Appendix 5.2. Fisheries Assessment Report, 2025

Fisheries assessment of Mortarstown WWTP upgrade works, Co. Carlow

Prepared by Triturus Environmental Ltd. for Atkins Realis

August 2025

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1. Introduction

1.1 Background

Triturus Environmental Ltd. were contracted by Atkins-Realis to undertake a baseline fisheries assessment of the River Barrow in the vicinity of proposed upgrade works to Mortarstown Wastewater Treatment Plant (WWTP) (licence no. D0018-01) near Carlow Town, Co. Carlow (**Figure 2.1**).

The upgrades (see section 1.2 below) involve works to the riverbank of the River Barrow and within the channel of the Barrow in the vicinity of the proposed WWTP outfall chamber and outfall pipe. The proposed works area is located within the River Barrow and River Nore SAC (002162), a site designated for a range of aquatic qualifying interests including Atlantic salmon (*Salmo salar*) and lamprey species (NPWS, 2011). Given that the proposed project will require a cofferdam and dry instream working area, the proposed project has the potential to impact juvenile lamprey (ammocoetes) during the construction period, if they are present within the footprint of the instream working area (i.e., within soft sediment along river margins).

Therefore, the survey was undertaken to establish baseline fisheries data used in the preparation of the NIS for the proposed works. A bathymetric survey of the River Barrow was also undertaken within the wider works footprint to identify the presence of and evaluate the quality of lamprey habitat not accessible by electro-fishing operators (i.e., due to depth constraints). The electro-fishing and bathymetry survey on the River Barrow in vicinity of the proposed works area are summarised on **Table 2.1 & Figure 2.1**. Whilst the survey focused primarily on assessing value for lamprey ammocoetes, electro-fishing also provided baseline information on the general fisheries habitat and value of the area in vicinity of the proposed works. The current survey (July 2025) helped to inform impact assessment and any subsequent mitigation for the project by updating the previous survey conducted during July 2021. This aimed to contemporise the data in line with CIEEM best practice (CIEEM, 2019). This was considered given the study area supports mobile species (i.e. lamprey) that have the potential to change distributions within the study area resultant of habitat condition and the stochastic patterns of larval lamprey settlement in dynamic river environments. This included an assessment of the quality and distribution of supporting soft sediment nursery and associated flow conditions from observational data.

1.2 Proposed works description

1.2.1 Mortarstown WWTP

The principal objective of the works associated with Mortarstown WWTP is to ensure that the treatment process can produce a treated effluent which satisfies the conditions of the Wastewater Discharge Licence (D0028-01). The works shall be designed to cater for 58,500 p.e. for the design horizon year 2047 and achieve ELV's of 25 mg/L BOD, 35 mg/L SS, 1.2 mg/L Ammonia and 1 mg/L Total Phosphate.

The WWTP was commissioned in 1986 as a conventional extended aeration WWTP with a design

capacity of 28,500PE. The aeration basins were upgraded in 2003 to a A20 bioreactor system (anaerobic, anoxic, aerobic) which provides an additional treatment capacity of 7,500PE in the bioreactors. Therefore, the WWTP had inadequate capacity to cater for future demand and much of the existing mechanical and electrical equipment is at end of serviceable life and is no longer functioning.

In addition, the Supervisory Control and Data Acquisition (SCADA) system is defunct and the systems for automatic control and measurement of the storm return and surplus sludge are not operational. The plant requires greater manual input than was originally intended.

As part of the upgrade works all flows to the WWTP will be subjected to preliminary treatment comprising fine screening, grit removal and storm water storage. Biological treatment for carbonaceous and nitrogen removal will be achieved by supplementing the existing activated sludge process with upstream primary treatment. Phosphorus removal will be achieved using a combination of biological and chemical treatment and all treated effluent will discharge by either gravity into the River Barrow.

A summary of the works required is as follows;

Mortarstown WWTP

- Provision of foul pumping station for local agglomeration adjacent to existing inlet works (supplemented by standby generator)
- Provision of a fuel storage tank and standby diesel generator to service the WWTP.
- Provision of new inlet works to include fine screening, mechanically raked by-pass screen, screening compaction and conveyance to skips, grit removal, grit classification and conveyance to skips. The new inlet works to be provided with an odour treatment unit.
- Provision of 2 no. stormwater storage tanks and 2 no. stormwater return pumps.
- Existing final settlement tanks and associated RAS/WAS to be retained, cleaned and decommissioned.
- Provision of 4 no. primary settlement tanks and scraper systems.
- Provision of 4 no. primary sludge pumps.
- Provision of 4 no. air blowers and modifications to existing air delivery pipework
- Provision of new air blower building.
- Provision of new fine bubble diffused air system in existing aeration tanks.
- Provision of 2 no. final settlement tanks with half-bridge scrapers.
- Provision of new RAS/WAS pumping station and station fitted with 2 no. RAS pumps and 2 no. WAS pumps.
- Structural refurbishment of picket fence tanks.
- Mechanical and electrical refurbishment of existing picket fence thickener and conversion of second existing tank to a sludge blending tank.
- Provision of 2 no. additional picket fence tank thickener.
- Provision of 1 no. belt press, polymer prep unit and polymer dosing pumps.
- Provision of new pumped sludge transfer system.

- Provision of sludge import facility.
- Provision of 1 no. new outfall chamber and outfall pipe.
- Modifications to existing administration building.
- Provision of MEICA and SCADA upgrades.
- New storage shed and associated gantry.
- Demolition of existing inlet works structure.
- Existing service relocations.
- General civil site works.

Microtunnel Gravity Sewer

- Provision of 775m microtunnel gravity sewer (Ø1650mm internal diameter) from the south side of the existing Kilkenny Road Pumping Station to the wet well of the new pumping station to be constructed adjacent the new inlet works of the upgraded WwTP. The microtunnel will be routed along the R448 Kilkenny Road before it traverses agricultural land to connect to the WwTP.
- The microtunnel comprises an interception manhole, 2 no. launch shafts and 2 no. reception shafts where the main launching facilities is proposed at the main PS shaft in the WwTP area.

New Wastewater Pumping Station

- Provision of 1 no. terminal pump station.
- Provision of 4 no. raw sewerage pumps inclusive of MEICA works.
- Provision of 1 no. standby generator and associated fuel storage.
- Provision of 1 no. odour control unit.
- Provision of 1 no. flow meter chamber

1.3 Fisheries asset of the survey area

The River Barrow is Ireland's second-longest river, flowing for some 192km and draining an area of approx. 3010km^2 (Delanty et al., 2017). The main channel, estuary and many of the sub-catchments are located within the River Barrow and River Nore SAC (site code: 002162). The following fish and aquatic invertebrate species are listed as qualifying interest species for the SAC (NPWS, 2025);

- Freshwater pearl mussel (*Margaritifera margaritifera*) [1029]
- White-clawed crayfish (*Austropotamobius pallipes*) [1092]
- Sea lamprey (*Petromyzon marinus*) [1095]
- Brook lamprey (*Lampetra planeri*) [1096]
- River lamprey (*Lampetra fluviatilis)* [1099]
- Twaite shad (*Alosa fallax*) [1103]
- Atlantic salmon (*Salmo salar*) (only in fresh water) [1106]

1.3.1 Lamprey species (Annex II)

All three of the lamprey species recorded in Ireland, brook (*Lampetra planeri*), river (*Lampetra fluviatilis*) and sea lamprey (*Petromyzon marinus*), are all listed on Annex II of the European Union (EU) Habitats Directive (92/43/EEC). Atypically for Ireland, all three species are known to occur in the River Barrow and are each listed as conservation objectives for the River Barrow and River Nore SAC (002162). All Irish lamprey species are semelparous, i.e. breed once in their lifetimes and then die.

A dedicated catchment-wide lamprey survey (King, 2006) found that the River Barrow was poor in terms of ammocoete distribution, with a greater number of negative sites encountered than in other surveys of large Irish river catchments. Over 50% of sites did not contain juvenile lamprey and none were recorded on the main Barrow channel. Likewise, Delanty et al. (2017) found similar results, with over half the sites returning negative results (i.e. no ammocoetes) and none recorded in the main river channel. According to Inland Fisheries Ireland, sea lamprey favour the turbulent aerated sections of the river for spawning, areas that are now largely restricted to the tail race of weir structures along the River Barrow (IFI, 2011). Sea lamprey occupy a very limited distribution in the Barrow catchment and were historically known to spawn below the weirs at Graiguenamanagh, Tinnahinch, Bahana and, particularly, St. Mullins (Kurz & Costello, 1999; pers. obs.). The latter is accepted as being the last remaining important spawning site for the species in the Barrow. Population sizes are, however, accepted as typically being small on the main River Barrow channel (King, 2006).

The nearest good-quality lamprey habitat to the Mortarstown WWTP survey area was identified via electro-fishing surveys in 2018 immediately below Carlow Weir (1.6km upstream; Macklin et al., 2018), where relatively high densities of *Lampetra* sp. were recorded (i.e., > 30 per m^2). A low density of *Lampetra* sp. ammocoetes (2.6 per m^2) was also recorded on the Barrow at Clongrennan lock, approx. 1.6km downstream of the proposed works area, in September 2020 (Triturus, 2020). The previous survey of the Mortarstown study area carried out by Triturus Environmental in July 2021 recorded low densities of larval lamprey, minnow and three-spined stickleback in the survey area (Triturus, 2021).

2. Methodology

2.1 Fisheries assessment (electro-fishing)

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 an electro-fishing survey in the footprint of the proposed Mortarstown WWTP upgrade works. Permission was granted in June 2025 and the survey was undertaken on the 3rd of July 2025, following notification to Inland Fisheries Ireland and under the conditions of a Department of Climate, Energy & Environment (DCEE) licence. A single anode Smith-Root LR24 backpack (12V DC input; 300V, 100W DC output) was used to electro-fish the River Barrow in the footprint of the proposed Mortarstown WWTP upgrade works. Soft sediment areas within the vicinity of the proposed works area were evaluated in terms of their suitability for lamprey ammocoetes.

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. Captured larval lamprey and other incidental 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. Electro-fishing methodology followed accepted European standards (CEN, 2003) and adhered to best practice (e.g. CFB, 2008).

The electro-fishing survey was undertaken at *n*=2 sites within the vicinity of the proposed WWTP outfall works (**Table 2.1, Figure 2.1**).

Table 2.1 Electro-fishing survey site locations in the vicinity the proposed Mortarstown WWTP upgrade works, Carlow

Site no.	Watercourse	EPA code	Location	X (ITM)	Y (ITM)
A	River Barrow	14B01	Near proposed Mortarstown WWTP outfall	671109	674928
B	River Barrow	14B01	Downstream of proposed Mortarstown WWTP outfall	671077	674894

2.1.1 Lamprey

Electro-fishing for lamprey ammocoetes was conducted using targeted quadrat-based electro-fishing (as per Harvey & Cowx, 2003) in objectively suitable areas of soft sediment, where encountered. As lamprey take longer to emerge from sediment and require a more persistent approach, they were targeted at a lower frequency (30Hz) burst DC pulse setting which also allowed the safe capture of European eel and other fish species, 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.

10–15 cm 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).

2.1.2 Fisheries habitat

A fisheries habitat appraisal upstream and downstream of the survey area was undertaken to establish the importance for salmonid, lamprey, European eel and other fish species. The appraisals of salmonids and lamprey were cognisant of species-specific habitat requirements and preferences as outlined in O'Grady (2006), Hendry et al. (2003), Armstrong et al. (2003), Harvey & Cowx (2003), Maitland (2003) and Hendry & Cragg-Hine (1997). River habitat surveys and fisheries assessments were also carried out utilising elements of the approaches in the River Habitat Survey Methodology (EA, 2003) and Fishery Assessment Methodology (O'Grady, 2006) to broadly characterise the riverine sites (i.e. channel profile, substrata etc.).

2.2 SONAR survey

To determine the bathymetry and substrata-type (i.e., bottom hardness) within the vicinity of the proposed WWTP outfall area, a SONAR survey was undertaken during July 2025, repeating the previous July 2021 survey effort to examine the soft sediment distributions. Primarily, this approach helped to estimate the extent of and elucidate any potential (soft sediment) larval lamprey areas that maybe present in poorly accessible deeper water zones (i.e., >1.3m in depth, beyond scope of backpack electro-fishing). However, the survey also provided information on the wider fisheries habitat present in the vicinity of works area. A Hummingbird Xplore 9 unit was mounted on a 3m RIB equipped with a total-scan transducer to log bathymetry and bottom hardness. Reefmaster v2.0 software was used to generate point clouds for map creation in QGIS.

2.3 Biosecurity

A strict biosecurity protocol including 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. The outboard engine was a Torqeedo electric engine (i.e. no impeller water cooling), thus minimising bilge water transfer associated with traditional outboard models (**Plate 2.1**). The engine, being light, was easy to clean in a barrel of Virkon before and after use to prevent the spread of invasive species and pathogens. Particular note was taken of the possibility of spreading crayfish plague (*Aphanomyces astaci*), known within the River Barrow since 2017 (NPWS, 2017, 2019).

Plate 2.1 Survey equipment used during the July 2025 survey

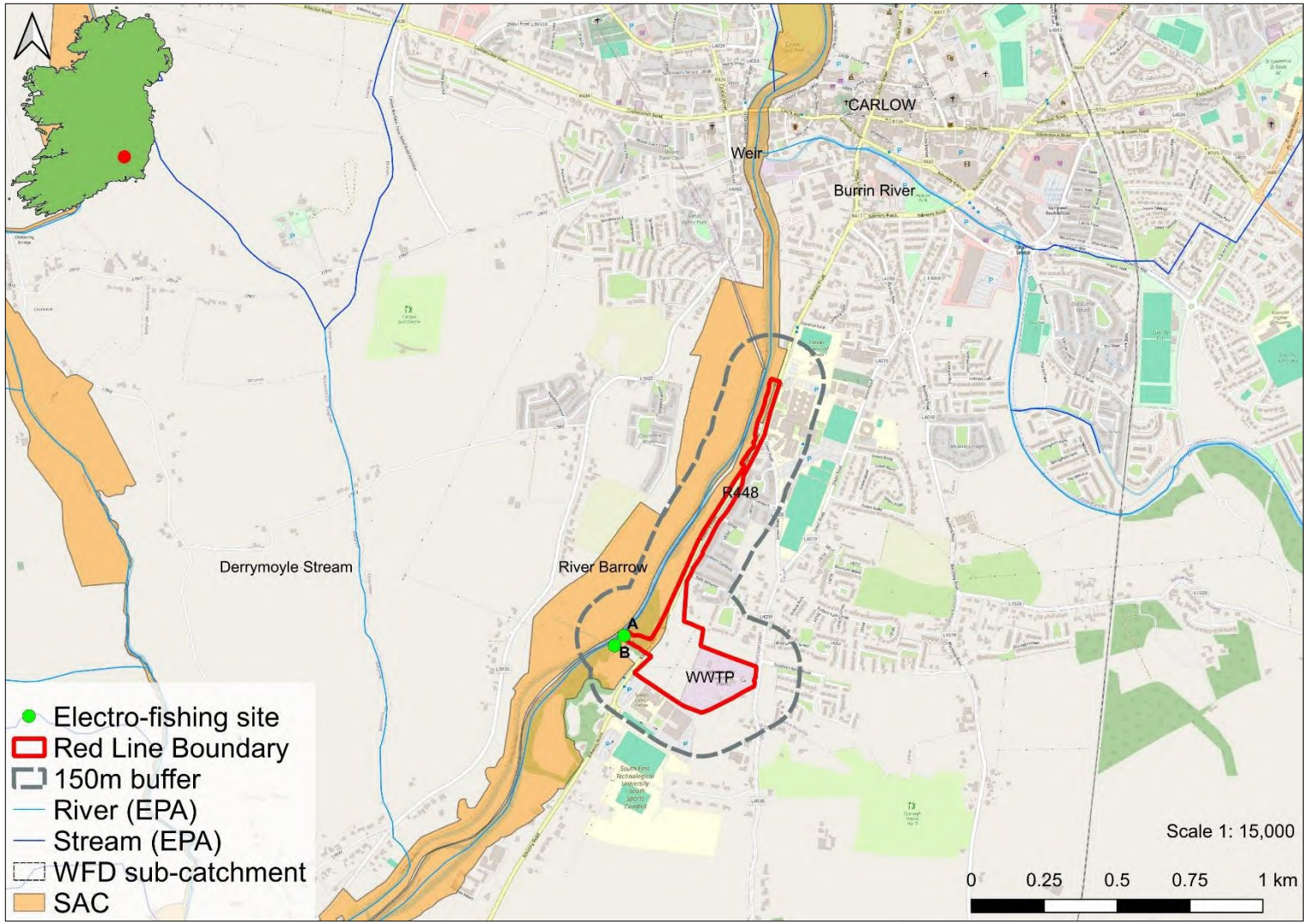

Figure 2.1 Location of the electro-fishing area in vicinity of the proposed Mortarstown WWTP upgrade works

Figure 2.2 Location of the electro-fishing spot points A and B in vicinity of the proposed Mortarstown WWTP upgrade works

3. Results

A targeted electro-fishing survey for lamprey ammocoetes was undertaken in the footprint of the proposed works on the 3rd of July 2025 following notification to Inland Fisheries Ireland. This survey repeated that carried out in July 2021 to establish potential changes in the habitat structure and fish composition. 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 lamprey and other fish species. Scientific names are provided at first mention only.

3.1 Fisheries assessment (electro-fishing)

3.1.1 Site A (within proposed works area)

Site A was located on the east bank of the River Barrow in the vicinity of the proposed outfall pipe works area (**Figure 2.2**). The river was a large lowland depositing watercourse (FW2; Fossitt, 2000) that averaged 30-35m wide and ranged from 1.2m deep in the margins to >3m in the central channel. The area was dominated by deep slow-flowing glide with localised area of deeper pool in the centre channel. The littoral area supported imperceptible flows and featured steeply-sloping banks of soft sediment (silt), which were invariably very deep (up to 0.3-0.4m) and near-anoxic in most areas. The littorals adjoined mixed coarse gravels with occasional cobble and boulder at the base of the marginal slope. The east bank of the river supported dense overhanging grey willow (*Salix cinerea*), crack willow (*Salix fragilis*) and osier (*Salix viminalis*). Riparian shading was high and this resulted in only limited macrophyte growth along the margins of the channel. This included occasional submerged arrowhead (*Sagittaria sagittifolia*) in addition to invasive Nuttall's pondweed (*Elodea nuttallii*). Nuttall's pondweed had increased in the littorals of the channel due to reduced flows in July 2025.

Minnow (*Phoxinus phoxinus*) and dace (*Leuciscus leuciscus*) were the only fish species recorded via electro-fishing from site A, situated in the footprint of the proposed outfall area (**Figure 3.1**). Despite the presence of abundant, organic-rich soft sediment areas, no lamprey ammocoetes were recorded from targeted electro-fishing of 3 no. contiguous 1m^2 areas. Dense overhanging growth of willow species had resulted in little to no flows along the river margins and very heavy shading thus creating conditions inimical to larval lamprey (**Plate 3.1**). The site, however, had some value as a coarse fish nursery habitat with both juvenile minnow and dace recorded (**Plate 3.2**).

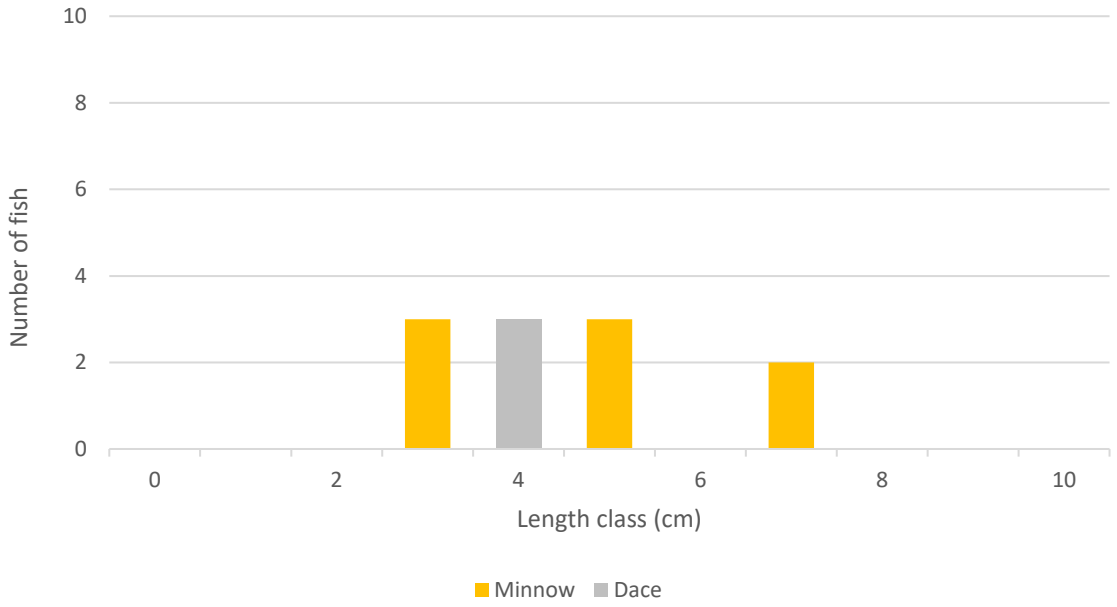

Figure 3.1 Length frequency distribution recorded via electro-fishing at site A on the River Barrow, July 2025

Plate 3.1 Dense willow growth adjoining site A resulting in poor mixing of flow and accretion of anoxic sediment, July 2025

Plate 3.2 Juvenile dace captured at site A, July 2025

3.1.2 Site B (downstream of proposed works area)

Site B was located in a small bay on the east bank of the River Barrow, approximately 30m downstream of the proposed outfall pipe works area (**Figure 2.2**). The site represented one of the few areas accessible to backpack electro-fishing in the vicinity of the proposed outfall works (i.e., <1.3m in depth). As per upstream, the river depths ranged from 1.1-1.3m in the margins to >3m in the central channel. The area was dominated by deep slow-flowing glide with localised area of deeper pool in the centre channel. The marginal substrata were dominated by organic-rich silt and sand (up to 0.2m in depth), grading into mixed gravels and occasional cobble and boulder at the base of the steep marginal slope. The site adjoined a residential property garden (GA2) and was more open that site A (historical tree clearance), with lower cover of overhanging trees. Thus, the area received some influence from currents, given the absence of overhanging trees and limbs which would otherwise restrict flow. However, flows were noticeably reduced when comparing July 2021 with the current July 2025 survey due to the dry spring. Macrophytes included occasional yellow water lily (*Nuphar lutea*), submerged arrowhead, with emergent water mint (*Mentha aquatica*) and reed canary grass (*Phalaris arundinacea*) along channel margins. The cover of invasive Nuttall's pondweed (*Elodea nuttallii*) had increased significantly in open areas of the bank inclusive of in the vicinity of site B. This was considered to provide improved nursery conditions for cyprinid fish and stickleback species.

Minnow, dace and three-spined stickleback (*Gasterosteus aculeatus*) were the only fish recorded during targeted electro-fishing at site B in July 2025(**Figure 3.2**). During the previous survey in July 2025 low densities of *Lampetra* sp. ammocoetes were recorded, equating to a density of 1 per m^2 of targeted habitat fished. However, none were recorded in the current survey. The increased marginal flows and reduced riparian shading compared with site A provided improved

ammocoete habitat, albeit the quality of nursery conditions was reduced between the current (2025) and previous (2021) survey. The reduced flows and increase in anoxic sediment conditions limited the suitability of ammocoete burial habitat during the current survey. The site was of greater value as a coarse fish nursery habitat with an observed increase in the densities of dace and minnow. These cyprinid fish likely benefited from the increased cover of Nuttall's pondweed at site B. The comparison of the fish recorded between July 2021 and July 2025 is summarised in **Table 3.1** below.

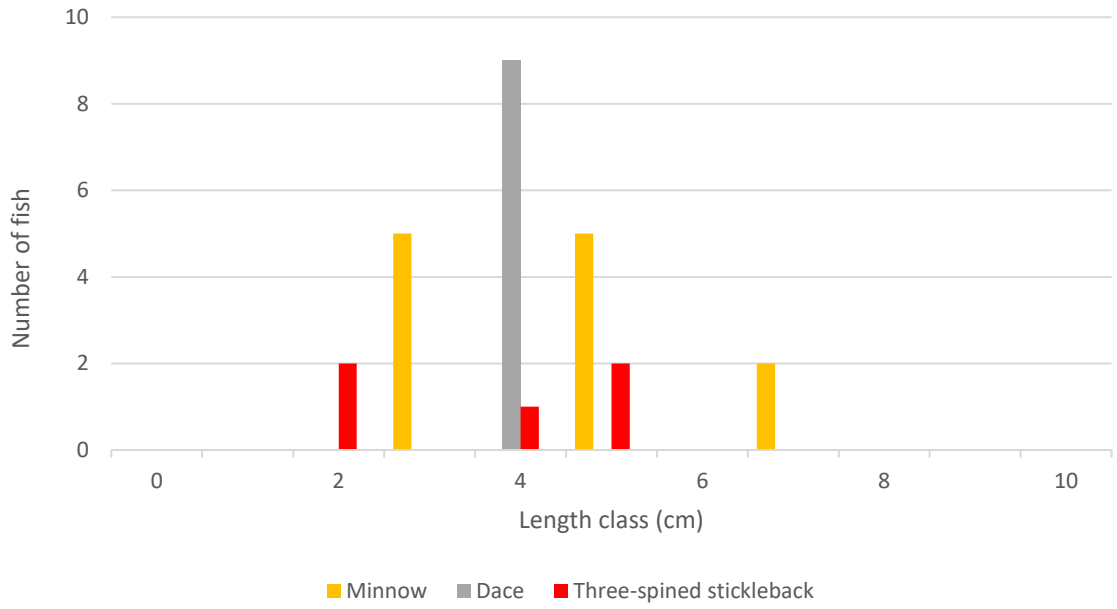

Figure 3.2 Length frequency distribution recorded via electro-fishing at site B on the River Barrow, July 2025

Plate 3.4 Representative image of site B on the River Barrow, July 2025 (located immediately downstream of the proposed outfall works area)

Plate 3.5 Juvenile cyprinid fish including minnow were frequent at site B, July 2025

Plate 3.6 *Lampetra* sp. ammocoete recorded from site B (downstream of the proposed outfall works area) during previous July 2021 survey (not recorded in July 2025)

Table 3.3 Comparison of fish recorded via electro-fishing between July 2021 and July 2025

Site no.	July 2021	July 2025	Notes
A	Minnow (7) & three-spined stickleback (1)	Dace (3) & minnow (8)	Dace and minnow recorded in 2025. Previously small numbers of three-spined stickleback and minnow were recorded
B	*Lampetra* sp. (3) & minnow (4)	Three-spined stickleback (5), dace (9) & minnow (13)	Increase in the numbers of cyprinid fish between 2021 and 2025, likely associated with the reduced flows and increase in cover of Nuttall's pondweed. Lamprey ammocoetes recorded at low densities in 2021 but not recorded in 2025

Plate 3.7 Electro-fishing of marginal silt at site B, July 2025

3.2 Bathymetric (SONAR) survey

3.2.1 Bathymetry

The SONAR survey conducted during July 2021 (Triturus, 2021) confirmed the high average mean depth of the River Barrow (2.4m ± 0.54m SD) in vicinity of the proposed outfall works area (**Figure 3.3**). As illustrated in **Figure 3.3**, the River Barrow followed a typical trapezoidal profile, with shallow margins steeply grading into a deeper centre channel of >3m. The minimum depth logged along the proposed works area (east bank) was 1.5m, although instream wading of marginal areas not accessibly by boat revealed a typical depth of approximately 1.2m under the overhanging willow canopy on a steeply-sloping river margin. The current 2025 bathymetric data output focused on the repeat of the bottom hardness study to establish potential changes in the distribution of larval lamprey soft sediment burial habitat (section 3.2.2 below).

3.2.2 Bottom (substrate) hardness

The plot of bottom (substrate) hardness between 2021 and 2025 (**Figures 3.4 & 3.5**, respectively) shows a mixture of both soft and harder substrata (gravels, cobble, occasional boulder) in the footprint of the proposed works area. Broadly, the distribution of soft sediments bordered the shallower east and west banks of the study area where increased rates of sediment accretion occur. Evidently, the areas of softer sediment (lighter shading) were restricted to the depositing channel margins along the east bank (that are covered by an extensive willow canopy and limbs that encourage deposition). These findings were supported by observing the bed with a bathyscope in strong sunlight. While such habitat can support lamprey ammocoetes (chosen for burial by juveniles), bathyscope and electro-fishing surveys carried out along the margins confirmed the near-anoxic soft sediment in this area was invariably deep (between 0.4-0.5m in depth) with very limited aeration due to restricted flow. A narrow band of soft sediment was also present along the east bank downstream of the proposed works area (i.e., in site B). During the 2021 survey this area supported shallower (maximum of 0.3m), lighter coloured, well-mixed sand, silt and organic matter. The silt layer had deepened in 2025 with noticeably darker coloured silt supporting increased anoxic conditions due to prolonged lower flow conditions (pers. obs.). This area was situated outside the main bathymetric study area but the pattern of softer substrata can be seen in the southwestern area of the sounding plot on **Figures 3.4 & 3.5**.

Figure 3.3 Bathymetry map of the proposed Mortarstown WWTP outfall works area, (darker shading indicates deeper water) Triturus data (2021)

Figure 3.4 Bottom hardness map of the proposed Mortarstown WWTP outfall works area, July 2021 (lighter shading indicates softer substrata)

Figure 3.5 Bottom hardness map of the proposed Mortarstown WWTP outfall works area, July 2025 (lighter shading indicates softer substrata)

4. Discussion

There was no suitability for lamprey ammocoetes within the proposed Mortarstown WWTP outfall works area (site A) despite the presence of soft substrata that could support lamprey ammocoetes (**Figure 3.4**). The soft sediment overlapping the proposed works area was considered unsuitable for lamprey ammocoetes, given high shading, poorly oxygenated sediment and poor flow rates (refer to section 3.2.2 of results). This was concluded during both the initial July 2021 and repeat July 2025 survey. The heavy growth of willows and overhanging/submerged limbs encouraged high levels of sediment accretion. However, the high quantities of depositional leaf litter and flow restrictions behind the limbs resulted in slow rates of breakdown and dark black anoxic silt that had very low suitability for lamprey (none recorded during either survey).

Some peripheral, sub-optimal ammocoete habitat (site B) existed a short distance downstream of the proposed outfall area. While a very low density (1 per m^2) of *Lampetra* sp. ammocoetes was recorded via electro-fishing during July 2021, no larval lamprey were recorded during July 2025. It was noted that the river flows were very low due to the dry spring/summer in 2025 and this may have discouraged larval lamprey settlement into this previously utilised area. Nonetheless, the historically recorded low density at site B was significantly lower than densities recorded downstream of Carlow Weir, 1.6km upstream of the study area. At Carlow Weir, >30 lamprey ammocoetes per m^2 were recorded in 2018 (Macklin et al., 2018) supporting the species' requirement for soft, organic rich and non-anoxic sediments. Conclusively, the area of river channel in vicinity of the proposed works were of low value to lamprey in terms of both spawning (i.e. no finer mixed gravels) and poor nursery habitat (sub-optimal). In this respect, lamprey ammocoetes require the deposition of fine, organic-rich sediment ≥5cm in depth in which to burrow and mature (Aronsuu & Virkkala, 2014; Goodwin et al., 2008; Gardiner, 2003). Furthermore, their survival depends on a permanent unidirectional water flow, to supply them with the proper nutrients, while promoting the exchange of respiratory gases and metabolic residues (Ferreira et al., 2013; Hardisty & Potter 1971).

The narrow band of soft sediment areas along the east bank of the River Barrow within the vicinity of proposed works area was broadly consistent between the two survey periods (**Figures 3.4 & 3.5**). However, while the soft sediment distribution was similar, the condition of the sediment for ammocoetes had declined. This was considered as a result of very low flows given high riparian shading from willow trees and limbs, thus encouraging more accretion of anoxic sediments. Evidently, this resulted in conditions inimical to larval lamprey (none recorded via electro-fishing at either location). Site B, located approximately 30m downstream of the proposed works area, was a more open habitat with lighter coloured silt, sand and organics than site A, during the previous July surveys when a low density of ammocoetes was recorded. However, the poorer flows recorded in July 2025 and associated reduced oxygenation of sediments resulted in darker anoxic silt. Consequently, while this area previously supported more favourable conditions for lamprey during July 2021 (i.e., organic-rich, better-oxygenated soft sediment), it appeared to be of significantly lower suitability in July 2025. The lower flow rates and poorer mixing of currents may have also impacted the larval drift settlement of ammocoetes. No finer well oxygenated gravels were present in the vicinity of the study area, indicating an absence of nearby suitable spawning areas adjoining soft sediment burial habitat.

Although it is becoming more widely accepted that larval lamprey may burrow at greater depths than previously thought (up to 1.5m), the optimal nursery water depth for *Lampetra* species (i.e., brook and river lamprey) is <1m and often <0.5m (Maitland, 2003). The SONAR survey confirmed that more optimal depths (i.e. <1m) are largely absent from the vicinity of the proposed outfall (**Figure 3.3**). *Lampetra* sp. ammocoetes in particular are known to prefer soft sediment areas with gradients no greater than 1% (Kelly & King, 2001). The marginal slopes of both the survey area, and much of the main channel of the River Barrow, are typically much steeper than this (Macklin et al., 2018; Triturus, 2017; pers. obs.) and are, thus, largely unsuitable for ammocoete settlement and burial. The exceptions to this are downstream of weirs and canal locks in addition to the confluence points of small tributaries and drains.

In support of previous findings on the River Barrow (Delanty et al., 2017; Triturus, 2017; King, 2006), lamprey spawning and ammocoete habitat was highly localised and limited in extent within the vicinity of the works area. Overall, the main channel of the River Barrow provides typically poor habitat for lamprey (Delanty et al., 2017) given the predominance of deep, slow-flowing glide with steep margins. As stated previously, the nearest good-quality lamprey habitat to the Mortarstown WWTP survey area was identified via electro-fishing surveys in 2018 immediately below Carlow Weir (1.6km upstream), where relatively high densities of *Lampetra* sp. were recorded (i.e., > 30 per m^2). A low density of *Lampetra* sp. ammocoetes (2.6 per m^2) was also recorded on the Barrow at Clongrennan lock, approximately 1.6km downstream of the proposed works area, in September 2020 (Triturus, 2020).

Whilst of low value for lamprey, the wider survey Mortarstown WWTP outfall area was of value as a coarse fish habitat. Indeed, the margins of channel, which supported macrophytes inclusive of invasive Nuttall's pondweed, provided good nursery conditions for juvenile cyprinids. Evidently the current survey supported increased numbers of minnow and dace between the July 2021 and July 2025 survey periods (**Table 3.1**). The deep margins and overhanging tree canopies along the east bank of the River Barrow (i.e., proposed works area) also provided good cover and nursery habitat for a range of species. This included species synonymous with the River Barrow including perch (*Perca fluviatilis*), dace (*Leuciscus leuciscus*) and roach (*Rutilus rutilus*). The adjoining deeper central channel (up to >3m) also provided good-quality coarse fish habitat for roach, dace, bream (*Abramis brama*) and bream hybrids, as well as adult pike (*Esox lucius*); these findings were consistent between the July 2021 and July 2025 surveys. This deeper glide was not considered to be of high value for adult salmonids (as holding habitat) or juveniles, given slow flow rates and a more homogenous profile. Better holding habitat exists in the faster flowing deep glide and pool downstream of Carlow Weir for approximately 250m. Good quality salmonid nursery habitat also (i.e., faster-flowing areas of riffle, supporting more varied cobble and boulder substrata) also exists downstream of Carlow Weir. The accelerated flows at Carlow Weir also provide spawning for salmon where mixed cobble, coarse and medium gravels provide spawning opportunities in pool tailings. Further good-quality nursery, spawning and holding habitat is also present downstream, near Clongrennan Lock. Historically, these areas were found to support moderate numbers of Atlantic salmon parr and low numbers of brown trout (Triturus, 2020; Macklin et al., 2018). On the main channel of the River Barrow (excluding tributaries) the best quality salmonid and lamprey habitat is found in the downstream vicinity of weirs, where flow rates are naturally higher (Delanty et al., 2017; King, 2006; pers. obs.).

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