Beinn Ghlas Wind Farm:
Survey of fish habitats

Commissioned Report to Alba Ecology Ltd.,

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Waterside Ecology
Druimindarroch
Arisaig
Inverness-shire
PH39 4NR
T: 01687 450298
M: 07788717605
jon@watersideecology.co.uk

www.watersideecology.co.uk

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Contractor: Waterside Ecology

SUMMARY

Background

This survey of fish habitats was commissioned to inform the Environmental Impact Assessment report for the proposed repowering of the Beinn Ghlas Wind Farm in northern Argyll. The wind farm is set in hill ground to the south of Taynuilt, and takes in headwater streams of three separate catchments: the River Lonan (River Nell/Feochan Mhor) which flows west and enters the sea at Loch Feochan south of Oban, and the River Nant and the Allt Nathais, both of which flow into Loch Etive to the north.

Methods

A qualitative walkover survey of stream habitats was carried out in June 2022, focusing on suitability of the habitat for trout. The streams in the survey area are not accessible to migratory fish (salmon or sea trout). Photographs and target notes were taken, and the habitat was assessed on its overall quality for trout fry and parr. Major obstacles were recorded.

Main findings

- Most of the surveyed watercourses are small and steep with relatively little flow, and offer poor habitat for fish.
- Good trout habitat was found in Laggan Burn in the east of the site, and in the lower reaches of Eas Ruadh in the southwest of the site.
- Trout were seen in Laggan Burn and Eas Ruadh and some of their tributaries. No trout or other fish species were seen in other surveyed watercourses.

The findings are discussed in relation to the proposed development, and recommendations are made in relation to impacts assessment and mitigation. Fish-monitoring requirements in the pre-construction stage are discussed, should the project gain consent.

1 Introduction

This survey of fish habitats was commissioned to inform the Environmental Impact Assessment report for the proposed repowering of the Beinn Ghlas Wind Farm in northern Argyll. The existing Beinn Ghlas wind farm has 14 turbines. The proposed new wind farm would extend over a substantially wider area, and would have up to 18 turbines.

The wind farm is set in hill ground to the south of Taynuilt, and takes in headwater streams of three separate catchments: the River Lonan to the northwest, which flows west into the River Nell/Feochan Mhor and enters the sea at the head of Loch Feochan south of Oban; the River Nant to the south and east of the site which flows into Loch Etive at Taynuilt; and the Allt Nathais, a small watercourse flowing almost due north from the site which also flows into Loch Etive. All watercourses within the proposed wind farm area are small first or second order streams, rising within the red line boundary. Access to the site is via an existing track from Barguillean in Glen Lonan.

2 Fish populations

2.1. Species presence

A waterfall (Eas nan Clag at NM 013 256) on the River Nant makes all of the streams draining the south side of the side impassable to migratory salmonids[1]. This includes all of the larger watercourses draining the development area. Due to steep gradients, it is clear that those reaches of the small watercourses draining north towards the River Lonan are also naturally inaccessible to migratory salmonids. As a result the only species of conservation interest potentially present in streams are resident brown trout *Salmo trutta* and European eel *Anguilla anguilla*. The latter may be able to access areas inaccessible to salmonids due to their ability to climb and crawl over certain obstacle types. There are no records of Arctic charr *Salvelinus alpinus* within the redline boundary (Maitland & Adams 2017) and the only substantial lochan (unnamed NM 950 260) is outside the area that would be developed[2].

2.2. Conservation status

The target species for this survey, brown trout, is listed as a priority species on the UK and Scottish Biodiversity Action Plan lists.

Due to recent declines, European 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, and are also listed as a priority species on the UK and Scottish Biodiversity Action Plan lists.

2.3. Habitat requirements

2.3.1. Trout

The physical habitat requirements of juvenile salmonids have been subject to a considerable amount of detailed study (for reviews see e.g. Crisp 1993; Hendry & Cragg-Hine 2003; Klemetsen *et al*. 2003; Summers *et al*. 1996). Trout spawn in late autumn and early winter, depositing their eggs in redds which they excavate 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 and trout may spawn in lochs where no spawning stream is available. Loch spawning usually takes place on clean gravel in locations such as spits or promontories, where wave action results in some water movement (Maitland & Campbell 1992). 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

[1] https://map.environment.gov.scot/sewebmap/
[2] Pegasus Environment, drawing P22-0086-22 (Layout 003)

mortality due to lack of oxygen. Egg survival in streams is also affected by redd 'washouts' during winter spates – the direct, physical, scouring out of eggs from the gravel.

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. 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.

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, particularly in smaller streams. In larger rivers and lochs this may be less important, as deep water provides refuge.

2.3.2. 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. 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).

3 Aims and objectives

The overall aim of the study was to provide data on fish habitats in streams within the proposed Beinn Ghlas Wind Farm area. The primary target species was brown trout.

The aim of the current survey was to provide data on fish habitats in order to support the Environmental Impact Assessment report for the site. Specific objectives were to:

(i) Identify the broad distribution and quality of fish habitats within the site;

(ii) Identify any important spawning areas for trout;

(iii) Identify key issues in relation to the potential impact of the proposed development on fish habitats.

4 Methods

The habitat surveys of watercourses within the Beinn Ghlas wind farm area were carried out on 23 June 2022 by Isabel Isherwood and Jon Watt. Survey conditions were good with low flows, good light and clear water.

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 were not mapped or quantified.

Walkover survey methods were broadly based on protocols described by Hendry and Cragg-Hine (1997), Summers *et al*. (1996) and SEPA (2010a). These characterise in-stream habitats according to depth, substrate, flow and thus suitability for different age classes of salmonid fish (**Table 1**). Note that 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. Substrates are described using the Wentworth scale.

Table 1 Habitat categories used for walkover survey

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 gravel and pebble. Fines (sand & fine gravel <2 mm) less than 20%. Not silted.

Other variables recorded in each survey section were: up and downstream grid reference, wet width, stability of substrate and compaction of substrate. 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 in each section, 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. Stream reaches that were inspected are listed in **Table 2** below. A map showing the locations of surveyed reaches is in **Appendix 8.1**.

Table 2 Stream habitat survey reaches

Catchment	Watercourse	Downstream	Upstream
River Lonan	Stream A	NM 97854 27124	NM 97802 26663
River Lonan	Stream B	NM 97656 26979	NM 97530 26628
River Lonan	Stream C	NM 97409 27073	NM 97192 26689
River Lonan	Stream D	NM 97123 27341	NM 96941 26935
River Nant	Stream E	NM 96290 25098	NM 96282 25548
River Nant	Eas Ruadh	NM 96290 25098	NM 96484 25645
River Nant	Stream F	NM 96419 25179	NM 96614 25294
River Nant	Stream G	NM 96805 24861	NM 97017 25210
River Nant	Garbh Allt	NM 97036 24539	NM 96228 24822
River Nant	Allt Carnaich	NM 98069 25159	NM 97893 25378
River Nant	Stream H	NM 98583 25394	NM 98298 25335
River Nant	Laggan Burn	NM 98826 25802	NM 98913 26784
River Nant	Stream I	NM 98764 26005	NM 98044 26036
River Nant	Stream J	NM 98771 26029	NM 99000 26351
Allt Nathais	Allt Nathais headwaters	NM 98402 27253	NM 98444 26885

5 Results

Details of the habitats in each watercourse, their likely value to fish, and any site-specific sensitivities are set out in the tables below. All the watercourses surveyed are within the red line boundary of the proposed

wind farm repowering development, with the exception of Garbh Allt and section 1 of Eas Ruadh, which were included in the survey as inspection of maps and aerial photographs indicated that they would be likely to hold good fish habitat, and they receive run-off from a large part of the site.

Additional photographs of surveyed reaches are shown in **Appendix 8.2**. The location of each stream is shown on the map in **Appendix 8.1**.

Stream	Date surveyed	NGR downstream	NGR upstream
Stream A	23/06/2022	NM 97854 27124	NM 97802 26663

Summary of habitat

Stream A holds some suitable habitat for juvenile trout, but lacks pools or bankside cover for adults. The lower part of the survey reach is around 1 m wide and entrenched between steep banks. Flow is mainly shallow (5-10 cm) run and glide with step-pool sequences. The substrate is a mix of unstable boulder, cobble and pebble with bedrock; bedrock accounts for around 40 % of the substrate. Upstream of the confluence at NM 97842 26855, the tributaries become very small (wet width <80 cm) but still provide some juvenile trout habitat. However no fish were seen anywhere in the survey reach. This stream is a headwater tributary of the River Lonan. Downstream of the survey reach the stream falls steeply through an entrenched wooded ravine, and is highly unlikely to be accessible to fish from further downstream. No fish were seen during the survey.

Potential value to fish

Low-Moderate (though potentially fishless).

Habitat appears suitable for trout but none were seen during the habitat survey.

Site specific sensitivities

No specific sensitivities in section.

Stream	Date surveyed	NGR downstream	NGR upstream
Stream B	23/06/2022	NM 97656 26979	NM 97530 26628

Summary of habitat

Another headwater tributary of the River Lonan, this stream is similar in character to Stream A, with unstable mixed juvenile habitat, shallow flow, and a substrate of bedrock, boulder, cobble and pebble. Wet width is 1-2 m in the lower part of the survey reach, decreasing upstream. As with Stream A, it appears inaccessible from the River Lonan.

This stream is dammed at NM 9758 2681, and water is abstracted. The dam is impassable to fish. A short distance upstream of the dam is a waterfall, which at 5 m high is also impassable. Although there is some reasonably good fish habitat in the survey reach, including small amounts of spawning substrate, it is fragmented and due to lack of access from downstream may also be fishless. No fish were seen during the survey.

Potential value to fish

Low-Moderate (though potentially fishless).

Habitat appears suitable for trout but none were seen during the habitat survey.

Site specific sensitivities

No specific sensitivities in section.

Stream	Date surveyed	NGR downstream	NGR upstream
Stream C	23/06/2022	NM 97409 27073	NM 97192 26689

Summary of habitat

Poor, unstable mixed juvenile habitat, with a substrate of angular cobble and boulder with much bedrock. Wet width is 0.8-1.2 m in the lower part of the survey section.

This stream is heavily abstracted, with very little compensation flow. The intake dam at NM 9737 2690 is impassable, and there are impassable waterfalls both upstream and downstream of the dam. Even in the unabstracted reach this is a small, steep, shallow stream holding poor quality habitat.

Given the fragmentation of the habitat and the heavy abstraction regime, it seems unlikely that this stream is able to support trout. No fish were seen during the survey.

Potential value to fish

Low.

No fish seen and fish likely to be absent or at very low density.

Site specific sensitivities

None in surveyed reach.

Stream	Date surveyed	NGR downstream	NGR upstream
Stream D	23/06/2022	NM 97123 27341	NM 96941 26935

Summary of habitat

Like streams B and C this stream is abstracted, with an intake dam at NM 9701 2706. The watercourse in the survey reach is steep and entrenched between high rocky banks, with a substrate of tumbled boulders and bedrock. At the time of survey there was virtually no compensation flow over or through the dam, and the streambed was largely dry in the abstracted reach.

It seems very likely that this stream is fishless

Potential value to fish

Low.

No fish seen and fish likely to be absent or at very low density.

Site specific sensitivities

None in surveyed reach

Stream	Date surveyed	NGR downstream	NGR upstream
Stream E	23/06/2022	NM 96290 25098	NM 96282 25548

Summary of habitat

Stream E is a tributary of Eas Ruadh, which it joins 300 m upstream of the confluence of Eas Ruadh and Garbh Allt. The lower reaches of the stream are moderate gradient and hold good mixed juvenile trout habitat. The substrate is largely boulder, cobble and pebble, with run flow and shallow pools. Wet width is 1 – 1.5 m. Some overhead cover is available along the banks. A complex of small waterfalls and rock steps at NM 9625 2523 may be impassable under all or most flow conditions. Upstream of this obstacle the stream steepens with step-pool sequences and more frequent obstacles. The stream becomes increasingly entrenched between steep banks and the proportion of bedrock in the substrate increases. No accumulations of spawning substrate were found. Trout were seen in the lower reaches of this stream.

Potential value to fish

Moderate. Some good mixed juvenile trout habitat. No substantial areas of spawning substrate.

Site specific sensitivities

Any crossings/culverts downstream of NM 9625 2523 must be passable for fish.

Downstream impacts into good trout habitats in Eas Ruadh and Garbh Allt should be avoided.

Stream	Date surveyed	NGR downstream	NGR upstream
Eas Ruadh section1	23/06/2022	NM 96228 24822	NM 96290 25098

Summary of habitat

Section 1 of Eas Ruadh is immediately outside the red line boundary, and runs from the confluence with Stream E to the confluence with Garbh Allt. This low-gradient reach holds good quality trout habitat, with shallow run and glide flow over a fairly stable substrate of mixed boulder, cobble and pebble. There is plenty of instream and bankside cover. Wet width is between 1.5 and 2 m. Spawning substrate is available in patches but there are no significant spawning accumulations. Trout were seen.

Potential value to fish

Moderate-High.

Good quality mixed juvenile trout habitat. Small areas of spawning substrate.

Site specific sensitivities

This reach is outside the developable area, but could be vulnerable to water quality changes or siltation events upstream.

Stream	Date surveyed	NGR downstream	NGR upstream
Eas Ruadh section 2	23/06/2022	NM 96290 25098	NM 96484 25645

Summary of habitat

The low gradient section of Eas Ruadh upstream of the confluence with Stream E holds good quality mixed juvenile trout habitat with shallow pool and run flow over a fairly stable substrate of mixed boulder, cobble and pebble. There is plenty of good cover among boulders and along banks. Wet width is 1-1.5 m. Small patches of spawning substrate are available. No fish were seen but this reach is accessible from downstream where trout were observed to be present.

A 4 m high waterfall at NM 9641 2525, upstream of the confluence with stream F, is impassable. Above the obstacle the gradient increases and the stream becomes deeply entrenched. The substrate is dominated by bedrock, and the stream flows in step-pool sequences with frequent obstacles.

Potential value to fish

Moderate-High.

Good quality mixed juvenile trout habitat. Small areas of spawning substrate.

Site specific sensitivities

Any crossings/culverts downstream of NM 9641 2525 must be passable for fish.

Downstream impacts into good trout habitats in Garbh Allt should be avoided.

Stream	Date surveyed	NGR downstream	NGR upstream
Stream F	23/06/2022	NM 96419 25179	NM 96614 25294

Summary of habitat

Stream F is a small tributary of Eas Ruadh. Only just over 100 m is accessible from Eas Ruadh before the gradient steepens and a series of obstacle culminating in an 8 m waterfall make the stream impassable. Very little useful fish habitat exists upstream of this obstacle.

The lower 100 m is poor quality mixed juvenile habitat with a boulder and bedrock substrate, wet width 1 m.

Potential value to fish

Low.

Site specific sensitivities

None in surveyed reach.

Downstream impacts into good trout habitats in Eas Ruadh and Garbh Allt should be avoided.

Stream	Date surveyed	NGR downstream	NGR upstream
Stream G	23/06/2022	NM 96805 24861	NM 97017 25210

Summary of habitat

Stream F is a tributary of Garbh Allt, but a bedrock cascade at the confluence may be impassable to trout. The habitat is mainly stable mixed juvenile habitat with boulder, cobble and pebble substrate, interspersed with short, steep bedrock sections. The latter are mostly passable, but a substantial bedrock chute at NM 9699 2496 is probably impassable to trout moving upstream. There are frequent small patches of spawning habitat. There are impassable obstacles on both branches upstream of the confluence at NM 97080 25017. Although there is some quite good trout habitat in this stream and spawning substrate is available, the habitat is rather fragmented and probably not connected to the good habitat in Garbh Allt. No fish were seen during the survey.

Potential value to fish

Moderate. Some good stable mixed juvenile trout habitat with small patches of spawning substrate, however no fish were seen during the survey and stream appears inaccessible from Garbh Allt.

Site specific sensitivities

Spawning areas would be at risk from siltation.

Any crossings/culverts must be passable for fish unless shown to be absent.

Downstream impacts into good trout habitats in Garbh Allt should be avoided

Stream	Date surveyed	NGR downstream	NGR upstream
Garbh Allt	23/06/2022	NM 97036 24539	NM 96228 24822

Summary of habitat

Garbh Allt is not within the proposed developable area, however it receives runoff from all the smaller streams draining the southwestern part of the site, and holds very good trout habitat. The stream is mainly 2-4 m wide, with shallow run and glide flow over a substrate of cobble, pebble and boulder. Gradient is shallow in the upper half of the survey reach; the lower half of the reach is a little steeper and more entrenched, with more boulders, some bedrock, and some deeper pool habitat. The lower gradient section holds substantial accumulations of good spawning substrate, amounting to around 20 m², in a series of short runs between NM 96552 24782 and NM 96496 24818. Trout fry were numerous in these areas at the time of the habitat survey.

Potential value to fish

Good quality trout habitat, with some important spawning areas.

Site specific sensitivities

This reach is outside the developable area, but could be vulnerable to water quality changes or siltation events upstream.

Stream	Date surveyed	NGR downstream	NGR upstream
Allt Carnaich	23/06/2022	NM 98069 25159	NM 97893 25378

Summary of habitat

This is a very small first order stream. Much of it is peat channel or dispersed flow through boggy ground, making it largely unsuitable for fish. There is a short reach of mixed juvenile habitat upstream of the main boggy area, but this is broken by frequent obstacles, and its lack of connectivity to better habitat downstream makes it unlikely to support fish. No fish were seen during the survey.

Potential value to fish

Low.

No fish seen, likely to be absent.

Site specific sensitivities

None in surveyed reach

Stream	Date surveyed	NGR downstream	NGR upstream
Stream H, section 1	23/06/2022	NM 98583 25394	NM 98534 25477

Summary of habitat

This stream flows into Laggan Burn at NM 9892 2524 (outside the red line boundary). The survey commenced approximately 0.5 km upstream of Laggan Burn and extended for 150 m up to the confluence of the two headwater channels. It is not known if the surveyed reach is accessible from Laggan Burn. The stream has a typical wet width of 1 m and a bed width of 1.3 m. Shallow pools are linked by little runs and steps. No obstacles are present in the section and habitat appeared well suited to trout. However, despite the low, clear water no fish were seen. Depth at the time of survey was typically 5 to 15 cm. No spawning habitat was recorded and substrates are predominant cobble, boulder and pebble.

Potential value to fish

Low - moderate (though potentially fishless).

Suitable habitat for trout but no fish seen. Lacks spawning substrate.

Site specific sensitivities

No specific sensitivities in section.

Stream	Date surveyed	NGR downstream	NGR upstream
Stream H, section 2	23/06/2022	NM 98534 25477	NM 98298 25335

Summary of habitat

This is the western fork of the headwaters of Stream H. It is a small, first order stream. A series of cascades at NM 9852 2548 renders it inaccessible from section 1. There are several further impassable obstacles up to 2 m in height through the survey section. Depth is mainly 5 to 10 cm and the channel has a typical wet width of 0.5 m. It is entrenched and substrate is bedrock-dominated. Habitat quality for trout or eels is very poor due to lack of depth and cover and no fish were seen. No spawning habitat was recorded.

Potential value to fish

Low.

Inaccessible and bedrock-dominated.

Site specific sensitivities

No specific sensitivities in section.

Stream	Date surveyed	NGR downstream	NGR upstream
Stream H, section 3	23/06/2022	NM 98534 25477	NM 98492 25629

Summary of habitat

This is the north fork of the headwaters of tributary 3. It is a small, first order stream. Depth at the time of survey was mainly less than 5 cm. Substrates are largely boulder and bedrock. The channel appears unsuited to fish production.

Potential value to fish

Low.

Very poor quality habitat. Much bedrock. Almost certainly fishless.

Site specific sensitivities

No specific sensitivities in section

Stream	Date surveyed	NGR downstream	NGR upstream
Stream I, section 1	23/06/2022	NM 98764 26005	NM 98414 26029

Summary of habitat

This stream flows into Laggan Burn at NM 9876 2601. Immediately upstream of the confluence it passes through a culvert, which seems likely to be passable at moderately elevated flows. A longer culvert at NM 9866 2605 also appears passable. The first 200 m of stream above the confluence are stony mixed juvenile habitat with runs and glides, as pictured below. Upstream of this the channel is deeply entrenched between bedrock banks. Between NM 9860 2608 and NM 9854 2613 there are several rocks steps up to 0.8 m high. These lack plunge pools and appear impassable, so any fish entering the stream from Laggan Burn are likely to be restricted to the first 200 to 250 m of channel. The stream has a wet width of 1.0 to 1.5 m. At the time of survey water depth was mainly between 5 and 15 cm, with pools to 30 cm. Substrate in the lower 200 m is mainly angular, unstable cobble and pebble. There is a high proportion of bedrock in the entrenched reaches further upstream. Overall habitat quality for juvenile trout – both fry and parr - was judged to be moderate. Spawning habitat is lacking, as are suitable pools for adult trout.

Potential value to fish

Low to moderate.

Small, limited access due to natural obstacles. No fish seen. If present, trout are likely to be at low density.

Inaccessible to migratory salmonids.

Site specific sensitivities

No specific sensitivities in section.

Downstream impacts into better reaches of Laggan Burn should be avoided.

Stream	Date surveyed	NGR downstream	NGR upstream
Stream I, section 2	23/06/2022	NM 98414 26029	NM 98044 26036

Summary of habitat

Upstream of the entrenched reach described above the gradient eases and the stream meanders through a 1 m wide channel in rough pasture. Flow types are run, glide and pool sequences. Depth throughout is mainly between 5 and 10 cm with pools to 30 cm. Small patches of gravel and pebble are present and would permit spawning. A short distance downstream of the existing track at NM 9834 2604 the gradient increases and the stream becomes entrenched with a substrate of embedded boulder and little bedload. This appears to be the limit of any potentially productive fish habitat. As it is small and shallow the stream is probably best suited to trout fry. However no fish were seen and trout, if present, seem likely to persist at very low density.

Potential value to fish

Low - moderate (though potentially fishless).

Habitat appears suited to trout but none seen. Obstacles near downstream end of section.

Inaccessible to migratory salmonids.

Site specific sensitivities

No specific sensitivities in section.

Downstream impacts into better reaches of Laggan Burn should be avoided.

Any crossings/culverts should be passable unless fish shown to be absent.

Stream	Date surveyed	NGR downstream	NGR upstream
Laggan Burn, section 1	23/06/2022	NM 98826 25802	NM 98621 26275

Summary of habitat

Laggan Burn flows directly into Loch Nant. This survey section is approximately 1 km upstream of Loch Nant. Here gradient is moderate and the stream meanders through heavily-grazed rough pasture. Flows comprise glide, riffle and run sequences. Depths are typically between 5 and 20 cm with shallow pools to 50 cm. Substrates are mainly of cobble and pebble with some gravel. There is good spawning potential at tails of pools and glides. Undercut turf provides cover for trout alongside the banks. Larger cover for eels is poor. Wet width ranges from 1 to 2 m. The upstream end of the survey section is a 30 m long section of steep, entrenched, boulder filled channel. At the time of survey there was no surface flow and this presented an impassable obstacle to upstream fish movement. It was judged likely to be permanently impassable, even at high flow, due to extreme turbulence and the presence of numerous rock-steps and sumps.

Potential value to fish

Moderate

Trout appeared plentiful. Good spawning potential.

Inaccessible to migratory salmonid species due to waterfalls in the River Nant.

Site specific sensitivities

Presence of good quality spawning habitats at pool tails. Good juvenile trout habitats.

Some areas of rapid bank erosion – these should not be exacerbated e.g. by damage from heavy machinery.

Any crossings must be passable for fish.

Stream	Date surveyed	NGR downstream	NGR upstream
Laggan Burn, section 2	23/06/2022	NM 98621 26275	NM 98913 26784

Summary of habitat

Upstream of the dry streambed described above, the stream is around 1 m wet width. Flow types are mainly run and glide with substrates of cobble and pebble. Depth 10 to 15 cm with pools to 40 cm. The stream passes under the existing track via a pipe culvert (NM 9868 2615) that appears passable. Upstream of the track the channel has a very low gradient and is incised between vertical banks of peat/soil. Width varies from 0.5 to 1.0 m. Flow types are mainly glide with some runs and shallow pools. Small substrates predominate and there appears to be little bedload. Many of the soft substrate reaches are filled with vegetation. Upstream of the confluence at NM 9890 2678 both forks flow partially beneath the turf. No well-defined spawning areas were recorded but pockets of gravel are present in runs that could permit spawning by trout. Instream cover is provided by vegetation and overhead cover from undercut banks is plentiful. However no fish were seen.

Potential value to fish

Moderate (though potentially fishless).

Habitat appears suited to trout but none seen upstream of impassable obstacle at bottom of section.

Inaccessible to migratory salmonids.

Site specific sensitivities

No specific sensitivities in section.

Downstream impacts into better reaches of Laggan Burn should be avoided.

Soft banks potentially prone to damage from machinery.

Any crossings/culverts must be passable for fish unless shown to be absent.

Stream	Date surveyed	NGR downstream	NGR upstream
Stream J	23/06/2022	NM 98771 26029	NM 99000 26351

Summary of habitat

This stream flows from Loch Bealach an Fiodhain to enter Laggan Burn at NM 9877 2603. It is a small stream with a wet width typically ranging from 0.4 to 1.0 m. A 2 m high cascade at the confluence with Laggan Burn includes steep steps lacking plunge pools and appears impassable for upstream migrants. Dominant substrate types are cobble and pebble with scattered boulders and a few patches of bedrock. Depth is typically 10 to 25 cm. The banks are stable with turf overlying boulders. Some overhead cover is present. No substantial areas of spawning habitat were recorded but small patches of gravel and pebble are widespread and would provide spawning opportunities for resident trout.

Trout were seen at several locations during the survey. Habitat quality for trout fry was judged moderate to good. Habitat quality for larger parr is moderate as the survey reach is largely shallow. Some cover for eels is present.

Potential value to fish

Moderate

Habitat is well suited to trout, which are present.

Inaccessible to migratory salmonids.

Site specific sensitivities

Suitable juvenile habitats and linkage to loch. Any crossings/culverts must be passable for fish.

Stream	Date surveyed	NGR downstream	NGR upstream
Allt Nathais headwaters	23/06/2022	NM 98402 27253	NM 98444 26885

Summary of habitat

Wet width 0.4 to 0.9 m. Depth typically 5 to 15 cm. Lower 250 m of surveyed reach are entrenched with much bedrock. A reach of dry streambed some 70 m up from the bottom of the survey section appears impassable. Other substrates mainly angular, shattered cobble and pebble. Bank faces steeply sloping with some bedrock. There is little or no overhead cover alongside the banks. Upstream of NM 9847 2704 the gradient decreases and the stream meanders through rough pasture. Flow types are runs (depth ~5 cm) and little pools to 20 cm deep. Undercut turfs provide overhead cover.

No fish were seen in the stream. No discrete areas of spawning habitat were recorded. Habitat quality for trout was judged to be poor, both for fry and parr and reach is inaccessible. Little cover is available for eels.

Potential value to fish

Low.

No fish seen and fish likely to be absent or at very low density.

Site specific sensitivities

None in surveyed reach.

6 Interpretation and potential scheme impacts

6.1. Survey design

Typically, a survey for a development of this nature would involve elements of electric fishing as well as habitat survey. In designing the current survey it was apparent from map data that the majority of watercourses within that part of the red line boundary likely to be developed are small, steep first order streams likely to provide little or no productive habitat for salmonid or other fish. Furthermore, due to the gradients and presence of impassable barriers downslope of the red line boundary it was clear that the only native fish species of conservation value potentially present would be resident brown trout and European eels. As a result, it was judged that sufficient information for the purposes of ecological impact assessment could be obtained by determining the distribution of habitats for these two species. The approach taken was one of site characterisation, identifying those streams and sections of stream within the red line boundary with potential for fish production and broadly assessing the quality of those habitats. This information will permit:

i) Formal assessment of risks to the fish species potentially present (trout and eels) within the Environmental Impact Assessment (EIA) Report.

ii) Identification of site-specific sensitivities for each watercourse, to support mitigation design in relation to stream crossings and other infrastructure.

iii) Design of a pre-construction baseline fish population survey, which could form part of a wider water quality monitoring programme during and post-construction.

6.2. Survey limitations

Within the stated aims of the survey, expanded on above, data quality is considered high. The surveyors (Jon Watt and Isabel Isherwood of Waterside Ecology) have over 40 years combined experience of fish habitat and population assessments, mainly conducted in Scottish uplands, including the west Highlands and Argyll. Furthermore, survey conditions were excellent with low, clear water and good light. Given the size of the streams the streambed habitats were clearly visible and it was often possible to see the presence of trout while conducting the assessments.

It is acknowledged that absence of trout in certain streams cannot be assumed simply because none were seen, unless habitat was entirely unsuitable as was the case in the upper reaches of some of the surveyed watercourses. Nevertheless, given the surveyors' experience, the survey conditions, and the nature of habitats in the survey reaches, the site characterisations presented in the results are considered a reliable reflection of the distribution of suitable habitats for target species.

6.3. Potential scheme impacts and habitat distribution

6.3.1. Distribution of productive habitat

As expected, most watercourses within the red line boundary were found to be small, steep and shallow providing little productive habitat for trout and very limited cover for eels. Observations made during the current survey confirmed the predicted inaccessibility of the streams draining towards Glen Lonan and identified that several of these have been impacted by abstractions. Many of the survey reaches are likely to be fishless, or nearly so, and most of the upper reaches of the watercourses were found to be too small and shallow for any quantitative fish population survey to be practicable. The main exceptions are Laggan Burn including the lower reaches of Stream J in the eastern part of the site, and the lower reaches of Eas Ruadh and Stream E (tributaries of Garbh Allt) in the southwest. Garbh Allt itself falls outside the red line boundary, but clearly provides good quality trout habitat including substantial areas of spawning substrate. Trout were seen in all these streams and protection of water and habitat quality in these reaches should form the primary focus of mitigation.

6.3.2. Potential scheme impacts

Onshore wind farm developments have the potential to adversely affect freshwater fish and associated fisheries through several mechanisms including[3]:

- Increased sediment transport and deposition
- Pollution incidents
- Altered hydrological pathways
- Removal or degradation of fish habitat, including spawning areas
- Reduction in food supply
- Obstruction to upstream and downstream migration of fish.

The EIA should consider how such mechanisms might impact on water quality or habitats in the productive reaches identified in the current report. The species most at risk from potential changes is brown trout. European eels, which are catadromous, are less likely to be impacted unless changes to water and habitat quality are severe. The results tables provide further guidance on any site-specific issues that may need to be considered e.g., fish passage at stream crossings or protection of spawning areas. While many of the survey reaches are likely to be fishless, all streams ultimately drain into watercourses that do support fish. Potential downstream effects will also have to be considered within the EIA Report.

6.4. Fish population assessments

Should the scheme gain consent it is recommended that a pre-construction fish population baseline is established. An initial survey plan is set out in Table 3 below, but this should be reviewed based on the results of EIA and the configuration of the final layout. The baseline, once established, would permit an assessment of the impact of any change in water quality or hydrology on fish populations. The need (or otherwise) for ongoing monitoring of fish as part of any wider water quality monitoring should be based on the degree of risk to habitats or fish identified within the EIA Report. Clearly, the primary target species for pre-construction baseline assessment should be brown trout.

Table 3 Outline plan for pre-construction baseline assessment

Watercourse	Pre-construction and construction phase monitoring needs	Rationale
Stream A	Determine trout presence. If appropriate, establish monitoring site x 1	Potentially suitable habitat in lower reaches but may be fishless
Streams B to D	None	Little suitable habitat, heavily impacted by abstraction
Eas Ruadh and Stream E	Establish 1 x monitoring site in each of Eas Ruadh and Stream E	Good quality habitat. Trout present.
Stream F	None	Unsuited to trout production
Stream G	Determine trout presence. If appropriate, establish monitoring site x 1	Potentially suitable habitat in lower reaches but may be fishless
Allt Carnaich and Stream H	None	Largely unsuited to trout production
Laggan Burn, Streams I and J	Establish 1 x monitoring site in each stream. The Laggan Burn site should be downstream of the confluence with Stream J where there is some good spawning potential.	Suitable habitat. Trout present.
Allt Nathais headwaters	None in surveyed reach. Monitoring further downstream may be appropriate if track upgrades proposed.	Largely unsuited to trout production in surveyed reach.

[3] See also https://www.gov.scot/publications/onshore-renewables-interactions/

If access can be agreed, we strongly recommend that baseline survey should also include at least one site in Garbh Allt. Although it lies outside the red line boundary it receives run-off from several streams within the site and it was clear from limited observations during the current survey that it supports large areas of good quality trout habitat.

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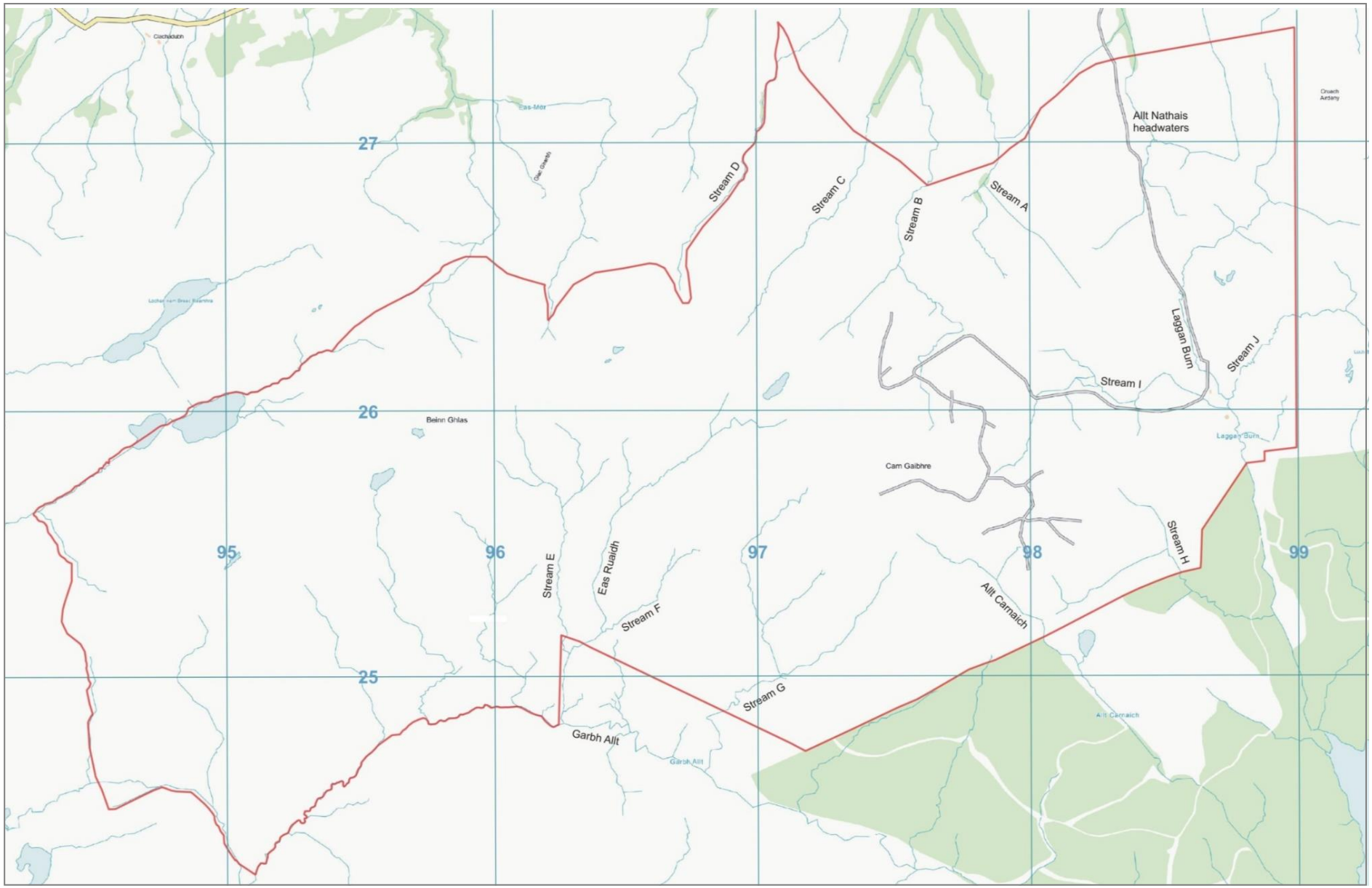
8 Appendices

8.1. Red line boundary and streams included in survey. Note that no development is proposed in the western part of the site.



8.2. Additional photographs of surveyed watercourses

	Stream A NM 9789 2695 Shallow mixed juvenile habitat; entrenched.
	Stream A East fork NM 9786 2682 Narrow, entrenched, little productive potential
	Stream B NM 9758 2680, looking downstream to red line boundary. Shallow mixed juvenile habitat

	Stream C NM 9741 2694, looking downstream. Shallow mixed juvenile habitat; entrenched.
	Stream D NM 9707 2732 Mixed juvenile habitat; very heavily abstracted.
	Stream E NM 9641 2525 Series of obstacles at point where stream begins to steepen. Probably impassable in most flows due to shallow plunge pools

	Eas Ruadh, section 2 NM 9651 2523 Narrow stream with much bedrock. Waterfall in background is 4 m high and impassable for trout.
	Stream F NM 9651 2524 The stream rises steeply to an impassable 8 m high waterfall.
	Stream G NM 9680 2466 Impassable obstacle at confluence with Garbh Allt

	Stream G NM 9699 2496 Impassable obstacle
	Stream G NM 9699 2496 Immediately upstream of obstacle in above photo: mixed juvenile habitat
	Stream G NM 9708 2503 North fork: holds mixed juvenile habitat but a further impassable obstacle is visible in the background of the photo

	Garbh Allt NM 9631 2481 View upstream at Eas Ruadh confluence. The stream becomes very low gradient with slow flow and deep glides and pools.
	Garbh Allt NM 9650 2482 Excellent spawning habitat for trout. Many fry were seen here.
	Garbh Allt NM 9678 2467 The lower part of the surveyed section of Garbh Allt is faster flowing and more entrenched, with a high proportion of boulders in the substrate.

	Allt Carnaich NM 9806 2517 View downstream: narrow peat channel
	Allt Carnaich NM 9806 2517 View upstream: shallow dispersed flow through boggy ground; unsuitable for fish
	Stream I, Section 1 NM 9858 2539

	Stream I, section 2 NM 9852 2548 Impassable cascades at downstream end of section.
	Laggan Burn, section 1 NM 9877 2601 Rapid erosion of bank faces, deposition on point bars.
	Laggan Burn, section 1 NM 9879 2592 5 m^2 of spawning habitat at tail of glide

	Laggan Burn, section 1 30 m of steep, dry stream bed. Likely to be permanently impassable due to sums and rock-steps.
	Laggan Burn, section 2 Looking downstream at NM 9891 2678 Shallow mixed juvenile habitat
	Laggan Burn, section 3 NM 9873 2664 Narrow channel with soft sediments, partly filled with vegetation

	Stream J NM 9878 2604 Cascade immediately upstream from Laggan Burn confluence. Total height approximately 2 m. Highest vertical step is 1.3 m.
	Stream J NM 9880 2616 Looking downstream towards Laggan Burn
	Stream I, section 1 NM 9875 2600 Confluence with Laggan Burn. Stream I flows beneath the track through the culvert.

	Stream I, section 1 NM 9854 2613 Entrenched with rock steps. Height of pictured step is approximately 0.8 m. No plunge pool (falls onto bedrock slab).
	Stream I, section 2 NM 9834 2604 Typical shallow habitat. Some spawning potential but no fish seen.
	Stream I NM 9804 2604 Looking upstream: entrenched first order stream with little productive potential.

	Allt Nathais NM 9837 2719 Section of partially dry streambed.
	Allt Nathais NM 9843 2709 Typical stream habitat in better areas – 5 to 10 cm deep with cobble substrate.
	Allt Nathais NM 9847 2704 Low gradient meanders in rough pasture. Partly filled with emergent vegetation. Some flow beneath turf.

	Allt Nathais NM 9853 2699 East fork. Tiny channel, partly flowing beneath turf.