Technical Appendix 7.4
Fish Survey Report

1 Fish Survey Report

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1 Fish Survey Report

1.1 Introduction

1.1.1 This appendix details the methodology, results, and conclusion of the fish surveys undertaken at the Proposed Development. All this information has been used to inform the Environmental Impact Assessment (EIA) detailed in the accompanying EIA Report chapter. The survey results are presented in **Annex A** and were produced by Waterside Ecology in March 2023.

Annex A: Fish Habitat and Population Surveys

Hagshaw Energy Cluster
Fish habitat and population surveys

Commissioned Report to ITP Energised Ltd.

March 2023

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Hagshaw Energy Cluster: fish habitat and population surveys

Commissioned Report to ITP Energised Ltd., March 2023

Contractor: Waterside Ecology

SUMMARY

Background

Waterside Ecology was commissioned by ITP Energised Ltd. to carry out a survey of fish habitats and populations to inform the Environmental Impact Assessment report for developments forming part of the Hagshaw Energy Cluster in East Ayrshire. The proposed developments cover an extensive area to the north of the village of Muirkirk and include a substantial wind farm of 72 turbines, a solar farm and a liquid hydrogen plant. The survey area takes in the Greenock Water catchment, an important tributary of the River Ayr, and small headwater tributaries of the River Clyde.

Methods

A walkover survey of stream habitats was carried out in May 2022. The survey characterised reaches according to their potential for production of salmonid fish. The habitat survey was followed by an electric fishing survey of suitable and representative habitats, conducted in August and September 2022. The electric fishing survey included 31 sites, 20 in the catchment of the River Ayr and 11 in the catchment of the River Clyde.

Main findings: River Ayr

- The survey area encompassed approximately 9.5 km of Greenock Water typical west widths of between 5 and 9 m. Greenock Water is the largest waterbody in the study area and it provides large expanses of good quality salmon and trout habitats with extensive reaches suited to spawning and juvenile production. Habitat quality is generally good, although there was some evidence of moderate siltation in the more downstream part of the study area, where gradient is low. Habitat suited to juvenile lampreys is present.
- Juvenile salmon were present at all six electric fishing sites in Greenock Water. Salmon fry and parr densities were found mainly to be good or excellent by regional standards. Trout densities in the mainstem of Greenock Water were generally low. Other fish species present were stone loach, common minnow and lamprey (probably brook lamprey).
- Dippal Burn and its headwaters, including Leaze Burn, are effectively an upstream continuation of Greenock Water. No substantial barriers to upstream migration were identified on Dippal Burn or Leaze Burn, so they are accessible to sea trout and salmon. A waterfall restricts migratory salmonids to the lower 0.4 km of the unnamed northern tributary (confluence NS 7098 3287). Salmon parr were found at the two most downstream survey sites on Dippal Burn, but fry were absent. Trout were present at all sites in Dippal Burn and Leaze Burn, and densities were highly variable. Other fish species present were stone loach, common minnow and European eel. The two former species may be restricted to the lower part of Dippal Burn by rapids and ledges around NS 693 318.
- Four northern tributaries of Greenock Water that drain directly from the development site were surveyed: Netherwood Burn, Back Burn, Harwood Burn and Leaze Burn. Of these, Back Burn and Harwood Burn provide the longest reaches of suitable habitat for salmonid production. No impassable obstacles were recorded on Back Burn but a perched culvert and a sump (resulting in a section of dry streambed) restrict migratory salmonids to the lower reaches of Harwood

Burn. Netherwood Burn is accessible throughout but habitat quality is very poor. Lamon Burn is accessible for approximately 150 m.

- Electric fishing found trout in all four of the northern tributaries listed above. Fry were abundant in the lower accessible reaches of Lamon Burn but no fish were found upstream of obstacles. Trout density in Nethwerood Burn was low and fry were absent. Better densities were present in Back Burn and Harwood Burn, and it is likely that trout distribution extends well up into the development site. With the exception of stone loach in Lamon Burn, no other fish species were identified from these tributaries.
- Blackside Burn flows into Greenock Water from the east. It has a wet width of around 1.5 m in its lower reaches and provides around 1.4 km of accessible and productive trout habitat. Electric fishing was conducted at two sites. No trout parr were caught. Trout fry density was poor at one site and excellent at the second. Stone loach and minnow were abundant at the more downstream site.
- Ponesk Burn drains the south-eastern portion of the development site and flows directly into the River Ayr. It is a substantial stream with a wet width of 4 to 5 m in the lower part of the study area. It is accessible from the River Ayr and the only obstacle of note is a 0.7 m high waterfall without a plunge pool at NS 7298 3091, approximately 1 km inside the redline boundary. The lower reaches are meandering and provide substantial areas of potential spawning habitat for salmon or trout. Upstream of Priesthill Farm the burn is more entrenched with some bedrock. However some suitable habitat for trout extends well upstream of this into the headwaters.
- Salmon were present only at the most downstream of the three electric fishing sites in Ponesk Burn. Parr density was excellent but fry were absent. Trout were present at two of the three sites, including a site upstream of the waterfall. This suggests trout will be present well into the headwaters. Minnows and stone loach were abundant downstream of the waterfall, but were absent upstream.
- The absence of European eels at all but one survey site may be indicative of barriers to migration in the lower reaches of the River Ayr.

Main findings: River Clyde

- Several streams were surveyed in the Glengavel Water sub-catchment. These included Powbrone Burn and its tributaries Self Grain, Middle Grain, Dead Grain and Little Grain as well as Patrick Burn. None of these streams is accessible to migratory salmonids due to natural and man-made obstacles further downstream. Surveys also included parts of the Logan Water catchment upstream of Logan Reservoir. Streams in this area included Logan Water, Kip Burn and Blaeberry Burn.
- Powbrone Burn has a typical wet width of 3 to 4 m. Gradient is moderate and it appears well suited to trout production. It is likely to make a substantial contribution to the fishery in Glengavel Reservoir. The tributary streams are of varying quality. Self Grain and Middle Grain appear to provide the largest areas of habitat suited to trout, although waterfalls restrict upstream access from Powbrone Burn to the lower 1.0 km and 0.4 km of stream respectively. Patrick Burn flows directly into Glengavel Reservoir. Those parts of the stream within the redline boundary are small (< 1 m wet width) and habitat quality is poor.
- Trout were present in Powbrone Burn and in accessible parts of its tributaries. No fish were found upstream of impassable waterfalls. Trout density was variable but excellent parr densities were present in Powbrone Burn itself. The only other fish species encountered were

stone loach, in Powbrone Burn only. No electric fishing took place in Patrick Burn but small numbers of trout were seen during the habitat survey.

- Logan Water, Kip Burn and Blaeberry Burn have moderate gradients and habitats appear well suited to trout production. Habitats in the lower reaches of Logan Water, in particular, appear of good quality and spawning habitats are available. None of the streams appears accessible from Logan Reservoir.
- Trout were present in all three streams and fry were widespread suggesting recent spawning. Juvenile trout abundance was variable, but generally rather low and the surveyor's impression was that density at most sites was likely to be below the carrying capacity of the habitat. Numbers may be limited by the lack of access for larger spawners from Logan Reservoir. No other fish species were present in the samples.

The findings are discussed in relation to the proposed development and potential impacts on fish habitats and populations are considered for each watercourse.

1 INTRODUCTION

1.1. Proposed development

Waterside Ecology was commissioned by ITP Energised Ltd. to carry out a survey of fish habitats and populations to inform the Environmental Impact Assessment report for developments forming part of the Hagshaw Energy Cluster in East Ayrshire. The proposed developments cover an extensive area to the north of the village of Muirkirk and include a substantial wind farm of 72 turbines, a solar farm and a liquid hydrogen plant. The solar farm would be located on the north side of the Greenock Water, and the wind turbines and associated track network would be located in three groups: a western cluster on the hills north of Greenock Water (Middlefield Law); an eastern cluster extending over Starpet Rig and Priesthill Height and the hills immediately to the south, taking in the Ponesk Burn catchment; and a northern cluster in forested ground on Goodbush Hill, Millstone Rig and Dungavel Hill, around the Powbrone Burn catchment.

Potential impacts on fish and fish habitats from a development such as this include direct damage to habitat at watercourse crossings, creation of obstacles to fish passage, and a range of water quality impacts. Water quality can be affected by silt, exposure of mineral-rich soils and rocks to weathering and oxidation which in turn can alter water chemistry, nutrient enrichment associated with blasting and direct pollution through spills.

1.2. Survey area

The survey area includes much of the Greenock Water catchment and the smaller Ponesk Burn to the east, both tributaries of the River Ayr, and parts of the headwaters of Glengavel Water and Logan Water, both in the upper River Clyde catchment.

The Greenock Water is the most substantial watercourse in the survey area. In the headwaters it is known as Dippal Burn. It rises in the middle of the proposed wind farm site as a number of smaller streams which combine to form Dippal Burn at NS 710 329, which in turn becomes Greenock Water at NS 691 314. From here it flows south, then turns towards the west near Greenock Bridge, flowing along the southern margin of the proposed development area and eventually joining the River Ayr at NS 628 269. A number of small tributaries drain into Greenock Water from the south-western section of the proposed wind farm site, and the proposed solar farm would be along a section of the right (northern) bank.

The catchment of the small Ponesk Burn takes in the south-eastern part of the proposed development area. The burn joins the River Ayr just east of Muirkirk.

The northern part of the survey area takes in the Powbrone Burn and smaller Patrick Burn catchments, both headwater tributaries of Glengavel Water which ultimately drains into the River Clyde.

The north-eastern part of the survey area covers the headwaters of the Logan Water catchment upstream of the Logan Reservoir, taking in Logan Water itself, Kip Burn and Blaeberry Burn.

Habitat within the survey area is mainly rough pasture and moorland, with a commercial forestry plantation in the northern part of the site. The land around Greenock Water is more intensively farmed with livestock and some arable crops.

1.3. Fish populations

1.3.1. Species

Based on existing data (Ayrshire River Trust 2009; McColl et al. 2009) species potentially present in the target area are:

River Ayr catchment

Atlantic salmon *Salmo salar*

Brown trout (including sea trout) *Salmo trutta*

Grayling *Thymallus thymallus*

European eel *Anguilla anguilla*

Brook lamprey *Lampetra planeri*

Stone loach *Barbatula barbatula*

Common minnow *Phoxinus phoxinus*

Three-spined stickleback Gasterosteus aculeatus

River Clyde catchment

Brown trout *Salmo trutta*

European eel *Anguilla anguilla*

Stone loach *Barbatula barbatula*

Common minnow *Phoxinus phoxinus*

1.3.2. Conservation status

The Atlantic salmon is listed on Annexes IIa and Va of the EU Council Directive 92/43/EEC on the conservation of natural habitats and of wild fauna and flora (known as the Habitats Directive). Atlantic salmon receive protection, particularly from over-exploitation, under the Bern Convention (Appendix 3). Salmon in Scotland receive further protection from Salmon and Freshwater Fisheries (Consolidation) (Scotland) Act 2003. This covers a number of regulatory areas, including legal methods of fishing and offences, close times and protection of juvenile and spawning salmon. The Atlantic salmon is listed vulnerable on the IUCN red list.

European grayling is listed in Annex IIa of the EC Habitats Directive. It is not native in Scotland but was successfully introduced in the nineteenth century to a number of rivers (Maitland 2007) where it now breeds successfully.

Due to recent declines, eels are of increasing conservation interest and are protected by European (EC No 1100/2007) and Scottish (Freshwater Fish Conservation (Prohibition on Fishing for Eels) (Scotland) Regulations 2008) legislation. The latter makes it illegal to take eels without a license from the Scottish Government. European eels are listed as critically endangered on the IUCN Red List.

All three UK lamprey species (brook lamprey *Lampetra planeri*, river lamprey *Lampetra fluviatilis* and sea lamprey *Petromyzon marinus*) are listed on Annex IIa of the Habitats Directive and Appendix III of the Bern Convention. The river lamprey is also listed on Annex Va of the Habitats Directive.

Atlantic salmon, brown trout (including sea trout) and European eel are listed as priority species on the UK and Scottish Biodiversity Action Plan lists.

Stone loach, minnow and three-spined stickleback have no special protections under current conservation legislation. There is some debate as to the status of stone loach and minnow in Scotland and there's no doubt that both species have been widely introduced to new waters. However, in lowland waters including those in the target area both may be native (Maitland 2007).

1.4. Ecology and habitat requirements

1.4.1. Salmon and trout

The physical habitat requirements of juvenile salmonids are reviewed by e.g. Crisp (1993), Hendry & Cragg-Hine (2003), Klemetsen *et al*. (2003), Summers *et al*. (1996) and Youngson & Hay (1996). Trout and salmon spawn in late autumn and early winter, depositing their eggs in redds excavated in gravel and pebble substrates. Eggs are often deposited in areas of accelerating flow, such as the tails of pools and glides, upstream from riffles. However, in upland streams eggs may be deposited in any areas of gravel that can be physically moved. A good supply of oxygen is essential for eggs to develop and this is facilitated by a flow of water through the gravel. Clogging with fine sediment such as silt and fine sand reduces water flow resulting in egg mortality due to lack of oxygen. Egg survival is also affected by redd 'washouts' during winter spates – the direct, physical, scouring out of eggs from the gravel. Substrate stability, the dynamics of water flow and the weather all determine the extent of siltation and washouts.

After hatching the young fry remain in the gravel, absorbing nutrient from the remaining yolk sac. On emergence, usually between March and early May, the young fry disperse and set up territories which they defend aggressively. Salmon fry prefer fast flows (>30 cm/s) and favour areas with surface turbulence (riffle habitat). They require a rough bed of pebble, cobble and gravel. Trout fry prefer areas of relatively low velocity water near the streambed. Cover from stones, plants or debris is required and good cover is essential for maintaining high fry densities.

Salmon that have survived their first winter (parr) prefer deeper water than fry (typically 15-40 cm) and a coarser substrate of pebbles, cobbles and boulders. Trout parr generally favour areas of relatively low current speed where cover is available. Juvenile trout are often to be found in cover alongside the banks, in undercuts, among tree roots or in marginal vegetation. Cover remains important for adult trout and salmon particularly in smaller streams. In larger rivers and lochs this may be less important, as deep water provides refuge.

1.4.2. Grayling

The grayling is not native to Scotland, but was successfully introduced to many rivers during the nineteenth century (Maitland 2007). Habitat requirements are largely as for trout, as the grayling is essentially a cold-water species occurring in clean, well-oxygenated waters. The grayling's typical habitat is cool water in swiftly flowing streams and rivers, usually characterised by stony substrate. Favoured habitat is often associated with intermediate river gradients (sometimes known as the grayling zone). Unlike trout or salmon, grayling spawn in the springtime. Spawning habitat is similar to that utilised by trout.

1.4.3. Eels

Eel habitat requirements have received less attention than those of salmonid fish. Tesch (1977) suggests that so long as temperature and oxygen requirements are met, there are few stretches of water that are not suitable for eels. The main requirement for eels is cover, as they are averse to light and require suitable refuges during daylight hours. Partly as a result of this, eels are generally more abundant in areas of coarse substrate (Degerman et al. 2019). Eels of different size show different substrate preferences. Larger eels require large hollows, crevices or weed beds whereas small eels are sometimes abundant in cobble substrates, where they can burrow between the stones. Tree stumps, roots and other large structures provide ideal cover for eels. Eel diet is diverse, but the majority of the diet consists of benthic species (Moriarty 1978; Kottelat & Freyhof 2007).

1.4.4. Lampreys

Three lamprey species occur in the UK: brook lamprey, river lamprey *Lampetra fluviatilis* and sea lamprey. The latter two species, like salmon, are anadromous and go to sea to feed as adults before returning to freshwater to spawn. Adult lampreys aggregate to spawn and extrude their eggs into 'nests'

excavated in the riverbed. After hatching the young lamprey larvae, known as ammocoetes, drift downstream with the current. They settle in nursery habitat consisting of fine, soft substrate in well oxygenated, slow flowing water. The ammocoetes are blind and spend several years in this muddy nursery habitat before metamorphosing (or transforming) from larval to adult form. Upstream migrating adult lampreys may be prevented from reaching spawning grounds by both natural and man-made barriers. They are weak jumpers, so can be prevented from moving upstream by relatively low vertical barriers. Lampreys require good water quality and the larvae require well-oxygenated sediments.

1.4.5. Stone loach

Stone loaches usually live in flowing stretches of streams and rivers and generally show a preference for well oxygenated water with gravel/stony substrates. However they can and do inhabit other habitats such as canals or lake shores. Stone loaches spawn in spring and summer shedding their sticky eggs among gravel and vegetation. The recently-hatched young show a preference for sandy riverbeds, shifting to gravelly or stony areas and faster flows as they develop. Stone loaches have they mouths on the underside of their heads and they are almost exclusively benthic in their habits, feeding on a variety of invertebrates. Stone loaches require good water quality.

1.4.6. Common minnow

Common minnows occupy a large variety of waterbodies from small streams, to large rivers and lakes. They are moderately tolerant of pollution but require clean gravel to spawn. Spawning takes place in the spring. Minnows are small fishes and they feed on invertebrates, algae and detritus.

1.4.7. Three-spined stickleback

Three spined sticklebacks are another small fish species, rarely exceeding 100 m in length and more typically 50 to 70 mm. They have a very broad habitat niche including brackish as well as freshwater environments. They spawn in late spring/early summer in nests that are prepared and subsequently guarded by the males. Sticklebacks feed on small invertebrates, particularly insects and crustaceans. They are generally quite tolerant of pollution.

2 METHODS

2.1. Habitat assessments

Habitat assessments were carried out in May 2022 by Jon Watt and Isabel Isherwood of Waterside Ecology. All watercourses within the red line boundary with the potential to support fish were inspected. Most watercourses within the study area were surveyed qualitatively. Qualitative surveys involved walking the streambanks and taking notes on the nature of stream habitats and their potential for fish production. Photographs were taken of typical habitats within each watercourse. Significant obstacles were recorded where these might determine the fish species present. Habitats in most streams were not mapped or quantified, the exception being Greenock Water. Walkover methods (qualitative and quantitative) were broadly based on protocols described by Hendry and Cragg-Hine (1997), Summers *et al*. (1996) and SEPA (2010). These characterise in-stream habitats according to depth, substrate, flow and thus suitability for different age classes of salmonid fish (Table 1). Substrates are described using the Wentworth scale.

Other variables recorded included wet width, stability of substrate and compaction. The availability of cover for fish alongside banks was recorded as this can be an important factor in determining trout density, particularly in habitats where cover on the streambed is sparse. In addition, surveyors made subjective assessments of typical habitat quality for juvenile trout or salmon, based on published habitat requirements and many years' experience of electric fishing in streams throughout Scotland.

There are no recognised UK protocols for assessing habitat suitability for European eels. Eels have a very broad habitat niche and their main requirement other than a food source is cover. This may take

the form of stones, roots or vegetation but eels also have the ability to bury themselves in soft streambeds. Target notes were maintained on likely habitat suitability for eels.

Lamprey larvae or ammocoetes require nursery habitat consisting of fine, soft substrate in well oxygenated, slow flowing water. Areas of suitable habitat are often found in backwaters, eddies and slow-flowing stream margins. Where significant areas of suitable habitat were found these were recorded and grid references noted.

Table 1 Habitat categories used for walkover survey and text of this report

Habitat category	Description
Fry habitat	For salmon, shallow fast flowing habitat with substrate of pebble and cobble. For trout, shallow slow flowing habitats with substrate of pebble and cobble.
Mixed juvenile habitat	Habitats with mixed depth and coarse substrates including cobble, boulder and pebble that provide cover for salmonid fry and parr. Depth typically 10 to 50 cm.
Glide	Low gradient channel with small substrates. Lacking cover for fish. Productive if instream macrophytes or bankside cover are present.
Deep pool	Over 1 m deep. Slow or eddying current. Suitable for adult salmonids if cover is present. If >1 m deep cover may be less important, as depth can provide refuge.
Bedrock	Sheet bedrock or compacted earth covering majority of streambed. No cover. Unproductive for fish.
Peat channel	Non-standard classification. Simple incised channel through peat and earth with no hard substrate. Unproductive for fish.
Spawning	Ideally well oxygenated, stable & not compacted. Typically comprising cobble, gravel and pebble. Fines (sand & fine gravel <2 mm) less than 20%. Not silted.

2.2. Electric fishing

2.2.1. Field survey

Fish populations were surveyed by electric fishing at 32 sites between 15th August and 8th September 2022 by Jon Watt and Martin Seed of Waterside Ecology. Surveys were conducted mainly using semi-quantitative methods as described by Scottish Fisheries Co-ordination Centre (SFCC 2014). A single electric fishing run was conducted at semi-quantitative survey sites. Four sites were surveyed using fully quantitative techniques. Three runs were made through fully quantitative sites and these were isolated using stop nets at the upstream and downstream limits. Three sites that were judged to be close to the upper limit of fish production (LA1, LG1 and LW3) were sampled qualitatively checking solely for presence or absence of target species. A further qualitative site, DB1, was sampled to help determine the upstream limit of stone loach and minnow distribution in the Greenock Water/Dippal Burn area.

Sites are listed in Table 2 below and further details of survey events are given in Appendix 7.2. Locations in relation to infrastructure (as proposed at time of survey) are shown on Figures 1 and 2.

Table 2 Locations of electric fishing sites and survey method

Catchment	Watercourse	Site code	NGR	Survey type
Ayr	Greenock Water	GW1	NS 65658 28188	Semi-quantitative
Ayr	Greenock Water	GW2	NS 68262 28820	Fully quantitative
Ayr	Greenock Water	GW3	NS 69308 29289	Semi-quantitative
Ayr	Greenock Water	GW4	NS 69354 31189	Fully quantitative
Ayr	Greenock Water	GW5	NS 70083 29787	Semi-quantitative
Ayr	Dippal Burn	DB1	NS 69158 31535	Qualitative
Ayr	Dippal Burn	DB2	NS 69640 32208	Semi-quantitative

Catchment	Watercourse	Site code	NGR	Survey type
Ayr	Dippal Burn	DB3	NS 70932 32856	Semi-quantitative
Ayr	Leaze Burn	LB1	NS 71887 32839	Semi-quantitative
Ayr	Leaze Burn	LB2	NS 72392 32810	Semi-quantitative
Ayr	Netherwood Burn	NB1	NS 66192 28478	Semi-quantitative
Ayr	Back Burn	BA1	NS 67212 28834	Semi-quantitative
Ayr	Harwood Burn	HB1	NS 67672 29337	Semi-quantitative
Ayr	Lamon Burn	LA1	NS 69171 29312	Semi-quantitative
Ayr	Lamon Burn	LA2	NS 69059 29787	Qualitative
Ayr	Blackside Burn	BB1	NS 70228 30236	Semi-quantitative
Ayr	Blackside Burn	BB2	NS 71221 30524	Semi-quantitative
Ayr	Ponesk Burn	PB1	NS 72048 30027	Semi-quantitative
Ayr	Ponesk Burn	PB2	NS 72139 30846	Semi-quantitative
Ayr	Ponesk Burn	PB3	NS 73027 30956	Semi-quantitative
Clyde	Powbrone Burn	PO1	NS 67943 33736	Fully quantitative
Clyde	Self Grain	SG1	NS 69284 34638	Semi-quantitative
Clyde	Self Grain	SG2	NS 69943 34872	Semi-quantitative
Clyde	Little Grain	LG1	NS 68627 34356	Qualitative
Clyde	Middle Grain	MG1	NS 69140 34653	Semi-quantitative
Clyde	Middle Grain	MG2	NS 69330 35135	Semi-quantitative
Clyde	Logan Water	LW1	NS 73742 34634	Semi-quantitative
Clyde	Logan Water	LW2	NS 73404 34361	Semi-quantitative
Clyde	Logan Water	LW3	NS 73264 34263	Qualitative
Clyde	Kip Burn	KB1	NS 73615 35032	Fully quantitative
Clyde	Kip Burn	KB2	NS 73187 34738	Semi-quantitative
Clyde	Blaeberry Burn	BL1	NS 73708 35558	Semi-quantitative

All electric fishing sites covered the full stream width and incorporated a representative range of habitat types. Sites were surveyed using a single anode using smooth DC. Fish were captured in hand-held dip nets then placed in bins of clean water where they were held until ready for processing. Fish were anaesthetised for handling and were identified to species. Salmonid fork length was measured to the nearest millimetre. All fish were allowed to recover fully in clean water before being released back into the survey reaches. Habitat descriptions were made at fully- and semi-quantitative survey sites using the SFCC (2014) protocol.

Spot checks were carried out for the presence of larval lampreys where suitable habitat (fine sand and silt) was noted within or adjacent to salmonid survey sites.

2.2.2. Data analyses and presentation

All fish densities are expressed as fish per 100 square metres of wetted stream area (fish.100m^{-2}). Salmonid densities are presented separately for fish fry and parr. Throughout this report the term 'fry' is used for salmonid fish in their first year of life (i.e. fish aged 0+ years). The term 'parr' is used for juvenile salmonid fish aged 1 year or older. Zippin estimates of total fish densities, with 95% confidence intervals, were calculated for fully quantitative sites using the programme Population Estimation by Removal Sampling (Pisces Ltd., version 2.2.2.22).

The classification provided by Godfrey (2006) is used to describe fish abundance in a regional context. The classifications are based on large data sets held by Scottish Fisheries Co-ordination Centre (SFCC). The quintile ranges of salmon and trout densities (Appendix 7.3) allow for comparison of fishery performance against regional and national reference points. The classification system is based on semi-quantitative fishing i.e. density based on number of fish captured during a single electric fishing run through an undisturbed site.

Figure 1. Electric fishing sites River Ayr catchment

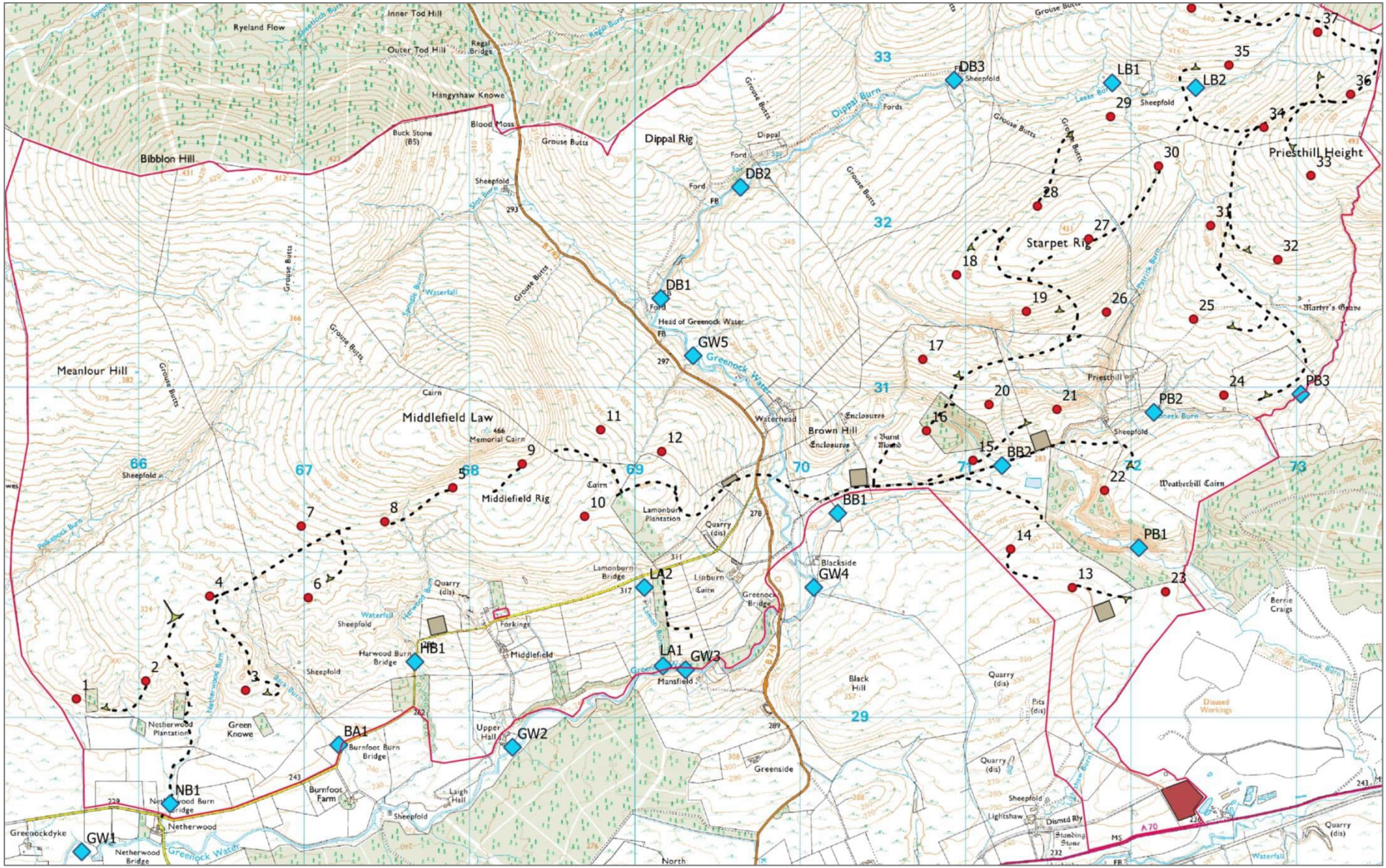
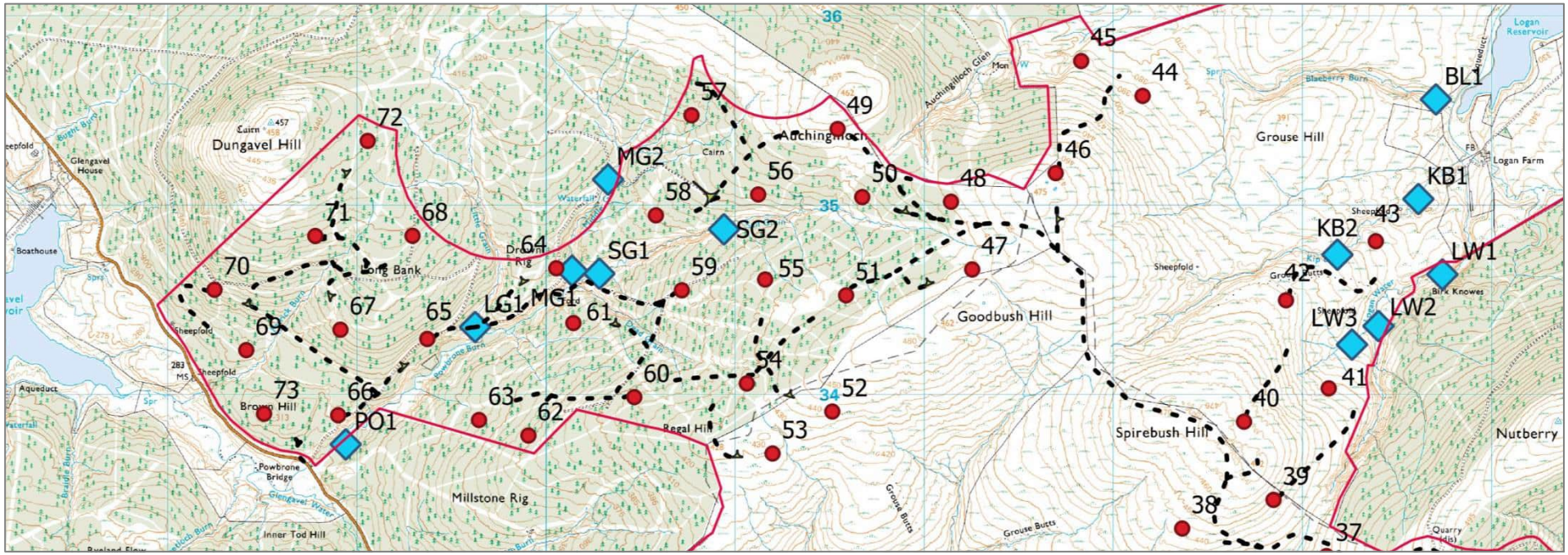


Figure 2. Electric fishing sites River Clyde catchment



3 RESULTS

3.1. Greenock Water and tributaries

Fish habitat surveys were carried out in Greenock Water and the larger accessible tributaries with the potential to be affected by the proposed development, extending from Head of Greenock Water as far downstream as the confluence of Greenock Water and Polkebock Burn at NS 6408 2853. The findings are set out in section 3.1.1. Based on the results of the habitat survey, eleven electric fishing sites were identified and surveyed on the Greenock Water and its tributaries Netherwood Burn, Back Burn, Harwood Burn, Lamon Burn and Blackside Burn (section 3.1.2).

3.1.1. Fish habitat

3.1.1.1. Greenock Water

Polkebock Burn to Aikencleugh ford (NS 6408 2853 to NS 6474 2818)

The most downstream of the surveyed reaches of Greenock Water flows through rough pasture. It is predominantly shallow (10-40 cm) mixed juvenile habitat with a substrate of cobble, pebble and flat slab-like boulders, with some bedrock. Flow types are run, riffle and glide. There are two deep pools (>1 m) and some deep glide towards the top of the reach. Wet width averages around 8 m. The reach is very stable, with instream macrophytes, and moss and vegetation on emergent boulders. There is plenty of cover both instream amongst the boulders and cobbles, and alongside the banks where undercuts provide overhead cover.

Pockets of clean spawning substrate suitable for trout are available, but are too small for salmon. Lamprey habitat was found in small patches throughout, with some larger areas near the top of the reach. The habitat appears of good quality for juvenile salmon and trout.

Aikencleugh ford to Netherwood (NS 6474 2818 to NS 6600 2826)

This long meandering reach through rough pasture is dominated by unproductive shallow glide habitat with a substrate of sand, silt and pebble. These reaches offer very little cover for fish. Long glides are interspersed with short pebble runs, but these are quite heavily silted reducing their value as spawning habitat. There are only a few short stretches of mixed juvenile habitat with some cover from cobbles and boulders. Wet widths are typically between 5 and 9 m. Depths range from 10 to 50 cm, with two deeper pools

near the top of the reach. There are some good areas of lamprey habitat towards the Aikencleugh end of the section. The banks are collapsing and eroding in many places.

Netherwood to Burnfoot (NS 6408 2853 to NS 6474 2818)

This reach holds mainly shallow mixed juvenile habitat, with slow run and glide over a substrate of cobble, pebble and boulder. Wet widths range from 5 to 9 m. Typical depths are typically 10-30 cm, and up to 45 cm in some areas towards the upstream end of the reach. Instream habitat and banks are fairly stable and offer moderately good cover. Much of the habitat appears better suited to fry than to parr. Two areas of spawning substrate totalling 28 m² were recorded in the lower part of this reach. Alternating with the mixed juvenile habitats, there are short sections of unproductive glide with sand/silt substrate and very little cover. Accumulations of silt were evident, and at the time of survey filamentous algae was quite abundant.

Burnfoot to Head of Greenock Water (NS 7233 2992 to NS 6911 3137)

This is a moderate-gradient reach of the Greenock Water, flowing through a mix of farmland (cattle, sheep) and some areas of woodland, giving way to rough pasture upstream of Blackside (NS 700 300). The river appears to provide good quality habitat for trout and salmon, with stable substrates of cobble, pebble some boulder. Wet widths are between 5 and 8 m. A high proportion of the surveyed reach was classified as productive mixed juvenile salmonid habitat. Deep holding pools suitable for adult salmon or trout are present and spawning habitats are widespread (see Appendix 7.8 for list of main spawning habitats in Greenock Water).

A 65 m long culvert carries Greenock Water beneath the B743 road. The apron is rather shallow and fish access has been recently eased by the installation of baffles. The culvert was judged passable and seems likely to have been so prior to the installation of the baffles, although they will almost certainly have increased the range of flows during which upstream migration is possible.

3.1.1.2. Netherwood Burn (NS 6617 2822 to NS 6639 2895)

This tributary joins Greenock Water from the north (right bank) close to Netherwood Farm, and flows mainly through rough pasture. The lower reaches comprise shallow mixed juvenile trout habitat, with depths of 2-10 cm and widths of 0.7-1.2 m. The substrate is mainly cobble, pebble, boulder and gravel, with short bedrock sections. A 1 m high rock step at NS 66190 28464 may be passable on higher flows

but lacks any pool at low to normal flow, and presents a significant obstacle to upstream migration. The substrate is stable and mossy with much algae in the reach alongside the farm.

The upper reaches are entrenched with substrates of stable, embedded cobbles and some bedrock. Here the channel is mainly less than 1 m wet width and depth is typically between 5 and 20 cm with occasional small pools to 30 cm. The substrate is largely immobile embedded cobble, and the lack of bedload means there is little spawning potential anywhere in the burn.

3.1.1.3. Back Burn (NS 6746 2846 NS 6694 2921)

This small stream joins Greenock Water from the north at Burnside. Between Greenock Water and the public road it is of moderate gradient, flowing between densely-vegetated banks of scrub and tall herbs. Upstream of the road it is slightly lower gradient, becoming quite entrenched between high steep banks. It holds mainly mixed juvenile habitat, with shallow run flow (2-10 cm deep), changing to step-pool in higher gradient areas, over a substrate of cobble, boulder and pebble. Widths are between 1 and 1.5 m downstream of the road, and 0.6-1 m upstream of the road, narrowing to 0.5 m or less towards the upstream survey limit. Upper parts of the survey reach are closed over in some places. Patches of spawning substrate suitable for trout is available. No impassable obstacles were noted.

3.1.1.4. Harwood Burn (NS 6746 2845 NS 6759 2965)

This tributary enters Greenock Water from the north at NS 6746 2845. The first 300 m upstream of the confluence have a low to moderate gradient and substrates of pebble, cobble and gravel. Spawning habitats suited to trout are present but the slower reaches are quite heavily silted. The stream passes under the Leigh Hall track at NS 6776 2871 via a twin-pipe culvert. This is perched approximately 45 cm above the streambed and as such is likely to be impassable for upstream migrants. The gradient increases upstream of the track and substrates are of cobble, boulder and some bedrock.

There is approximately 200 m of dry channel between NS 6779 2891 and NS 6776 2902, where the stream disappears down a sump in the bedrock. Upstream of this dry reach the stream appears to provide moderately good quality trout habitat, perhaps best suited to fry, with typical depths of 10 to 30 cm and varied flow types. Some small patches of spawning habitat are present.

3.1.1.5. Lamon Burn (NS 6918 2927 NS 6900 2993)

Lamon Burn flows into Greenock Water from the north at NS 6918 2927. It is a small stream of less than 1 m wet width in its lower reaches. The first 100 m of the watercourse upstream of the confluence has a moderate gradient and substrates of pebble, cobble and boulder. There are small pockets of habitat suited to spawning by trout.

Further upstream the burn becomes increasingly steep and it flows in a steep-sided gully that eventually becomes gorge-like. Habitat quality in the entrenched reach is very poor and there are several little cascades and strainers that may be impassable. The most downstream of these is at NS 69172 29531. The habitat in the surrounding area is clear-felled conifer that has now been replanted with broadleaves. There was some siltation of substrates at the time of survey.

3.1.1.6. Blackside Burn (NS 7004 2987 NS 7122 3055)

Blackside Burn drains the gently sloping ground between Blackside and Priesthill to join Greenock Water from the east (left bank) at NS 7004 2987. The lower reaches meander through grazed pasture. Substrates are dominated by pebble and cobble, and flow types are riffle, glide and pool. Spawning habitats suited mainly to trout are present. The middle reaches are steeply incised into earth with no exposed margins; this reach flows through damp ground dominated by rushes. In places the streambed is scoured to clay, but there is a little bedload and a few pockets of potential spawning habitat are present. Wet width varies from 1.5 to 0.5 m.

The stream forks upstream of the Priesthill track and both forks are too small to provide any significant areas of fish habitat. Some siltation was evident at the time of survey, particularly in the lower reaches where banks are eroding and slumping. No obstacles to migration were recorded.

3.1.2. Fish populations

3.1.2.1. Salmon

Salmon fry and parr were present at all five sites surveyed in Greenock Water (Table 3). Single run fry densities ranged from 20.3 fry per 100 m² to 69.4 fry per 100 m², and were classed as either good or

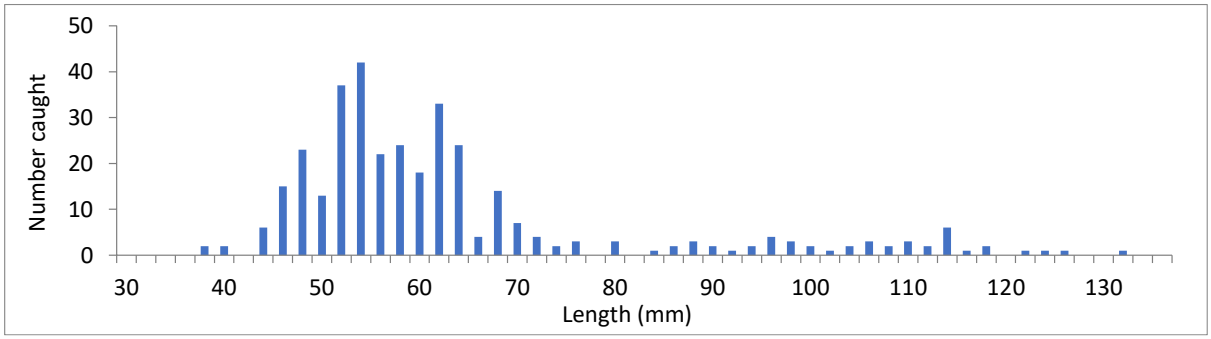
excellent (Table 3). Parr single run densities in Greenock Water ranged from 1.4 parr per 100 m² (very poor) to 10.0 parr per 100 m² (excellent).

Table 3 Electric fishing results for salmon, Greenock Water

Watercourse	Site	**Fry density** (fish.100m^{-2}) Single run density (Zippin)	Fry classification	**Parr density** (fish.100m^{-2}) Single run density (Zippin)	Parr classification
Greenock Water	GW1	22.0	Good	1.4	Very poor
Greenock Water	GW2	28.5 (36.6)	Good	10.0 (18.0)	Excellent
Greenock Water	GW3	69.4	Excellent	3.7	Fair
Greenock Water	GW4	37.1 (58.4)	Good	6.4 (8.1)	Good
Greenock Water	GW5	20.3	Good	6.8	Good
Netherwood Burn	NB1	0.0	Absent	0.0	Absent
Back Burn	BA1	1.0	Very poor	0.0	Absent
Harwood Burn	HB1	0.0	Absent	0.0	Absent
Lamon Burn	LA1	0.0	Absent	0.0	Absent
Blackside Burn	BB1	0.0	Absent	0.9	Very poor
Blackside Burn	BB2	0.0	Absent	0.0	Absent

A single salmon fry was caught in Back Burn, and a single parr in Blackside Burn. No salmon were recorded in any of the other small tributary burns. It is likely that both individuals swam up from the Greenock Water.

Figure 3 Length-frequency distribution for salmon, Greenock Water and tributaries



Salmon fry caught in Greenock Water ranged in length from 37 mm to around 70 mm, while parr ranged from 76 mm to 131 mm. Ages were confirmed by scale-reading; small numbers of fry larger than 70 mm or parr smaller than 76 mm may have been present but scales were only taken from a sample of the fish caught. Scale readings found that both 1+ and 2+ parr were present in the sample. There was a substantial degree of overlap in the lengths of these two cohorts; the smallest 2+ salmon from which scales were taken was 113 mm in length while the largest 1+ was 121 mm long. There was some overlap in length between fry and 1+ parr across the five sites surveyed, but no indication of overlap at any individual site.

3.1.2.2. Trout

Trout were present at all 11 of the 12 survey sites (Table 4), although either fry or parr were absent at five of these.

On the Greenock Water itself juvenile trout densities were generally very low, with fry and parr classified as either absent or very poor at all sites except GW4 where the fry density was good.

Trout fry densities in the small tributary streams were very variable, ranging from absent in Netherwood Burn and poor at the lower Blackside Burn site (BB1) to excellent in Lamon Burn and at the upper Blackside Burn site (BB2). The density of 127.8 fry per 100 m² recorded in Lamon Burn is exceptionally

high, but it should be noted that suitable habitat in this stream is very restricted in extent and that high fry densities could result from very few spawning adults. No fish were present at site LA2, upstream of the gorge-like section.

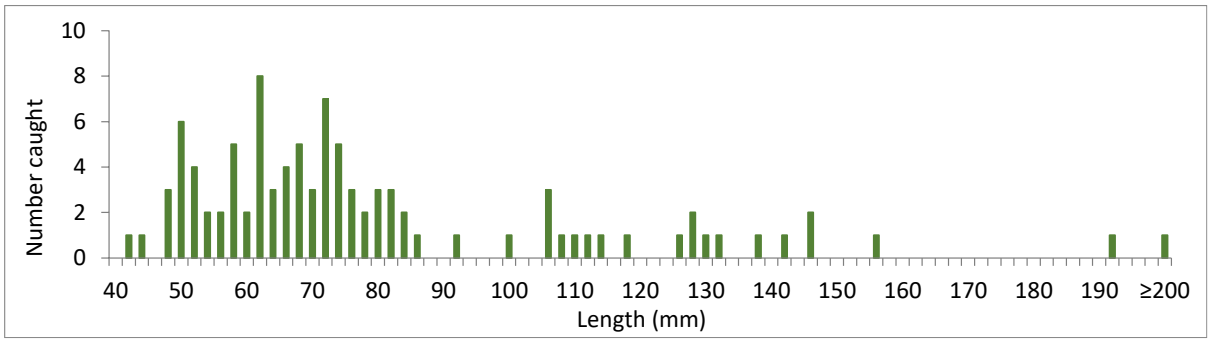
Parr densities in the five tributary streams ranged from absent at both sites in Blackside Burn to excellent in Harwood Burn.

Table 4 Electric fishing results for trout, Greenock Water

Watercourse	Site	**Fry density** (fish.100m^{-2}) Single run density (Zippin)	Fry classification	**Parr density** (fish.100m^{-2}) Single run density (Zippin)	Parr classification
Greenock Water	GW1	0.0	Absent	0.7	Very poor
Greenock Water	GW2	1.4 (1.5)	Very poor	1.4 (2.1)	Very poor
Greenock Water	GW3	0.6	Very poor	0.0	Absent
Greenock Water	GW4	8.9 (10.9)	Good	1.6 (2.7)	Very poor
Greenock Water	GW5	0.8	Very poor	0.8	Very poor
Netherwood Burn	NB1	0.0	Absent	3.8	Fair
Back Burn	BA1	4.8	Fair	4.8	Fair
Harwood Burn	HB1	16.4	Good	8.2	Excellent
Lamon Burn	LA1	127.8	Excellent	3.8	Fair
Lamon Burn	LA2	0.0	Absent	0.0	Absent
Blackside Burn	BB1	2.7	Poor	0.0	Absent
Blackside Burn	BB2	64.0	Excellent	0.0	Absent

Trout fry ranged from 41 mm to 86 mm (Figure 4). Parr ranged from 91 mm to 246 mm, and included 1+, 2+ and 3+ fish.

Figure 4 Length-frequency distribution for trout, Greenock Water and tributaries



Lampetra (lamprey) larvae were present in suitable habitats at GW1 (Table 5). Lamprey larvae are rarely caught in standard electric fishing surveys aimed at salmonids, as their habitat requirements are different and a different sampling technique is required for their capture. However, if present at GW1 it is highly probable that they will be present in other low gradient reaches of Greenock Water, as no obstacles were recorded. Due to weirs further downstream, which are probably impassable to lampreys, these larvae are almost certainly brook lamprey, a resident species.

Stone loach were found throughout Greenock Water, on Lamon Burn, and at the lower site on Blackside Burn. Recorded density was highest at BB1 on Blackside Burn with a single-run density of 43.8 fish per 100 m². They were not recorded in any of the other tributaries.

Minnows were also recorded throughout Greenock Water. They were absent from all tributary sites except BB1 on Blackside Burn where, like stone loach, they were recorded at high density (single-run density of 59.8 fish per 100 m²).

Table 5 Electric fishing results for other fish species, Greenock Water

Watercourse	Site	Stone loach density (fish.100m^{-2})	Minnow density (fish.100m^{-2})	Other species
Greenock Water	GW1	33.7	23.4	*Lampetra* sp. present
Greenock Water	GW2	5.0	19.9	none
Greenock Water	GW3	11.1	10.4	none
Greenock Water	GW4	25.8	48.4	none
Greenock Water	GW5	16.1	19.5	none
Netherwood Burn	NB1	0.0	0.0	none
Back Burn	BA1	0.0	0.0	none
Harwood Burn	HB1	0.0	0.0	none
Lamon Burn	LA1	3.8	0.0	none
Lamon Burn	LA2	0.0	0.0	none
Blackside Burn	BB1	43.8	59.8	none
Blackside Burn	BB2	0.0	0.0	none

No other fish species were recorded and it is notable that no European eels were recorded at any site.

3.2. Dippal Burn catchment

Dippal Burn and its tributaries form the upper part of the Greenock Water catchment, draining the central-northern section of the development site. The two largest headwater tributaries Leaze Burn and an unnamed stream to the north both have the potential to be impacted by, or receive runoff from, the proposed works. Land use in the area is predominantly upland sheep farming and grouse moor. Both headwater streams and Dippal Burn were surveyed, and the findings are set out in section 3.2.1.

Based on the results of the habitat survey, three electric fishing sites were identified and surveyed on Dippal Burn and two on Leaze Burn (section 3.2.2).

3.2.1. Fish habitat

3.2.1.1. Dippal Burn

NS 6911 3137 to NS 7300 3317

Dippal Burn is the upstream continuation of Greenock Water. Its gradient is generally rather steeper than that of Greenock Water and some of the channel is partly entrenched in a v-shaped valley. Substrates are mixed cobble, boulder and pebble. Much of this material is composed of angular or flat plates of sedimentary rock and the smaller substrates are quite unstable.

Typical wet width is between 2.5 and 4.5 m and depths are mainly between 15 and 40 cm. Potential spawning habitat is present but egg washout may be a concern due to instability. Instream cover in most reaches is moderate to good. No obstacles to upstream migration by salmonids were recorded but some low rock-steps are present in the little gorge at NS 693 318.

3.2.1.2. Leaze Burn

NS 70976 32849 to NS 73001 33169

Leaze Burn is an upland stream flowing through rough pasture and moorland. It provides mixed juvenile trout habitat, with run and glide flow interspersed with shallow pools. The substrate is mainly cobble and pebble with some gravel and patchy bedrock. The lower reaches of the stream have low to moderate gradient with many meanders, becoming gradually steeper and more entrenched further upstream where there are some small, but passable, bedrock obstacles.

Depth ranges from 2 to 50 cm, and width from 0.7 to 2 m. Spawning substrate suitable for small trout is available. The habitat is mostly stable and cover is fairly good both instream and alongside the banks where undercuts provide overhead cover. The habitat quality deteriorates somewhat further upstream, but the stream remains accessible to fish all the way to NS 7300 3317 when it becomes a wet flush.

3.2.1.3. Dippal Burn tributary

NS 70977 32871 to NS 71544 33993

This is a small, quite steep unnamed upland stream flowing through moorland and rough pasture. Widths range from 1 to 3 m. The lower reaches hold moderately good mixed juvenile trout habitat, the upper, steeper parts are poorer and very broken by rock steps and small waterfalls. A 2.5 m high cascade with a very shallow plunge pool at NS 71151 33192 is likely to be impassable, restricting access from Dippal Burn to the lower 0.4 km of this stream. No substantial patches of spawning habitat were recorded.

3.2.2. Fish populations

Five sites were surveyed by electric fishing in the upper Greenock Water catchment, three on Dippal Burn and two on Leaze Burn. The most downstream site on Dippal Burn (DB1) was fished as a presence/absence survey with the aim of determining the upstream distribution of stone loach and/or minnows; the remaining four surveys were semi-quantitative. Due to the short reach of accessible habitat on the unnamed Dippal Burn tributary, no electric fishing was carried out on this stream.

3.2.2.1. Salmon

No salmon fry were recorded on Dippal Burn, however salmon parr were present at all three sites (Table 6). Densities at DB2 and DB3 were 8.5 parr per 100 m² (classified as good) and 4.7 parr per 100 m²

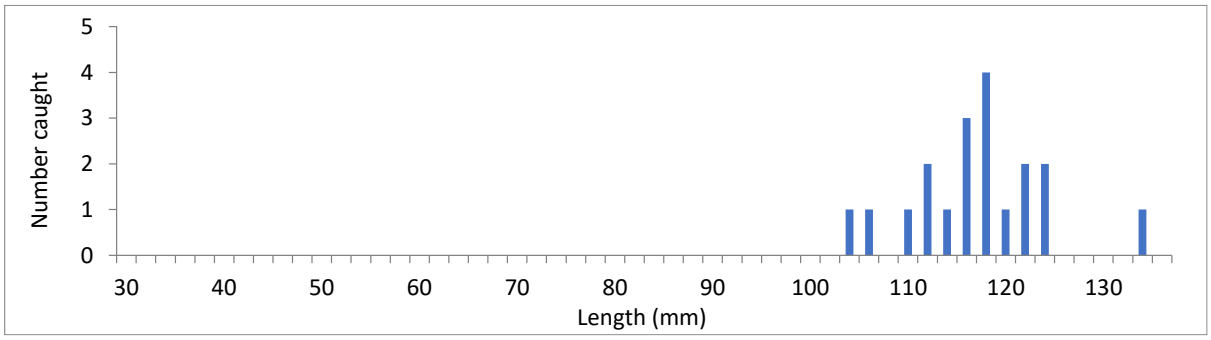
(fair) respectively. No salmon fry or parr were found in Leaze Burn. The absence of fry in Dippal Burn may suggest intermittent spawning in this part of the catchment, or it is possible that parr might have moved into Dippal Burn from the upper reaches of Greenock Water.

Salmon parr in Dippal Burn ranged from 104 to 133 mm, and scale reading indicated that all were aged 1+.

Table 6 Electric fishing results for salmon, Dippal Burn and Leaze Burn

Watercourse	Site	**Fry density** (fish.100m^{-2}) Single run density	Fry classification	**Parr density** (fish.100m^{-2}) Single run density	Parr classification
Dippal Burn	DB1	Absent	Absent	Present	Present
Dippal Burn	DB2	0.0	Absent	8.5	Good
Dippal Burn	DB3	0.0	Absent	4.7	Fair
Leaze Burn	LB1	0.0	Absent	0.0	Absent
Leaze Burn	LB2	0.0	Absent	0.0	Absent

Figure 5 Length-frequency distribution for salmon, Dippal Burn



3.2.2.2. Trout

Trout fry were absent from the two sites in the lower reaches of Dippal Burn, but they were present at the most upstream sites DB3 as well as at both sites in Leaze Burn (Table 7). Trout fry densities were classified as very poor at DB3 and LB2, the upstream site on Leaze Burn. At the lower Leaze Burn site LB1 a trout fry density of 9.4 per 100 m² was recorded, classified as good.

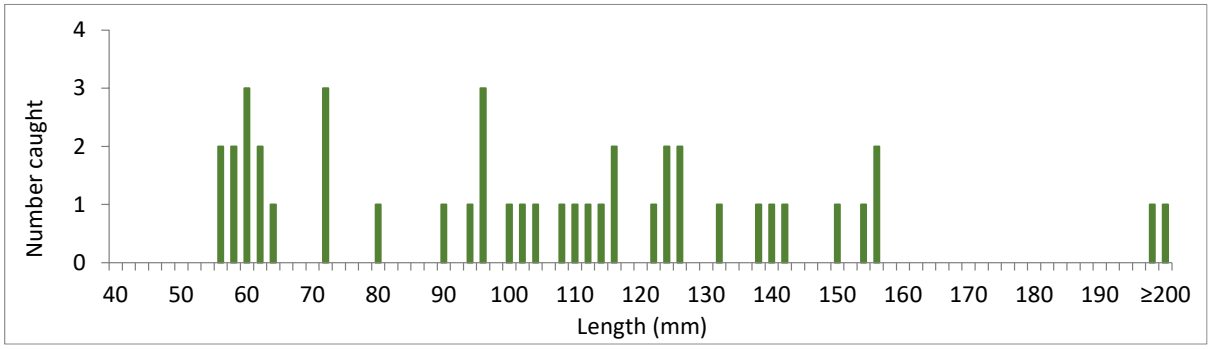
Trout parr were recorded at all sites on Dippal and Leaze Burns. Parr densities at sites DB2 and DB3 were classified as good and excellent respectively. On Leaze burn densities were classified as Fair at LB1 and Poor at LB2.

Table 7 Electric fishing results for trout, Dippal Burn and Leaze Burn

Watercourse	Site	**Fry density** (fish.100m^{-2}) Single run density	Fry classification	**Parr density** (fish.100m^{-2}) Single run density	Parr classification
Dippal Burn	DB1	Absent	Absent	Present	Present
Dippal Burn	DB2	0.0	Absent	6.2	Good
Dippal Burn	DB3	0.6	Very poor	8.3	Excellent
Leaze Burn	LB1	9.4	Good	4.3	Fair
Leaze Burn	LB2	2.1	Very poor	2.1	Poor

The presence of salmon in Dippal Burn indicates that the watercourse is accessible to migratory salmonids, so it is possible that the trout population includes a migratory stock component.

Figure 6 Length-frequency distribution for trout, Dippal Burn and Leaze Burn



Trout fry in Dippal and Leaze Burns ranged in length from 56 mm to 79 mm. Parr ranged from 89 mm to 204 mm, with larger individuals likely to be 2+ or older.

3.2.2.3. Other fish species

Both stone loach and minnow were abundant at DB1 but absent at sites further upstream. It seems likely that the rapids and low rock ramps around NS 693 318 restrict stone loach and minnow to the lower reaches of Dippal Burn.

Two large eels were captured at DB3. One of these was a silver eel, indicating that it was ready to migrate to sea. No eels were caught at any other sites in the Greenock Water or Ponesk Burn catchments, which is indicative of significant (known) access issues further down the Ayr catchment.

Table 8 Electric fishing results for other fish species, Dippal Burn and Leaze Burn

Watercourse	Site	Stone loach density (fish.100m^{-2})	Minnow density (fish.100m^{-2})	Other species
Dippal Burn	DB1	Present	Present	None
Dippal Burn	DB2	0.0	0.0	None
Dippal Burn	DB3	0.0	0.0	2 eels
Leaze Burn	LB1	0.0	0.0	None
Leaze Burn	LB2	0.0	0.0	none

3.3. Ponesk Burn catchment

Ponesk Burn and its tributary Patrick Burn form a small sub-catchment of the River Ayr draining the south-eastern portion of the development site.

Land use in the surrounding area is predominantly upland sheep faming. Between the survey area and the River Ayr the stream flows through (now disused) opencast mine workings. Fish habitat surveys were carried out in Ponesk Burn and Patrick Burn.

Based on the results of the habitat survey, electric fishing was carried out at three sites on Ponesk Burn (section 3.3.2).

3.3.1. Fish habitat

3.3.1.1. Ponesk Burn

Downstream: NS 7233 2992 to NS 7184 3078

The reach of Ponesk Burn downstream of Priesthill Farm (shown in the photograph above) provides moderate quality juvenile habitats and some good quality spawning. The stream flows in a narrow, flat-bottomed, steep-sided valley. Gradient is low and the stream meanders to and fro across the flat valley floor. Shallow riffles with cobble, pebble and boulder substrate alternate with shallow glide flows and occasional deeper pools (to 60 cm). Potential spawning habitats are present at the run-outs of many of the pools and glides. There is evidence of widening and shallowing in places due to bank erosion. Some modification has taken place in the past, with a partial embankment visible along a section of the left bank. Spawning habitat suited to trout and salmon is widespread. Wet widths are mainly between 2 and 3.5 m.

Upstream: NS 7183 3073 to NS 7328 3132

The character of the stream changes upstream of Priesthill Farm. The gradient steepens somewhat, and the channel is partly entrenched in a steep-sided v-shaped valley. Patchy bedrock throughout reduces the quality of the habitat, but short sections of more productive cobble-dominated habitat are present. There are a few patches of spawning calibre substrate suited to trout, but these are poor quality and unstable. Wet widths range from 1.5 to 2.5 m. A 0.7 m high waterfall without a plunge pool at NS 7298 3091 may be impassable to fish.

3.3.1.2. Patrick Burn

NS 7192 3127 to NS 7212 3165

Patrick Burn is a small tributary of Ponesk Burn, which it joins at Priesthill Farm. It has a wet width of around 1 m in the lower reaches and 0.5 m towards the upstream end of the surveyed reach. The stream is entrenched between steep v-shaped banks. Substrates are of angular shattered cobbles and pebbles with some areas of bedrock. It appears very unstable. No fish were seen during the habitat survey. Typical depths are between 5 and 15 cm with some small pools to 40 cm. There are a number of areas of rapid bank erosion in the lower reaches. Bankside cover is lacking. While there are small pockets of spawning calibre substrates these are very unstable and likely to be ephemeral. In summary, this is a highly unstable small stream with poor spawning and little productive potential.

3.3.2. Fish populations

Three sites on Ponesk Burn were surveyed by electric fishing. No sites were surveyed on Patrick Burn due to the poor quality and limited extent of available habitat. Sites PB1 and PB2 are in the more downstream part of the reach; PB3 is upstream of the waterfall at NS 7298 3091.

3.3.2.1. Salmon

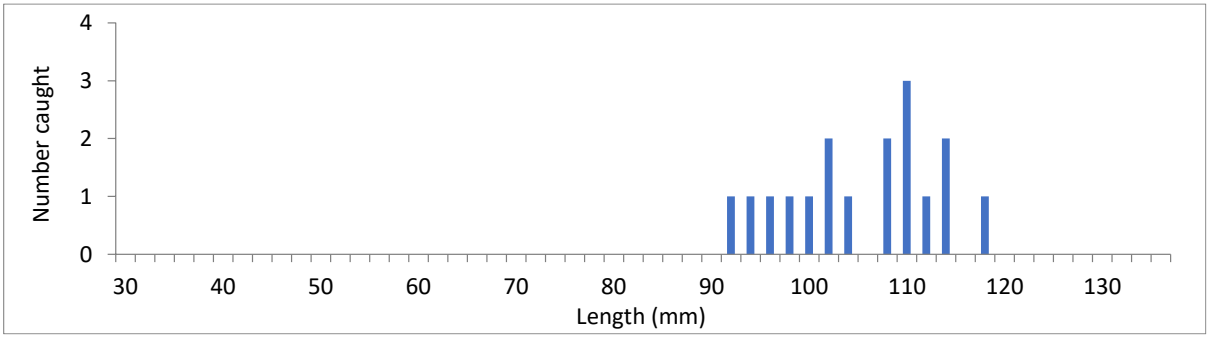
Salmon parr were present at the two lower sites on Ponesk Burn (PB1 and PB2), but not at PB3. Parr densities were excellent at PB1 but very poor at PB2. No fry were caught at any of the sites, suggesting that salmon may not spawn successfully in this part of Ponesk Burn every year.

The salmon parr caught on Ponesk Burn ranged in length from 92 mm to 114 mm, and scale reading indicated that all were likely to be 1+ individuals.

Table 9 Electric fishing results for salmon, Ponesk Burn

Watercourse	Site	**Fry density** (fish.100m^{-2}) Single run density	Fry classification	**Parr density** (fish.100m^{-2}) Single run density	Parr classification
Ponesk Burn	PB1	0.0	-	13.4	Excellent
Ponesk Burn	PB2	0.0	-	1.0	Very poor
Ponesk Burn	PB3	0.0	-	0.0	-

Figure 7 ..Length-frequency distribution for salmon, Ponesk Burn



3.3.2.2. Trout

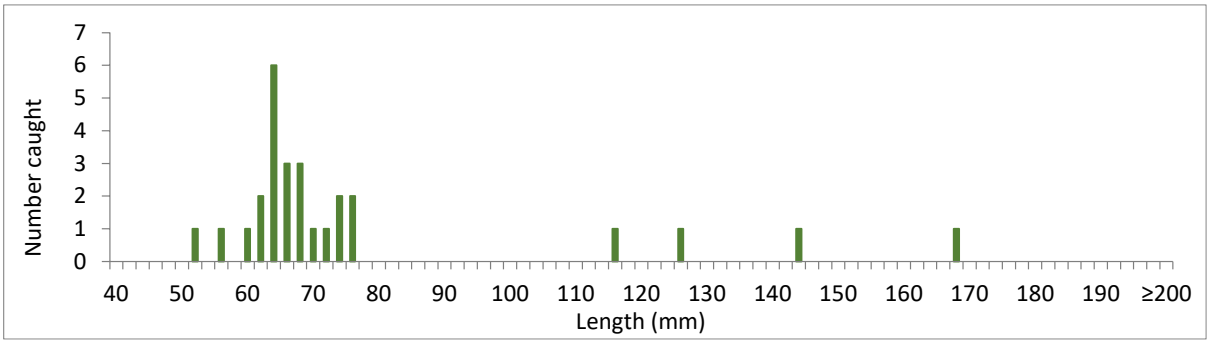
Trout were present at the lower and upper sites on Ponesk Burn (PB1 and PB3), but absent at the middle site PB2 (Table 10) despite the apparent suitability of stream habitat. Parr were absent at PB1, but the single run density classification for trout fry was excellent at this site. Fry and parr were both found at low density at PB3 (classified as very poor for fry and poor for parr). Although densities were low, the presence of trout at PB3 which is upstream of a probably impassable waterfall demonstrates that resident (brown) trout are present in the headwaters; their distribution is likely to extend throughout suitable headwater habitats. The presence of salmon downstream of the waterfall indicates that the downstream reach of the Ponesk Burn is accessible to migratory fish, and that the trout population in this reach may therefore have a migratory (sea trout) component.

Table 10 Electric fishing results for trout, Ponesk Burn

Watercourse	Site	**Fry density** (fish.100m^{-2}) Single run density	Fry classification	**Parr density** (fish.100m^{-2}) Single run density	Parr classification
Ponesk Burn	PB1	17.9	Good	0.0	-
Ponesk Burn	PB2	0.0	-	0.0	-
Ponesk Burn	PB3	1.3	Very poor	3.2	Poor

Trout size distribution is shown in Figure 8 below. There was a clear size split between the trout fry and parr groups in Ponesk Burn, with fry lengths ranging from 51 to 76 mm and parr from 116 to 168 mm. It is likely that at least two age classes of parr are represented.

Figure 8 Length-frequency distribution for trout, Ponesk Burn



3.3.2.3. Other fish species

Stone loach were present at sites PB1 and PB2, with a particularly high density at PB1 (37.5 fish per 100 m²), but they were absent from PB3 upstream of the waterfall (Table 11). Minnows were also present at both downstream sites and absent from PB3, but they were at much lower density at PB1 (2.7 fish per 100 m²) compared to PB2 (38.8 fish per 100 m²). No other fish species were recorded on Ponesk Burn.

Table 11 Electric fishing results for other fish species, Ponesk Burn

Watercourse	Site	Stone loach density (fish.100m^{-2})	Minnow density (fish.100m^{-2})	Other species
Ponesk Burn	PB1	37.5	2.7	None
Ponesk Burn	PB2	20.3	38.8	None
Ponesk Burn	PB3	0.0	0.0	None

3.4. Glengavel Water catchment

The north-western part of the proposed wind farm area is drained by a group of headwater tributaries of the Glengavel Water. The watercourses with potential to be affected by the development are the small Patrick Burn and the larger Powbrone Burn and its tributaries Self Grain, Middle Grain, Little Grain and Dead Grain. Glengavel Water flows into the Avon Water which is itself a major tributary of the River Clyde.

There is a reservoir on Glengavel Water 1 km downstream of the Powbrone Burn confluence and 200 m downstream of the Patrick Burn confluence, which supports a sport fishery for brown trout. Obstacles downstream of the Glengavel Reservoir make the Powbrone and Patrick Burn catchments inaccessible to migratory fish species[1].

The Powbrone and Patrick Burn catchments drain most of the northern part of the proposed wind farm site. Landuse within the catchments of these streams is predominantly mature commercial conifer plantation.

[1] https://map.environment.gov.scot/sewebmap/ (obstacles to fish migration layer)

Fish habitat was surveyed in Powbrone Burn and tributaries and also in Patrick Burn on 1 May 2022, and electric fishing surveys were carried out at six sites in the Powbrone Burn catchment on 8 and 9 September 2022 (Section 3.4.2).

3.4.1. Fish habitat

3.4.1.1. Powbrone Burn

NS 6806 3387 NS 6910 3452

Powbrone Burn is the largest headwater tributary of Glengavel Water. The 1 km of Glengavel Water between the Glengavel Reservoir and the Powbrone Burn confluence at NS 6762 3349 are outside the survey area but were observed from the B943 road. This reach is meandering with a low to moderate gradient, and it appears to provide suitable habitat for trout including spawning opportunities. No obstacles to migration could be seen so Powbrone Burn is considered accessible to fish from the reservoir.

Upstream of the B743 road Powbrone Burn meanders through a steep-sided, flat-bottomed valley in conifer plantation. There is a largely un-forested buffer strip along most of the reach, but conifers have been planted to the stream edge in a few places. Instream habitat is characterised by short fairly stable sections of mixed juvenile habitat and glide 3-4 m wide, separated by wider (5-7 m) mobile braided sections with active erosion and deposition. Bankside cover is rather poor, but instream cover is good, and scattered patches of spawning habitat are available.

The stream provides substantial areas of productive trout habitat and is likely to make an important contribution to the trout fishery in Glengavel Reservoir.

3.4.1.2. Self Grain

NS 6910 3452 to NS 6910 3452

Self Grain is the largest tributary of Powbrone Burn. The burn is entrenched between steep banks in a narrow valley through commercial forestry plantation. The lower reaches of the stream provide some good mixed juvenile trout habitat, interspersed with short reaches of bedrock and small pools. The substrate is varied with boulder, cobble, pebble, gravel and sand. Pockets of spawning habitat suited to trout are present. Depths vary from 5 to 20 cm, occasionally reaching up to 80 cm in pools. Wet widths in the lower reaches are mainly between 1.5 and 2 m. There are numerous small rock step obstacles, but all appear passable in the right conditions. The exception is a 2.6 m high waterfall at NS 69870 34868, approximately 1 km upstream of the confluence with Powbrone Burn, which is impassable due to its height.

Upstream of this obstacle there are alternating reaches of productive mixed juvenile trout habitat and bedrock in a channel with a typical wet width of 1 m. The stream becomes smaller and incised into turf around NS 704 350 with some sections running under the turf. Here the stream is less than 0.5 m wide and habitat appears largely unsuited to fish production.

3.4.1.3. Middle Grain

NS 6916 2459 to NS 6927 3499

Middle Grain is a substantial tributary of Powbrone Burn, flowing in a narrow, deeply-cut valley through forestry plantation. Approximately 350 m are accessible downstream of an impassable 3.5 m waterfall at NS 69270 34998. The habitat is quite unstable but there is good cover in shallow step-pool sequences with boulders, cobbles and pebbles. There is some suitable spawning substrate for trout. Widths range from 2 to 2.5 m. Most of the reach is shallow, between 10 and 30 cm.

3.4.1.4. Dead Grain

NS 69153 37579 to NS 69467 34408

Dead Grain is a small, steep tributary of Powbrone Burn. The habitat is boulder-dominated, forming step-pool sequences with numerous small obstacles. The substrate is mainly unstable. Habitat quality for trout appears poor, especially for fry, and spawning substrate is lacking. Width is mainly around 1 m and depths vary from 10 to 50 cm

This is stream has very limited potential for fish production due to its small size, instability and lack of spawning habitat.

3.4.1.5. Little Grain

NS 68613 34274 to NS 68655 34431

Little Grain is a small tributary of Powbrone Burn, less than 1 m in width. The majority of the watercourse is outside the red line boundary. A short reach of stable mossy mixed juvenile habitat between Powbrone Burn and the existing forestry track track gives way to poorer, steeper and more unstable mixed juvenile habitat upstream. The pipe culvert under the track has very shallow flow which may

make it quite unattractive to fish looking to move upstream. No spawning habitat was recorded and bedload is clearly very limited.

3.4.1.6. Patrick Burn

NS 6720 3402 to NS 6787 3469

Patrick Burn is a small, first order tributary of Powbrone Burn. It enters Powbrone Burn some 200 m upstream of Glengavel Reservoir. The reaches downstream of the B743 road appear to be accessible from the reservoir and look as if they would provide a little spawning and juvenile habitat for trout. This part of the burn is outside the area for which access permissions had been obtained so it was observed only from the public road.

Stream reaches within the redline boundary are also likely to be accessible from the reservoir, but this is uncertain as the culvert beneath the B743 road has a sill that presents a depth barrier on some flows.

Upstream of the road the stream runs through conifer plantation. Trees have been planted to the edge of the stream in places and some of the burn is consequently quite degraded. The stream is small with a wet width of less than 1.0 m and typical depths from 2 to 10 cm. The first 300 m upstream of the road have a moderate gradient and small numbers of trout parr were seen. Substrates are mainly pebble, cobble and gravel. Little pockets of spawning calibre substrate are present but these are unstable. Gradient and the proportion of bedrock on the streambed both increase around 300 m upstream of the road and from here to the forestry track there is little productive trout habitat. Wet width at the top of the survey reach is around 0.5 m and depths were mainly less than 5 cm. In summary, Patrick Burn provides rather poor-quality trout habitat. Trout are likely to be the only species present.

3.4.2. Fish populations

A total of six sites were surveyed on the Powbrone Burn sub-catchment, of which one was surveyed fully quantitatively, three were semi-quantitative, and two were presence/absence surveys. Based on the poor quality and limited extent of habitat, no electric fishing was carried out on Patrick Burn or on Dead Grain.

Two sites (SG2 and MG2) were upstream of impassable obstacles. No fish were found at either site, suggesting that the headwaters of these streams may be fishless.

3.4.2.1. Trout

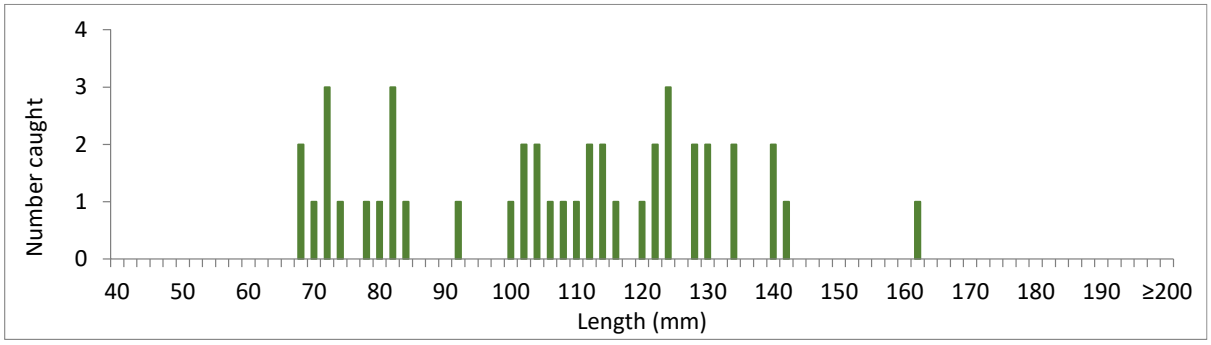
Trout fry were found at only two of the four accessible survey sites, on Powbrone Burn (PO1) and Self Grain (SG1) (Table 12). Densities were classified as very poor and fair at the two sites respectively. Fry were not recorded in Middle Grain or Little Grain. Trout parr were found at all four of the accessible survey sites, with density classifications ranging from fair at SG1 to excellent at PO1. No trout (or other fish) could be found upstream of impassable waterfalls on Self Grain or Middle Grain. It seems likely that the reaches of these streams that are inaccessible from Powbrone Burn are fishless.

Trout fry ranged in length from 67mm to 84 mm (Figure 9), and parr from 91 mm to 161 mm. Scale - reading showed that most of the parr were 1+ with the exception of the 161 mm individual caught at PO1 which was 2+.

Table 12 Electric fishing results for trout, Glengavel Water catchment

Watercourse	Site	**Fry density** (fish.100m^{-2}) Single run density (Zippin)	Fry classification	**Parr density** (fish.100m^{-2}) Single run density (Zippin)	Parr classification
Powbrone Burn	PO1	2.2 (4.0)	Very poor	13.7 (14.9)	Excellent
Self Grain	SG1	8.3	Fair	3.6	Fair
Self Grain	SG2	0.0	-	0.0	-
Little Grain	LG1	Absent	-	Present	-
Middle Grain	MG1	0.0	-	7.2	Good
Middle Grain	MG2	0.0	-	0.0	-

Figure 9 Length-frequency distribution for trout, Glengavel Water catchment



3.4.2.2. Other fish species

Stone loaches were found at low density at PO1 on Powbrone Burn, but they were not present at any other site in the catchment. No minnows, eels or other fish species were recorded (Table 13).

Table 13 Electric fishing results for other fish species, Glengavel Water catchment

Watercourse	Site	Stone loach density (fish.100m^{-2})	Minnow density (fish.100m^{-2})	Other species
Powbrone Burn	PO1	3.6	0.0	None
Self Grain	SG1	0.0	0.0	None
Self Grain	SG2	0.0	0.0	None
Little Grain	LG1	Absent	Absent	None
Middle Grain	MG1	0.0	0.0	None
Middle Grain	MG2	Absent	Absent	None

3.5. Logan Water catchment

The headwaters of Logan Water and two of its tributaries, Kip Burn and Blaeberry Burn, drain the north-eastern area of the development site. At the time of survey, six wind turbines and associated tracks are proposed within the catchment.

The Logan Water forms a sub-catchment of the River Nethan which is itself a tributary of the River Clyde. There is a reservoir in the upper catchment of the Logan Water. The headwaters of Logan Water itself, and its tributary streams Kip Burn and Blaeberry Burn are not accessible from the Logan Reservoir as flow is captured by an aqueduct on the west side of the reservoir which discharges to an impassable spillway (W. Yeomans, Clyde River Foundation, pers. comm.). This is likely to limit trout egg deposition in the surveyed streams, as stream-dwelling adult trout will be small compared to those

living in the reservoir (egg number is largely a function of fish size). The streams are also inaccessible to migratory salmonids and, probably, to eels.

Land use in the area is predominantly upland sheep farming and grouse moor, with some clear-felled commercial forestry plantation along the right bank of Logan Water. There is a fenced exclosure which includes both banks of Logan Water at Birk Knowes geological SSSI, and another on the upper reaches of Kip Burn where a new native woodland has been planted.

Fish habitat surveys were carried out on the upper Logan Water, Kip Burn and Blaeberry Burn on 30/05/2022, and electric fishing surveys were conducted at six sites on 17/08/2022. The findings are set out below.

3.5.1. *Fish habitat*

3.5.1.1. Logan Water

NS 7387 3497 to NS 7317 3351

Logan Water holds good stable mixed juvenile habitat with run, riffle and glide flows and occasional pools. The substrate is cobble, pebble and boulder, and there are some good patches of spawning substrate available, suitable for trout. Wet widths are mainly between 1 and 2 m, less in the upper reaches. Instream and bankside cover are good.

A series of rock step obstacles around NS 7378 3466 are probably passable in suitable flows. The western tributary (NS 733 343) is probably inaccessible from Logan Water due to a rock ramp 50 m up from the confluence. Substantial reaches of potentially productive trout habitat are present, although the lack of connection to Logan Reservoir may limit trout production.

3.5.1.2. Kip Burn

NS 7350 3496 to NS 7231 3439

Like Logan Water, Kip Burn is inaccessible from Logan Reservoir as its flow is captured by the aqueduct on the west side of the reservoir.

The upper reaches of Kip Burn are entrenched in a steep-sided valley with friable eroding banks; the lower reaches are more open and meandering. The habitat is mixed juvenile with run, riffle and glide flow over a cobble, pebble and boulder substrate. Bedrock is present in places and its proportion increases with distance upstream. There is some spawning habitat suitable for trout available, and in the general habitat quality appears good. A 1.8 m high

waterfall at NS 7330 3485 lacks a pool and may be impassable to salmonid fish. Substantial reaches of potentially productive trout habitat are present, although lack of connection to Logan Reservoir may limit egg deposition.

3.5.1.3. Blaeberry Burn
NS 7380 3554 to NS 7265 3569

Blaeberry Burn, like Logan Water and Kip Burn, flows into an aqueduct on the west side of Logan Reservoir, effectively isolating it from the reservoir. Blaeberry Burn itself appears to provides moderate quality trout habitat. The meandering lower reaches include some areas where spawning would be possible. Substrates are mainly flat plates of broken shale, so cover is rather poor, and areas of bedrock are present throughout the survey reach. Wet widths are typically 1.5 to 2.3 m in the lower reaches, but approximately 1.0 m further upstream.

No obstacles were recorded upstream of the aqueduct. The habitat is generally of moderate quality for trout, which are likely to be the only species present.

3.5.2. Fish populations

Six sites were surveyed by electric fishing on 17/08/2022 (Table 14). One site was surveyed fully quantitatively and four semi-quantitatively, while one (LW3) was a presence/absence survey upstream of an obstacle.

3.5.2.1. Trout

Trout were present in five out of six sites surveyed. The presence/absence survey upstream of an obstacle on a small unnamed tributary of Logan Water found no fish.

Trout fry and parr were present at both sites on Logan Water (LW1 and LW2), but densities were very low, classified as very poor or poor.

Fry were present at only one of two sites on Kip Burn, but the density was classified as fair, while parr densities were good at both Kip Burn sites.

A single site was surveyed on Blaeberry Burn. Fry density was very poor but parr density was fair.

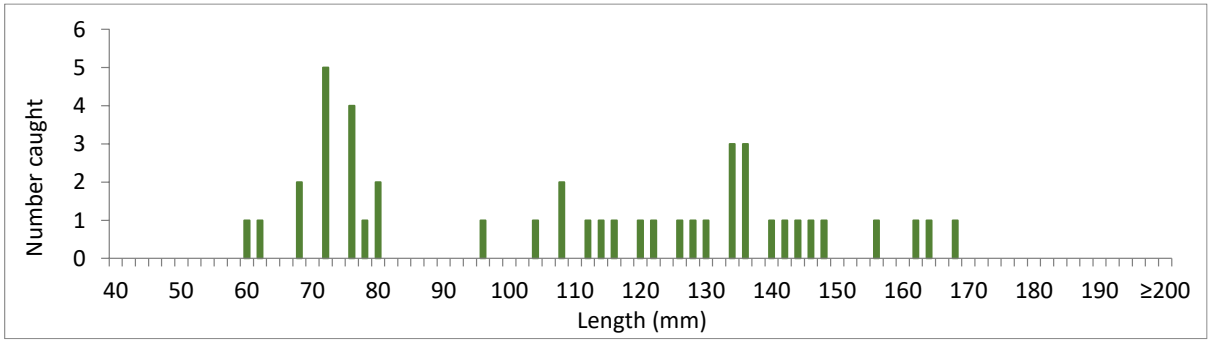
Table 14 Electric fishing results for trout, Logan Water catchment

Watercourse	**Site**	**Fry density** (fish.100m^{-2}) Single run density (Zippin)	**Fry classification**	**Parr density** (fish.100m^{-2}) Single run density (Zippin)	**Parr classification**
Logan Water	LW1	2.3	Very poor	2.3	Poor
Logan Water	LW2	3.3	Poor	0.4	Very poor
Logan tributary	LW3	Absent	-	Absent	-
Kip Burn	KB1	4.8 (6.0)	Fair	6.0 (6.0)	Good
Kip Burn	KB2	0.0	-	6.1	Good
Blaeberry Burn	BL1	0.7	Very poor	4.4	Fair

Trout fry lengths in the Logan Water headwaters fell between 60 mm and 80 mm (Figure 10). In the sample of fish captured, there was overlap in length between fry and the 1+ year class. Trout parr

ranged from 96 mm to 168 mm. Scale readings indicated confirmed that most of the parr over 130 mm were likely to be aged 2+.

Figure 10 Length-frequency distribution for trout, Logan Water catchment



3.5.2.2. Other fish species

No other fish species were recorded in the Logan Water headwaters.

Table 15 Electric fishing results for other fish species, Logan Water catchment

Watercourse	Site	Stone loach density (fish.100m^{-2})	Minnow density (fish.100m^{-2})	Other species
Logan Water	LW1	0.0	0.0	None
Logan Water	LW2	0.0	0.0	None
Logan Water tributary	LW3	0.0	0.0	None
Kip Burn	KB1	0.0	0.0	None
Kip Burn	KB2	0.0	0.0	None
Blaeberry Burn	BL1	0.0	0.0	None

4 DISCUSSION

4.1. Data quality

Survey conditions were good throughout the habitat surveys, with low to moderate water levels at all sites. Most of the streams run clear so it was possible to examine substrates in all but the deepest sections of each watercourse. The habitat surveyors, Jon Watt and Isabel Isherwood, both have over 20 years of experience of fisheries assessments in upland Scotland so it is likely that the interpretation of habitat structure in relation to fish utilisation potential is reliable.

Electric fishing surveys were judged to be effective and most of the fish seen were captured at each site. Relatively consistent depletions in fish numbers were attained during consecutive runs through most fully-quantitative sites (Appendix 7.4), and the surveys achieved good levels of efficiency.

Overall, the electric fishing data for salmonids, stone loaches and minnows are considered a reliable indication of the distribution and relative densities of these species throughout the survey area.

As discussed above, the methodology for surveying lampreys is different for that for salmonids, so while suitable habitat for lampreys was recorded at various locations on Greenock Water and spot-checks confirmed that *Lampetra sp.* are present, the surveys carried out for this study do not provide information on population density or distribution of lampreys.

4.2. Salmon

As expected, juvenile salmon were found in the larger watercourses that are accessible from the River Ayr i.e. Greenock Water, Dippal Burn and Ponesk Burn. Salmon were found throughout Greenock Water and into the lower reaches of Dippal Burn, and average salmon fry and parr densities in Greenock Water were good by regional standards. The variety and distribution of substrates, depths and flows in Greenock Water provides good habitat for all ages of salmon as well as substantial areas of spawning habitat. The Ayrshire Rivers Trust highlights the Greenock Water and Dippal Burn as 'valuable habitat' and 'some of the most pristine spawning' in the River Ayr catchment[2]. This is consistent with the findings of the current survey and protection of habitat quality in Greenock Water must be a primary focus for mitigation should the development proceed to construction.

Salmon were also found in the lower surveyed reaches of Ponesk Burn, and the parr density at site PB1 was classified as excellent by regional standards, however no fry were caught at either of the two accessible sites, indicating that perhaps spawning in Ponesk Water may not be an annual event. The reasons for this are unclear, as habitats in the lower part of the surveyed reach appeared quite well suited to salmon production.

As expected, not salmon were found in streams linked to the River Clyde catchment, due to the known presence of obstacles further downstream.

4.3. Trout

Trout were present at 18 of the 20 sites in the River Ayr catchment. The highest densities were found in some of the Greenock Water tributaries, and it is probable that sea trout may spawn in the lower, accessible, reaches of these small but apparently productive streams. Ponesk Burn, which is also accessible to migratory fish for much of its length, had good trout fry densities in the lower reaches and may also be used by sea trout as might Dippal and Lease Burns. While trout fry and parr densities in Greenock Water itself were mainly rather low, the large area of habitat that it provides nevertheless suggests that it will make a significant contribution to trout production in the survey area. Furthermore, it is probable that many of the young trout spawned in minor tributaries may drop back into Greenock to grow on. Larger trout parr often inhabit deeper pool and glide habitats, so they may be under-represented in the Greenock Water data set which was collected mainly from shallower mixed juvenile habitats.

The River Clyde tributaries Glengavel Water and Logan Water are not accessible to sea trout. Consequently the populations in the upper Logan Water and the Powbrone Burn catchment are isolated populations of resident brown trout. Powbrone Burn is accessible to fish from the Glengavel Reservoir and it is likely that trout production from this stream is important to the reservoir's fishery. No trout (or other fish) could be found upstream of impassable waterfalls on Self Grain or Middle Grain. It seems likely that the reaches of these streams that are inaccessible from Powbrone Burn are fishless.

Logan Water, Kip Burn and Blaeberry Burn are not accessible to fish from Logan Reservoir. Trout fry densities in these streams were rather low and the surveyor's impression was that population density in these streams is unlikely to be at carrying capacity. As noted above, the lack of connectivity to the reservoir means that stream dwelling trout, which are likely to be relatively small, will be the only spawners in these burns and that egg deposition will consequently be rather low. The presence of good parr densities at some locations probably suggests that the productive potential of the streams is relatively high.

[2] https://www.ayrshireriverstrust.org/project/greenock-culvert-fish-pass/

4.4. Other fish species

Eels were found at only one of the 32 sites surveyed - DB3 on Dippal Burn. Habitats at many sites in the Greenock Water catchment appeared suitable for eels and it is likely that their scarcity is due to access problems at weirs further down the River Ayr. Obstacles downstream apparently prevent eels accessing any of the sites within the River Clyde catchment.

Stone loach and common minnow were widespread and abundant. The distributions of these two species were identical. At a number of sites including some in Ponesk Burn, Greenock Water and Blackside Burn these two species outnumbered salmonids. Both were absent in smaller tributaries and headwaters. This seems likely to be due to the presence of obstacles that prevent further upstream colonisation from core areas. Both species lack significant jumping ability and it is likely that their maximum swimming speeds are less than those of salmonids. This may mean that upstream movements can be prevented by barriers that would be passable to salmonid species.

Lampetra larvae, almost certainly brook lamprey, were present at GW1 in Greenock Water. Capture of lamprey larvae generally requires targeted surveys using a different technique and over different habitats than would normally be sampled for salmonids. Their absence from fish samples should not, therefore, be considered as evidence of absence from stream reaches where suitable habitats are present. As no obstacles were recorded lampreys are likely to be present in suitable habitats throughout Greenock Water. Very little lamprey habitat was recorded in the other streams in the survey area and it is highly probable that Greenock Water is the most important streams in the study area for lampreys. The larvae of Lampetra lamprey species (brook lamprey and river lampreys) cannot be distinguished in the field (Gardiner 2003). However, given the known presence of barriers to migration in the lower reaches of the River Ayr it is likely that the larvae found during the current survey were of brook lamprey. This would be consistent with the known distribution of this species in the Ayr catchment (Watt & Ravenscroft 2005).

5 CONCLUSIONS AND RECOMMENDATIONS

5.1. Greenock Water and tributaries

5.1.1. Conclusions

Greenock Water provides large expanses of good quality salmon and trout habitats with extensive reaches suited to spawning and juvenile production. It supports a healthy salmon population, and recent work by the Ayrshire Rivers Trust to ease fish passage over the shallow apron at Greenock Bridge (NS 6987 2961) should lead to increasing numbers of salmon and sea trout returning to spawn in the upper reaches of Greenock Water and into Dippal Burn. The small tributary streams appear to be important for trout. The presence of brook lamprey larvae at GW1 demonstrates that this Annex II species is also likely to be widespread in the Greenock Water. The absence of grayling at electric fishing sites suggests this species may no longer be present, or that they are at low density in this part of the catchment. The Ayrshire River Trust Fisheries Management Plan Stone loach and minnow were present throughout.

5.1.2. Sensitivities and recommendations

Greenock Water is recognised as the most important sub-catchment in the River Ayr system for salmon production, and protection of water and habitat quality in this watercourse must be a priority for environmental management during the construction of the energy cluster. Greenock water also supports a population of brook lamprey, an Annex II species requiring good water quality.

Greenock Water receives runoff from most streams draining the south-western part of the development area. A total of twelve turbines and associated access tracks are proposed here, as well as a new crossing on Greenock Water at NS 6983 3045. In addition, the proposed solar array will be constructed

along a large part of the right bank of Greenock Water (i.e. to the north of the river) between Greenock Bridge and Netherwood. As a result, generic threats relating to water quality including siltation apply throughout Greenock Water.

The new crossing must not create an obstacle to fish moving up or downstream, and should ideally be in the form of a bridge in order to minimise impact on instream habitats. If instream work is required at this location, spawning and incubation periods (October to April) should be avoided. Detailed pre-construction assessments of this and other watercourse crossings are recommended.

The most direct potential threat to the wider habitat in Greenock Water may come from any deterioration in water quality in Netherwood Burn, Back Burn, Harwood Burn, Lamon Burn or Blackside Burn. These burns appear to be important trout spawning burns, and all flow directly into reaches of Greenock Water that support substantial expanses of salmon and lamprey habitats.

Silt control measures around Greenock Water and its inflow streams must be robust and strictly enforced, and water quality around excavations, turbine bases and tracks should be closely monitored during construction.

5.2. Dippal Burn and Leaze Burn

5.2.1. Conclusions

Dippal Burn provides substantial reaches of moderate to good quality salmonid habitat and some good spawning areas. Salmon and trout are both present in Dippal Burn, although salmon may not spawn in the river every year, perhaps as a consequence of the difficult access at Greenock Bridge. However works carried out here in March 2022 should have improved access for both salmon and sea trout and the picture in Dippal Burn may change in future years. No substantial barriers to upstream migration were identified on Dippal Burn or Leaze Burn. A waterfall restricts migratory salmonids to the lower 0.4 km of the unnamed norther tributary.

It is possible that the rapids and low rock ramps around NS 693 318 restrict stone loach and minnow to the lower reaches of Dippal Burn while permitting upstream access for salmonids. The two eels caught at DB2 were the only ones captured in the River Ayr catchment survey sites, indicative of significant access issues for eels further down the catchment.

5.2.2. Sensitivities and recommendations

Spawning habitat and juvenile salmonid habitat in Dippal Burn will not be directly impacted by the proposed development which has no infrastructure close to the watercourse. However there will be several turbines and associated tracks including watercourse crossing in the upper catchment around Leaze Burn. Leaze Burn is accessible throughout and supports trout, so care will be required in the siting and construction of any watercourse crossings to avoid damage to spawning habitats, and the crossing should not create an obstacle to fish. Other potential risks are generic, relating to any deterioration in water quality through siltation or other pollution.

5.3. Ponesk Burn

5.3.1. Conclusions

The lower reaches of Ponesk Burn provide good quality spawning and moderate quality juvenile habitats, and are accessible to salmon and sea trout. Stone loach and minnow are also present. Upstream of the waterfall at NS 72980 30913 the stream appears to be fishless.

5.3.2. Sensitivities and recommendations

A substantial amount of infrastructure is proposed in the catchment of Ponesk Burn and its tributary Patrick Burn including turbines and the associated track network, a storage compound and a crossing point at approximately NS 714 306. The proposed crossing is in a reach of Ponesk Burn which holds

good salmonid habitat. This crossing stricture should not create an obstacle to fish, and should ideally be in the form of a bridge rather than a culvert. If instream work is required at this location, spawning and incubation periods (October to April) should be avoided. Detailed pre-construction assessments of this and other watercourse crossings are recommended.

Runoff from excavations, tracks and turbine bases should be controlled and monitored, and particular care should be taken with turbines T13, T22, T23 and their associated track network as these are upslope of the better habitats in the lower reaches of Ponesk Burn where salmon are present.

5.4. Glengavel Water (Powbrone Burn and Patrick Burn)

5.4.1. Conclusions

Powbrone Burn and Patrick Burn are not accessible to migratory fish, but are accessible to trout from the Glengavel Reservoir, and stone loach and minnow are present in the lower reaches. Patrick Burn holds poor habitat, however Powbrone Burn and its main tributary Self Grain provide substantial areas of productive trout habitat and some good spawning, and are likely to make an important contribution to the trout population in Glengavel Reservoir which is managed as sport fishery by the Upper Avon Angling Association.

5.4.2. Sensitivities and recommendations

A very large amount of infrastructure is proposed in the upper Glengavel Water catchment, including 25 turbines, the associated network of new and upgraded tracks, and ten watercourse crossings. In places both tracks and turbines will be very close to the watercourses.

The existing crossing at NS 6908 3452 on Powbrone Burn will be upgraded as part of the track upgrade. This is in a reach of good trout habitat and the new crossing should be constructed in a manner that will permit upstream and downstream access for trout. If instream work is required at this location, spawning and incubation periods (October to April) should be avoided. Detailed pre-construction assessments of this and other watercourse crossings are recommended.

Dead Grain will be crossed by tracks at three different points. The two upper crossings are above the limit of useable fish habitat, but the lowermost crossing should be constructed in a manner that will retain up and downstream access for trout.

Most of the remaining watercourse crossings are in the upper reaches where the streams are steep and likely to be fishless; in these locations the priority will be to avoid water quality impacts on habitats downstream through siltation or pollution.

Water quality can be affected by silt, exposure of mineral-rich soils and rocks to weathering and oxidation, nutrient enrichment associated with blasting and direct pollution through spills. Runoff from excavations, tracks and turbine bases should be controlled and monitored, particularly where these are close to watercourses.

5.5. Logan Water

5.5.1. Conclusions

Logan Water, Kip Burn and Blaeberry Burn hold substantial reaches of potentially productive trout habitat, but are not accessible to migratory fish, nor are they accessible to trout from the Logan Reservoir. The only species recorded in these watercourses during electric fishing surveys was brown trout, which is found at low density throughout.

5.5.2. Sensitivities and recommendations

Six turbines and their associated track network are proposed in the catchment of Logan Water, Kip Burn and Blaeberry Burn. No stream crossings are proposed, so no direct impacts on stream habitats are anticipated. However caution will need to be exercised with works around Logan Water and Kip

Burn as the underlying rock in this area appears extremely friable, so siltation and water chemistry impacts may need to be considered. Runoff from excavations, tracks and turbine bases should be controlled and monitored, particularly where these are close to watercourses.

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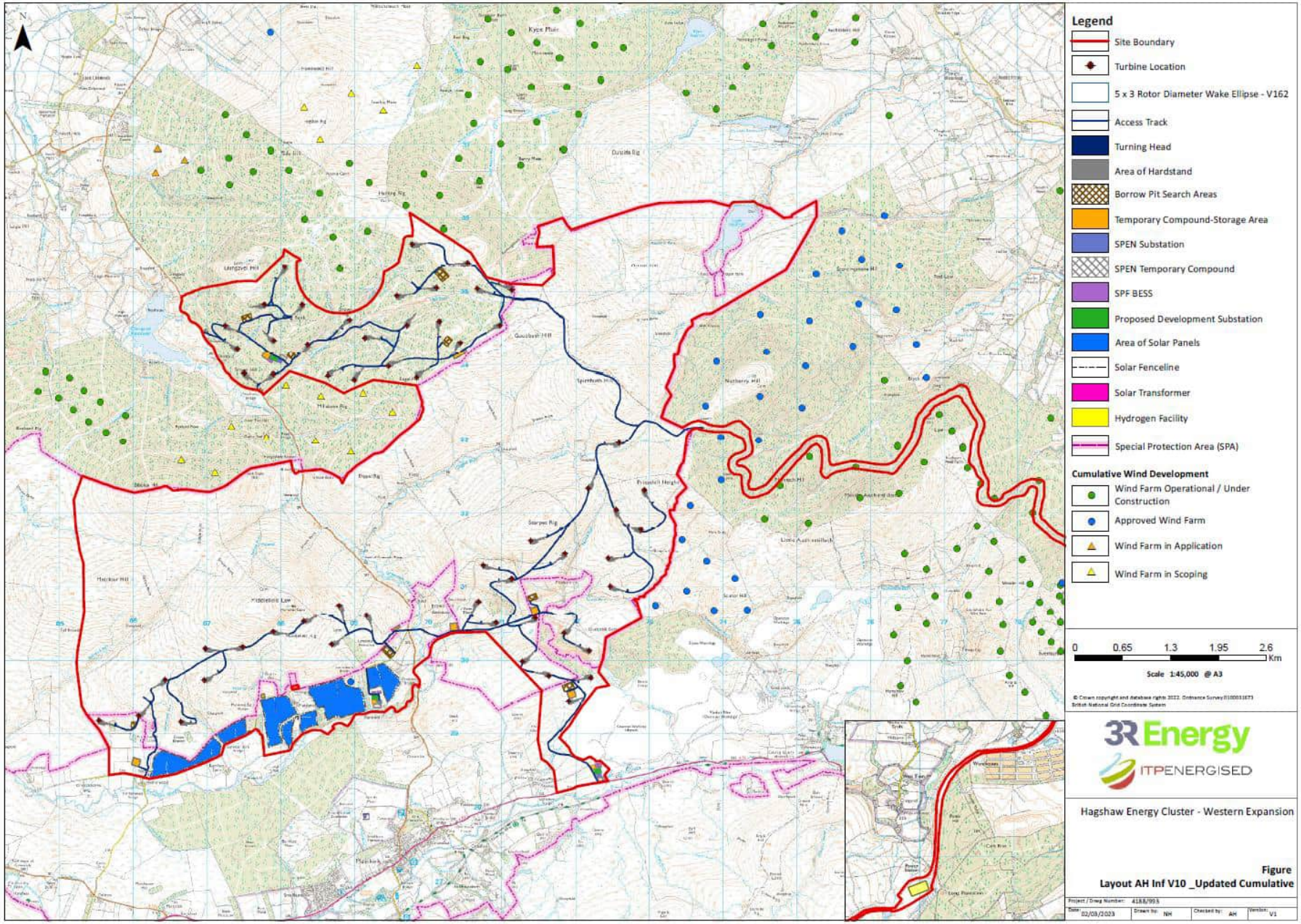
7 APPENDICES

7.1. Proposed layout at 02/03/2023



7.2. Electric fishing survey site locations and survey event details.

Watercourse	Site	NGR	Date sampled	Length (m)	Width (m)	Area (m^2)	Volts	Amps	Conductivity ($\mu S.cm^{-1}$)	Temp (°C)	Water level
Greenock Water	GW1	NS 65658 28188	15/08/2022	25.5	5.7	145.4	120	0.7	248	18.0	Low
Greenock Water	GW2	NS 68262 28820	15/08/2022	26.5	5.3	140.5	120	0.8	238	17.0	Low
Greenock Water	GW3	NS 69308 29289	07/09/2022	17.5	9.3	162.8	150	0.6	111	12.0	Low
Greenock Water	GW4	NS 69354 31189	15/08/2022	28.2	4.4	124.1	140	0.7	230	16.2	Low
Greenock Water	GW5	NS 70083 29787	07/09/2022	21.5	5.5	118.3	170	0.6	111	14.0	Low
Dippal Burn	DB1	NS 69158 31535	16/08/2022				140	0.5	185	16.5	Low-mod
Dippal Burn	DB2	NS 69640 32208	15/08/2022	36	3.6	129.6	150	0.5	185	16.5	Low-mod
Dippal Burn	DB3	NS 70932 32856	16/08/2022	47	3.6	169.2	210	0.5	87	14.0	Low-mod
Leaze Burn	LB1	NS 71887 32839	16/08/2022	69	1.7	117.3	210	0.5	67	115.0	Low-mod
Leaze Burn	LB2	NS 72392 32810	16/08/2022	69	1.4	96.6	210	0.5	61	15.0	Low-mod
Netherwood Burn	NB1	NS 66192 28478	08/09/2022	88	0.9	79.2	150	0.4	90	14.0	Low
Back Burn	BA1	NS 67212 28834	08/09/2022	86	1.2	103.2	150	0.4	85	13.0	Low
Harwood Burn	HB1	NS 67672 29337	07/09/2022	71	1.2	85.2	120	0.9	201	16.5	Low
Lamon Burn	LA1	NS 69171 29312	07/09/2022	38	0.7	26.6	140	0.3	130	14.0	Low
Blackside Burn	BB1	NS 70228 30236	07/09/2022	70	1.6	112.0	150	0.7	105	17.0	Low
Ponesk Burn	PB1	NS 72048 30027	16/08/2022	40	2.8	112.0	200	0.6	91	16.0	Low-mod
Ponesk Burn	PB2	NS 72139 30846	16/08/2022	43	4.8	206.4	200	0.5	83	15.5	Low-mod
Ponesk Burn	PB3	NS 73027 30956	16/08/2022	93	1.7	158.1	260	0.7	80	15.0	Low-mod
Powbrone Burn	PO1	NS 67943 33736	08/09/2022	38.5	3.6	138.6	180	0.6	118	14.5	Low-mod.
Self Grain	SG1	NS 69284 34638	08/09/2022	60	1.4	84.0	200	0.4	48	14.0	Low
Self Grain	SG2	NS 69943 34872	09/02/2022	260	1	260.0	230	0.4	40	12.0	Moderate
Little Grain	LG1	NS 68627 34356	09/02/2022				230	0.4	51	14.0	Moderate
Middle Grain	MG1	NS 69140 34653	08/09/2022	69	1.4	96.6	230	0.5			Mod.-high
Middle Grain	MG2	NS 69330 35135	08/09/2022			PA	230	0.5	NR	NR	Low
Logan Water	LW1	NS 73742 34634	17/08/2022	40	2.2	88.0	260	0.4	56	13.0	Low
Logan Water	LW2	NS 73404 34361	17/08/2022	220	1.1	242.0	260	0.5	62	15.5	Low
Logan Water	LW3	NS 73264 34263	17/08/2022				240	0.4	NR	NR	Low
Kip Burn	KB1	NS 73615 35032	17/08/2022	70	1.2	84.0	200	0.5	64	15.0	Low
Kip Burn	KB2	NS 73187 34738	17/08/2022	190	1.2	228.0	220	0.4	85	15.2	Low
Blaeberry Burn	BL1	NS 73708 35558	17/08/2022	86	1.6	137.6	200	0.5	64	15.5	Low

7.3. Quintile range of salmonid densities for rivers in Clyde Coast region (Godfrey 2006)

	Density (fish.100 m^{-2})			
	Salmon 0+	*Salmon 1++*	*Trout 0+*	*Trout 1++*
Min	0.33	0.26	0.44	0.25
20th percentile	5.04	1.56	2.33	1.84
40th percentile	10.66	3.06	4.69	3.29
60th percentile	18.88	5.06	8.65	5.22
80th percentile	47.66	9.17	20.66	7.60
Max	210.61	36.96	145.47	42.95

Descriptive categories for density used in text (see above for quintile ranges)

Density in regional classification	**Description used in text**
< 20th percentile	Very poor
20th to 40th percentile	Poor
40th to 60th percentile	Fair
60th to 80th percentile	Good
80th to 100th percentile	Excellent

7.4. Numbers of salmonid fish caught during consecutive electric fishing runs at fully quantitative sites

Site	**Salmon fry**			**Salmon parr**			**Trout fry**			**Trout parr**			**Total (all fish)**		
	run 1	run 2	run 3	run 1	run 2	run 3	run 1	run 2	run 3	run 1	run 2	run 3	run 1	run 2	run 3
GW2	40	7	5	14	5	4	1	1	0	2	1	0	57	14	9
GW4	46	20	9	8	2	1	11	3	1	2	0	1	67	25	12
PO1	0	0	0	0	0	0	3	3	0	19	4	1	22	7	1
KB1	0	0	0	0	0	0	4	1	0	5	0	0	9	1	0

7.5. Lower and upper 95% confidence limits for fish densities at fully quantitative sites

Site	**Salmon fry** (fish.100 m^{-2})		**Salmon parr** (fish.100 m^{-2})		**Trout fry** (fish.100 m^{-2})		**Trout parr** (fish.100 m^{-2})	
	Lower 95%	Upper 95%	Lower 95%	Upper 95%	Lower 95%	Upper 95%	Lower 95%	Upper 95%
GW2	35.8	38.6	15.8	22.9	1.4	2.5	2.1	2.6
GW4	53.4	64.9	23.7	9.2	10.7	12.1	2.1	6.2
PO1	N.A.	N.A.	N.A.	N.A.	3.7	5.6	14.7	15.6
KB1	N.A.	N.A.	N.A.	N.A.	6.0	6.4	6.0	6.0

7.6. Instream habitats at electric fishing sites

SITE	DEPTH						SUBSTRATE									FLOW TYPES							
	<10	11-20	21-30	31-40	41-50	>50	HO	SI	SA	GR	PE	CO	BO	BE	OB	SM	DP	SP	DG	SG	RU	RI	TO
GW1	30	25	25	20	0	0	0	5	5	10	30	45	5	0	0	0	0	20	10	20	20	30	0
GW2	20	40	20	20	0	0	0							5		5	0	10	20	25	20	20	0
GW3	20	70	10	0	0	0	0	0	0	3	22	55	20	0	0	10	0	10	0	0	30	50	0
GW4	15	40	20	20	5	0	0	0	7	10	10	48	25	0	0	15	0	10	10	15	30	20	0
GW5	20	50	25	5	0	0	0	0	0	3	12	75	15	5	0	5	0	10	0	10	55	20	0
DB1	P/A survey, habitat data not collected																						
DB2	20	55	20	5	0	0	0	0	2	3	15	35	40	5	0	5	5	10	0	15	45	20	0
DB3	20	30	30	20	0	0	0	0	0	2	20	33	35	10	0	10	10	10	10	0	40	20	0
LB1	5	30	20	20	10	5	0	3	7	10	25	45	5	0	5	5	5	5	20	20	30	15	0
LB2	5	25	35	15	5	5	0	5	0	5	15	20	10	0	40	0	5	5	25	20	35	10	0
NB1	30	55	10	5	0	0	0	10	0	0	20	35	15	30	0								
BA1	25	50	15	10	0	0	0	15	0	5	15	55	10	0	0	10	10	20	0	20	25	25	0
HB1	40	30	20	5	5	0	0	20	5	10	25	35	5	0	0	20	10	15	0	20	30	5	0
LA1	70	30	0	0	0	0	0	0	2	8	20	40	30	0	0	10	0	40	0	0	40	10	0
BB1	35	40	10	7	5	3	0	5	2	3	30	50	10	0	0	10	15	20	0	0	40	15	0
BB2	P/A survey, habitat data not collected																						
PB1	10	50	20	15	5	0	0	0	0	3	17	45	35	0	0	5	15	10	0	10	50	10	0
PB2	10	50	30	10	0	0	0	0	0	3	17	40	30	10	0	0	0	10	10	25	25	30	0
PB3	20	40	20	15	5	0	0	0	0	3	7	40	30	20	0	5	5	10	15	10	35	20	0
PO1	20	45	25	10	0	0	0	0	5	15	20	40	20	0	0	5	0	10	10	40	25	10	0
SG1	20	45	25	10	0	0	0	0	5	5	20	40	30	0	0	10	10	20	0	10	30	20	0
SG2	P/A survey, habitat data not collected																						
LG1	P/A survey, habitat data not collected																						
MG1	30	50	15	5	0	0	0	0	5	10	30	40	15	0	0	15	5	15	0	25	20	20	0
MG2	P/A survey, habitat data not collected																						
LW1	10	50	20	15	5	0	0	0	0	5	25	40	20	10	0								
LW2																							
LW3																							
KB1	20	45	25	10	0	0	0	0	2	8	20	25	5	0	0	5	5	10	5	30	30	15	0
KB2																							
BL1	15	60	15	5	3	2	0	0	0	3	20	37	25	15	0	10	5	10	5	20	30	20	0

Substrates: HO = high organic (peat); SI = silt; SA = sand; GR = gravel; PE = pebble; CO = cobble; BO = boulder; BE = bedrock; OB = obscured; p=present
Flow types: SM = shallow marginal; DP = deep pool; SP = shallow pool; DG = deep glide; SG = shallow glide; RU = run; RI = riffle; TO = torrent.

7.7. Bankside and streambed cover at electric fishing sites

SITE	Left Bank				Right Bank				Cover in streambed
	UC	DR	BA	MA	UC	DR	BA	MA	
GW1	0	0	85	10	25	15	60	15	Moderate
GW2	0	0	100	0	5	0	95	0	Good
GW3	0	0	100	0	40	70	30	0	Moderate
GW4	0	0	100	0	5	0	95	0	Moderate
GW5	15	20	80	0	20	20	80	0	Good
DB1	P/A survey, habitat data not collected								
DB2	10	0	90	0	5	0	95	0	Moderate
DB3	5	0	95	0	20	0	80	0	Moderate
LB1	20	10	75	0	40	10	55	0	Moderate
LB2	50	5	50	0	50	5	50	0	Moderate
NB1	10	30	60	30	10	30	60	30	Poor
BA1	15	30	60	10	15	30	60	10	Moderate
HB1	40	25	55	5	40	25	60	5	
LA1	10	30	70	10	10	30	70	10	Moderate
BB1	10	10	75	10	15	10	70	10	Moderate
BB2	P/A survey, habitat data not collected								
PB1	30	0	70	0	15	0	85	0	Good
PB2	20	0	80	0	20	5	80	0	Good
PB3	20	5	75	0	20	5	75	0	Moderate
PO1	10	0	90	0	5	0	95	0	Good
SG1	15	10	80	0	10	10	80	0	
SG2	P/A survey, habitat data not collected								
LG1	P/A survey, habitat data not collected								
MG1	5	5	90	0	5	5	90	0	Moderate
MG2									
LW1	30	0	70	0	25	0	75	0	Good
LW2									
LW3									
KB1	30	0	70	0	50	0	50	0	Poor
KB2									
BL1	20	5	80	0	20	5	80	0	Poor

Bankside fish cover: UC = undercut bank; DR = draped vegetation; BA = bare (no cover); MA = marginal vegetation (incl. tree roots).

7.8. Spawning habitats recorded in Greenock Water

Watercourse	NGR	Area (m^2)	Quality (salmon)	Quality (trout)	Notes
Greenock Water	NS 64461 28322	9	Poor	Good	Patches among boulders.
Greenock Water	NS 64854 28095	11	Poor	Moderate	Shallow run into pool. Pebble and gravel, some sand
Greenock Water	NS 65193 28098	12	Moderate	Moderate	Pebble in shallow run flow 5-10 cm deep. Rather sandy in places
Greenock Water	NS 66156 28219	8	Moderate	Good	Pebble and gravel with some cobble. Uncompacted. Good depth of substrate, some silt in matrix but kicks out. In very shallow run flow 2-5 cm deep.
Greenock Water	NS 66257 28224	20	Poor	Good	Shallow gentle run over pebble in 2-5 cm depth of water.
Greenock Water	NS 67421 28349	8	Moderate	Poor	Uncompacted. Some silt present
Greenock Water	NS 67432 28402	8	Moderate	Moderate	On left side of channel downstream of deep glide
Greenock Water	NS 67542 28438	6	Moderate	Unsuitable	Coarse. Unsuitable for trout.
Greenock Water	NS 67636 28427	8	Moderate	Poor	Patchy spawning in an area of fry habitat
Greenock Water	NS 68309 28853	10	Moderate	Moderate	Run into pool. Depth 5-10 cm
Greenock Water	NS 68487 29040	3	Poor	Moderate	Better for trout than salmon. Right margin of river.
Greenock Water	NS 68525 29028	9	Moderate	Moderate	In 5-15 cm of water to the right side and middle of the channel
Greenock Water	NS 68728 29111	12	Moderate	Poor	Substrate better suited to salmon than trout at top and both sides of island. 5-10 cm water depth.
Greenock Water	NS 68978 29165	11	Moderate	Moderate	2 spawning areas in a broad riffle section; 3-10 cm water depth.
Greenock Water	NS 68983 29189	25	Good	Moderate	Good spawning runs, 10 cm water depth.
Greenock Water	NS 69491 29335	6	Moderate	Moderate	At pool tail.
Greenock Water	NS 69797 29493	22	Moderate	Moderate	Suboptimal flow but adequate. Depth 5-7 cm. Potential for washout.
Greenock Water	NS 69971 29600	19	Good	Moderate	Good salmon spawning. 7 cm water depth
Greenock Water	NS 70007 29635	14	Good	Moderate	2-10 cm water depth
Greenock Water	NS 70031 29673	18	Moderate	Moderate	Three patches in riffles
Greenock Water	NS 70048 29692	26	Moderate	Moderate	Patches in broad riffle/glide at top of braids
Greenock Water	NS 70077 29852	15	Good	Moderate	Good salmon spawning run 10-15 cm deep.

7.9. Electric fishing site photographs

Photographs show sites from downstream unless stated otherwise

	Greenock Water GW1
	Greenock Water GW2
	Greenock Water GW3

	Greenock Water GW4
	Greenock Water GW4
	Dippal Burn DB2

	Dippal Burn DB3
	Leaze Burn LB1
	Leaze Burn LB2

	Netherwood Burn NB1
	Back Burn BA1 Typical habitat in middle of 86 m long electric fishing site
	Harwood Burn HB1

	Lamon Burn LA1
	Lamon Burn LA2 From public road at upstream end of site
	Blackside Burn BB1

	Blackside Burn BB2
	Ponesk Burn PB1
	Ponesk Burn PB2

	Ponesk Burn PB3
	Powbrone Burn PO1
	Self Grain SG1

	Self Grain SG2
	Middle Grain MG1
	Middle Grain MG2

	Logan Water LW1
	Logan Water LW2
	Kip Burn KB1

	Kip Burn KB2
	Blaeberry Burn BL1