Appendix VI
Aquatic Baseline Report

Aquatic baseline report for BusConnects Dublin – Core Bus Corridor Infrastructure Works

Prepared by Triturus Environmental Ltd. for Scott Cawley

August 2022

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1. Introduction

1.1 Background

Triturus Environmental Ltd. were contracted by Scott Cawley Ltd. to undertake an updated baseline aquatic and fisheries survey (2022) along numerous watercourses in the footprint of the proposed BusConnects Dublin – Core Bus Corridor Infrastructure Works project. The survey would provide more contemporary data over the initial aquatic surveys carried out for the project in 2020 given the time lapse since those surveys were conducted to support EIAR preparation for the project.

The 2022 surveys were undertaken to establish the importance of the watercourses in the footprint of the project from an aquatic ecological and fisheries perspective. This included specifically an appraisal of the fisheries, biological water quality data, macrophyte composition including Annex I Habitat associations and an evaluation of the presence or absence of white-clawed crayfish (*Austropotamobius pallipes*). This would help inform mitigation to minimise impacts to sensitive aquatic receptors relative to the proposals. Proposed infrastructure includes the crossing of riverine and artificial watercourses via the installation of pedestrian footbridges and cycle bridges as well as road culvert extension (instream works) and local road widening.

1.2 Project description

BusConnects is the National Transport Authority's programme to greatly improve bus services in Irish cities. It is a key part of the Government's policy to improve public transport and address climate change in Dublin and other cities across Ireland. BusConnects Dublin includes the Network Redesign and Implementation of 16 Core Bus Corridors throughout the city. The Core Bus Corridor Projects will see the roll-out of approximately 230km of continuous bus priority and 200km of cycle routes.

2. Methodology

2.1 Desktop review

A desktop review was undertaken to collate and review available information, datasets and documentation sources pertaining to the natural environment of the aquatic survey sites. Records available on the National Biodiversity Data Centre and National Parks and Wildlife Service websites were reviewed, in addition to previous surveys of the respective watercourses undertaken by Triturus Environmental Ltd. in October and November 2020 that have been resurveyed in 2022.

2.2 Aquatic surveys

Aquatic surveys were undertaken at a total of *n*=8 sites in July 2022 by Triturus Environmental Ltd. aquatic ecologists. Survey sites were located on the River Tolka, Grand Canal, River Poddle, River Camac and Royal Canal (**Table 2.1, Figure 2.1**). Each site was assessed in terms of fisheries habitat, white-clawed crayfish (*Austropotamobious pallipes*), biological water quality (Q-sampling at riverine sites, macro-invertebrate sampling at canal sites) and macrophytes in the vicinity of the proposed watercourse crossings and works areas. Rare, protected and or conservation interest water dependent species such as otter (*Lutra lutra*) were also noted, where encountered. This holistic approach informed the overall aquatic ecological evaluation of each site in context of the proposed project infrastructure.

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 hydromorphological modification(s)
- Substrate type, listing substrate fractions in order of dominance (i.e. bedrock, boulder, cobble, gravel, sand, silt etc.)
- Flow type by proportion of riffle, glide and pool in the sampling area
- An appraisal of the macrophyte and aquatic bryophyte community at each site
- Riparian vegetation composition

Table 2.1 Location of the *n*=8 aquatic survey sites in the vicinity of the Dublin BusConnects project, July 2022

Site no.	Watercourse	EPA code	Location	X (ITM)	Y (ITM)
1	River Tolka	09T01	Frank Flood Bridge	716117	736764
2	Grand Canal	n/a	Emmett Bridge	714869	732443
3	River Poddle	09P03	Mount Argus	714062	731420
4	River Camac	09C02	Nangor Road (R134)	707780	732083
5	River Camac	09C02	Yellowmeadows	708581	732055
6	River Poddle	09P03	Source of Poddle, Greenhills Road	709543	728096
7	River Tolka	09T01	N3 culvert	707833	739035
8	Royal Canal	n/a	5th level, Phibsborough Road	715117	736258

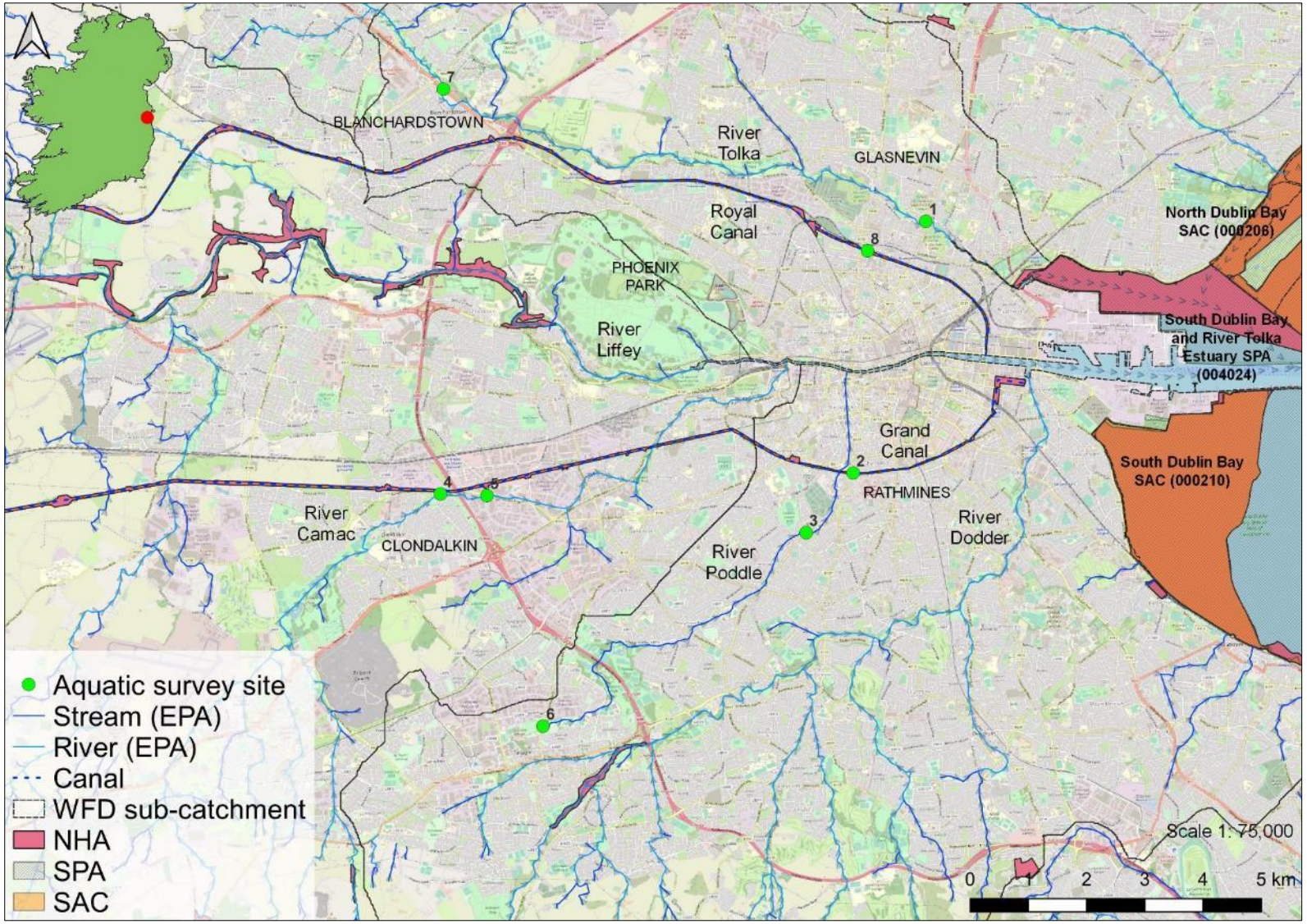

Figure 2.1 Overview of the *n*=8 aquatic survey site locations for the Dublin BusConnects project, July 2022

2.3 Fisheries habitat appraisal

A fisheries habitat appraisal of the watercourses in the footprint of the BusConnects project (**Figure 2.1)** was undertaken to establish their importance for fish of high conservation value including salmonid (*Salmo* spp.), lamprey (*Lampetra* spp.), European eel (*Anguilla anguilla*). The baseline assessment considered the quality of spawning, nursery and holding habitat within the vicinity of the survey sites using Life Cycle Unit (salmonids) and Lamprey Habitat Quality Index scores (lamprey). A broad appraisal of the upstream and downstream habitat at each survey site was also undertaken to evaluate the wider contribution to salmonid and lamprey spawning and general fisheries habitat. Further detail on the fisheries habitat assessment is provided below.

2.3.1 Salmonid habitat

Fisheries habitat for salmonids was assessed using the Life Cycle Unit method (Kennedy, 1984; O'Connor & Kennedy, 2002) to map survey sites as nursery, spawning and holding water, by assigning quality scores to each type of habitat. Those habitats with poor quality substrata, shallow depth and a poorly defined river profile received a higher score. Higher scores in the Life Cycle Unit method of fisheries quantification are representative of poorer value, with lower scores being more optimal, despite this appearing counter intuitive. Overall scores are calculated as a simple function of the sum of individual habitat scores.

Table 2.2 Life Cycle Unit scoring system for salmonid nursery, spawning and holding habitat value (as per Kennedy, 1984 & O'Connor & Kennedy, 2002)

Habitat quality	Habitat score	Total score (three components)
Poor	4	12
Moderate	3	9-11
Good	2	6-8
Excellent	1	3-5

2.3.2 Lamprey habitat

Lamprey habitat evaluation for each survey site was undertaken using the Lamprey Habitat Quality Index (LHQI) scoring system, as devised by Macklin et al. (2018). The LHQI broadly follows a similar rationale as the Life Cycle Unit score for salmonids. Those habitats with a lack of soft, largely organic sediment areas for ammocoete burrowing, a shallow sediment depth (<10cm) or of a compacted sediment nature, receive a higher score. Higher scores in this index are thus of poorer value (in a similar fashion to the salmonid Life Cycle Unit Index), with lower scores being more optimal. Overall scores are calculated as a simple function of the sum of individual habitat scores.

Larval lamprey habitat quality as well as the suitability of adult spawning habitat is assessed based on the information provided in Maitland (2003) and other relevant literature (e.g. Gardiner, 2003). Unlike the salmonid Life Cycle Unit index, holding habitat for adult lamprey is not assessed owing to their

different migratory and life history strategies, and that electro-fishing surveys routinely only sample larval lamprey.

The LHQI scoring system provides additional information compared to the habitat classification based on the observations of Applegate (1950) and Slade et al. (2003), which deals specifically with larval (sea) lamprey settlement habitat. Under this scheme, habitat is classified into three different types: preferred (Type 1), acceptable (Type 2), and not acceptable for larvae (Type 3) (Slade et al., 2003). Type 1 habitat is characterized by soft substrate materials usually consisting of a mixture of sand and fine organic matter, often with some cover over the top such as detritus or twigs in areas of deposition. Type 2 habitat is characterized by substrates consisting of shifting sand with little if any organic matter and may also contain some gravel and cobble (lamprey may be present but at much lower densities than Type 1). Type 3 habitat consists of materials too hard for larvae to burrow including bedrock and highly compacted sediment. This classification can also be broadly applied to other lamprey species ammocoetes, including *Lampetra* species.

Table 2.3 Lamprey Habitat Quality Index (LHQI) scoring system for lamprey spawning and nursery habitat value (Macklin et al., 2018)

Habitat quality	Habitat score	Total score (two components)
Poor	4	8
Moderate	3	6-7
Good	2	3-5
Excellent	1	2

2.3.3 General fisheries habitat

A broad appraisal 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 river sites (i.e. channel profiles, substrata etc.).

2.4 White-clawed crayfish survey

A survey for white-clawed crayfish (*Austropotamobius pallipes*) habitat across six riverine sites and two canal sites was undertaken in July 2022 (**Table 2.1; Figure 2.1**).

The crayfish survey was undertaken under the National Parks and Wildlife (NPWS) under licence no. C31/2022, as prescribed by Sections 9, 23 and 34 of the Wildlife Act (1976-2021) to capture and release them 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 transfer invasive propagules

(including crayfish plague) in an upstream direction. An aquatic biosecurity protocol was also applied for equipment use in water (refer to section 2.7 below).

2.4.1 Sweep netting & hand searching

Sweep netting and hand-searching (following Reynolds et al., 2010) was utilised at each survey site to detect both adult and juvenile crayfish. Sweep netting involves the sampling of more stable refugia such as boulder and cobble accumulations, in addition to macrophyte beds and other potential habitat such as tree root systems. A second operator (with sweep net) was present to capture escape-swimming crayfish observed following the initial sweep or refuge search. To estimate the relative density of crayfish at each site, searches were undertaken (moving upstream) in objectively suitable refugia (as per Peay, 2003). Following capture, all crayfish were held temporarily in a retaining tank containing fresh river water. Each crayfish was sexed, measured (carapace length, to nearest mm) and general condition noted before being released in-situ where captured.

2.4.2 Mustelid spraint (visual) inspection

Further to physical crayfish survey methods, riparian walkover surveys were undertaken to examine any spraint from mustelids (i.e. otters & mink) feeding along riparian corridors. Given that mustelids hunt large areas of river, they can forage cryptic prey present at low densities not easily detectable via conventional survey methodologies (e.g. sweep netting). Whilst not quantitative, riparian walkover/spraint surveys are useful for clarifying the presence or absence of crayfish at a particular site.

2.5 Macro-invertebrates (Q-sampling & sweep samples)

To evaluate biological water quality across the survey area, Q-sampling was carried out at *n*=6 riverine sites, namely sites 1 & 7 (River Tolka), 3 & 6 (River Poddle), 4 & 5 (River Camac) (**Table 2.1, Figure 2.1**). All samples were taken with a standard kick sampling hand net (250mm width, 500µm mesh size) from areas of riffle/glide utilising a 2-minute kick sample, as per Environmental Protection Authority (EPA) methodology (Feeley et al., 2020). Large cobble was also washed at each site for 1-minute (where present) to collect attached macro-invertebrates (as per Feeley et al., 2020). Samples were elutriated and fixed in 70% ethanol for subsequent laboratory identification. Samples were converted to Q-ratings as per Toner et al. (2005) and assigned to WFD status classes (**Table 2.4**).

Site 2 on the Grand Canal and site 8 on the Royal Canal were unsuitable for Q-sampling given their more lacustrine habitat. Thus, a composite macrophyte sweep sample was undertaken to collate data on the macro-invertebrate community present. The sample was taken with a standard kick sampling hand net (250mm width, 500µm mesh size) which was used to sweep macrophytes to capture macro-invertebrates. The net was also moved along the canal bed to collect epibenthic and epiphytic invertebrates from the substratum (as per Cheal et al., 1993). A 3-minute sampling period was divided amongst the range of canal meso-habitats present to get the best representative sample.

All samples were elutriated and fixed in 70% ethanol for subsequent laboratory identification. Any rare invertebrate species were identified from the NPWS Red List publications for beetles (Foster et al., 2009), stoneflies (Feeley et al., 2020), mayflies (Kelly-Quinn & Regan, 2012) and other relevant taxa (i.e. O'Connor, 2020; Byrne et al., 2009; Nelson et al., 2011).

Table 2.4 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

2.6 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).

2.7 Biosecurity

A strict biosecurity protocol following IFI (2010) and the Check-Clean-Dry approach was employed during the survey. Equipment and PPE used was disinfected with Virkon® between survey sites to prevent the transfer of pathogens and/or invasive species between survey areas. Where feasible, equipment was also be thoroughly dried (through UV exposure) between survey areas. Particular cognisance was given towards preventing the spread or introduction of crayfish plague (*Aphanomyces astaci*), given the known distribution of a particularly valuable peri-urban population of white-clawed crayfish in the River Camac catchment. As per best practice, surveys were undertaken at sites in a downstream order (i.e. uppermost site surveyed first etc.) to prevent the upstream mobilisation of invasive propagules and pathogens. Any invasive species recorded within or adjoining the survey area were geo-referenced.

3. Results

The following section summarises each aquatic survey site in terms of aquatic habitats, physical characteristics and overall value for fish, macro-invertebrates and macrophyte communities. Biological water quality results (riverine sites only) are also summarised. Habitat codes are according to Fossitt (2000). Scientific names are provided at first mention only. An evaluation of the ecological importance of each survey site based on the aquatic surveys is provided below and summarised in **Table 3.5**.

3.1 Desktop review

A desktop review of aquatic flora and fauna covering 10km grid squares adjoining the survey area (i.e. O02, O03 & O13) revealed records for a number of protected (freshwater) aquatic species in the vicinity of the proposed watercourses crossings.

In terms of aquatic invasive species, records were available for curly waterweed (*Lagarosiphon major*) and fringed water-lily (*Nymphoides peltata*) in isolated ponds. Invasive plant species associated with aquatic habitats such as Himalayan balsam (*Impatiens glandulifera*) and Japanese knotweed (*Fallopia japonica*) were common in the respective grid squares. New Zealand pigmyweed (*Crassula helmsii*) is known from several locations on the Grand Canal (NBDC data; pers. obs.), with the rare and protected opposite-leaved pondweed (*Groenlandia densa*) known from several locations on the Grand Canal and Royal Canal (BEC, 2011; NBDC data).

A number of rare and protected macro-invertebrate species are known from the Royal and Grand Canals in the vicinity of Dublin (e.g. Moorkens & Killeen, 2005) – please see the Discussion section for more details.

The River Tolka and River Camac are known to support a range of fish species such as brown trout (*Salmo trutta*), European eel (*Anguilla anguilla*), minnow (*Phoxinus phoxinus*), stone loach (*Barbatula barbatula*), three-spined stickleback (*Gasterosteus aculeatus*) and *Lampetra* sp. lamprey (Matson et al., 2018, 2019; Kelly et al., 2012, 2014; Triturus unpublished data). Atlantic salmon (*Salmo salar*) parr were recorded from the lower reaches of the River Camac in September 2020 (Triturus, 2020a). Atlantic salmon records were also available for the River Tolka (Kelly et al., 2012). The River Poddle was only known to support three-spined stickleback, with significant water quality issues and instream fish migration barriers present (Aquafact, 2020).

White-clawed crayfish (*Austropotamobius pallipes*) records were available from the River Camac (NBDC data), with a particularly healthy population known in the Camac and selected tributaries (Triturus, 2020b; Sweeney, 2018).

Otter (*Lutra lutra*) records were widespread across grid squares O02, O03 & O13 (NBDC data), with the River Tolka and River Camac known to be particularly important watercourses for the species (Macklin et al., 2019; Brazier & Macklin, 2020).

3.2 Aquatic survey site results

3.2.1 Site 1 – River Tolka, Frank Flood Bridge

Site 1 was located on the River Tolka (EPA code: 09T01) at Frank Flood Bridge, Drumcondra. The river was a semi-natural lowland depositing watercourse (FW2) with a swift flow. Despite being located in a heavily urbanised area with high retaining walls, the river profile was surprisingly natural downstream of the bridge (upstream being glide dominated, held between retaining walls and with less natural character). The channel width was variable between 15m and 20m wide, being narrower downstream. The depth ranged from 0.3-1.2m. The river level was low at the time of survey (July 2022) and none of the 3 no. bridge arches were passable to fish (apart from European eel), i.e. c.0.3m fall from bridge apron. The profile was dominated by shallow fast glide and riffle with more localised pool (the largest of which was located immediately downstream of the bridge apron/weir). The riverbed comprised rendered concrete under the road crossing but downstream of the bridge the substrata were dominated by boulder and cobble with interstitial fine-medium gravels. The substrata were bedded but large pockets of well-sorted medium and coarse gravels were present at the pool tailing downstream of the bridge apron (weir). Siltation was moderate overall. Macrophytes were limited to occasional water mint (*Mentha aquatica*), bulrush (*Typha latifolia*) and watercress (*Nasturtium officinale*) along island margins, with rare blue water speedwell (*Veronica anagallis-aquatica*). The site supported a high cover of aquatic bryophytes, with frequent *Platyhypnidium riparoides* and occasional *Fontinalis antipyretica*. Filamentous algae was very high (>50% cover of *Cladophora* sp.), with discolouration and sewage fungus also recorded at an inflowing storm drain adjacent to the bridge apron (north bank). The riparian zone supported marginal stands of osier (*Salix viminalis*), grey willow (*Salix cinerea*) and crack willow (*Salix fragilis*) with abundant reed canary grass (*Phalaris arundinacea*) and abundant invasive Himalayan balsam (*Impatiens glandulifera*) on the north bank. Himalayan balsam coverage was noticeably higher than the previous October 2020 survey. Small gravel islands were colonised by reed canary grass with hedge bindweed (*Calystegia sepium*). Additionally, the invasive giant hogweed (*Heracleum mantegazzianum*) was present at the downstream end of the island/bar along the north bank of the river.

Downstream of the bridge, the river was considered a good brown trout nursery and good holding area for adult fish. Spawning for both salmonids and lamprey was considered locally good, despite siltation pressures and compaction of substrata. Upstream of the bridge, the river was mainly a holding area for salmonids with deeper glide habitat held between retaining walls. Lamprey ammocoete habitat was sparse given the high energy nature of the site. European eel habitat was good downstream of the bridge owing to ample boulder refugia and deeper pool areas. A stone loach (*Barbatula barbatula*) and juvenile flounder (*Platichthys flesus*) were recorded in the macro-invertebrate kick sample. White-clawed crayfish are not known from the River Tolka and none were recorded during the survey. A regular otter spraint site (2 sites, 4 spraints) was recorded on the edge of bridge apron under the Waterfront Apartments on the south bank immediately downstream of the bridge (ITM 716123, 736752).

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

In summary, habitat of good salmonid and European eel quality, and regular utilisation by otter, was observed at this site.

Given the presence good quality salmonid, lamprey and European eel habitat and otter utilisation of the site, the aquatic ecological evaluation of site 1 was of **local importance (higher value) (Table 3.5).**

Plate 3.1 Representative image of site 1 on the River Tolka, facing upstream towards Frank Flood Bridge)

3.2.2 Site 2 – Grand Canal, Emmett Bridge

The Grand Canal at Emmett Bridge was a 15m wide channel bound by retaining walls on the south bank with a semi-natural grassy verge along the north. The canal averaged 1.5-2m deep (deeper locally west of the bridge) and featured a bed dominated by organic-rich silt. Some limited gravels and boulders were present in the vicinity of the bridge. The clear-water site was very heavily vegetated with abundant Canadian pondweed (*Elodea canadensis*) and fragile stonewort (*Chara globularis*) with frequent whorled water-milfoil (*Myriophyllum verticillatum*). Yellow water lily (*Nuphar lutea*) and arrowhead (*Sagittaria sagittifolia*) were present but rare. Fennel pondweed (*Stuckenia pectinatus*, syn. *Potamogeton pectinatus*) was present but rare. Submerged and floating mats of filamentous algae were abundant. The moss *Fontinalis antipyretica* grew on retaining walls. The north margin to the east of the bridge supported a narrow riparian fringe dominated by reed sweet grass (*Glyceria maxima*), reed canary grass and great willowherb (*Epilobium hirsutum*), with a strip of amenity grassland (GA2) and scattered planted trees. A mature treeline (WL2) of mostly alder (*Alnus glutinosa*) and sycamore (*Acer psuedoplatanus*) grew along the north bank of the canal heading west.

This section of the Grand Canal was of high value for coarse fish species, particularly as a spawning and nursery habitat given the proliferation of macrophyte vegetation. Species including pike (*Esox lucius*), perch (*Perca fluviatilis*) and roach (*Rutilus rutilus*) are known in the section (pers. obs.). The site was also of high value for European eel. Some good suitability for white-clawed crayfish was

present but none were recorded from the survey. Crayfish are known from the Grand Canal but not in the vicinity of Dublin (NPWS & NBDC data; pers. obs.). A single otter spraint was recorded during the survey on the ledge underneath Emmett Bridge (ITM 714862, 732441). Non-native mink (*Neovison vison*) are also known from this section of canal (Triturus, 2021).

The non-riverine site was not suitable for biological water quality calculation via Q-sampling but sweep samples were collected. No macro-invertebrate species of conservation value greater than 'least concern', according to national red lists, were recorded via sweep netting (**Appendix A**).

Given the location of the site within the Grand Canal pNHA (002104), the aquatic ecological evaluation of site 2 was of **national importance** (**Table 3.5**). The site was also of high value for coarse fish species, Red-listed European eel and utilised by Annex II otter.

Plate 3.2 Representative image of site 2 on the Grand Canal at Emmett Bridge, facing eastwards from bridge

3.2.3 Site 3 – River Poddle, Mount Argus Park

Site 3 was located at an existing footbridge on the River Poddle (09P03) at Mount Argus Park. Here, the watercourse was a very heavily modified channel with retaining walls on both banks (0.3m high). The river was swift flowing but a homogenous 0.05m depth at the time of survey with no variation in depth (no pool or deeper areas). The bed was rendered concrete (i.e. an open culvert) with only very localised superficial mixed gravels and small cobbles (<1% surface area). Given the artificial bed, macrophytes were absent. However, the moss *Rhynchostegium riparoides* was locally abundant growing on the concrete bed, typically in more shaded areas. Filamentous algae was abundant, indicating enrichment. The survey site was located immediately upstream of a small artificial pond (FL8). This pond also featured a 100% rendered concrete bed with depths from 0.1-0.3m. The river in the vicinity of the footbridge was heavily shaded by mature treelines of sycamore (*Acer pseudoplatanus*), ash (*Fraxinus excelsior*), willow (*Salix* sp.) and silver birch (*Betula pendula*) with

scrubby understories of hogweed (*Heracleum sphondylium*), nettle (*Urtica dioica*), bramble (*Rubus fruticosus* agg.), ivy (*Hedera* sp.), wood avens (*Geum urbanum*), hedge bindweed and ornamental species such as box-leaved honeysuckle (*Lonicera pileata*). The site was located in scattered trees and parkland habitat (WD5) with amenity grassland (GS2) and artificial surfaces (BL3).

With the exception of three-spined stickleback (*Gasterosteus aculeatus*) (which were recorded via kick sampling and observed in the pond connected to the river), the River Poddle was of little to no fisheries value at this location given its very heavily modified, shallow nature, poor hydromorphology and known downstream barriers to migration (e.g. steep closed culvert downstream of the parkland). The river is also known to suffer from significant water quality issues which preclude the establishment and persistence of a healthy fish populations.

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

Given the poor-quality fisheries and aquatic habitats present, in addition to poor water quality, the aquatic ecological evaluation of site 3 was of **local importance (lower value) (Table 3.5).**

Plate 3.3 Representative image of site 3 on the River Poddle in Mount Argus Park, facing upstream to the existing footbridge illustrating the heavily modified nature of the channel

3.2.4 Site 4 – River Camac, Yellowmeadows

Site 4 was located on the River Camac (09C02) at Yellowmeadows near Clondalkin. The river was a lowland depositing watercourse (FW2) that had been historically straightened and heavily modified, with a retaining wall present along the south bank of the river (adjoining residential areas). The channel averaged 3-4m wide and 0.1-0.25m deep, with bankfull heights of 2-3m. Shallow fast glide predominated with occasional riffles and very limited small pool (to 0.5m). The channel featured an open masonry culvert in the vicinity of the survey site with only localised superficial accumulations of cobble and medium to coarse gravels. Small boulder were also present but localised with occasional sand. Siltation was moderate overall with some shallow accumulations in association with macrophyte beds. Instream macrophytes were rare given the concrete rendered riverbed. Lesser water parsnip (*Berula erecta*), fool's watercress (*Apium nodiflorum*), watercress and localised brooklime (*Veronica beccabunga*) were present in the margins. Cobble zones supported frequent spiked-water milfoil (*Myriophyllum spicatum*). Aquatic bryophytes were limited to occasional *Platyhypnidium riparoides*. Filamentous algal cover was high (30% cover) indicating enrichment. Numerous point sources were present locally, adjoining from the Nangor Road bank. The river margins were dominated by linear belts of reed canary grass with abundant nettle. The north bank was heavily scrubbed with primarily ornamental species like red osier dogwood (*Cornus sericea*) and *Cotoneaster* sp. with frequent invasive buddleja (*Buddleja davidii*), great willowherb and hedge bindweed. Downstream, a mature willow-dominated treeline was present along the river, with ash and sycamore. The site was bordered by parkland (WD5) to the south and artificial surfaces (BL3) to the north (Nangor Road).

Site 4 was of moderate value for salmonids only given its poor hydromorphology and shallow nature, with superior habitat both upstream and (especially) downstream. Spawning and nursery value was limited but nonetheless present (moderate value only). Holding habitat was good despite the lack of pool areas given the undercut banks/overhanging reed canary grass vegetation. White-clawed crayfish were present at a 'low' density >0 to <1 per 10 refugia; Peay, 2003). A total of *n*=2 crayfish were recorded via sweep netting, with one adult and one hatchling recorded. Three-spined stickleback (*Gasterosteus aculeatus*) were visibly abundant. Lamprey ammocoete habitat was present very locally also but spawning habitat was poor (few finer gravels present given high flows rates and rendered bed). No otter signs were recorded during the site visit but the River Camac in the vicinity of the survey site is known to support otter (Macklin et al., 2019).

Biological water quality, based on Q-sampling, was calculated as **Q3 (poor status)** (**Appendix A**). 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 Annex II white-clawed crayfish and moderate quality salmonid habitat the aquatic ecological evaluation of site 4 was of **local importance (higher value)** (**Table 3.5**).

Plate 3.4 Representative image of site 4 on the River Camac, facing upstream towards Áras Na Cluaine

3.2.5 Site 5 – River Camac, Nangor Road (R134)

Site 5 was located on the River Camac (09C02) at the Nangor Road crossing (R134). The river was a lowland depositing watercourse (FW2) which had been historically straightened and modified upstream and downstream of the existing R134 road culvert (an extensive twin-bore corrugated pipe, 75m long). These culverts were passable to fish even at low summer flows. However, good recovery was evident instream, despite being surrounded by industrial/urban areas. Upstream of the culvert, the river averaged 3-4m wide and 0.5-1m deep with locally deeper glide and pools to 1m. The profile was dominated by deep glide with localised pool[1]. The substrata were dominated by relatively clean, unbedded/mobile fine to coarse gravels with low siltation (only light plumes underfoot). Cobble and small boulder was occasional (more prominent downstream of culvert). Silt beds were present marginally and in association with abundant growth of instream macrophytes. Downstream of the R134 culvert the river was 3m wide on average and 0.4-0.6m deep, with locally deeper pools to 0.8-1m. The flow was greater than upstream and fast glide predominated with occasional riffle areas and localised pools. Given the high flow rates, the substrata were dominated by cobble with occasional boulder. Medium to coarse gravels were frequent and present in small interstitial patches. Sand/silt accumulations were present in pool slacks near the culvert. Overall siltation was moderate. The substrata were relatively compacted (in contrast to upstream slower glide habitat). Macrophyte growth was dominated by abundant spiked water milfoil (50% cover) and frequent curled pondweed (*Potamogeton crispus*) with the margins and riparian slopes dominated by reed canary grass. Downstream, given high shading, instream macrophytes were limited to marginal watercress and

[1] A small deep pool located c.10m upstream of the culvert provided excellent quality holding habitat for salmonids in 2020. However, the value has been reduced in the interim given the removal of a very large overhanging willow tree that provided shading over the main salmonid holding pool in the river reach.

some fool's watercress. Aquatic mosses were limited to localised *Cinclidotus fontinaloides* and *Rhynchostegium riparoides*. Downstream, riparian shading was high given dense bramble-dominated scrub with mature treelines on both banks of sycamore, poplar (*Populus* sp.), crack willow, osier and elder (*Sambucus nigra*). Dogwood (*Cornus* sp.), wild angelica (*Angelica sylvestris*), ivy (*Hedera helix*), nettle (*Urtica dioica*) and hogweed (*Heracleum sphondylium*) were abundant also. Non-native winter heliotrope (*Petasites fragrans*) was frequent along both banks. Upstream, the open banks sloped to the river and supported abundant reed canary grass and occasional bramble scrub.

Site 4 offered some very good salmonid habitat (brown trout only given downstream barriers). Upstream of the culvert provided excellent quality spawning and nursery habitat (among the best on the entire river, pers. obs.) with very good holding habitat for abundant adult trout in undercut banks/under overhanging reed canary grass. Downstream, whilst spawning and nursery value was somewhat reduced, adult holding habitat was very good given undercut banks and prominent submerged tree roots (willow and sycamore). These also offered excellent refugia for white-clawed crayfish, which were recorded at 'very high' densities (>5 per 10 refugia; Peay, 2003). A total of *n*=25 crayfish were recorded from 30 refugia via sweep netting, with males, females and juveniles present, ranging from 18-38mm carapace length. The culverts also provided high quality crayfish habitat given an abundance of cobble and boulder. Lamprey ammocoete habitat was present both upstream and downstream of the culvert, usually in association with instream macrophyte beds. European eel habitat was good throughout but better upstream. Two otter spraint sites were recorded under the southern culvert on instream trash/debris (both were old and contained crayfish remains, ITM 708589, 732063 & 708572, 732050).

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

Given the presence of a healthy white-clawed crayfish population, the aquatic ecological evaluation of site 5 was of **county importance** (given the paucity of sites in Co. Dublin supporting healthy crayfish populations). The site also provided high quality salmonid, lamprey and European eel habitat, in addition to utilisation by otter (**Table 3.5**).

Plate 3.5 Representative image of site 5 on the River Camac, facing upstream from culverts

Plate 3.6 One of many white-clawed crayfish recorded from site 5 via hand searching in July 2022

3.2.6 Site 6 – River Poddle, Greenhills Road (R819)

Site 6 was located on the upper reaches of the River Poddle (09P03) where it emanated from a long underground culvert adjacent to the Greenhills Road and Bancroft Park. The river at this location represented a small, lowland depositing watercourse (FW2) that had been historically straightened and deepened, (a two-stage channel was evident). The river averaged ≤1m wide and 0.1-0.2m deep in a deep U-shaped channel with 2-3m bankfull heights. Shallow glide predominated with occasional riffle zones and localised small pool. The substrata were dominated by cobble and small boulder which were heavily silted and compacted. Some medium to coarse gravels were present interstitially. Siltation was high overall although sediment accumulations were largely absent at the swift flowing site. Hydrocarbon plumes were evident underfoot on disturbance of sediment during Q sampling. Natural bank erosion (scouring) was evident in the narrow channel and was contributing to siltation, in addition to surface water run-off from adjoining hard standing areas (BL3). The river was heavily tunnelled by scrub and herbaceous vegetation which resulted in a lack of macrophyte growth. Filamentous algal cover was high in all open areas (>50% cover), indicating heavy enrichment. The riparian areas supported abundant nitrophilous species such as great willowherb, nettle and hedge bindweed. Other riparian species included meadowsweet, meadow buttercup (*Ranunculus acris*), common knapweed (*Centaurea nigra*), gorse (*Ulex europaeus*), ragwort (*Jacobaea vulgaris*) and rank grasses. Very dense bramble scrub was present in the vicinity of the road culvert. The site was bordered by dry meadows (GS2) and scattered trees and parkland habitat (WD5) with ornamental hedging.

With the exception of three-spined stickleback, the River Poddle at site 6 was of little to no fisheries value given water quality issues (including very heavy siltation) poor hydromorphology and known downstream barriers to migration. The river is also known to suffer from significant water quality issues which preclude the establishment and persistence of a healthy fish populations. No white-clawed crayfish were recorded and none were known from river. The site was not of value to otter.

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

Given the poor-quality fisheries and aquatic habitats present, in addition to poor water quality, the aquatic ecological evaluation of site 6 was of **local importance (lower value) (Table 3.5).**

Plate 3.7 Representative image of site 6 on the upper reaches of the River Poddle

3.2.7 Site 7 – River Tolka, N3 culvert

Site 7 was located on the River Tolka (09T01) downstream of the N3 road culvert. The lowland depositing watercourse (FW2) had been deepened and heavily modified historically, with bank reinforcements (boulder revetment) present downstream. The river averaged 4-5m wide and 0.2-0.8m deep, with locally deeper pool to 1.3m. The profile comprised deep slow-flowing glide with localised deep pool and riffle near the meander downstream of the culvert. The riverbed featured a rendered concrete apron under the road crossing. The substrata were dominated by cobble with mixed gravels and silt accumulations. The substrata were typically very heavily bedded and silted, with localised mobile gravels present downstream of the survey site. The site supported limited macrophyte growth, with occasional branched bur-reed (*Sparganium erectum*) and very localised water crowfoot (*Ranunculus* sp.) and common water starwort (*Callitriche stagnalis*). Cobble substrata supported heavy cover of *Fontinalis antipyretica* with abundant filamentous algae (*Phormidium* sp. and *Cladophora glomerata*) indicating significant enrichment. The riparian areas were heavily scrubbed with dense bramble, ornamental dogwood (*Cornus* sp.), great willowherb, nettle, hogweed and colt's-foot (*Tussilago farfara*). The riparian areas also supported scattered mature sycamore, osier (*Salix viminalis*) and crack willow (*Salix* x *fragilis* agg.).

Site 7 was of moderate value for salmonids only given evident water quality pressures, chiefly siltation. The river at this location was considered a moderate quality brown trout nursery, with some localised deeper pools (including immediately downstream of the culvert) providing some good, although localised, holding habitat. The quality of spawning habitat for salmonids and lamprey was significantly compromised by siltation and high coverage of filamentous algae. However, some improved spawning habitat for both salmonids and lamprey was present >100m downstream of the culvert (but was absent elsewhere). The site offered poor lamprey ammocoete habitat given the high flow rates and predominance of hard substrata. The site was of moderate value to European eel although bedding of

substrata, instream barriers and water quality issues reduced suitability. White-clawed crayfish are not present in the River Tolka (no known records) and were not recorded during the survey, despite some low physical suitability. Otter spraint sites were recorded on both the west and east banks immediately downstream of the culvert (ITM 707817,739018 and 707822, 739014),

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

Given the moderate value for salmonids, lamprey and European eel, in addition to otter utilisation, the aquatic ecological evaluation of site 7 was of **local importance (higher value) (Table 3.5).**

Plate 3.8 Representative image of site 7 on the River Tolka, facing downstream to meander from N3 culvert

3.2.8 Site 8 – Royal Canal, Phibsborough (5th level)

The Royal Canal between the 4th and 5th lock (level 4, Phibsborough) was a uniform 10-12m wide and 1.5-2.5m deep, with a centrally deeper navigation channel in most areas. The substrata were dominated by silt with high clay fractions (often >0.3m in depth), with scattered boulder and localised marginal cobble/gravel areas. Instream, the macrophyte community was dominated by whorled watermilfoil with frequent heterophyllus yellow lily. Ivy-leaved duckweed (*Lemna trisulca*) was abundant. Canadian pondweed (*Elodea canadensis*), Nuttall's pondweed (*Elodea nuttallii*) and stonewort (*Chara* sp.) were all frequent. Amphibious bistort (*Persicaria amphibia*) was occasional along the canal margins. The rare and protected opposite-leaved pondweed (*Groenlandia densa*) is known from this area of the Royal Canal (BEC, 2011; NPWS data) but no stands were observed during the survey (July 2022). The lock structures were covered by the generalist moss species *Fontinalis antipyretica* and *Rhychostegium riparoides* a species common in alkaline waters. The canal margins were lined by narrow linear strips (FS1) dominated by reed sweet grass with frequent stands of iris

(*Iris pseudacorus*) and occasional reed canary grass. The riparian zones supported a range of common species such as great willowherb, nettle, meadowsweet, yarrow (*Achillea millefolium*), marsh ragwort (*Jacobaea aquatica*), hedge bindweed, creeping thistle, hogweed and non-native buddleja (*Buddleja davidii*). Intermittent planted treelines of sycamore and cherry (*Prunus* sp.) were present in maintained grassland strips (WD5 and GA2).

This section of the Royal Canal was of high value for coarse fish species, particularly as a spawning and nursery habitat given the proliferation of macrophyte vegetation. The site was also of high value for European eel. Some good suitability for white-clawed crayfish was present but depths precluded effective surveying via sweep netting or hand searching. No white-clawed crayfish are known from the eastern extent of the Royal Canal in Dublin City (NBDC, NPWS data, pers. obs.), despite some good physical habitat and physiochemical suitability. No otter signs were recorded during the site visit although suitable marking areas were largely absent. Otters are known on the Royal Canal both upstream and downstream of this point (Triturus, 2022).

No macro-invertebrate species of conservation value greater than 'least concern', according to national red lists, were recorded via sweep netting (**Appendix A**).

Given the location of the site within the Royal Canal pNHA (002103), the aquatic ecological evaluation of site 8 was of **national importance (Table 3.5).** The site was also of high value for coarse fish species and Red-listed European eel.

Plate 3.9 Representative image of site 8 on the Royal Canal at Phibsborough, facing downstream from Cross Guns Bridge to the 4th lock

3.3 Fisheries habitat

3.3.1 Salmonid habitat

Salmonid habitat varied considerably across the riverine survey sites (**Table 3.1**). Site 5 on the River Camac was the only site to provide excellent quality salmonid habitat, with good quality spawning and holding habitat in addition to nursery habitat of very high value (among the best of the entire river, pers. obs.). Site 1 on the River Tolka at Frank Flood Bridge provided good quality salmonid habitat although the value was considerably reduced due to pressures including siltation, point sources and alterations to hydromorphology – this was especially the case for spawning habitat. Sites 4 (River Camac) and 7 (River Tolka) were considered of moderate value only to salmonids given evident siltation, hydromorphological and or water quality issues. Atlantic salmon have been recorded from the River Camac in recent years but are confined to the lower reaches of the river due to impassable instream barriers (Triturus, 2020a).

The River Poddle at sites 3 and 6 was of little to no value to salmonids, with poor quality spawning, nursery and holding habitat present. This was primarily due to significant channel alterations (hydromorphology) and evident water quality issues, as well as known instream barriers within the catchment.

Site 2 on the Grand Canal and site 8 on the Royal Canal were not suitable for assessment using Life Cycle Unit scores (lacustrine environment), although brown trout are known occasionally from both waterways (pers. obs.).

Table 3.1 Life Cycle Unit scores for salmonid habitat at the sites surveyed for the BusConnects project, July 2022

Site no.	Salmonid habitat value	Spawning	Nursery	Holding	Total score
1	Good	3	2	2	**7**
2	n/a – canal habitat	n/a	n/a	n/a	n/a
3	Poor	4	4	4	**12**
4	Moderate	3	3	4	**10**
5	Excellent	2	1	2	**5**
6	Poor	4	4	4	**12**
7	Moderate	4	3	2	**9**
8	n/a – canal habitat	n/a	n/a	n/a	n/a

3.3.2 Lamprey habitat

Lamprey habitat ranged from poor to moderate quality across the majority of survey sites (**Table 3.2**). Only site 5 on the River Camac provided good quality lamprey habitat in terms of spawning and nursery opportunities. The remainder of sites provided moderate quality habitat, at best, due to a paucity or lack of suitable ammocoete burial habitat (i.e. soft sediment areas), in addition to sub-optimal spawning substrata that was often heavily silted.

Table 3.2 Lamprey Habitat Quality Index (LHQI) scores for lamprey habitat at the sites surveyed for the BusConnects project, July 2022

Site no.	Lamprey habitat value	Spawning	Nursery	Total score
1	Moderate	3	4	**7**
2	n/a – canal habitat	n/a	n/a	n/a
3	Poor	4	4	**8**
4	Moderate	2	4	**6**
5	Good	2	2	**4**
6	Poor	4	4	**8**
7	Moderate	4	3	**7**
8	n/a – canal habitat	n/a	n/a	n/a

3.3.3 European eel & general fisheries habitat

Habitat for Red-listed European eel (King et al., 2011) was typically moderate to good across the majority of survey sites. The best eel habitat was present on the Grand and Royal Canal sites given an abundance of instream refugia, varied prey resources and superior water quality compared with riverine sites. The canal sites also provided excellent quality habitat for a range of coarse fish species, with particularly suitable spawning and nursery habitat given a high coverage of macrophyte growth.

The survey sites on the River Camac, and to a lesser degree, the River Tolka, also provided some good suitability for eel. However, instream barriers to eel migration are known for the River Camac and distribution within the Camac is therefore restricted (Triturus, 2020a). The Poddle is only known to support three-spined stickleback (Aquafact, 2020), where water quality issues and the modified nature of the watercourse has reduced eel and overall fisheries habitat quality.

3.4 White-clawed crayfish

White-clawed crayfish were only recorded from sites 4 and 5 on the River Camac during the survey period (via sweep sampling), aligning with the known distribution of the species in the wider study area (i.e. only known from the River Camac and selected tributaries). There are historical records available for the River Tolka or River Poddle despite some physical habitat suitability. Whilst crayfish are known from the Grand Canal and to a lesser extent the Royal Canal (near Mullingar, NBDC data),

there were no records available for the survey area or wider Dublin area and none were recorded during the current survey, despite some good habitat suitability.

3.5 Biological water quality & macro-invertebrate communities

No rare or protected macro-invertebrate species (according to national red lists) were recorded in the biological water quality (*n*=6 riverine sites) and sweep samples (*n*=2 canal sites) in July 2022 (**Figure 3.1, Appendix A**). Q-samples were collected and analysed from the *n*=6 riverine survey sites, in addition to composite sweep samples taken from site 2 and 8 on the Grand Canal and Royal Canal, respectively. A total of *n*=28 species across *n*=22 families were recorded in the riverine kick samples, with a total of *n*=13 species across *n*=12 families recorded from the Grand and Royal Canal sites. A summary of results and detailed species compositions per sample are provided in **Appendix A**.

All of the riverine sites sampled achieved **Q3** or **Q2-3 (poor status)** water quality (**Table 3.4, Appendix A**) given the absence of EPA group A (clean water indicators) and or low numbers of EPA group B (also clean water indicators) with a dominance of class C species (moderate water quality indicators). The River Poddle at site 6 had the lowest water quality being denoted as **Q2-3 (poor status),** i.e. intermediate between Q2 (bad status) and Q3 (poor status) due to the predominance of poor water quality indicator molluscan and Hirudinidae fauna and *Asellus aquaticus* (**Appendix A**). Thus, none of the riverine sites met target good status (≥Q4) requirements of the European Union Environmental Objectives (Surface Waters) (Amendment) Regulations 2019 and the Water Framework Directive (2000/60/EC).

The Grand Canal (site 2) and Royal Canal (site 8) samples, which were not suitable for biological water quality analysis via Q-sampling, did not support any rare invertebrate species based on national red lists. Primarily, the samples contained molluscan, crustacean and dipteran species (see **Appendix A**).

A comparison of biological water quality for the survey sites in October 2020 and July 2022 is provided in **Table 3.4** below. There were no changes in biological water quality between the two sampling periods.

Table 3.4 Comparison of biological water quality (Q-samples) for the Dublin BusConnects survey sites in October 2020 and July 2022

Site no.	Watercourse	Location	Q-rating Oct 2020	Q-rating July 2022
1	River Tolka	Frank Flood Bridge	Q3 (poor status)	Q3 (poor status)
2	Grand Canal	Emmett Bridge	n/a	n/a
3	River Poddle	Mount Argus	Q3 (poor status)	Q3 (poor status)
4	River Camac	Nangor Road (R134)	Q3 (poor status)	Q3 (poor status)
5	River Camac	Yellowmeadows	Q3 (poor status)	Q3 (poor status)
6	River Poddle	Source of Poddle, Greenhills Road	Q2-3 (poor status)	Q2-3 (poor status)
7	River Tolka	N3 culvert	Q3 (poor status)	Q3 (poor status)
8	Royal Canal	5th level, Phibsborough Road	n/a	n/a

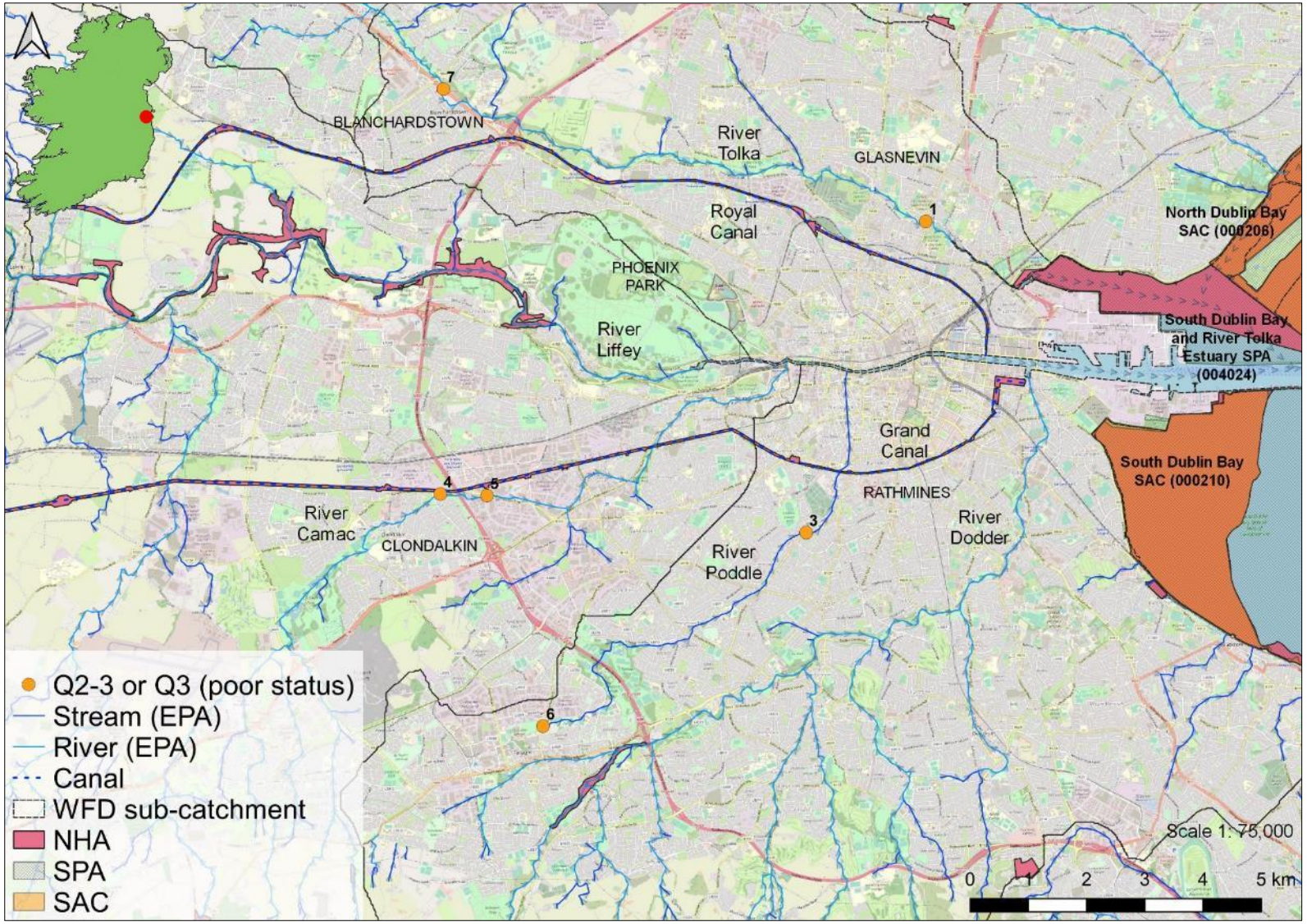

Figure 3.1 Overview of the biological water quality status in the vicinity of the proposed Dublin BusConnects project, July 2022

3.6 Aquatic ecological evaluation

An aquatic ecological evaluation of each survey site was based on the results of desktop review, fisheries habitat assessments, the presence of protected or rare invertebrates (e.g. white-clawed crayfish), the presence of rare macrophytes and aquatic bryophytes and or associated representations of Annex I habitats. Furthermore, biological water quality status also informed the evaluation (**Table 3.5**).

Site 2 on the Grand Canal (Emmett Bridge) and site 8 on the Royal Canal (Phibsborough) were evaluated as **national importance** given their location with the Grand Canal pNHA (002104) and Royal Canal pNHA (002103), respectively.

Site 5 on the River Camac, in the vicinity of R134 Nangor Road culvert, was evaluated as **county importance** given the presence of a high density of Annex II white-clawed crayfish. This was considered in light of the known distribution of crayfish within the wider Dublin City area and throughout County Dublin.

None of the remaining aquatic survey sites were evaluated as greater than **local importance (higher value)**. The higher value sites were present on the River Tolka (sites 1 and 7) and River Camac (site 4). Primarily, this evaluation was due to the suitability for (or known presence of) salmonids, lamprey and or European eel, the presence of Annex II otter and, in the case of the River Camac, the presence of Annex II white-clawed crayfish.

The survey sites on the River Poddle (sites 1 and 6) were evaluated as of **local importance (lower value)** in terms of their aquatic ecology given an absence of species or habitats of high conservation value.

Table 3.5 Aquatic ecological evaluation summary of the pre-construction survey sites according to NRA (2009) criteria

Site no.	Watercourse	EPA code	Evaluation of importance	Rationale summary
1	River Tolka	09T01	**Local importance (higher value)**	Good quality salmonid and European eel habitat, moderate lamprey habitat; site utilised by Annex II otter (spraint sites recorded); Q3 (poor status) biological water quality;
2	Grand Canal	n/a	**National importance**	Located within Grand Canal pNHA (002104) a highly valuable ecological corridor; high value for coarse fish species and European eel; known utilisation by Annex II otter upstream and downstream of survey site; supports rare molluscan red list invertebrates, no other aquatic species or habitats of high conservation value
3	River Poddle	09P03	Local importance (lower value)	No fisheries value with the exception of three-spined stickleback; Q2-3 (poor status) water quality; no aquatic species or habitats of high conservation value
4	River Camac	09C02	**Local importance (higher value)**	Moderate quality salmonid, lamprey and European eel habitat; poor suitability for white-clawed crayfish but low density recorded; Q3 (poor status) water quality; no other aquatic species or habitats of high conservation value
5	River Camac	09C02	**County importance**	High density of Annex II white-clawed crayfish present, one of the last remaining healthy populations within Co. Dublin; excellent quality salmonid habitat (among the best on the entire river) with good quality European eel and lamprey habitat; site utilised by Annex II otter (regular spraint sites recorded under culvert); Q3 (poor status) water quality; no other aquatic species or habitats of high conservation value
6	River Poddle	09P03	Local importance (lower value)	No fisheries value with the exception of three-spined stickleback; Q2-3 (poor status) water quality; no aquatic species or habitats of high conservation value
7	River Tolka	09T01	**Local importance (higher value)**	Moderate quality salmonid, lamprey and European eel habitat; site utilised by Annex II otter (spraint site recorded); Q3 (poor status) biological water quality; no aquatic species or habitats of high conservation value
8	Royal Canal	n/a	**National importance**	Located within Royal Canal pNHA (002103) that is a highly valuable ecological corridor; of high value for coarse fish species and European eel; known utilisation by otter with spraint site recorded adjacent to bridge; rare macrophytes & red listed molluscan fauna known within section (between 4th and 5th locks)

Conservation value: Atlantic salmon (*Salmo salar*), sea lamprey (*Petromyzon marinus*), brook lamprey (L*ampetra planeri*), river lamprey (*Lampetra fluviatilis*) and otter (*Lutra lutra*) are listed under Annex II of the Habitats Directive [92/42/EEC]. Atlantic salmon, river lamprey, freshwater pearl mussel and otter are also listed under Annex V of the Habitats Directive [92/42/EEC]. Freshwater pearl mussel and 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 Fisheries Acts 1959 to 2019, brown trout have no legal protection in Ireland.

4. Discussion

4.1 Most valuable areas for aquatic ecology

The survey sites of highest aquatic ecological value were located on the Grand Canal (site 2) and Royal Canal (site 8); both were evaluated as **national importance** given their location with the Grand Canal pNHA (002104) and Royal Canal pNHA (002103), respectively. This evaluation is supported by the fact that the Grand and Royal Canals in vicinity of the survey area support rare macrophytes within their corridors, rare molluscan fauna and Annex II otter populations. Both canals are also an important coarse fishery resource, in addition to supporting Red-listed European eel populations. The waterways are also highly valuable ecological corridors in the context of Dublin City.

The rare, near-threatened (Wyse-Jackson et al., 2016) species opposite-leaved pondweed (*Groenlandia densa*) was recorded in several sections of the Royal Canal (1st to 4th levels, inclusive) during a survey conducted in 2011 (BEC, 2011). The species is legally protected and is listed on Schedule A of the Flora (Protection) Order, 2022. Survey site 8 was located in the 4th level (i.e. between the 4th and 5th locks) but no opposite leaved pondweed was recorded during the site visit. Whilst the species is also known from several areas of the Grand Canal in the vicinity of Dublin, no examples were recorded at survey site 2 during the current survey. However, detection of opposite-leaved pondweed in deep water sites like the Grand and Royal Canals can be difficult. It is considered likely that the species is still present between the 4th and 5th locks of the Royal Canal. Tassel stonewort (*Tolypella intricata*), listed as vulnerable in Ireland (Stewart & Church, 1992), is also known from the Royal Canal in Dublin, the only site in Ireland where it is now found (NPWS, 1995). The species has been recorded historically from the Royal Canal between Cross Gun's Bridge (5th lock) and Granard Bridge (near 12th lock), with records from 1992 (Nash & King, 1993). The species was recorded typically within 1m metre from the bank growing in silt in 0.5m water depth (Nash & King, 1993). The species was not recorded during the current 2022 survey (or the 2020 survey) between the 4th and 5th locks of the Royal Canal. The survey area at Phibsborough typically had water between 1.5m and 2.5m deep and thus may be unsuitable for the species. Whilst several rare or declining aquatic molluscs have been recorded from both the Grand Canal and Royal Canal (Byrne et al., 2009; Moorkens & Killeen, 2005; e.g. whirlpool ramshorn snail *Anisus vortex*, false orb pea mussel (*Pisidium pseudosphaerium*), none were recorded in sweep samples collected at sites 2 (Grand Canal) and 8 (Royal Canal) during the current survey.

Site 5 on the River Camac, in the vicinity of R134 Nangor Road culvert, was evaluated as **county importance** given the presence of a high density of Annex II white-clawed crayfish. The abundance of suitable refugia such as cobble, boulder and instream debris and banks for burrowing were abundant in vicinity of the site. A total of *n*=25 crayfish, including juveniles and adults ranging from 18-38mm carapace length, were recorded from a search of thirty instream refugia, equating to a 'very high' density (i.e. >5 per 10 refugia; Peay, 2003). A high density of crayfish was also recorded during targeted crayfish surveys at this site in 2020 (Triturus, 2020b). Known crayfish populations in Co. Dublin are restricted to the Liffey and Camac catchments (NPWS & NBDC data). In light of this distribution and the national decline of the species in recent years due to crayfish plague (*Aphanomyces astaci*), the presence of a healthy, recruiting population in the River Camac (Triturus, 2020b) warrants significant

protection from pressures such as water quality[2] and biosecurity[3]. Site 5 on the River Camac also provided among the best salmonid habitat (in terms of spawning and nursery) on the entire river (surveyed by Triturus, 2020a). Thus, the River Camac represents a highly valuable urban habitat for salmonids (including Atlantic salmon in the lower reaches; Triturus 2020a), otter and white-clawed crayfish and should be protected from potential impacts as a result of the proposed BusConnects project.

Sites 1 and 7 on the River Tolka, and site 4 on the River Camac were evaluated as **local importance (higher value)**. In the case of the Tolka this was based primarily on the suitability for salmonids, lamprey and European eel, in addition to utilisation by Annex II otter. However, water quality issues (both sites achieved Q3 (poor status) in October 2020 and July 2022 surveys; **Table 3.4**) are a significant threat to the aquatic species and habitats of the Tolka. Despite heavy modification to the channel, poor hydromorphology and a low fisheries value, site 4 on the River Camac was also evaluated as **local importance (higher value)** given the presence of a 'low' density of white-clawed crayfish (>0 to <1 per 10 refugia; Peay, 2003). A low density of crayfish was also recorded during targeted crayfish surveys at this site in 2020 (Triturus, 2020b).

4.2 Least valuable areas for aquatic ecology

Sites 3 and 6 on the River Poddle were evaluated as **local importance (lower value)** given evident water quality issues (Q2-3 to Q3, poor status; **Table 3.4**), significant hydromorphological modifications and a very low fisheries value. The Poddle is not a recognised salmonid watercourse according to Inland Fisheries Ireland and is one of the most heavily modified river channels in Dublin City, only of value to the highly pollution-tolerant three-spined stickleback. Whilst otters are known to use the river, this is primarily confined to Tymon Park, approx. 2km upstream of site 6 and 4km downstream of site 6 (Triturus, 2021; Macklin et al., 2019). No species or habitats of high conservation value were recorded at the survey sites during the current survey.

[2] The River Camac is currently failing to meet target 'good status' water quality (≥Q4) set out under the Water Framework Directive (2000/60/EC), with biological water quality ranging from Q3 to Q3-4 (EPA data; Triturus, 2020b; **Table 3.4**)

[3] While crayfish plague is not known from the River Camac catchment, porcelain disease (caused by the microsporidian parasite *Thelohania contejeani*) was noted in numerous individuals in the Camac sub-catchment in 2018 (Sweeney, 2018)

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6. Appendix A – biological water quality & macro-invertebrate communities

Table 8.1 Macro-invertebrate Q-sampling results, July 2022 (*sites 2 and 8 are canal sites and thus Q-sampling is not applicable)

Group	Family	Species	1	2*	3	4	5	6	7	8*	EPA class
Trichoptera	Leptoceridae	*Triaenodes bicolor*		1							B
Trichoptera	Leptoceridae	*Ceraclea senilis*								1	B
Ephemeroptera	Baetidae	*Baetis rhodani*	8		7	16	3	13	73		C
Ephemeroptera	Ephemerellidae	*Serratella ignita*	25		4	6	28		22		C
Trichoptera	Hydropsychidae	*Hydropsyche siltalai*					1				C
Trichoptera	Polycentropodidae	*Polycentropus kingi*	1								C
Trichoptera	Rhyacophilidae	*Rhyacophila dorsalis*	3			3					C
Trichoptera	Rhyacophilidae	*Rhyacophila munda*					1				C
Diptera	Chironomidae	non-*Chironomus* spp.	1	3	3	2	1			6	C
Diptera	Limoniidae	*Antocha* sp.				1					C
Diptera	Simuliidae	Simuliidae species	1		9	4			87		C
Hemiptera	Corixidae	Corixidae nymph		4							C
Mollusca	Bithnyiidae	*Bithynia tentaculata*	11	42						31	C
Mollusca	Neritidae	*Theodoxus fluviatilis*		4						1	C
Mollusca	Planorbidae	*Ancylus fluviatilis*	1								C
Mollusca	Planorbidae	*Planorbis planorbis*		4					3		C
Mollusca	Planorbidae	*Hippeutis complanatus*			1						C
Mollusca	Planorbidae	*Gyraulus* sp.			2						C
Mollusca	Sphaeriidae	Sphaeriidae agg. excl. *Pisidium pseudosphaerium*	3	18	5		3			6	C
Mollusca	Tateidae	*Potamopyrgus antipodarum*			2	14	11	13	16		C
Crustacea	Gammaridae	*Gammarus duebeni*	14	2		13	4		15		C
Arachnida	Hydrachnidiae	Unidentified species			3					1	C
Crustacea	Asellidae	*Asellus aquaticus*	1	16	6			6		12	D
Mollusca	Lymnaeidae	*Ampullacaena balthica*	1		1						D
Mollusca	Physidae	*Physa fontinalis*		2							D

Hirudinidae	Erpobdellidae	*Erpobdella sp.*							3		D
Hirudinidae	Glossiphoniidae	*Glossiphonia complanata*						4			D
Hirudinidae	Glossiphoniidae	Unidentified species		4				4			D
Diptera	Chironomidae	*Chironomus* spp.		2	1				3	3	E
Annelidae	Oligochaeta	Unidentified species	3		1		1		2		n/a
Abundance			**73**	**102**	**45**	**59**	**53**	**40**	**227**	**61**	
Q-rating			**Q3**	n/a	**Q3**	**Q3**	**Q3**	**Q2-3**	**Q3**	n/a	
WFD status			**Poor**	n/a	**Poor**	**Poor**	**Poor**	**Poor**	**Poor**	n/a	

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