local importance (higher value)	Heavily modified, heavily vegetated & over-deepened lowland depositing river with evident enrichment; brown trout, perch, pike & three-spined stickleback recorded via electro-fishing; Q3 (poor status) water quality (tentative rating)
C2	Yellow River	07Y02	Local importance (higher value)	Historically modified lowland depositing river with some good instream recovery and good salmonid nursery habitat; brown trout (high densities) & stone loach recorded via electro-fishing; Q3-4 (moderate status) water quality
C3	Coolcor Stream	07C08	Local importance (higher value)	Heavily modified, heavily silted, heavily vegetated & over-deepened lowland depositing stream with evident enrichment; ten-spined stickleback & three-spined stickleback recorded via electro-fishing; otter holt recorded on banktop; Q3 (poor status) water quality (tentative rating)
C4	Coolcor Stream	07C08	Local importance (lower value)	Heavily modified, heavily silted, heavily vegetated & over-deepened lowland depositing stream with evident enrichment and very poor hydromorphology/fluviial connectivity; electro-fishing not undertaken due to prohibitive depths (>1.5m) but ten-spined stickleback & three-spined stickleback recorded via sweep netting; Q2-3 (poor status) water quality (tentative rating); no aquatic species or habitats of high conservation value
C5	Coolcor Stream	07C08	Local importance (lower value)	Heavily modified, heavily vegetated & canalised lowland depositing river with very poor hydromorphology & poor aquatic value; three-spined stickleback recorded via electro-fishing; Q3 (poor status) water quality (tentative rating); no aquatic species or habitats of high conservation value
C6	Clonin Stream	07C74	Local importance (lower value)	Historically modified ephemeral channel with an absence of aquatic species or habitats at the time of survey
C7	Yellow River	07Y02	Local importance (higher value)	Historically modified & over-deepened lowland depositing river with some good recovery & very good salmonid nursery value; Atlantic salmon, brown trout, <i>Lampetra</i> sp. European eel, stone loach & minnow recorded via electro-fishing; Q3 (poor status) water quality
D1	Unnamed stream	n/a	Local importance (lower value)	Heavily modified, dry ephemeral channel with no aquatic value at the time of survey
D2	Road River	14R53	Local importance (lower value)	Heavily modified, heavily silted, heavily vegetated lowland depositing river with evident enrichment & poor hydromorphology; three-spined stickleback recorded via electro-fishing; Q2 (bad status) water quality (tentative rating); no aquatic species or habitats of high conservation value
D3	Esker Stream	14 E03	Local importance (higher value)	Historically modified, swift-flowing lowland depositing river with some good instream recovery and moderate quality salmonid habitat; brown trout, minnow, dace & stone loach recorded via electro-fishing; Q3 (poor status) water quality
E1	Rochfort Demesne Stream	25R11	Local importance (lower value)	Heavily modified, heavily vegetated & canalised lowland depositing stream with very poor hydromorphology & poor aquatic value; three-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
E2	Rochfort Demesne Stream	25R11	Local importance (lower value)	Historically modified lowland depositing stream with some instream recovery & moderate quality salmonid habitat; brown trout and three-spined stickleback recorded via electro-fishing; Q2-3 (poor status) water quality (tentative rating); no aquatic species or habitats of high conservation value
X1	Gallstown Stream	07G36	Local importance (lower value)	Heavily modified, heavily silted, heavily vegetated & over-deepened lowland depositing stream with poor flows & evident enrichment; three-spined stickleback recorded via electro-fishing; Q2-3 (poor status) water quality (tentative rating); no aquatic species or habitats of high conservation value
X2a	Derry River	07D28	Local importance (lower value)	Heavily modified, heavily silted, heavily vegetated & over-deepened lowland depositing stream with no flows (stagnant); no fish recorded via electro-fishing; Q2 (bad status) water quality (tentative rating); no aquatic species or habitats of high conservation value
X2b	Rochfortbridge Stream	07R04	Local importance (lower value)	Historically straightened, heavily silted, heavily vegetated & over-deepened lowland depositing stream with imperceptible flows; three-spined stickleback recorded via electro-fishing; Q2-3 (poor status) water quality (tentative rating); no aquatic species or habitats of high conservation value
X3	Yellow River	07Y02	Local importance (higher value)	Heavily modified, heavily vegetated & over-deepened lowland depositing river with evident enrichment; brown trout, minnow & pike recorded via electro-fishing; otter spraint site (with white-clawed crayfish remains) recorded; Q2-3 (poor status) water quality
X4	Grand Canal	n/a	National importance	Located within Grand Canal pNHA (002104); site of high value for European eel & coarse fish species
X5	Grand Canal	n/a	National importance	Located within Grand Canal pNHA (002104); site of high value for European eel & coarse fish species; site supported the IUCN vulnerable diving beetle dinghy skipper (<i>Laccophilus hyalinus</i>)
X6	Toberdaly Stream	14T28	Local importance (lower value)	Heavily modified, heavily silted, heavily vegetated lowland depositing stream with poor hydromorphology; three-spined stickleback recorded via electro-fishing; Q2-3 (poor status) water quality (tentative rating); no aquatic species or habitats of high conservation value
X7	Toberdaly Stream	14T28	Local importance (lower value)	Heavily modified, dry ephemeral channel not considered of high aquatic value

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

Sites X4 and X5 on the Grand Canal were evaluated as **national importance** given their location within the Grand Canal pNHA (002104). Both sites were also of high value for a range of coarse fish species, European eel and foraging otter. Site X5 supported the dinghy skipper (*Laccophilus hyalinus*), a diving water beetle listed as ‘vulnerable’ in Ireland (Foster et al., 2009).

None of the remaining 29 no. aquatic survey sites in the vicinity of the proposed Derrygreenagh Power development were evaluated as of greater than **local importance (higher value)** in terms of their aquatic ecology. A total of 15 no. **local importance (higher value)** sites were present on the Rochfortbridge Stream (site A1), Kiltonan Stream (A3 & A4), unnamed stream (A5), Castlejordan River (A6), Milltownpass River (A8), Kinnegad River (B1, B3), Hightown River (B2), Yellow River (C1, C2, C7, X3), Coolcor Stream (C3) and the Esker Stream (D3). This evaluation was primarily due to the presence of salmonids ($n=11$ sites), lamprey (*Lampetra* sp.) ($n=7$ sites) or other species of high conservation value such as otter (signs recorded at $n=4$ sites) (**Table 4.4**). All 4 no. survey sites on the Yellow River were evaluated as **local importance (higher value)**.

The remaining 14 no. sites on the Castlejordan River (A2), unnamed stream (A7), Coolcor Stream (C4, C5), Clonin Stream (C6), unnamed stream (D1), Road River (D2), Rochfort Demesne Stream (E1, E2), Gallstown Stream (X1), Derry River (X2a), Rochfortbridge Stream (X2b) and the Toberdaly Stream X6 & X7) were evaluated as **local importance (lower value)** in terms of their aquatic ecology given poorer hydromorphological character, an absence of aquatic species or habitats of high conservation value and or **less than Q4 (good status)** water quality.

5.1.1 Fish species of high conservation value

Brown trout were recorded, invariably in low densities, at a total of 11 no. sites (**Table 4.2**). Atlantic salmon were present, in moderate densities, at a single site on the Yellow River (site C7). In general, the Yellow River provided the best quality salmonid habitat and supported the highest salmonid density (site C7) within the survey area (**Appendix A**).

Lamprey ammocoetes (*Lampetra* sp.) were recorded from 7 no. sites on the Rochfortbridge Stream (A1), Kiltonan Stream (A3 & A4), unnamed stream (A5), Castlejordan River (A6), Milltownpass River (A8) and the Yellow River (C7) (**Table 4.2**). Apart from site A8 on the Milltownpass River, which supported a medium density of 4.4 per m², ammocoetes were present in low densities of ≤ 1.5 per m². This reflected the often low summer flows, the poor hydromorphology of most sites and the dominance of peat-dominated soft sediment (**Appendix A**).

European eel were only recorded (in low densities) from a single site on the Yellow River at Clongall Bridge (C7) (**Table 4.2; 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). As eel occurrence decreases significantly with increasing distance from the sea (Degerman et al., 2019), the paucity of eel observed in the Yellow[Castlejordan]_SC_010, Boyne_SC_030, Figile_SC_020 and Brosna_SC_010 river sub-catchments can be largely explained by the distance between the survey area and marine habitats (Chadwick et al., 2007) (>100km nearest instream distance) (**Appendix A**).

5.1.2 Otter

Despite some suitability at numerous survey locations, otter signs were only recorded at a total of 4 no. sites. Spraint sites were recorded on the Kiltonan Stream (site A3), Yellow River (X3) and Milltownpass River (A8). Given the heavily modified (straightened, deepened) nature of many of the surveyed watercourses there was a general paucity of marking opportunities for otter (e.g. boulders, grassy promontories) and this reflected the low number of signs recorded.

Site A8 on the Milltownpass River also supported a heavily used latrine and couch (ITM 652521, 742386). An otter holt was recorded at the top of the peaty embankment adjoining the pipe culvert at site C3 on the Coolcor Stream (ITM 650601, 733322). This did not appear active at the time of survey given the presence of cobwebs at the entrance, with no indications of recent access (e.g. slides, prints).

As otters are food-limited and prey availability is a crucial factor in determining mortality, breeding success and the status of local populations (Sittenhaler et al., 2019; Ruiz-Olmo et al., 2009), those watercourses with healthier and more abundant fish populations provided the best quality otter habitat. These would include the Yellow River, Castlejordan River, Milltownpass River, Esker Stream and Grand Canal.

5.1.3 White-clawed crayfish & crayfish plague

Historical white-clawed crayfish records were relatively widespread in the vicinity of the proposed development, with records available for the Castlejordan River, Esker Stream and, most recently (in 2018), the Yellow River (**Figure 3.1**). However, no white-clawed crayfish were detected via hand searching ($n=31$ sites) or field examination of otter spraint ($n=4$ sites) during the survey period. No crayfish DNA was detected at sites on the Kinnegad River (B3), Esker Stream (D3) or Rochfort Demesne Stream (E2). Nonetheless, white-clawed crayfish and crayfish plague eDNA was detected at site C7 on the Yellow River at Clongall Bridge (upper Boyne catchment) in September 2022 (1 and 10 positive qPCR replicates out of 12, respectively) (**Table 4.1; Appendix D**).

The patchy distribution and often low abundances of white-clawed crayfish in a given river system may also strongly influence detection probability (Sint et al., 2022). Our results highlight the importance of a multifaceted approach to crayfish surveying, i.e. a combination of traditional crayfish surveys, inspection of otter spraint and eDNA sampling.

Crayfish plague is listed as one of the world's 100 worst invasive species (GISD, 2022; Lowe et al., 2000) and is becoming highly prevalent across Ireland. *Aphanomyces astaci* is considered an obligate crayfish parasite not capable of surviving for a long period outside a crayfish host (Strand et al., 2011; Söderhall & Cerenius, 1999). Thus, the detection of crayfish plague in the Yellow River is likely to further jeopardise existing crayfish populations within the river and wider Boyne catchment.

5.1.4 Macro-invertebrates & biological water quality

The diving water beetle dinghy skipper (*Laccophilus hyalinus*) was recorded in the sweep sample from site X5 on the Grand Canal. This species favours well-vegetated margins of rivers and lakes and is listed as 'vulnerable' in Ireland (Foster et al., 2009). No other rare or protected macro-invertebrate species

(according to national red lists) were recorded in the biological water quality samples taken from 25 no. riverine or 2 no. canal sites in August-September 2022 (**Appendix B**).

None of the 25 no. Q-sampling sample sites achieved **Q4 (good status)** water quality and thus **all 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 4.2**).

The biological water quality of the wider survey area was evidently impacted by historical modifications (poor hydromorphology) and low summer flows at the time of sampling, with the Q-rating for a total of 12 no. sites considered tentative (**Appendix B**) given poor flows and or an absence of suitable riffle areas for sampling (as per Toner et al., 2005). Impacts from peat extraction and agriculture are known to be significant threats to water quality in the wider survey area (EPA, 2018a, 2018b) and this was supported by observations made during the aquatic surveys.

5.2 Aquatic ecology summary

In summary, approximately half of the surveyed watercourses in the vicinity of the proposed Derrygreenagh Power development were of **local importance (higher value)** in terms of their aquatic ecology given the presence of species of high conservation value such as salmonids, lamprey (*Lampetra* sp.), white-clawed crayfish and otter. However, widespread historical drainage pressures (hydromorphology) and siltation (primarily from peat escapement) have significantly reduced the quality of aquatic habitats on most watercourses in the vicinity of the proposed project.

Typically, larger watercourses with higher flow rates, greater water volumes and better connectivity, such as the Yellow River, Milltownpass River and (to the south) Esker Stream, are better able to buffer against such impacts and these watercourses supported the best quality aquatic habitats within the vicinity of the proposed development for aquatic receptors of high conservation value. The Grand Canal at sites X4 and X5 (i.e. at potential electricity grid transmission crossings) were evaluated as **national importance** given their location within the Grand Canal pNHA (002104) and also given these important water corridors provide high quality habitats for a range of high conservation value aquatic species. This includes fish species such as red-listed European eel and the vulnerable diving water beetle dinghy skipper (*Laccophilus hyalinus*), recorded during the current survey.

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7. Appendix A – fisheries assessment report

Please see accompanying fisheries assessment report

Fisheries assessment report for Derrygreenagh Power, Co. Offaly & Co. Westmeath



Prepared by Triturus Environmental Ltd. for Bord na Móna Powergen Limited

February 2023

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1. Introduction

1.1 Background

Triturus Environmental Ltd. were commissioned by Bord na Móna Powergen Limited to undertake a baseline fisheries assessment of numerous watercourses in the vicinity of the proposed Derrygreenagh Power gas-fired development, inclusive of proposed grid connection and gas pipeline routes, located near Rochfortbridge, Co. Offaly & Co. Westmeath (**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 $n=29$ riverine sites was undertaken (**Table 2.1; Figure 2.1**), where possible. Of the 29 riverine survey sites it was not possible to electro-fish seasonal channels that contained very limited or no water at the time of the survey (i.e. survey sites B3, C4, C6, D1, X2a and X4). Electro-fishing helped to identify the importance of the watercourses as nurseries and habitats for salmonids, lamprey (*Petromyzon marinus* and *Lampetra* spp.) and European eel (*Anguilla anguilla*). Other species of lower conservation value were also recorded. A fisheries assessment (no electro-fishing) was also undertaken on 2 no. sites on the Grand Canal which overlapped proposed development infrastructure. 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.

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 development. Permission was granted on the 23rd August 2022 and the survey was undertaken in late August and September 2022.

1.2 Fisheries asset of the survey area

The $n=31$ survey sites¹ were located within the Yellow[Castlejordan]_SC_010, Boyne_SC_030, Figile_SC_020 and Brosna_SC_010 river sub-catchments. The proposed development and associated infrastructure was not located within a European site although there was downstream hydrological connectivity (via several watercourses) with the Lough Ennell SAC (000685), Lough Ennell SPA (004044) and the River Barrow and River Nore SAC (002162). Fisheries survey sites were present on the Rochfortbridge Stream (EPA code: 07R04), Castlejordan River (07C04) and unnamed tributary, Kiltonan Stream (07K04), Milltownpass River (07M04), Kinnegad River (07K01), Hightown River (07H16), Yellow River (07Y02), Coolcor Stream (07C08), Clonin Stream (07C74), Road River (14R53) and unnamed tributary, Esker Stream (14E03), Rochfort Demesne Stream (25R11), Gallstown River (07G36), Derry River (07D28), Toberdaly Stream (14T28) and the Grand Canal (**Table 2.1**).

The Kinnegad River, Yellow River and the Castlejordan River (aka Mongagh River) are known to support *Lampetra* sp. (O'Connor, 2006). These rivers are also known to support good stocks of small-sized brown trout (*Salmo trutta*) (O'Reilly, 2009). The Kinnegad River and Castlejordan (Mongagh) River

¹ The fisheries survey included 29 riverine sites and 2 canal sites with some of the riverine channels dry at the time of the survey as detailed in this report

support a genetically distinct sub-population of trout within the Boyne catchment (Massa-Gallucci & Mariani, 2011).

The Grand Canal, crossed by the potential electricity GCR option 1, is known to support a range of coarse fish species, including perch (*Perca fluviatilis*), pike (*Esox lucius*), bream (*Abramis brama*), roach (*Rutilus rutilus*), rudd (*Scardinius erythrophthalmus*) and their respective hybrids, European eel (*Anguilla anguilla*), tench (*Tinca tinca*) and highly localised common carp (*Cyprinus carpio*) and brown trout (IFI data; McLoone, 2011; Tierney et al., 1999; pers. obs.). *Lampetra* sp. lamprey have also been recorded at a low number of locations, e.g. 11th lock, ROD, 2016; 7th lock, Caffrey et al., 2006; 5th lock, MKO, 2019).

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

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 Derrygreenagh Power development on Wednesday 31st August and Thursday 1st, Friday 2nd, Thursday 22nd, Friday 23rd 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).

The catchment-wide electro-fishing (CWEF) survey was undertaken across $n=29$ sites with a fisheries appraisal undertaken on the Grand Canal given prohibitive depths for back-pack electro-fishing (see **Table 2.1, Figure 2.1**).

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, 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 calcareous geologies) a voltage of 200-230v, 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 using targeted box 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 (Environment Agency, 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. Specific consideration was given to highly virulent crayfish plague (*Aphanomyces astaci*) given known historical outbreaks in connecting downstream catchments. Surveys were undertaken at sites in a downstream order to minimise the risk of upstream propagule mobilisation of pathogens and invasive species. 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 $n=31$ aquatic survey sites in the vicinity of the proposed Derrygreenagh Power development, Co. Offaly & Co. Westmeath († fisheries assessment only)

Site no.	Watercourse	EPA code	Location	X (ITM)	Y (ITM)	Potential associated infrastructure (watercourse crossing)
A1	Rochfortbridge Stream	07R04	R400 road crossing, Castlelost West	644392	741635	Gas pipeline route option 1
A2	Castlejordan River	07C04	R400 road crossing, Farthingstown	646879	740315	Gas pipeline route option 1 & 2
A3	Kiltonan Stream	07K04	Mongagh Bridge	648553	738867	Gas pipeline route option 1 & 2
A4	Kiltonan Stream	07K04	Farthingstown, east of R400 road crossing	649613	739013	Gas pipeline route option 1 & 3
A5	Unnamed stream	n/a	Carrick	652197	739948	Gas pipeline route option 1 & 3
A6	Castlejordan River	07C04	Carrick	652484	741375	Gas pipeline route option 1 & 3
A7	Unnamed stream	n/a	Milltown	652487	742166	Gas pipeline route option 1 & 3
A8	Milltownpass River	07M04	Milltown	652497	742393	Gas pipeline route option 1 & 3
B1	Kinnegad River	07K01	Rattin	653352	744648	Gas pipeline route option 1 & 3
B2	Hightown River	07H16	R446 road crossing, Rattin	653436	744861	Gas pipeline route option 1 & 3
*B3	Kinnegad River	07K01	Killaskillen	658163	744354	n/a
C1	Yellow River	07Y02	Derrygreenagh	649916	736283	Electricity GCR option 2
C2	Yellow River	07Y02	R400 road crossing, Derryiron	651801	735983	Electricity GCR option 3
C3	Coolcor Stream	07C08	Barrysbrook	650625	733333	Electricity GCR option 1 & 2
C4	Coolcor Stream	07C08	Coolcor	651310	734459	Electricity GCR option 2
C5	Coolcor Stream	07C08	R400 road crossing, Coolcor	652286	735536	Electricity GCR option 3
C6	Clonin Stream	07C74	R400 road crossing, Coolcor	652408	735420	Electricity GCR option 3
*C7	Yellow River	07Y02	Clongall Bridge	659381	737570	n/a
D1	Unnamed stream	n/a	Rathcobican	653388	732740	Electricity GCR option 3
D2	Road River	14R53	Rathcobican	652986	731991	Electricity GCR option 3
*D3	Esker Stream	14 E03	Newtown Bridge	652952	728554	n/a

Site no.	Watercourse	EPA code	Location	X (ITM)	Y (ITM)	Potential associated infrastructure (watercourse crossing)
E1	Rochfort Demesne Stream	25R11	Kilbrennan	642171	742741	Gas pipeline route option 1
*E2	Rochfort Demesne Stream	25R11	Stoneford Bridge	641792	744109	n/a
X1	Gallstown Stream	07G36	R400 road crossing, Gortumly	645879	742809	Gas pipeline route option 2
X2a	Derry River	07D28	R400 road crossing, Castlelost	646378	741569	Gas pipeline route option 2
X2b	Rochfortbridge Stream	07R04	Castlelost	646370	741537	Adjacent to gas pipeline route option 2
X3	Yellow River	07Y02	Derrygreenagh	649706	736462	Electricity GCR option 1 & 2
X4†	Grand Canal	n/a	Coole	650889	730911	Electricity GCR option 1
X5†	Grand Canal	n/a	Toberdaly	651780	731377	Electricity GCR option 1
X6	Toberdaly Stream	14T28	Toberdaly	651751	731394	Electricity GCR option 1
X7	Toberdaly Stream	14T28	Toberdaly	651791	731158	Electricity GCR option 1

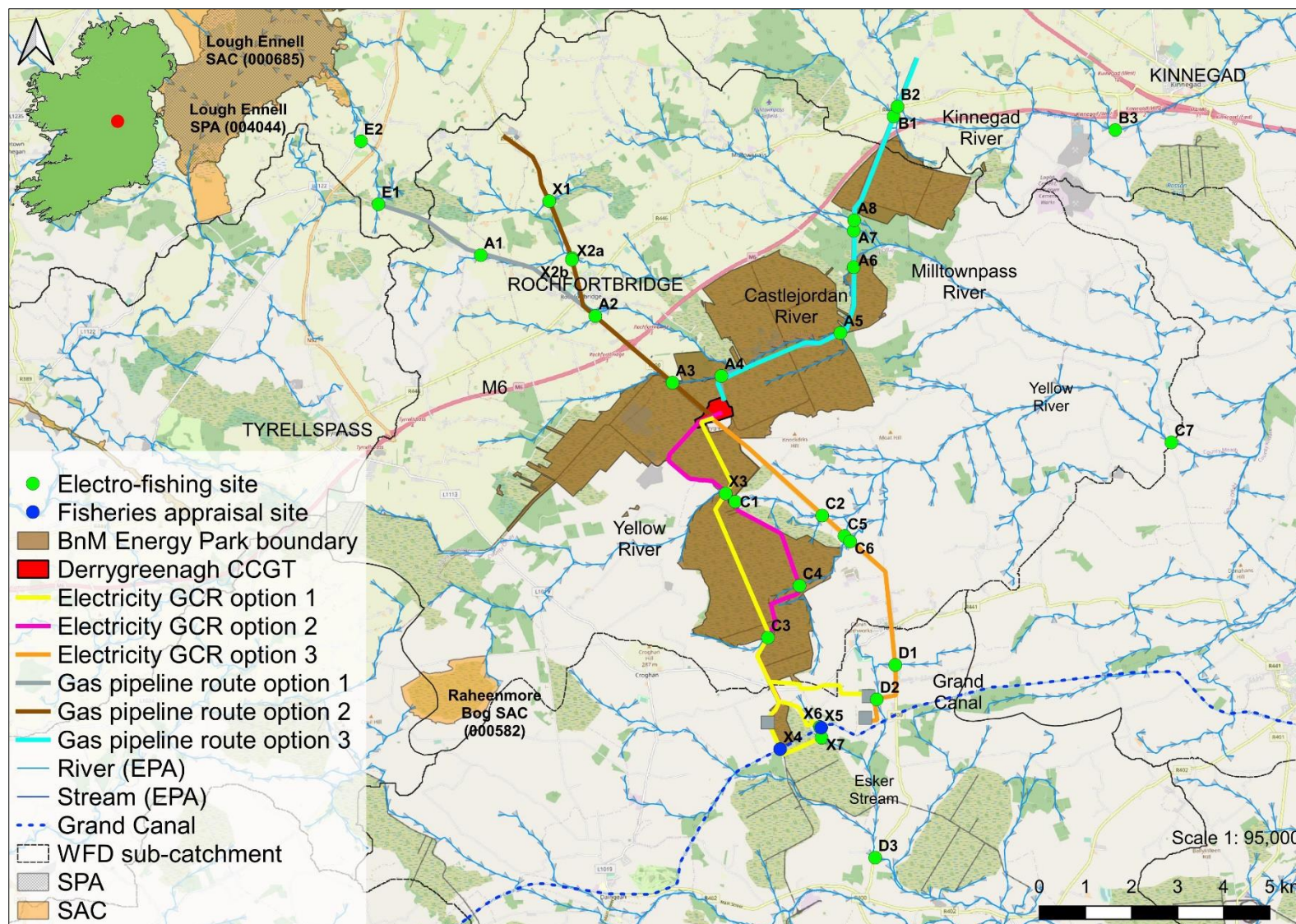


Figure 2.1 Overview of the $n=31$ fisheries survey site locations in vicinity of the proposed Derrygreenagh Power development, Aug-Sept 2022

3. Results

A catchment-wide electro-fishing survey of $n=29$ riverine sites in the vicinity of the proposed Derrygreenagh Power development was conducted on Wednesday 31st August and Thursday 1st, Friday 2nd, Thursday 22nd, Friday 23rd September 2022, following notification to Inland Fisheries Ireland. A fisheries appraisal (no electro-fishing) was also undertaken on 2 no. sites on the Grand Canal. 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 – Rochfortbridge Stream, Castlelost West

Three-spined stickleback (*Gasterosteus aculeatus*) ($n=16$) and lamprey (*Lampetra* sp.) ($n=2$) were the only fish species recorded via electro-fishing at site A1 (**Figure 3.1**).

The site was a poor quality salmonid nursery being degraded due to historical drainage, poor flow rates, heavy siltation and evident enrichment. The quality of spawning habitat was also poor (for both salmonids and lamprey) being reduced by the deterioration of the bed from algae and sedimentation. Holding water for adult salmonids was also poor given very limited deeper areas. However, the site was of moderate value for lamprey ammocoetes with localised shallow silt deposits supporting a low density population (0.5 per m²). There was some suitability for European eel given the presence of dense macrophyte refugia but the poor flows and more limited cobble and boulder refugia reduced the overall value (none recorded).

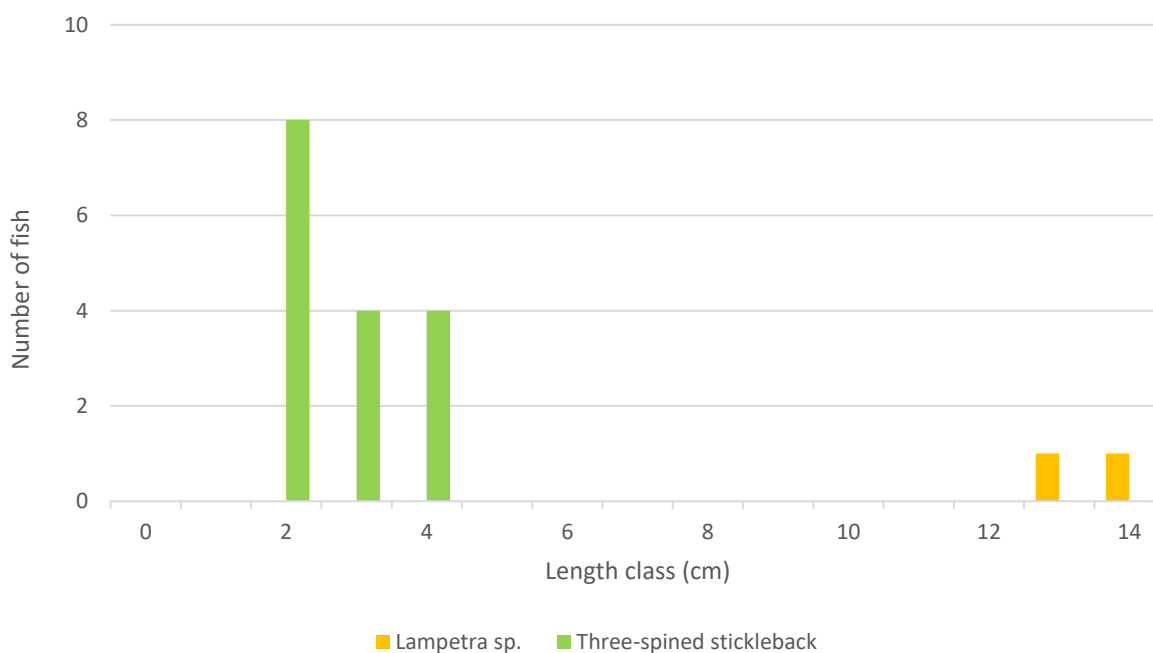


Figure 3.1 Length frequency distribution recorded via electro-fishing at site A1 on the Rochfortbridge Stream, August 2022



Plate 3.1 Representative image of site A1 on the Rochfortbridge Stream, August 2022

3.1.2 Site A2 – Castlejordan River, Farthingstown

Three-spined stickleback ($n=16$) was the only fish species recorded via electro-fishing at site A2 (**Figure 3.1**).

Apart from three-spined stickleback, the heavily vegetated site was not of fisheries value given historical modifications, poor hydromorphology, low flows and heavy siltation.

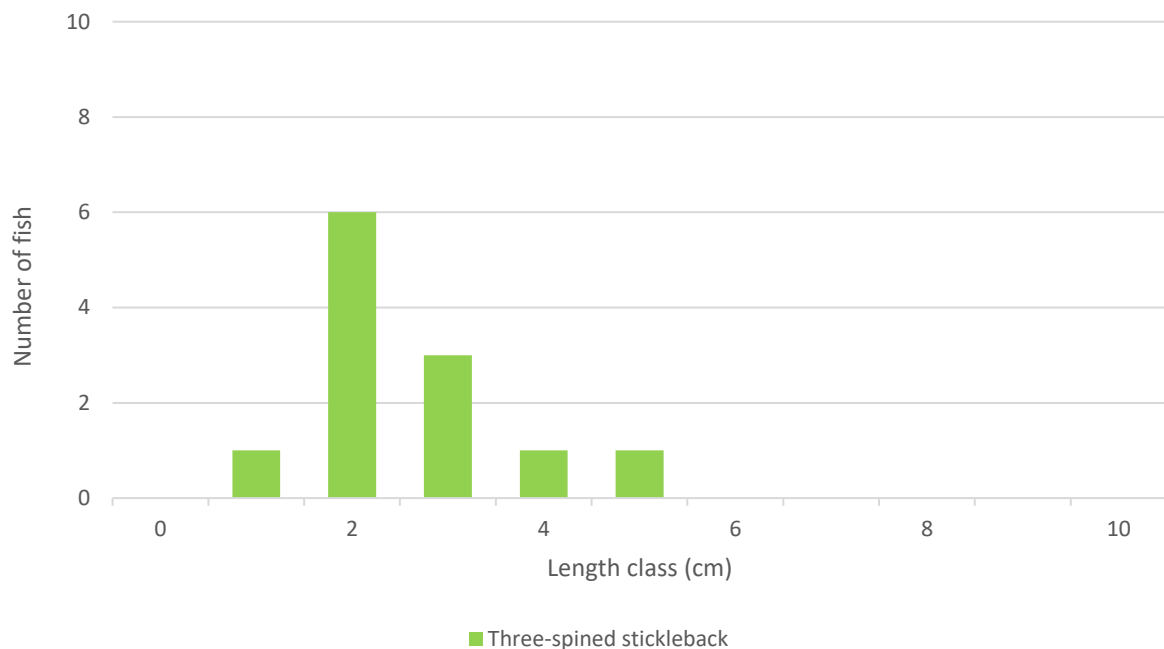


Figure 3.2 Length frequency distribution recorded via electro-fishing at site A2 on the Castlejordan Stream, August 2022



Plate 3.2 Representative image of site A2 on the Castlejordan Stream, August 2022

3.1.3 Site A3 – Kiltonan Stream, Mongagh Bridge

Brown trout (*Salmo trutta*) ($n=8$) and three-spined stickleback ($n=8$) were the only fish species recorded via electro-fishing at site A3 (**Figure 3.3**).

The modified site was considered a moderate quality salmonid nursery given the historical drainage, slower flow, heavy sedimentation and dense macrophyte growth. The spawning quality was poor due to the heavy sedimentation of the channel. Holding habitat was moderate overall due to the heavy macrophyte growth and the limited pool habitat. The channel had high suitability for lamprey ammocoetes given the soft organic rich sediment. However, very limited spawning habitat was present given heavy sedimentation and an absence of hard substrata (no lamprey were recorded). European eel habitat was moderate overall given the presence of dense macrophyte growth and pockets of deeper glide, although no eel were recorded.



Plate 3.3 Brown trout recorded at site A3 on the Kiltonan Stream (Mongagh River), September 2022

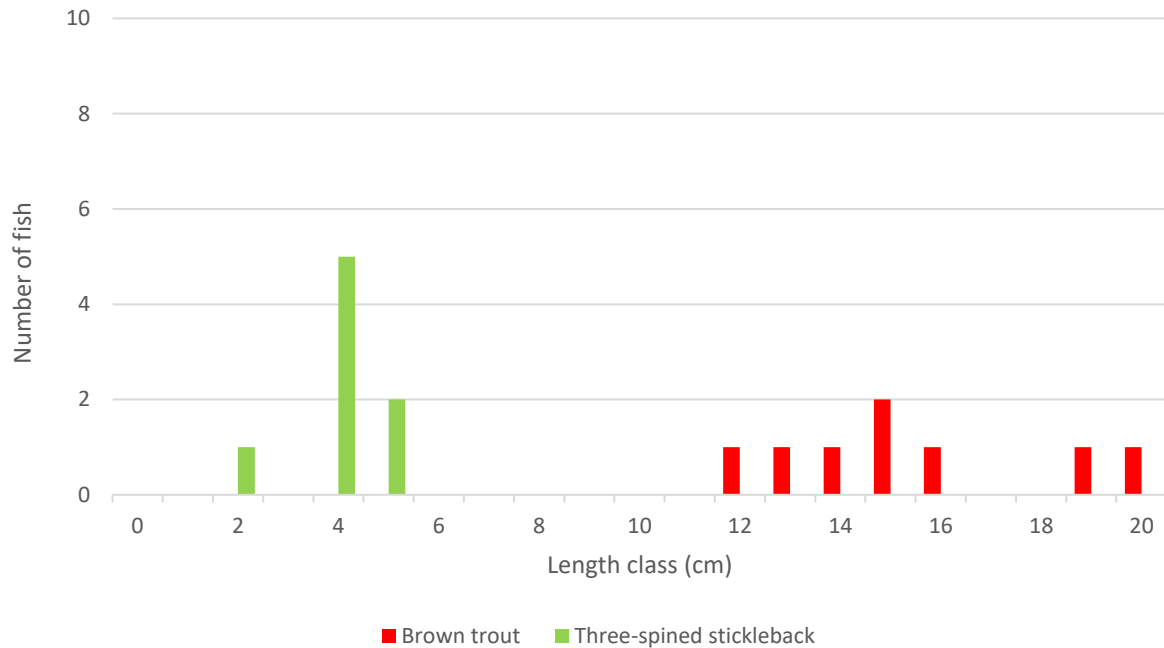


Figure 3.3 Length frequency distribution recorded via electro-fishing at site A3 on the Kiltonan Stream, September 2022

3.1.4 Site A4 – Kiltonan Stream, Farthingstown

Brown trout ($n=1$), lamprey (*Lampetra* sp.) ($n=2$), roach (*Rutilus rutilus*) ($n=6$) and three-spined stickleback ($n=20$) were recorded via electro-fishing at site A4 (**Figure 3.4**).

The site was of poor value to salmonids (only a single adult trout recorded) given poor flows, poor hydromorphology and evident siltation and enrichment pressures. Spawning habitat was not present and the site was not of value as a salmonid nursery. Despite the presence of frequent soft sediment accumulations, the site only supported a low density of *Lampetra* sp. ammocoetes (0.67 per m^2). This was considered to reflect the poor flows/hydromorphology and clay-dominated substrata. Despite some good suitability for European eel, none were recorded. Juvenile non-native roach were present in low numbers.

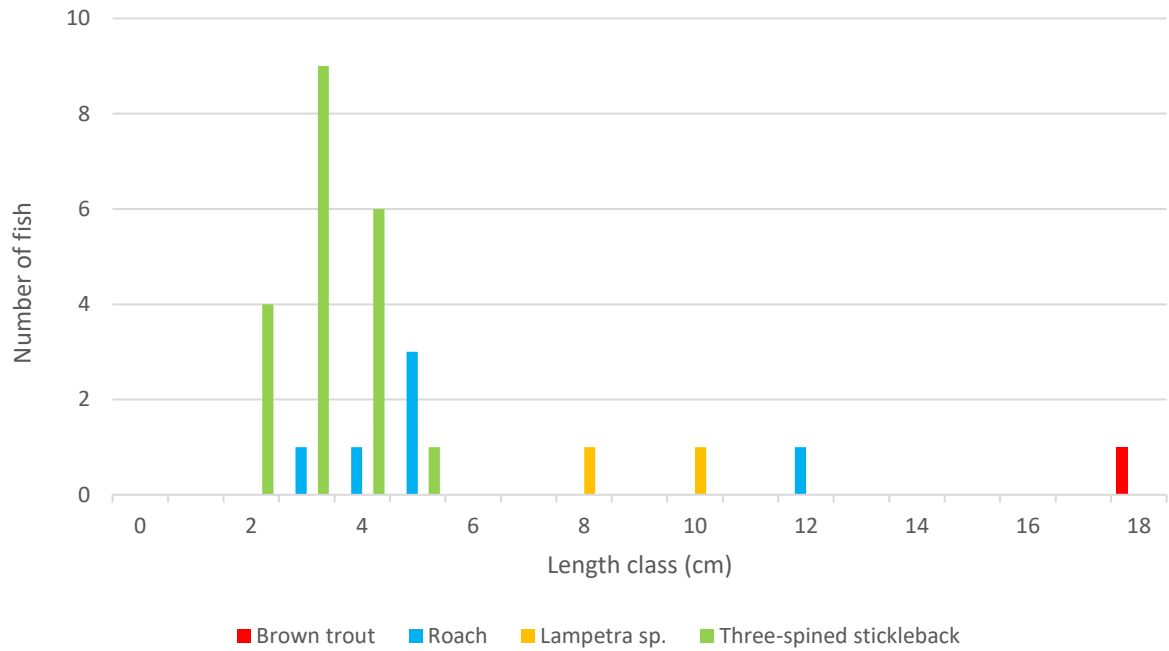


Figure 3.3 Length frequency distribution recorded via electro-fishing at site A4 on the Kiltonan Stream, August 2022



Plate 3.4 Representative image of site A4 on the Kiltonan Stream (Mongagh River), August 2022

3.1.5 Site A5 – unnamed stream, Carrick

A total of six fish species were recorded via electro-fishing at site A5, namely lamprey (*Lampetra* sp.) ($n=2$), roach ($n=51$), minnow (*Phoxinus phoxinus*) ($n=6$), perch (*Perca fluviatilis*) ($n=1$), gudgeon (*Gobio gobio*) ($n=1$) and pike (*Esox lucius*) ($n=1$) (**Figure 3.5**).

The site was of poor value to salmonids given poor flows, poor hydromorphology and evident siltation pressures - none were recorded. However, the plunge pool at the culvert provided some low potential as an adult holding habitat (as did the downstream-connecting Castlejordan River). Spawning habitat was almost entirely absent and the site was not of value as a salmonid nursery. The site was primarily of value as a coarse fish nursery, supporting high numbers of (mostly juvenile) non-native roach. Despite the presence of frequent soft sediment accumulations, the site only supported a low density of *Lampetra* sp. ammocoetes (0.75 per m²). This was considered to reflect the poor flows/hydromorphology and clay-dominated substrata. Despite some good suitability for European eel, none were recorded.

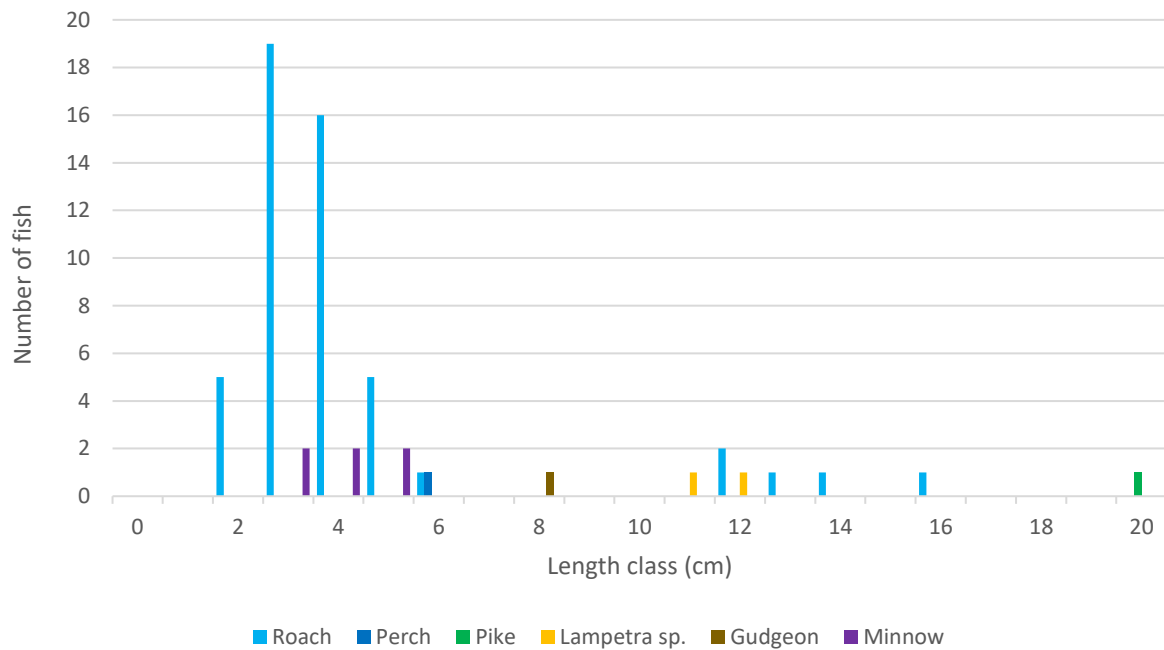


Figure 3.5 Length frequency distribution recorded via electro-fishing at site A5 on an unnamed Castlejordan River tributary, August 2022



Plate 3.5 Juvenile and adult roach recorded at site A5 on an unnamed Castlejordan River tributary, August 2022

3.1.6 Site A6 – Castlejordan River, Carrick

Brown trout ($n=1$), lamprey (*Lampetra* sp.) ($n=1$), pike ($n=1$), perch ($n=4$) and stone loach (*Barbatula barbatula*) ($n=2$) were recorded via electro-fishing at site A6 (**Figure 3.6**).

The site was of moderate value for salmonids given considerable hydromorphological and siltation pressures, supporting a very low density of brown trout (single juvenile only). Except for the short section near the bridge (moderate value), the site was not of value as a salmonid spawning or nursery habitat. However, given the predominance of deeper glide areas, good holding opportunities were present. The site was primarily of value as a coarse fish habitat. Despite the presence of frequent soft sediment accumulations, the site only supported a low density of *Lampetra* sp. ammocoetes (0.5 per m²). Despite some good suitability for European eel (abundant instream refugia), none were recorded.

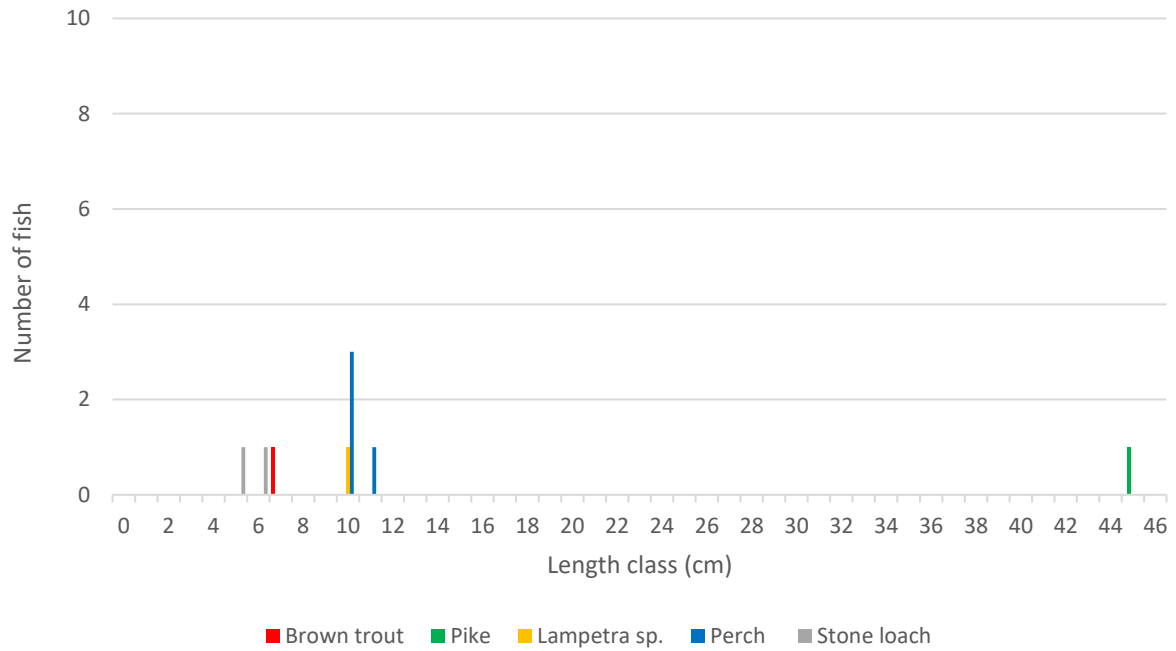


Figure 3.6 Length frequency distribution recorded via electro-fishing at site A6 on the Castlejordan River (Mongagh River), August 2022

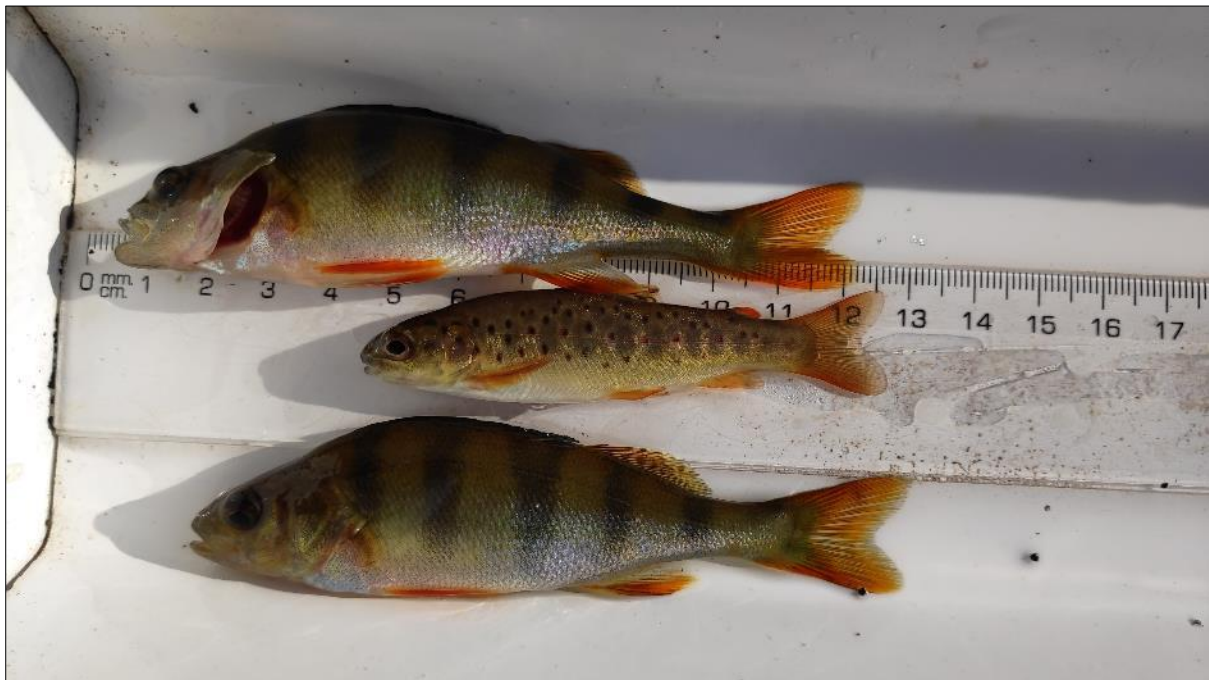


Plate 3.6 Juvenile perch and brown trout recorded at site A6 on the Castlejordan River (Mongagh River), August 2022

3.1.7 Site A7 – unnamed stream, Milltown

Site A7 was located on an unnamed stream at a potential gas pipeline route option 1 and 3 crossing, approx. 0.6km upstream of the Castlejordan River (Mongagh River) confluence. Despite being present on EPA mapping, no channel was identified during the survey, with a dry peat-base drainage ditch

present alongside the mapped route of the stream. The Castlejordan River tributary was likely realigned historically as part of land drainage works. Site A7 was not of fisheries value given an absence of aquatic habitats.



Plate 3.7 Representative image of site A7 on an unnamed Castlejordan River tributary, August 2022 (no channel or aquatic habitats present)

3.1.8 Site A8 – Milltownpass River, Milltown

Brown trout ($n=20$), lamprey (*Lampetra* sp.) ($n=11$) and pike ($n=1$) were recorded via electro-fishing at site A8 (**Figure 3.7**).

Site A8 was of high value for salmonids, despite hydromorphological, enrichment and siltation pressures, supporting a moderate density of primarily adult brown trout. The site was of highest value as a holding area for adult salmonids (excellent quality pool habitat under the bridge). Good quality spawning habitat for both salmonids and lamprey was present downstream of the aforementioned pool (mobile mixed gravels). The site was of relatively poor value as a salmonid nursery. However, the site was an excellent quality lamprey nursery (abundant soft sediment accumulations) and supported a moderate density of ammocoetes (4.4 per m^2) – this was the highest density recorded during the survey. Despite high suitability for European eel, none were recorded. The site was also of good value for coarse fish species such as pike, perch and roach (although the latter two species were not recorded).

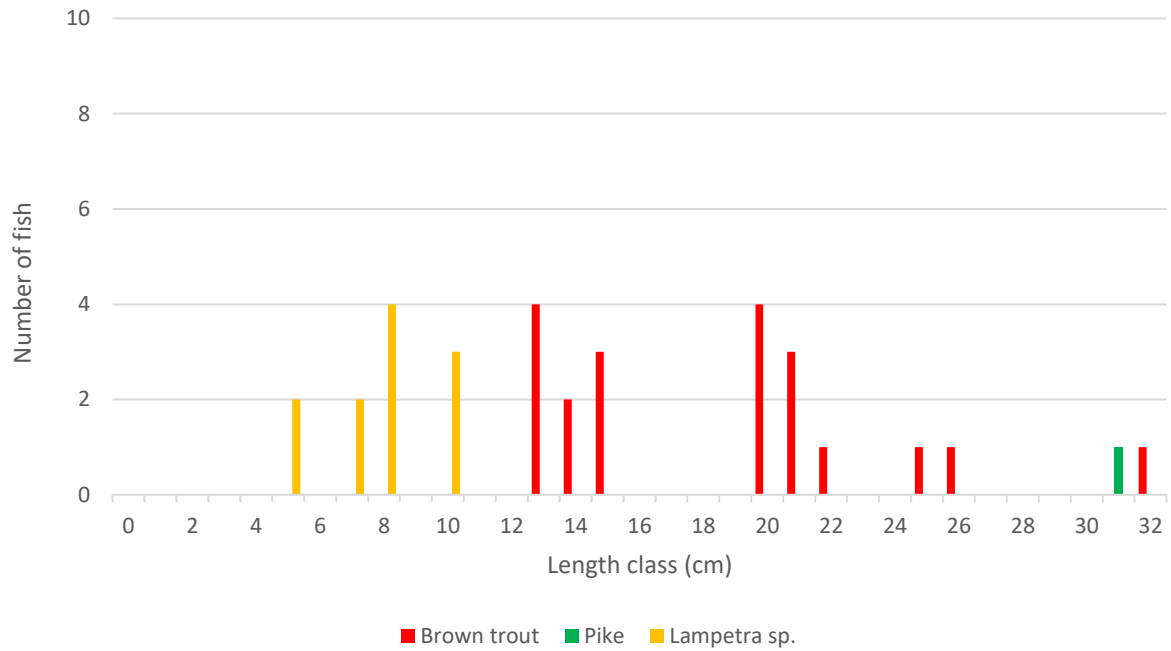


Figure 3.7 Length frequency distribution recorded via electro-fishing at site A8 on the Milltownpass River, August 2022



Plate 3.8 Adult brown trout and juvenile pike recorded at site A8 on the Milltownpass River, August 2022

3.1.9 Site B1 – Kinnegad River, Rattin

Brown trout ($n=11$) and three-spined stickleback ($n=3$) were the only fish species recorded via electro-fishing at site B1 (**Figure 3.8**).

The site was considered a moderate quality salmonid nursery, despite moderate to heavy siltation. Whilst some areas of good quality spawning habitat were present locally, the overall value was reduced due to historical drainage and sedimentation pressures. Holding habitat was of poor quality given a paucity of deeper glide and pool habitat. The site provided some good quality lamprey spawning habitat. Despite some suitability locally in soft sediment accumulations, no larval lamprey were recorded. Whilst the site was of moderate suitability for European eel given the presence of ample refugia, none were recorded.

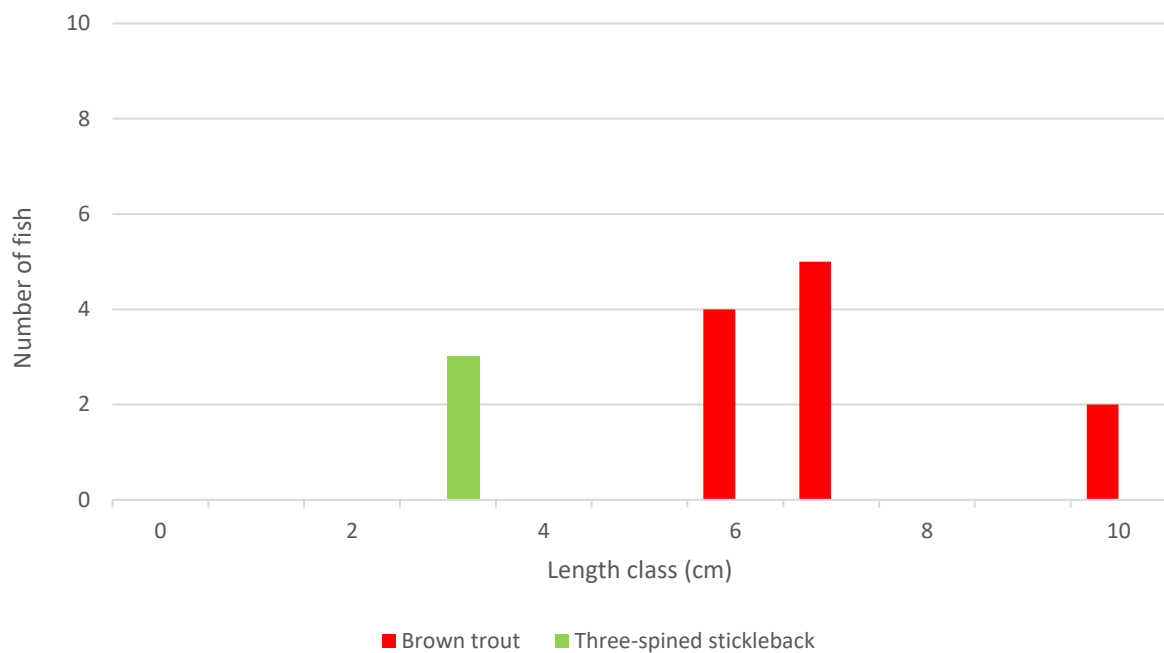


Figure 3.8 Length frequency distribution recorded via electro-fishing at site B1 on the Kinnegad River, August 2022



Plate 3.9 Representative image of site B1 on the Kinnegad River, August 2022

3.1.10 Site B2 – Hightown River, Rattin

Brown trout ($n=18$), minnow ($n=6$) and three-spined stickleback ($n=3$) were recorded via electro-fishing at site B2 (**Figure 3.9**).

The site was considered a moderate quality salmonid nursery given the presence of localised riffle and slow flowing glide, despite moderate to heavy siltation and compaction. A moderate density of juvenile trout were recorded. The spawning value for salmonids and lamprey was locally good but moderate overall given historical drainage and siltation pressures. Holding habitat quality was moderate overall due to a paucity of deeper pool habitat. Whilst some suitable soft sediment areas for lamprey ammocoete was present locally, none were recorded during targeted electro-fishing. Despite some moderate suitability, no European eel were recorded.

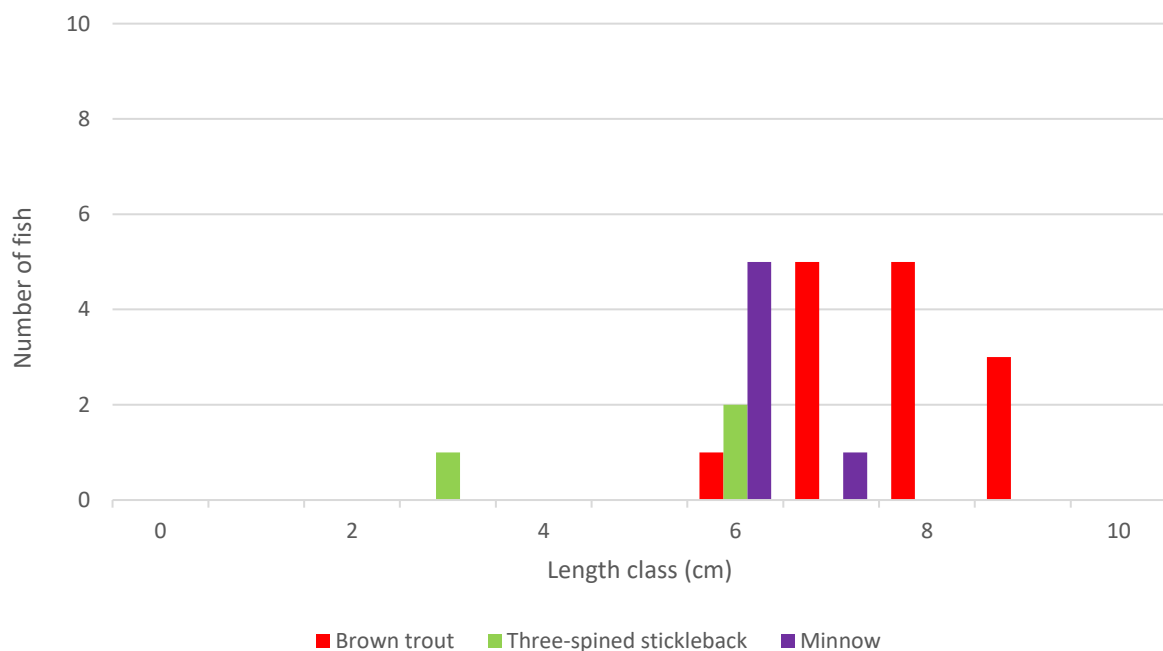


Figure 3.9 Length frequency distribution recorded via electro-fishing at site B2 on the Hightown River, August 2022



Plate 3.10 Brown trout recorded at site B2 on the Hightown River, August 2022

3.1.11 Site B3 – Kinnegad River, Killaskillen

Electro-fishing was not undertaken at site B3 given prohibitive depths of >1.3m and a soft riverbed (deep silt). The Kinnegad River at this location was considered a poor quality salmonid nursery given the poor flows, heavy sedimentation and dense macrophyte growth. The spawning quality was also poor due to the absence of even moderate flows. The site was of some value as a holding area for adult salmonids but overall the site was more suited to coarse fish species such as roach and pike. The site could theoretically support ammocoetes given the abundant soft sediment accumulations but the very low summer flows observed reduced the suitability for the species in addition to the absence of suitable spawning habitat. European eel habitat was moderate overall given the presence of dense macrophyte growth and deep pools.



Plate 3.11 Representative image of site B3 on the Kinnegad River, August 2022

3.1.12 Site C1 – Yellow River, Derrygreenagh

Brown trout, perch, pike and three-spined stickleback were recorded via electro-fishing at site C1 (Figure 3.10).

The heavily vegetated site was considered a good habitat for coarse fish and supported low numbers of pike and perch. The site was considered a poor to moderate quality salmonid nursery given the historical drainage, slower flow, heavy sedimentation and dense macrophyte growth. Only a low number of small brown trout were recorded. The spawning quality was poor due to the heavy siltation of the channel. Holding habitat was moderate overall due to the heavy macrophyte growth despite the presence of deeper glide and localised pools. The channel had moderate suitability for lamprey ammocoetes given the presence of soft sediment, but the peat influences and very limited spawning habitat reduced the potential for the species (none recorded). Despite some moderate suitability for European eel, none were recorded.

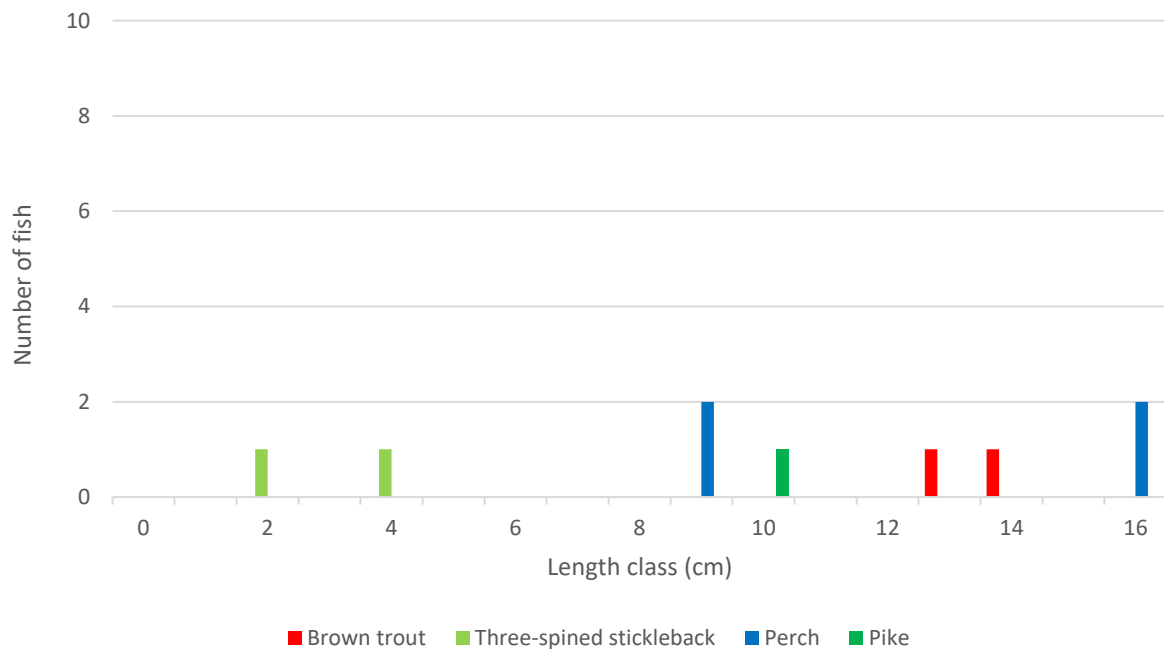


Figure 3.10 Length frequency distribution recorded via electro-fishing at site C1 on the Yellow River, September 2022



Plate 3.12 Perch and juvenile pike recorded at site C1 on the Yellow River, September 2022

3.1.13 Site C2 – Yellow River, Derryiron

Brown trout ($n=55$) and stone loach ($n=1$) were the only fish species recorded via electro-fishing at site C2 (**Figure 3.11**).

The site was a good quality salmonid habitat supporting relatively high numbers of mixed-cohort brown trout (the highest density recorded during the survey). Good quality nursery habitat was present although this was reduced by evident siltation and enrichment pressures. Localised deeper glide and pool, in addition to macrophyte beds, provided some good quality holding habitat for adult salmonids. Some good quality spawning habitat for salmonids and lamprey was present but again the value was reduced by siltation. The site was of poor suitability for lamprey ammocoetes given the dominance of hard substrata and none were recorded. Despite some good suitability (abundant refugia), no European eel were recorded.

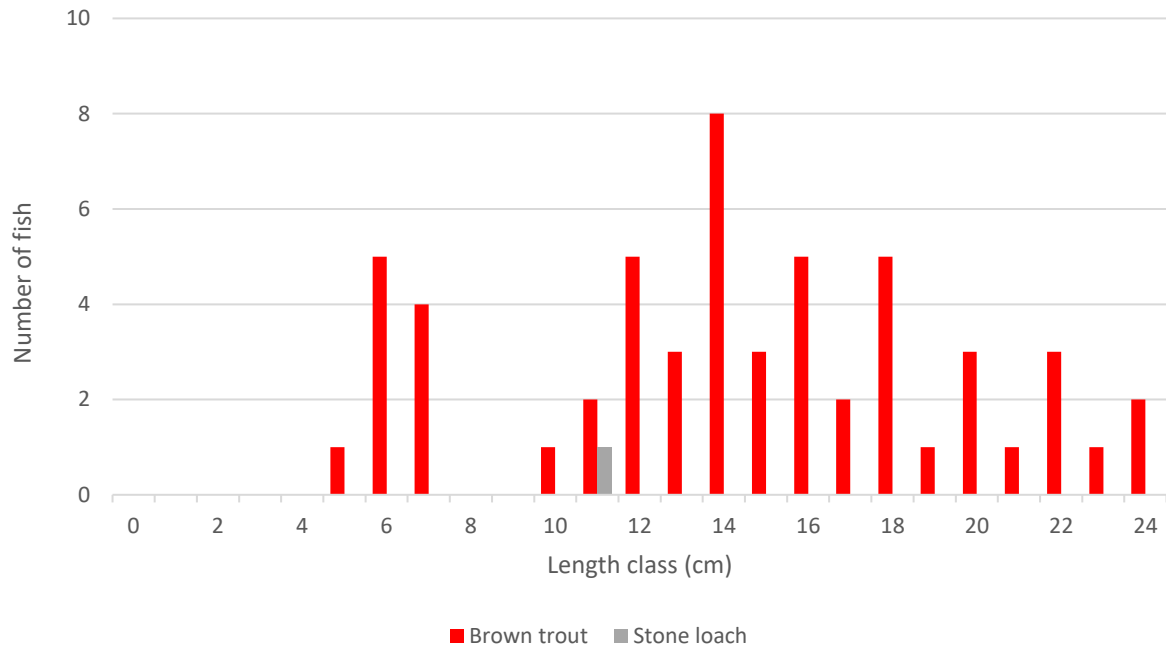


Figure 3.11 Length frequency distribution recorded via electro-fishing at site C2 on the Yellow River, September 2022



Plate 3.13 Representative image of site C2 on the Yellow River, September 2022

3.1.14 Site C3 – Coolcor Stream, Barrysbrook

Three-spined stickleback ($n=25$) and ten-spined stickleback (*Pungitius pungitius*) ($n=2$) were the only fish species recorded via electro-fishing at site C3 (**Figure 3.12**).

Apart from stickleback species, site C3 was not of fisheries value given poor hydromorphology, heavy siltation and poor connectivity with superior downstream habitats. There was no suitability for salmonids given low seasonal flows and heavy siltation pressures. There was some low suitability for European eel although connectivity issues would likely preclude the species.

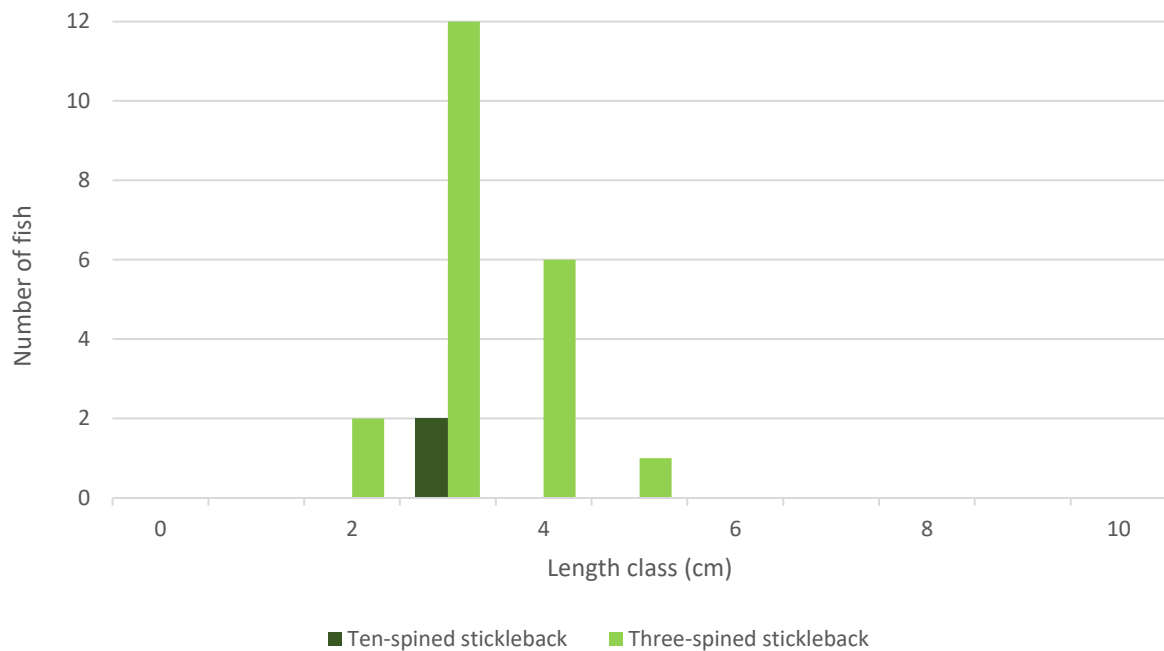


Figure 3.12 Length frequency distribution recorded via electro-fishing at site C2 on the Yellow River, September 2022



Plate 3.14 Three-spined & ten-spined stickleback recorded at site C3 on the Coolcor Stream, September 2022

3.1.15 Site C4 – Coolcor Stream, Coolcor

Electro-fishing was not undertaken at site C4 given prohibitive depths of >1.5m and a soft bed (deep silt). Except for three-spined stickleback and ten-spined stickleback (recorded via sweep netting), site

C4 was not of fisheries value given poor hydromorphology, heavy siltation and poor connectivity with superior downstream habitats. There was no suitability for salmonids given regulated flows and siltation pressures. There was some low suitability for European eel although connectivity issues would likely obstruct the species from passing upstream (west) of the pumping station.



Plate 3.15 Representative image of site C4 on the Coolcor Stream, September 2022

3.1.16 Site C5 – Coolcor Stream, Coolcor

Three-spined stickleback ($n=12$) was the only fish species recorded via electro-fishing at site C5 (**Figure 3.13**).

Except for three-spined stickleback, recorded in low densities, the site was not of fisheries value given historical modifications, poor hydromorphology, low flows and heavy siltation.

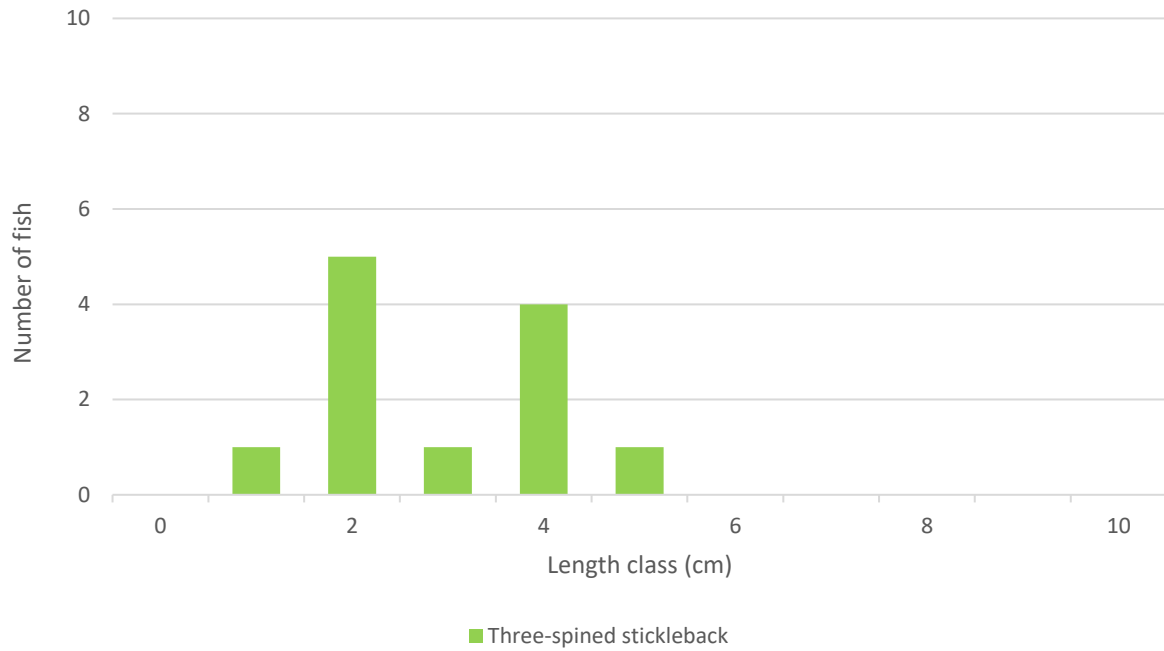


Figure 3.13 Length frequency distribution recorded via electro-fishing at site C5 on the Coolcor River, September 2022



Plate 3.16 Representative image of site C5 on the Coolcor River, September 2022

3.1.17 Site C6 – Clonin Stream, Coolcor

Site C6 was located on the uppermost reaches of the Clonin Stream (07C74) at the R400 road and potential electricity GCR option 3 crossing. The Castlejordan River tributary was dry at the time of survey with no aquatic species or habitats present. Site C6 was not of fisheries value given an absence of aquatic habitats.



Plate 3.17 Representative image of site C6 on the Clonin Stream (dry, ephemeral channel)

3.1.18 Site C7 – Yellow River, Clongall Bridge

A total of six fish species were recorded via electro-fishing at site C7, namely Atlantic salmon (*Salmo salar*) ($n=20$), brown trout ($n=14$), lamprey (*Lampetra* sp.) ($n=3$), European eel ($n=1$), stone loach ($n=3$) and minnow ($n=10$) (**Figure 3.14**). This was the only survey site found to support Atlantic salmon and European eel.

The site was a good salmonid nursery with swift flowing glide habitat and abundant boulder and cobble refugia, supporting moderate densities of juvenile Atlantic salmon. Spawning habitat was of moderate quality overall given limited gravels and dominance of boulder and cobble. Good quality holding habitat was present given abundant deep glide and pool in addition to overhanging vegetation and scoured banks – such areas supported a low density of adult brown trout. Whilst some good quality lamprey nursery habitat was present, soft sediment areas only supported a low density of ammocoetes (1.5 per m^2). Suitability for European eel was very high given abundant refugia, with a single adult recorded.

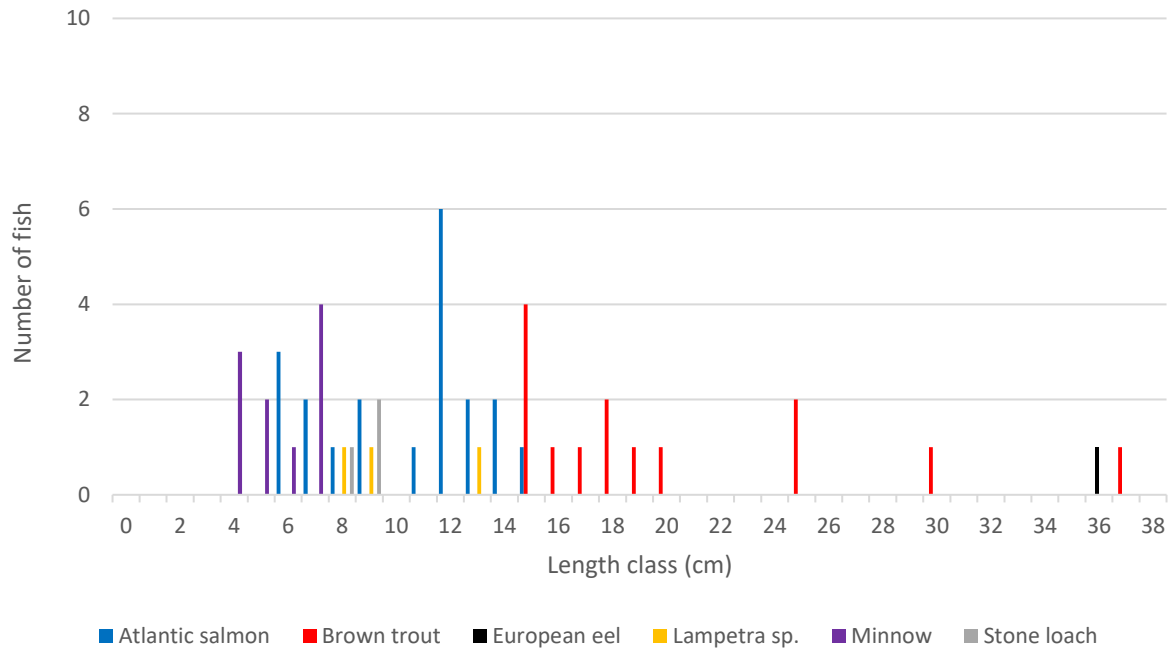


Figure 3.14 Length frequency distribution recorded via electro-fishing at site C7 on the Yellow River at Clongall Bridge, September 2022



Plate 3.18 Atlantic salmon parr recorded at site C7 on the Yellow River, September 2022

3.1.19 Site D1 – unnamed stream, Rathcobican

Site D1 was located on an unnamed stream at the R400 road and potential electricity GCR option 3 crossing, approx. 0.5km upstream of the Road River confluence. The stream was dry at the time of survey with no aquatic species or habitats present. Site D1 was not of fisheries value given an absence of aquatic habitats.



Plate 3.19 Representative image of site D1 on an unnamed stream, August 2022 (dry channel)

3.1.20 Site D2 – Road River, Rathcobican

Three-spined stickleback ($n=9$) was the only fish species recorded via electro-fishing at site D2 (**Figure 3.15**).

With the exception of three-spined stickleback (recorded at low densities), site D2 was not of fisheries value given poor hydromorphology, heavy siltation and poor connectivity with superior downstream habitats.

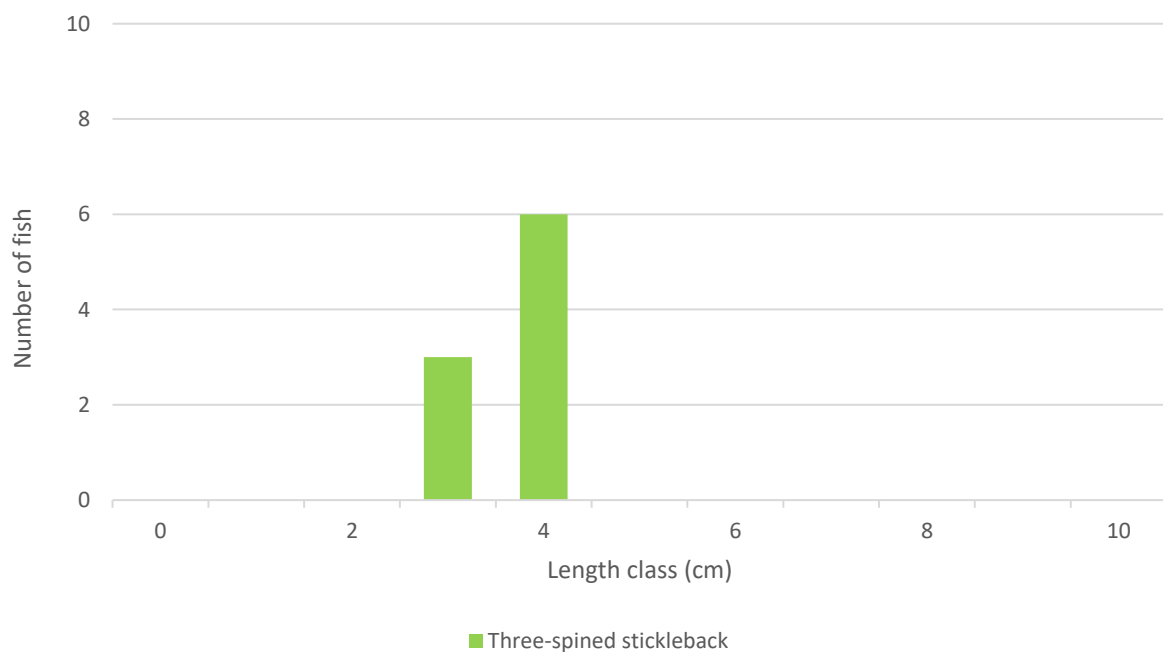


Figure 3.15 Length frequency distribution recorded via electro-fishing at site D2 on the Road River, August 2022



Plate 3.20 Representative image of site D2 on the Road River, August 2022

3.1.21 Site D3 – Esker Stream, Newtown Bridge

Brown trout ($n=23$), minnow ($n=8$), stone loach ($n=5$) and dace (*Leuciscus leuciscus*) ($n=26$) were recorded via electro-fishing at site D3 (**Figure 3.16**).

The site was a moderate quality salmonid nursery, although it supported only a low density of juvenile trout due to historical drainage, siltation and enrichment pressures. Some moderate quality spawning habitat (for both salmonids and lamprey) was present but was also reduced in quality due to filamentous algae and sedimentation. Holding habitat for adult salmonids was present but localised, and the site supported mostly adult trout. Although some suitability existed for larval lamprey, none were recorded via targeted lector-fishing of soft sediment deposits. Despite good suitability for European eel, none were recorded. Mixed cohorts of the invasive dace were present.

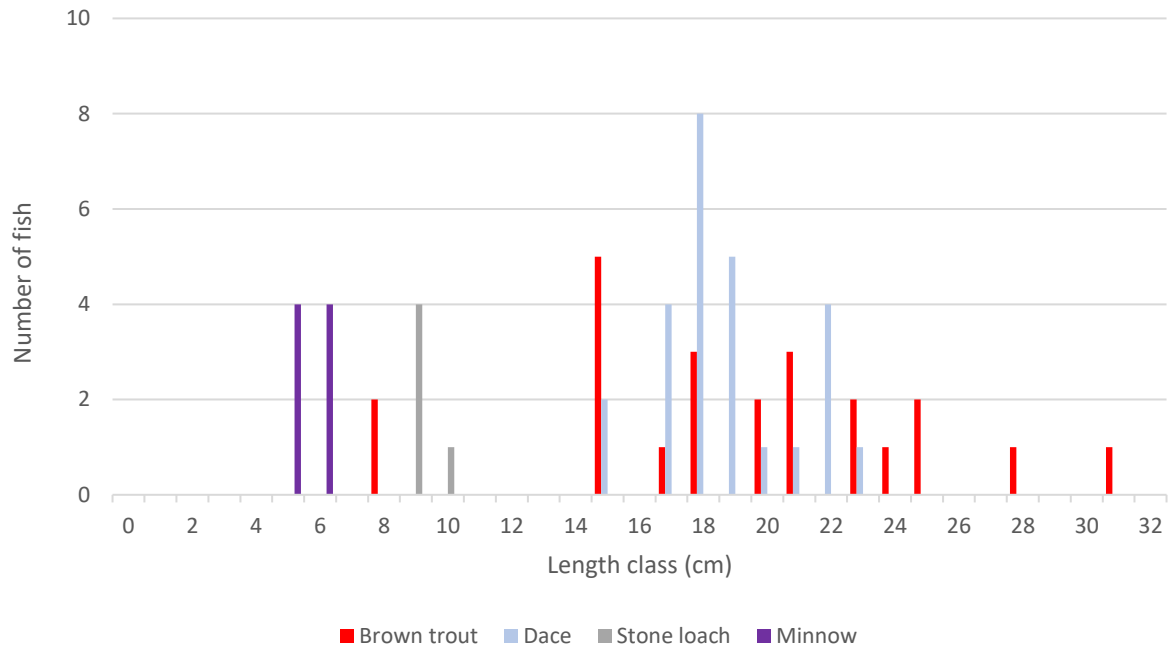


Figure 3.16 Length frequency distribution recorded via electro-fishing at site D3 on the Esker Stream at Newtown Bridge, September 2022



Plate 3.21 Minnow and stone loach recorded at site D3 on the Esker Stream at Newtown Bridge, September 2022

3.1.22 Site E1 – Rochfort Demesne Stream, Kilbrennan

Three-spined stickleback ($n=12$) was the only fish species recorded via electro-fishing at site E1 (**Figure 3.17**).

With exception of three-spined stickleback, the site was not of fisheries value given historical modifications, poor hydromorphology, poor connectivity with downstream habitats, low flows and very heavy siltation.

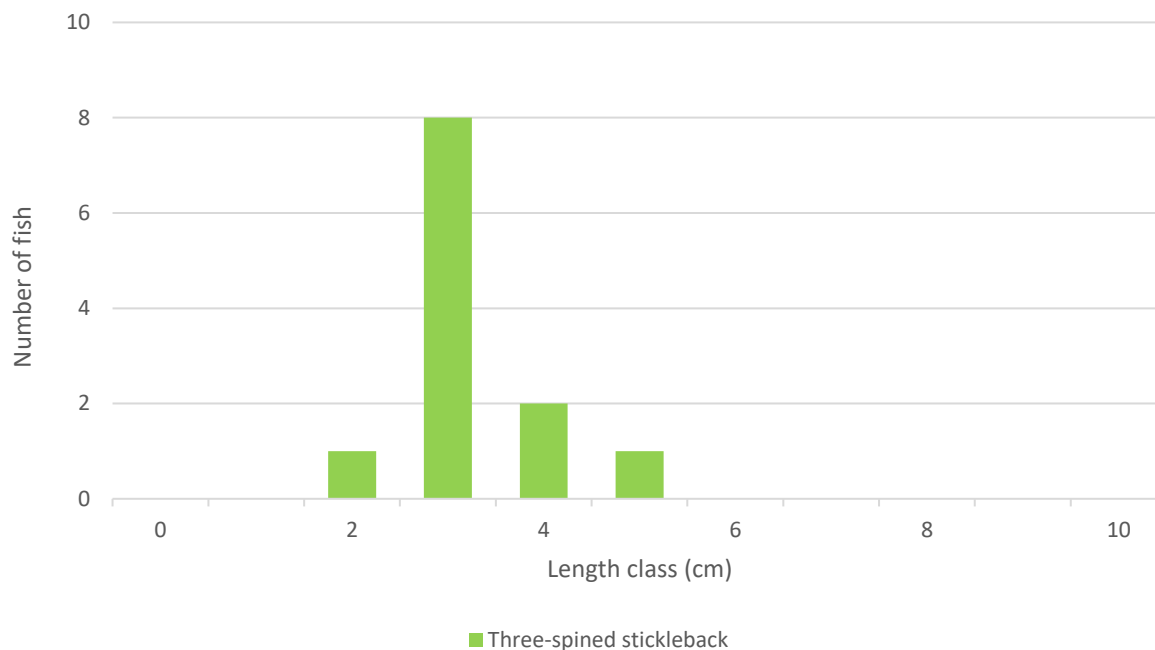


Figure 3.17 Length frequency distribution recorded via electro-fishing at site E1 on the Rochford Demesne Stream, September 2022



Plate 3.22 Representative image of site E1 on the Rochford Demesne Stream, September 2022

3.1.23 Site E2 – Rochford Demesne Stream, Stoneford Bridge

Brown trout ($n=14$) and three-spined stickleback ($n=12$) were the only fish species recorded via electro-fishing at site E2 (**Figure 3.18**).

The site was a moderate quality salmonid nursery, supporting a moderate density of juvenile trout, with some moderate quality spawning habitat also present. However, the value was considerably reduced due to historical drainage, siltation and enrichment pressures. The shallow site was a poor quality holding habitat for adult salmonids. The site was also of poor quality for lamprey ammocoetes

in terms of burial habitat given limited areas of organic-rich silt and limited suitable spawning areas (none recorded). Despite some moderate suitability for European eel, none were recorded.

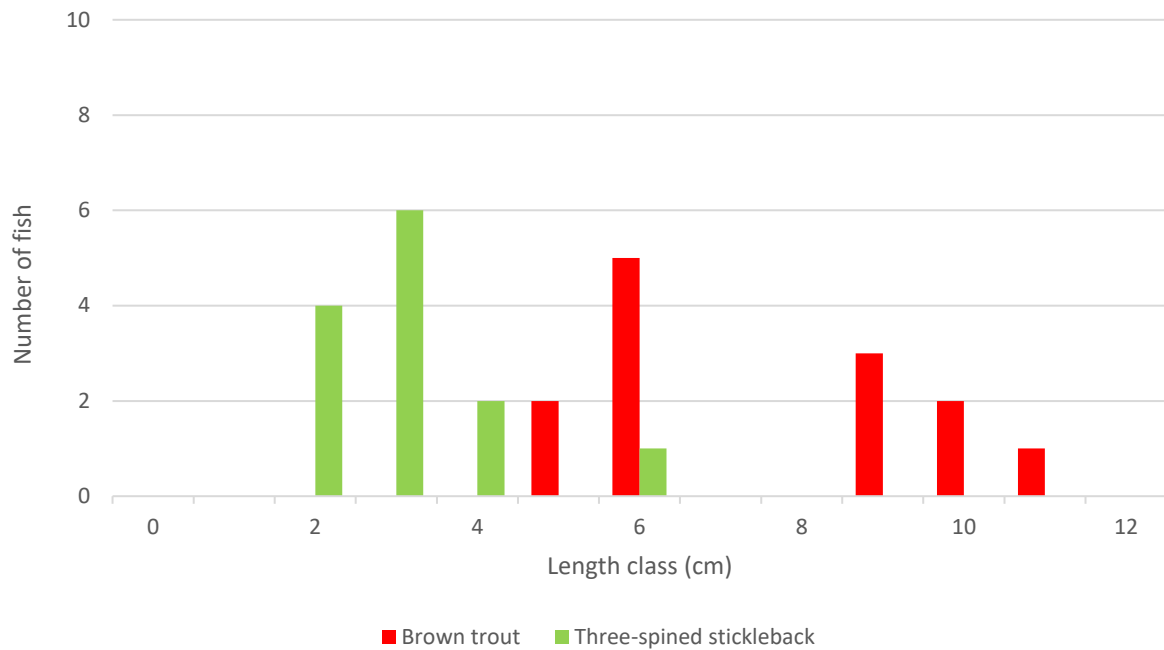


Figure 3.18 Length frequency distribution recorded via electro-fishing at site E2 on the Rochford Demesne Stream, September 2022



Plate 3.23 Representative image of site E2 on the Rochford Demesne Stream, September 2022

3.1.24 Site X1 – Gallstown River, Gortumly

Three-spined stickleback ($n=7$) was the only fish species recorded via electro-fishing at site X1 (**Figure 3.19**). Apart from three-spined stickleback, recorded in low densities, the site was not of fisheries value given historical modifications, poor hydromorphology, poor connectivity with downstream habitats, low flows and very heavy siltation.

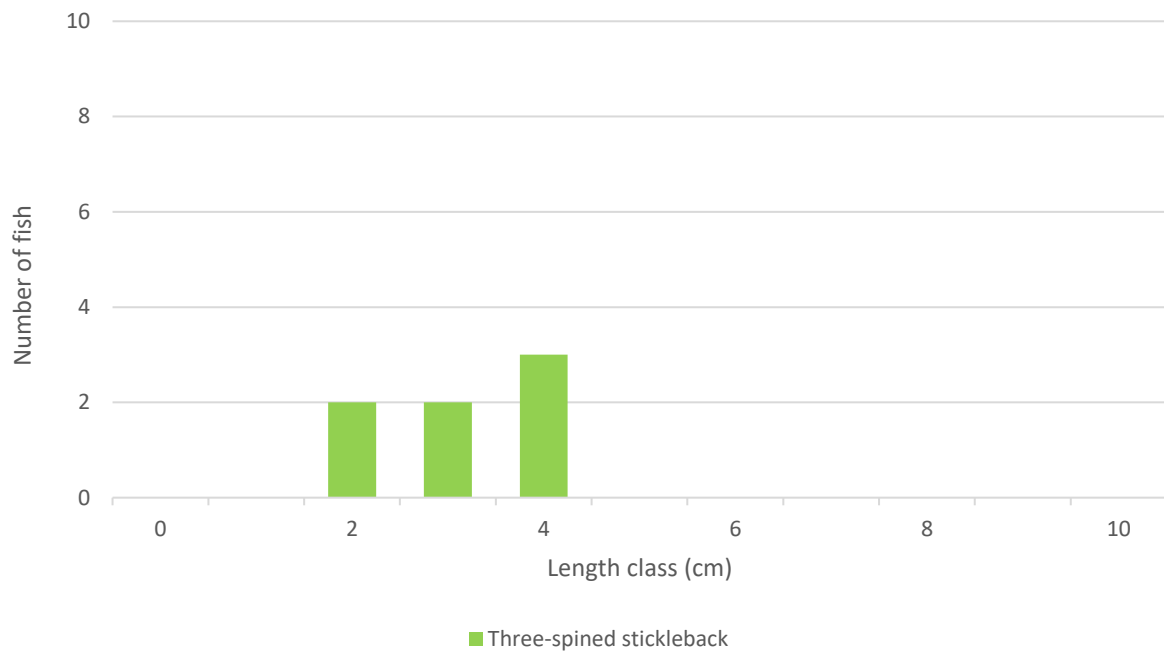


Figure 3.19 Length frequency distribution recorded via electro-fishing at site X1 on the Gallstown River, September 2022



Plate 3.24 Representative image of site X1 on the Gallstown River, September 2022

3.1.25 Site X2a – Derry River, Rahanine

Survey site X2a was not suitable for electro-fishing due to isolated pools of water being present only. The site was not of fisheries value given historical modifications, poor hydromorphology, heavy shading, poor connectivity with downstream habitats, no flowing water and heavy siltation.



Plate 3.25 Representative image of site X2a on the Derry River, September 2022

3.1.26 Site X2b – Rochfortbridge Stream, Rahanine

Three-spined stickleback ($n=14$) was the only fish species recorded via electro-fishing at site X2b (**Figure 3.20**).

Apart from three-spined stickleback, recorded at low densities, the site was not of very poor fisheries value given historical modifications, poor hydromorphology, poor connectivity with downstream habitats, low flows and very heavy siltation. However, there was some low suitability for European eel (none recorded).

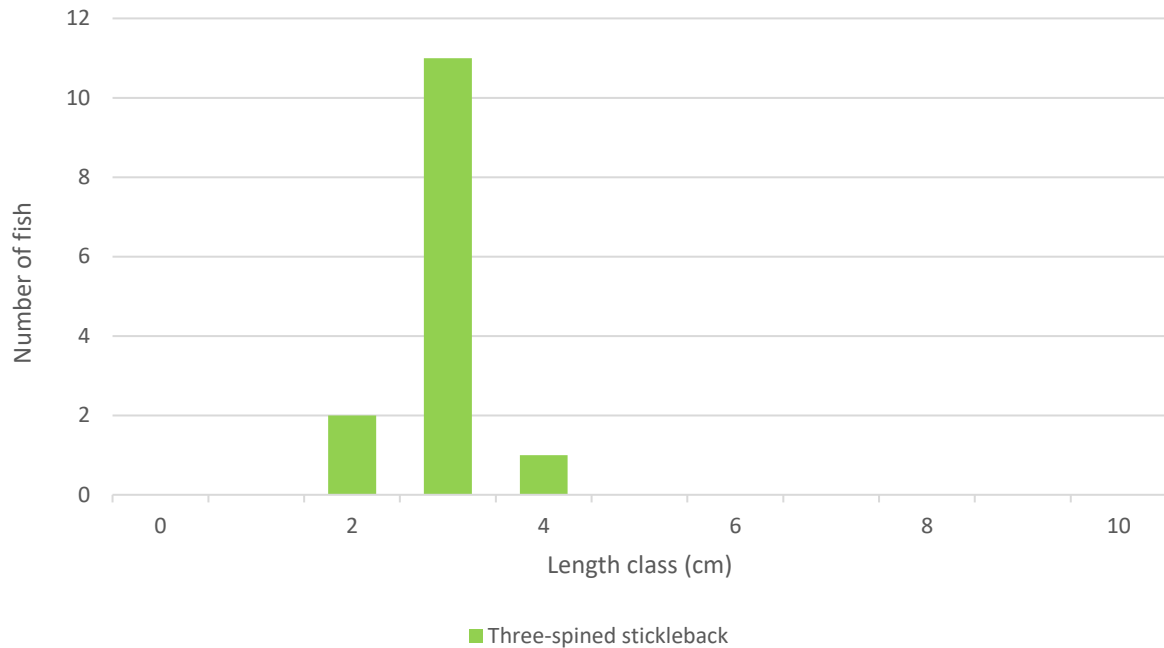


Figure 3.20 Length frequency distribution recorded via electro-fishing at site X2b on the Derry River, September 2022



Plate 3.26 Representative image of site X2b on the Derry River, September 2022

3.1.27 Site X3 – Yellow River, Derrygreenagh

Brown trout ($n=11$), minnow ($n=1$) and pike ($n=2$) were recorded via electro-fishing at site X3 (**Appendix A**). The site was a moderate quality salmonid nursery, supporting a low density of juvenile brown trout. This reflected the significant hydromorphological modifications. However, some moderate quality spawning habitat was present for both salmonids and lamprey. The site of good

value as an adult salmonid holding habitat with deeper pools and glide being abundant. Soft sediment accumulations were humic in nature and unsuitable for lamprey ammocoetes (none recorded). Despite some moderate suitability for European eel, none were recorded.

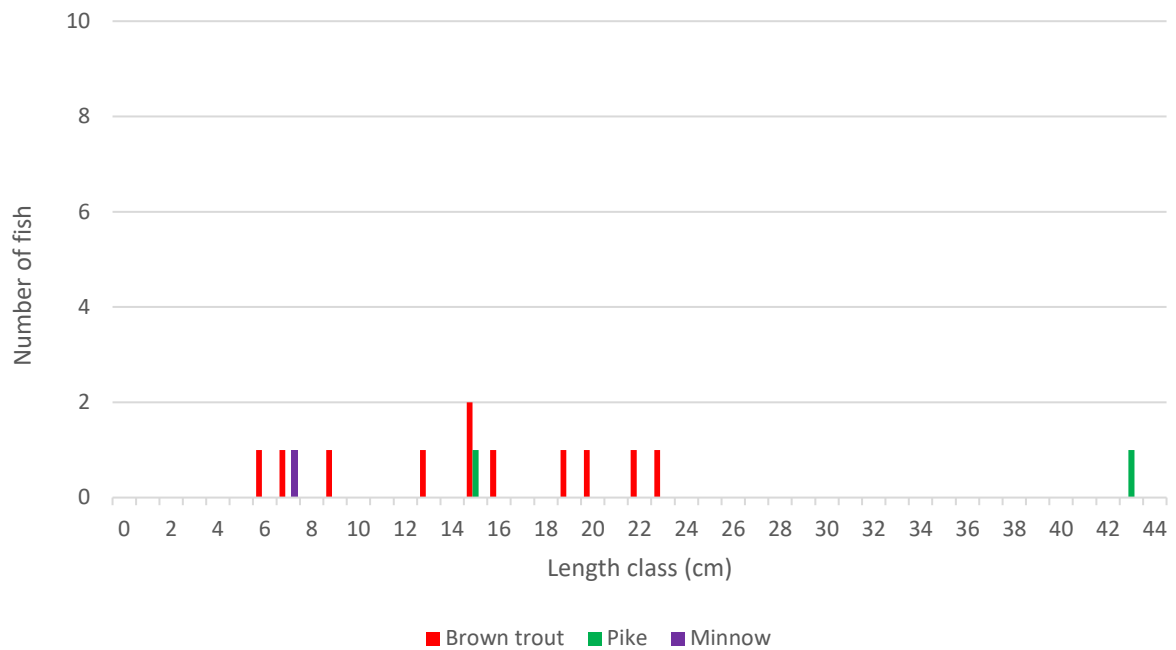


Figure 3.21 Length frequency distribution recorded via electro-fishing at site X3 on the Yellow River, September 2022



Plate 3.27 Juvenile pike recorded at site X3 on the Yellow River, September 2022

3.1.28 Site X4 – Grand Canal, Coole

Electro-fishing was not undertaken at site X4 given prohibitive depths and inherent unsuitability (i.e. canal site). However, a fisheries appraisal was undertaken. Site X4 was of high value for a range of coarse fish species with abundant nursery and spawning habitat present given abundant macrophyte cover. Species such as roach and perch were visibly abundant in vicinity of the bridge. The site was also highly suitable as a European eel habitat.



Plate 3.28 Representative image of site X4 on the Grand Canal, September 2022

3.1.29 Site X5 – Grand Canal, Toberdaly

Electro-fishing was not undertaken at site X4 given prohibitive depths and inherent unsuitability (i.e. canal site). However, a fisheries appraisal was undertaken. Site X4 was of high value for a range of coarse fish species with abundant nursery and spawning habitat present given abundant macrophyte cover. Species such as roach, perch and pike were observed during the survey. The site was also highly suitable as a European eel habitat as with site X4 on the Grand Canal.



Plate 3.29 Representative image of site X5 on the Grand Canal, September 2022

3.1.30 Site X6 – Toberdaly Stream, Toberdaly

Three-spined stickleback ($n=15$) was the only fish species recorded via electro-fishing at site X6 (**Figure 3.20**). With exception of three-spined stickleback, the site was not of fisheries value given historical modifications, poor hydromorphology, low flows and heavy siltation. There was low suitability for European eel but none were recorded.

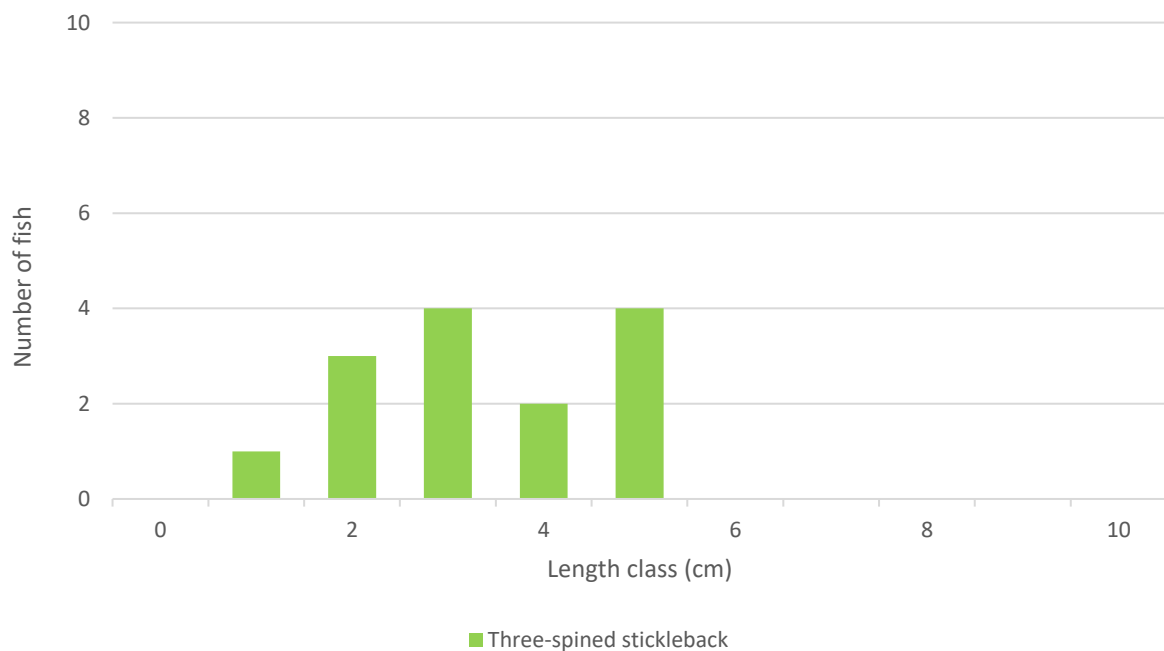


Figure 3.22 Length frequency distribution recorded via electro-fishing at site X6 on the Toberdaly Stream, September 2022



Plate 3.30 Representative image of site X6 on the Toberdaly Stream, September 2022

3.1.31 Site X7 – Toberdaly Stream, Toberdaly

Site X7 was located on the Toberdaly Stream (14T28) south of the Grand Canal. The stream had been evidently realigned and the section south of the channel did not appear hydrologically connected with that surveyed at site X6. The stream at this location was ephemeral and dry at the time of survey. Thus, site X7 was not of fisheries value given an absence of aquatic habitats.



Plate 3.31 Representative image of site X7 on the Toberdaly Stream, September 2022 (dry, ephemeral channel)

Table 3.1 Fish species densities per m² recorded at sites in the vicinity of the proposed Derrygreenagh Power development via electro-fishing in August-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	Roach	Perch	Pike	Gudgeon	Minnow	Stone loach	Dace
A1	Rochfortbridge Stream	5	170	0.000	0.000	0.5 per m ²	0.000	0.094	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
A2	Castlejordan River	5	50	0.000	0.000	0.000	0.000	0.240	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
A3	Kiltonan Stream	10	80	0.000	0.100	0.000	0.000	0.100	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
A4	Kiltonan Stream	10	100	0.000	0.010	0.67 per m ²	0.000	0.200	0.000	0.060	0.000	0.000	0.000	0.000	0.000	0.000
A5	Unnamed stream	5	75	0.000	0.000	0.75 per m ²	0.000	0.000	0.000	0.680	0.013	0.013	0.013	0.080	0.000	0.000
A6	Castlejordan River	10	180	0.000	0.006	0.5 per m ²	0.000	0.000	0.000	0.000	0.022	0.006	0.000	0.000	0.011	0.000
A7	Unnamed stream	n/a	n/a - dry channel	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
A8	Milltownpass River	10	210	0.000	0.095	4.4 per m²	0.000	0.000	0.000	0.000	0.000	0.005	0.000	0.000	0.000	0.000
B1	Kinnegad River	10	200	0.000	0.055	0.000	0.000	0.015	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
B2	Hightown River	10	200	0.000	0.090	0.000	0.000	0.015	0.000	0.000	0.000	0.000	0.000	0.030	0.000	0.000
B3	Kinnegad River	n/a	n/a - too deep	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
C1	Yellow River	10	390	0.000	0.005	0.000	0.000	0.005	0.000	0.000	0.010	0.003	0.000	0.000	0.000	0.000
C2	Yellow River	10	380	0.000	0.145	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.003	0.000
C3	Coolcor Stream	5	60	0.000	0.000	0.000	0.000	0.417	0.033	0.000	0.000	0.000	0.000	0.000	0.000	0.000
C4	Coolcor Stream	n/a	n/a - too deep	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
C5	Coolcor Stream	5	50	0.000	0.000	0.000	0.000	0.240	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

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	Roach	Perch	Pike	Gudgeon	Minnow	Stone loach	Dace
C6	Clonin Stream	n/a	n/a - dry channel	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
C7	Yellow River	10	320	0.063	0.044	1.5 per m ²	0.003	0.000	0.000	0.000	0.000	0.000	0.000	0.031	0.009	0.000
D1	Unnamed stream	n/a	n/a - dry channel	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
D2	Road River	5	40	0.000	0.000	0.000	0.000	0.225	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
D3	Esker Stream	10	300	0.000	0.077	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.027	0.017	0.087
E1	Rochfort Demesne Stream	5	80	0.000	0.000	0.000	0.000	0.150	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
E2	Rochfort Demesne Stream	10	280	0.000	0.050	0.000	0.000	0.043	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
X1	Gallstown Stream	5	50	0.000	0.000	0.000	0.000	0.140	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
X2a	Derry River	5	40	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
X2b	Rochfortbridge Stream	5	50	0.000	0.000	0.000	0.000	0.280	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
X3	Yellow River	10	280	0.000	0.039	0.000	0.000	0.000	0.000	0.000	0.000	0.007	0.000	0.004	0.000	0.000
X6	Toberdaly Stream	5	80	0.000	0.000	0.000	0.000	0.188	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
X7	Toberdaly Stream	n/a	n/a - dry channel	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	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 Derrygreenagh Power development, August-September 2022

Site	Watercourse	Relative abundance				Other species
		Atlantic salmon	Brown trout	<i>Lampetra</i> sp.	European eel	
A1	Rochfortbridge Stream			Low		Three-spined stickleback
A2	Castlejordan River					Three-spined stickleback
A3	Kiltonan Stream			Low		Three-spined stickleback
A4	Kiltonan Stream		Low	Low		Three-spined stickleback, roach
A5	Unnamed stream			Low		Roach, perch, pike, gudgeon, minnow
A6	Castlejordan River		Low	Low		Stone loach, perch, pike
A7	Unnamed stream	No fish recorded (dry channel)				
A8	Milltownpass River		Medium	Medium		Pike
B1	Kinnegad River		Medium			Three-spined stickleback
B2	Hightown River		Medium			Three-spined stickleback, minnow
B3	Kinnegad River	No electro-fishing undertaken (too deep)				
C1	Yellow River		Low			Three-spined stickleback, pike, perch
C2	Yellow River		High			Stone loach
C3	Coolcor Stream					Three-spined stickleback, ten-spined stickleback
C4	Coolcor Stream	No electro-fishing undertaken (too deep)				
C5	Coolcor Stream					Three-spined stickleback
C6	Clonin Stream	No fish recorded (dry channel)				
C7	Yellow River	Medium	Medium	Low	Low	Stone loach, minnow
D1	Unnamed stream	No fish recorded (dry channel)				
D2	Road River					Three-spined stickleback
D3	Esker Stream		Medium			Dace, minnow, stone loach
E1	Rochfort Demesne Stream					Three-spined stickleback
E2	Rochfort Demesne Stream		Medium			Three-spined stickleback

Site	Watercourse	Relative abundance				Other species
		Atlantic salmon	Brown trout	<i>Lampetra</i> sp.	European eel	
X1	Gallstown Stream					Three-spined stickleback
X2a	Derry River	No fish recorded				
X2b	Rochfortbridge Stream					Three-spined stickleback
X3	Yellow River		Medium			Pike, minnow
X4	Grand Canal	n/a – fisheries appraisal only				
X5	Grand Canal	n/a – fisheries appraisal only				
X6	Toberdaly Stream					Three-spined stickleback
X7	Toberdaly Stream	No fish recorded (dry channel)				

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 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.

4. Discussion

The watercourses in the vicinity of the proposed Derrygreenagh Power development were typically small, modified, lowland depositing channels draining areas of cutover bog. Historical drainage pressures (straightening & deepening) and siltation have significantly reduced the quality and heterogeneity of aquatic habitats in the vicinity of the proposed development. Nevertheless, the larger watercourses, such as the Yellow River, Milltownpass River, Castlejordan River and Esker River, were found to support salmonid populations and or lamprey (*Lampetra* sp.) and provided better quality fisheries habitats. The Grand Canal was of very high value for a range of coarse fish species, as well as European eel.

Brown trout were recorded, invariably in low densities, at a total of 11 no. sites on the Kiltonan Stream (site A4), Castlejordan River (A6), Milltownpass River (A8), Kinnegad River (B1), Hightown River (B2), Yellow River (C1, C2, C7 & X3), Esker Stream (D3) and the Rochfort Demesne Stream (E2) (**Table 3.1, 3.2**). The Kinnegad River and Castlejordan (Mongagh) River support a genetically distinct sub-population of trout within the Boyne catchment (Massa-Gallucci & Mariani, 2011) and are thus of particular conservation value. All 4 no. survey sites on the Yellow River supported salmonids, with Atlantic salmon recorded in moderate densities at site C7 (Clongall Bridge), the only site found to support the species during the survey. The Yellow River supported the highest Atlantic salmon (C7) and brown trout (C2) densities recorded.

Without exception, all watercourses surveyed in the vicinity of the proposed Derrygreenagh Power development had been historically modified and the majority were exposed to considerable siltation pressures. Historical straightening and deepening of watercourses damages habitat and hydromorphological heterogeneity, encourages sediment deposition and invariably results in an irreparable reduction in fisheries potential, particularly for salmonids (O'Grady et al., 2017, O'Grady, 2006). Diffuse siltation is one of the greatest threats to salmonid populations, particularly in peat and agricultural catchments such as that adjoining 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). Gravel compaction from sedimentation reduces the spawning capacity of a channel and it has been shown that eggs laid in clean gravels which have subsequently been silted over by peat have failed to hatch (Crisp 1993, 2000).

Lamprey ammocoetes (*Lampetra* sp., likely *L. planeri* given the location in the upper reaches of the respective catchments) were recorded from 7 no. sites on the Rochfortbridge Stream (A1), Kiltonan Stream (A3 & A4), unnamed stream (A5), Castlejordan River (A6), Milltownpass River (A8) and the Yellow River (C7) (**Table 3.1, 3.2**). Apart from site A8 on the Milltownpass River which supported a medium density of ammocoetes (4.4 per m²), lamprey were present at low densities in the remaining survey areas containing the species (i.e. ≤ 1.5 per m²) of targeted larval survey habitat. These low densities in the Castlejordan/Yellow sub-catchment were similar to those recorded by O'Connor (2006) who found a widespread albeit clumped distribution of lamprey in these catchments.

Lamprey habitat was generally poor across the survey area and the abundances and distribution of *Lampetra* sp. ammocoetes observed during this survey reflected the often low summer flows, the poor hydromorphology of most sites and the dominance of peat-dominated soft sediment. Owing to their relatively small morphologies, *Lampetra* species such as brook lamprey require clean, fine gravels in which to dig their redds (Lasne et al., 2010; Rooney et al., 2013; Dawson et al., 2015) although areas may also include fractions of sand, larger gravels, and cobble (Nika & Virbickas, 2010). Spawning habitat in the vicinity of the proposed development was appreciably sparse and of poor quality due to significant (peat) siltation pressures (as outlined above). Furthermore, lamprey ammocoetes require the deposition of fine, organic-rich sediment $\geq 5\text{cm}$ in depth in which to burrow and mature (Gardiner, 2003; Goodwin et al., 2008; Aronsuu & Virkkala, 2014). Peat-dominated substrata (i.e., humic deposits), such as those typically found in the vicinity of the proposed development, do not provide suitable burial/burrowing habitat complexity or structure for ammocoetes given their invariably fine and flocculent nature (pers. obs.).

European eel were only recorded (single individual) from a one site on the Yellow River, at Clongall Bridge (C7) (**Table 3.1, 3.2**). 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). This restricted distribution largely reflected the poor hydromorphology and reduced instream habitat heterogeneity resulting from historical modifications, providing a low frequency of suitable refugia (e.g. boulders, pools) required by the species (Laffaille et al., 2003). Nevertheless, numerous sites provided some good physical suitability for the species but no eel were recorded. As eel occurrence decreases significantly with increasing distance from the sea (Degerman et al., 2019), the paucity of eel and patchy distribution recorded during the electro-fishing survey in the Yellow[Castlejordan]_SC_010, Boyne_SC_030, Figile_SC_020 and Brosna_SC_010 river sub-catchments can be further explained by the considerable distance between the survey area and marine habitats ($>100\text{km}$ nearest instream distance) (Matondo et al., 2021; Chadwick et al., 2007).

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

Table 8.1 Macro-invertebrate Q-sampling results for sites A1, A2, A3, A4, A5, A6, A8, B1, B2, B3, C1, C2, C3 & C4, September 2022

Group	Family	Species	A1	A2	A3	A4	A5	A6	A8	B1	B2	B3	C1	C2	C3	C4	EPA group
Ephemeroptera	Heptageniidae	sp. indet.						1									A
Plecoptera	Nemouridae	<i>Protonemura meyeri</i>												2			A
Plecoptera	Nemouridae	<i>Nemurella picteti</i>			1												A
Ephemeroptera	Baetidae	<i>Alainites muticus</i>			3			10		20	22		3				B
Ephemeroptera	Baetidae	<i>Centroptilum luteolum</i>										1					B
Plecoptera	Leuctridae	<i>Leuctra hippopus</i>												2			B
Trichoptera	Goeridae	<i>Silo pallipes</i>						8									B
Trichoptera	Limnephilidae	<i>Limnephilus lunatus</i>			1	8			9				1				B
Trichoptera	Phryganeidae	<i>Agrypnia obsoleta</i>					1										B
Trichoptera	Sericostomatidae	<i>Sericostoma personatum</i>									3						B
Odonata	Calopterygidae	<i>Calopteryx splendens</i>				1		7	1			3	9				B
Odonata	Aeshnidae	<i>Aeshna</i> sp.											2				B
Odonata	Coenagrionidae	<i>Coenagrion</i> sp.					4										B
Ephemeroptera	Baetidae	<i>Baetis rhodani</i>			65	8	47	256	31	20	183		6	165			C
Ephemeroptera	Ephemerellidae	<i>Serratella ignita</i>						33	35	1	1			7			C
Ephemeroptera	Caenidae	<i>Caenis luctuosa</i>					1										C
Trichoptera	Caseless caddis pupa	sp. indet.				1					1						C
Trichoptera	Hydropsychidae	<i>Hydropsyche instabilis</i>				17		8					1	83			C
Trichoptera	Polycentropodidae	<i>Polycentropus kingi</i>						1									C
Trichoptera	Polycentropodidae	<i>Polycentropus flavomaculatus</i>											2				C
Crustacea	Gammaridae	<i>Gammarus duebeni</i>	13	52	1	1	11		52	38	82	5	57	54	2		C
Gastropoda	Bithyniidae	<i>Bithynia tentaculata</i>							4								C
Gastropoda	Lymnaeidae	<i>Stagnicola fuscus</i>	1	101								1	2		9		C
Gastropoda	Lymnaeidae	<i>Lymnaea stagnalis</i>				4		2							10		C
Gastropoda	Physidae	<i>Physella acuta</i>					7	12									C

Group	Family	Species	A1	A2	A3	A4	A5	A6	A8	B1	B2	B3	C1	C2	C3	C4	EPA group
Gastropoda	Planorbidae	<i>Bathyomphalus contortus</i>	2										3		3		C
Gastropoda	Planorbidae	<i>Planorbis planorbis</i>					11		3								C
Gastropoda	Planorbidae	<i>Gyraulus albus</i>				10	8										C
Gastropoda	Tateidae	<i>Potamopyrgus antipodarum</i>			1			6		2		1	2	2			C
Coleoptera	Dytiscidae	Dytiscidae larva			9	1	2						1				C
Coleoptera	Dytiscidae	<i>Dytiscus</i> sp.											1				C
Coleoptera	Dytiscidae	<i>Graptodytes pictus</i>											5		1		C
Coleoptera	Dytiscidae	<i>Ilybius fuliginosus</i>													2	2	C
Coleoptera	Dytiscidae	<i>Nebrioporus depressus</i>					1		1								C
Coleoptera	Dytiscidae	<i>Stictonectes lepidus</i>					1						1		3	2	C
Coleoptera	Dytiscidae	<i>Agabus nebulosus</i>				1											
Coleoptera	Elmidae	<i>Brychius elevatus</i>			4				5								C
Coleoptera	Elmidae	<i>Elmis aenea</i>				3		2	23		6		1	4			C
Coleoptera	Elmidae	<i>Limnius volckmari</i>											1				C
Coleoptera	Gyrinidae	Gyrinidae nymph			2												C
Coleoptera	Gyrinidae	<i>Gyrinus substriatus</i>		1							2		1		1		C
Coleoptera	Gyrinidae	<i>Orectochilus villosus</i>				11											C
Coleoptera	Halpliidae	<i>Haliplus lineatocollis</i>										1	1		11		C
Coleoptera	Halpliidae	<i>Haliplus ruficollis</i> group			5		8	1	1						5	2	C
Coleoptera	Hydrophilidae	<i>Anacaena globulus</i>		1													C
Coleoptera	Hydrophilidae	<i>Helophorus brevipalpis</i>			1					1							C
Diptera	Chironomidae	Non- <i>Chironomus</i> spp.			12		11			1		1					C
Diptera	Dixidae	sp. indet.			6			15		2							C
Diptera	Ephydriidae	sp. indet.														1	C
Diptera	Pediciidae	Dicranota sp.											1				C
Diptera	Simuliidae	sp. indet.						26	1		18		3				C
Hemiptera	Corixidae	Corixidae nymph			7		1						1			8	C

Group	Family	Species	A1	A2	A3	A4	A5	A6	A8	B1	B2	B3	C1	C2	C3	C4	EPA group
Hemiptera	Corixidae	<i>Hesperocorixa sahlbergi</i>													1		C
Hemiptera	Corixidae	<i>Hesperocorixa</i> sp.											2				C
Hemiptera	Corixidae	<i>Siagara</i> sp.					22		2			1			25	16	C
Hemiptera	Gerridae	Gerridae nymph			1				1	1		5					C
Hemiptera	Gerridae	<i>Gerris</i> sp.		3	1		3				1		1	1	1		C
Hemiptera	Hydrometridae	<i>Hydrometra stagnorum</i>			2	1									1		C
Hemiptera	Nepidae	<i>Nepa cinerea</i>					1										C
Hemiptera	Notonectidae	<i>Notonecta marmorea viridis</i>					3	1									C
Hemiptera	Veliidae	Veliidae nymph			2				1	1	1						C
Hydracarina	Hydrachnidae	sp. indet.		1	2	1	8										C
Crustacea	Asellidae	<i>Asellus aquaticus</i>	15		14	107	24	52	29		1		67	3	21		D
Gastropoda	Lymnaeidae	<i>Ampullacaena balthica</i>		106	14	12	9								1	37	D
Gastropoda	Physidae	<i>Physa fontinalis</i>		103				2	2								D
Mollusca	Sphaeriidae	sp. indet.					21	2									D
Hirudinidae	Glossiphoniidae	sp. indet.		3	1			1									D
Megaloptera	Sialidae	<i>Sialis lutaria</i>			2				1			3					D
Diptera	Chironomidae	<i>Chironomus</i> spp.			13		7										E
Annelidae	Oligochaeta	sp. indet.		1							1	1					n/a
Nematomorpha	Gordiidae	sp. indet.								1							n/a
Abundance			31	372	170	187	212	446	202	88	322	23	175	323	97	68	
Q-rating			3	2-3	3-4	2-3*	3	3-4	3	3	3	3*	2-3	3-4	3*	2-3*	
WFD status			Poor	Poor	Mod	Poor	Poor	Mod	Poor	Poor	Poor	Poor	Poor	Mod	Poor	Poor	

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

Table 8.2 Macro-invertebrate Q-sampling results for sites C5, C7, D2, D3, E1, E2, X1, X2a, X2b, X3, X4, X5 & X6, September 2022

Group	Family	Species	C5	C7	D2	D3	E1	E2	X1	X2a	X2b	X3	X4	X5	X6	EPA group
Ephemeroptera	Baetidae	<i>Alainites muticus</i>		7												B
Plecoptera	Leuctridae	<i>Leuctra hippopus</i>		2												B
Trichoptera	Cased caddis pupa	sp. indet.		1			1	1								B
Trichoptera	Goeridae	<i>Silo pallipes</i>									1					B
Trichoptera	Leptoceridae	<i>Triaenodes bicolor</i>											1			B
Trichoptera	Limnephilidae	<i>Limnephilus lunatus</i>						23				1			1	B
Trichoptera	Sericostomatidae	<i>Sericostoma personatum</i>						1			1					B
Odonata	Calopterygidae	<i>Calopteryx splendens</i>	1													B
Odonata	Coenagrionidae	<i>Coenagrion</i> sp.											11	23	1	B
Ephemeroptera	Baetidae	<i>Baetis rhodani</i>		2		30		15				3				C
Ephemeroptera	Ephemerellidae	<i>Serratella ignita</i>		4		1		1				1				C
Ephemeroptera	Caenidae	<i>Caenis luctuosa</i>											2			C
Trichoptera	Hydropsychidae	<i>Hydropsyche instabilis</i>		10		1										C
Trichoptera	Hydropsychidae	<i>Hydropsyche siltalai</i>				1										C
Trichoptera	Polycentropodidae	<i>Polycentropus kingi</i>				2										C
Trichoptera	Polycentropodidae	<i>Plectrocnemia conspersa</i>											1			C
Trichoptera	Polycentropodidae	<i>Plectrocnemia geniculata</i>												2		C
Crustacea	Gammaridae	<i>Gammarus duebeni</i>	35	15	3	115	15	58	22	6	6	5	4	3		C
Gastropoda	Bithyniidae	<i>Bithynia tentaculata</i>		1										6		C
Gastropoda	Lymnaeidae	<i>Stagnicola fuscus</i>	3					1							3	C
Gastropoda	Lymnaeidae	<i>Lymnaea stagnalis</i>	23													C
Gastropoda	Physidae	<i>Physella acuta</i>												1		C
Gastropoda	Planorbidae	<i>Bathymphalus contortus</i>						2			6				4	C
Gastropoda	Planorbidae	<i>Planorbis planorbis</i>			1			3			19					C
Gastropoda	Planorbidae	<i>Gyraulus albus</i>											1			C

Group	Family	Species	C5	C7	D2	D3	E1	E2	X1	X2a	X2b	X3	X4	X5	X6	EPA group
Gastropoda	Tateidae	<i>Potamopyrgus antipodarum</i>				204						17	1			C
Gastropoda	Valvatidae	<i>Valvata piscinalis</i>											1	1		C
Coleoptera	Dytiscidae	Dytiscidae larva			1			1				2				C
Coleoptera	Dytiscidae	<i>Hydroporus tessellatus</i>							1							C
Coleoptera	Dytiscidae	<i>Ilybius fuliginosus</i>	3					2	1							C
Coleoptera	Dytiscidae	<i>Laccophilus hyalinus</i> [†]												1		C
Coleoptera	Dytiscidae	<i>Nebrioporus depressus</i>									2	7				C
Coleoptera	Dytiscidae	<i>Stictonectes lepidus</i>												1		C
Coleoptera	Elmidae	<i>Brychius elevatus</i>		4		7										C
Coleoptera	Elmidae	<i>Elmis aenea</i>		8		3		12			1					C
Coleoptera	Elmidae	<i>Limnius volckmari</i>						1								C
Coleoptera	Gyrinidae	Gyrinidae nymph	2			2										C
Coleoptera	Gyrinidae	<i>Gyrinus substriatus</i>				11									2	C
Coleoptera	Halipliidae	<i>Haliplus flavicollis</i>										1				C
Coleoptera	Halipliidae	<i>Haliplus lineatocollis</i>	1										1			C
Coleoptera	Halipliidae	<i>Haliplus ruficollis</i> group	4											3		C
Diptera	Chironomidae	Non- <i>Chironomus</i> spp.				8		5		4		1		1		C
Diptera	Culicidae	sp. indet.											1			C
Diptera	Muscidae	<i>Limnophora</i> sp.				2			1							C
Diptera	Pediciidae	Dicranota sp.		1				1								C
Diptera	Tipulidae	<i>Tipula</i> sp.								2						C
Diptera	Simuliidae	sp. indet.		2		1										C
Hemiptera	Corixidae	<i>Siagara</i> sp.	12									7	1	23		C
Hemiptera	Gerridae	Gerridae nymph				2		1								C
Hemiptera	Gerridae	<i>Gerris</i> sp.		23				1								C
Hemiptera	Hydrometridae	<i>Hydrometra stagnorum</i>	2								1					C
Hemiptera	Veliidae	Veliidae nymph					1									C

Group	Family	Species	C5	C7	D2	D3	E1	E2	X1	X2a	X2b	X3	X4	X5	X6	EPA group
Hydracarina	Hydrachnidae	sp. indet.						3					1	22		C
Platyhelminthes	Dugesidae	<i>Dugesia</i> sp.												5		C
Platyhelminthes	Planariidae	sp. indet.				1										C
Crustacea	Asellidae	<i>Asellus aquaticus</i>	6		45	26	16	129	25		17	16	3	6	3	D
Gastropoda	Lymnaeidae	<i>Ampullacaena balthica</i>	15							2		75			31	D
Gastropoda	Physidae	<i>Physa fontinalis</i>									9					D
Hirudinidae	Glossiphoniidae	sp. indet.			1	3		2		2					2	D
Megaloptera	Sialidae	<i>Sialis lutaria</i>					2					1				D
Diptera	Chironomidae	<i>Chironomus</i> spp.	2			7	2	1	1	6		1				E
Annelidae	Oligochaeta	sp. indet.	1					1								n/a
Arachnida	Dictynidae	<i>Argyroneta aquatica</i>												2		n/a
Abundance			110	80	51	427	37	265	51	22	63	138	29	100	47	
Q-rating			3*	3	2*	3	2-3*	2-3*	2-3*	2*	2-3*	2-3	n/a	n/a	2-3*	
WFD status			Poor	Poor	Bad	Poor	Poor	Poor	Poor	Bad	Poor	Poor	n/a	n/a	Poor	

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

† the water beetle dinghy skipper *Laccophilus hyalinus* is listed as 'vulnerable' in Ireland (Foster et al., 2009)

Sites X4 and X5 were located on the Grand Canal and thus unsuitable for Q-sampling (i.e. sweep sample only)

9. Appendix C – physiochemical water quality results

Table 9.1 Summary of physio-chemical water quality results in the vicinity of the proposed Derrygreenagh Power development, September 2022 (values in **bold** exceed the good status thresholds set out under the Surface Water Regulations (S.I. 77 of 2019))

Parameter	A2	A3	A6	A8	B3	C2	C4	C7	D3	E2	X2b	X3	X4	X5
pH	8.13	7.53	7.69	7.69	7.87	7.99	7.38	7.97	7.7	7.62	7.72	7.82	8.14	8.12
Total Alkalinity (mg CaCO ₃ /l)	349	332	196	195	282	249	74	245	218	236	312	207	167	166
Total Oxidised Nitrogen (mg N/l)	2.670	2.030	1.183	1.181	1.082	1.225	1.459	1.213	1.165	1.015	0.978	1.418	<0.010	<0.010
Total Ammonia (mg N/l)	0.044	0.023	0.410	0.421	0.024	0.015	1.668	0.016	0.019	0.052	0.022	0.055	0.008	0.010
Total P (mg P/l)	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	0.018	0.016
MRP (mg P/l)	0.050	0.015	0.015	0.016	0.029	0.011	0.010	0.013	0.052	0.028	0.050	0.012	n/a	n/a
Chloride (mg Cl/l)	24.57	28.79	16.69	16.53	40.69	14.88	9.37	14.42	19.79	18.02	22.26	14.54	n/a	n/a
BOD (mg O ₂ /l)	0.6	0.9	1.5	1.8	6.8	0.8	5.8	1.0	1.8	1.4	1.2	1.9	n/a	n/a
COD (mg O ₂ /l)	10.1	28.7	59.0	58.5	44.7	42.1	82.3	45.6	45.1	52.0	29.1	45.6	n/a	n/a
Suspended Solids (mg/l)	2.0	2.7	2.2	1.8	50.5	1.5	14.0	2.7	2.5	3.2	2.2	2.3	1.5	1.8
Chlorophyll a (µg/l)	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	6.51	4.93

10. Appendix D – eDNA analysis lab report

Folio No: E15394
 Report No: 1
 Purchase Order: edna Sep 22 Derrygreenagh
 Client: Triturus Environmental Limited
 Contact: Ross Macklin

TECHNICAL REPORT

ANALYSIS OF ENVIRONMENTAL DNA SAMPLES FOR THE DETECTION OF CRAYFISH SPECIES AND CRAYFISH PLAGUE

SUMMARY

All organisms continuously release small amounts of environmental DNA (eDNA) into their habitat. By collecting and analysing this eDNA from water samples from lakes, ponds or rivers we can detect the presence or absence of crayfish species including: the white-clawed crayfish (*Austropotamobius pallipes*), signal crayfish (*Pacifastacus leniusculus*), the marbled crayfish (*Procambarus virginalis*) and the crayfish plague (*Aphanomyces astaci*).

RESULTS

Date sample received at Laboratory: 13/09/2022
Date Reported: 20/09/2022
Matters Affecting Results: None

Lab Sample ID.	Site Name	O/S Reference	Species	Result	SIC	DC	IC	Positive Replicates
FK768	E2 Derrygreenagh		White-Clawed Crayfish	Negative	Pass	Pass	Pass	0
			Crayfish Plague	Negative	Pass	Pass	Pass	0
FK769	B3 Derrygreenagh		White-Clawed Crayfish	Negative	Pass	Pass	Pass	0
			Crayfish Plague	Negative	Pass	Pass	Pass	0
FK781	D3 Derrygreenagh		White-Clawed Crayfish	Negative	Pass	Pass	Pass	0
			Crayfish Plague	Negative	Pass	Pass	Pass	0



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FK783	C7 Derrygreenagh	White-Clawed Crayfish	Positive	Pass	Pass	Pass	1
		Crayfish Plague	Positive	Pass	Pass	Pass	10

If you have any questions regarding results, please contact us: ForensicEcology@surescreen.com

Reported by: Chelsea Warner

Approved by: Gabriela Danickova

METHODOLOGY

The analysis is conducted in two phases. The sample first goes through an extraction process where the filter is incubated in order to obtain any DNA within the sample. The extracted sample is then tested via real time PCR (also called q-PCR) for each of the selected target species. This process uses species-specific molecular markers (known as primers) to amplify a select part of the DNA, allowing it to be detected and measured in 'real time' as the analytical process develops. qPCR combines amplification and detection of target DNA into a single step. With qPCR, fluorescent dyes specific to the target sequence are used to label targeted PCR products during thermal cycling. The accumulation of fluorescent signals during this reaction is measured for fast and objective data analysis. The primers used in this process are specific to a part of mitochondrial DNA only found in each individual species. Separate primers are used for each of the species: white-clawed crayfish, signal crayfish and crayfish plague, ensuring no DNA from any other species present in the water is amplified.

Analysis of eDNA requires scrupulous attention to detail to prevent risk of contamination. True positive controls, negative controls and spiked synthetic DNA are included in every analysis and these have to be correct before any result is declared and reported. Stages of the DNA analysis are also conducted in different buildings at our premises for added security. These methods have been extensively tested since 2015 in a number of different environments, habitats, conditions and ecological situations in order to successfully enable the full application of eDNA for the detection of crayfish species and the crayfish plague.

RESULTS INTERPRETATION

SIC: Sample Integrity Check [Pass/Fail]

When samples are received in the laboratory, they are inspected for any tube leakage, suitability of sample (not too much mud or weed etc.) and absence of any factors that could potentially lead to inconclusive results.

DC: Degradation Check [Pass/Fail]

Analysis of the spiked DNA marker to see if there has been degradation of the kit or sample, between the date it was made to the date of analysis. Degradation of the spiked DNA marker may indicate a risk of false negative results.

IC: Inhibition Check [Pass/Fail]

The presence of inhibitors within a sample are assessed using a DNA marker. If inhibition is detected, samples are purified and re-analysed. Inhibitors cannot always be removed, if the inhibition check fails, the sample should be re-collected.

Result: Presence of eDNA [Positive/Negative/Inconclusive]

Positive: DNA was identified within the sample, indicative of species presence within the sampling location at the time the sample was taken or within the recent past at the sampling location.

Positive Replicates: Number of positive qPCR replicates out of a series of 12. If one or more of these are



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found to be positive the pond is declared positive for species presence. It may be assumed that small fractions of positive analyses suggest low level presence, but this cannot currently be used for population studies. In accordance with Natural England protocol, even a score of 1/12 is declared positive. 0/12 indicates negative species presence.

Negative: eDNA was not detected or is below the threshold detection level and the test result should be considered as evidence of species absence, however, does not exclude the potential for species presence below the limit of detection.

Inconclusive: Controls indicate inhibition or degradation of the sample, resulting in the inability to provide conclusive evidence for species presence or absence.



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INTERPRETATION OF RESULTS

- SIC: Sample Integrity Check [Pass/Fail]**
When samples are received in the laboratory, they are inspected for any tube leakage, suitability of sample (not too much mud or weed etc.) and absence of any factors that could potentially lead to inconclusive results.
- DC: Degradation Check [Pass/Fail]**
Analysis of the spiked DNA marker to see if there has been degradation of the kit or sample, between the date it was made to the date of analysis. Degradation of the spiked DNA marker may indicate a risk of false negative results.
- IC: Inhibition Check [Pass/Fail]**
The presence of inhibitors within a sample are assessed using a DNA marker. If inhibition is detected, samples are purified and re-analysed. Inhibitors cannot always be removed, if the inhibition check fails, the sample should be re-collected.
- Result: Presence of eDNA [Positive/Negative/Inconclusive]**
- Positive:** DNA was identified within the sample, indicative of species presence within the sampling location at the time the sample was taken or within the recent past at the sampling location.
- Positive Replicates:** Number of positive qPCR replicates out of a series of 12. If one or more of these are found to be positive the pond is declared positive for species presence. It may be assumed that small fractions of positive analyses suggest low level presence, but this cannot currently be used for population studies. Even a score as low as 1/12 is declared positive. 0/12 indicates negative species presence.
- Negative:** eDNA was not detected or is below the threshold detection level and the test result should be considered as evidence of species absence, however, does not exclude the potential for species presence below the limit of detection.
- Inconclusive:** Controls indicate inhibition or degradation of the sample, resulting in the inability to provide conclusive evidence for species presence or absence.





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