WINDBURN WIND FARM

TECHNICAL APPENDIX 8.3: FISHERIES HABITAT SURVEY

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1 INTRODUCTION

This report presents the methods and results of Fish Habitat Surveys (FHS) undertaken to obtain the baseline ecological information required to inform the Environmental Impact

Assessment (EIA) of the proposed Windburn Wind Farm, hereafter referred to as the 'Development'.

Mhor Environmental Ltd was commissioned by SLR Consulting Limited (SLR) to undertake a FHS in September 2023 on their behalf, for Wind 2 Ltd. (hereafter referred to as 'the Developer').

The following terminology is used throughout this technical report:

- The Development: the whole physical process involved in the development of land at Windburn Wind Farm, including wind farm construction, operation and decommissioning (not a piece of land or an area);
- Development Site Boundary (hereafter referred to as 'the Site'): the proposed area of land, provided by the Developer, within which all development works for the wind farm will take place . Fish Habitat Surveys were undertaken within and in close proximity to the Development Site Boundary.

1.1 Site Description

The Site is situated approximately 14.5km north-east of Stirling, near the town of Alva in Clackmannanshire. Various watercourses are present within the Site, with the three main watercourses, the Burn of Ogilvie, Danny Burn and Devon Burn being of most importance. All watercourses recorded close to the Site have the potential to be impacted by the proposed Development. These watercourses are included in the sample locations.

Watercourses to the north of the Site, Buttergask burn, Burn of Ogilvie and the Danny burn, flow into Allan water passing below the A9 through box culverts.

The river Devon to the east of the Site is dammed downstream, creating Upper Glendevon, Lower Glendevon and Castlehill reservoirs. Further downstream, Cauldron Linn waterfall is impassable to migratory fish[1].

The small headwaters to the south of the Site, flow into the Alva burn through the steep-sided Alva Glen. Heavily modified, the Alva burn flows into the lower reaches of the river Devon downstream of Cauldron Linn falls.

Watercourses to the west of the Site are unlikely to be impacted by the Development as the proposed access track and turbine locations remain to the east of Blairdenon Hill.

The landscape surrounding the Site is dominated by steep-sided slopes, peatland, moorland and farmland. Deciduous woodland and forestry plantation is recorded to the north of the Site.

1.2 River Basin Management Plan

The European Union's Water Framework Directive (WFD) requires all inland and coastal waters within defined river basin districts to reach at least 'good' ecological status/potential by a set deadline[2]. SEPA is the lead authority to ensure compliance with WFD requirements. With input from responsible authorities and other stakeholders, SEPA has coordinated the production of the Scotland River Basin Management Plan (RBMP) to ensure the protection, improvement and sustainable use of the water environment for future generations. The overall aim is for 98% of Scotland's waters to be in a good condition by 2027, to be progressively implemented through three RBMP cycles (2009-2015; 2015-2021 and 2021-2027)[3].

[1] https://marinescotland.atkinsgeospatial.com (Accessed online – 27/12/2023)

[2] EU Water Framework Directive (2000) - Directive 2000/60/EC

[3] https://www.sepa.org.uk/media/163445/the-river-basin-management-plan-for-the-scotland-river-basin-district-2015-2027.pdf (Accessed online – 20/12/2023)

The RBMP has identified the following key pressures on the water environment in Scotland:

- Morphological alterations (e.g., modifications to beds, banks and shores as the result of historical engineering and urban development);
- Diffuse source pollution (e.g., agriculture, urban development);
- Point source pollution (e.g., the discharge of sewage, manufacturing and quarrying);
- Abstraction and flow regulation (e.g., alterations to water flows and levels as the result of electricity generation and public water supplies); and
- invasive non-native species.

RBMPs set out how organisations, stakeholders and communities will work together to improve the water environment.

1.3 Objectives

The aim of the FHS were to undertake a detailed assessment of watercourse bankside and habitat quality along the main watercourse and various tributaries within and in close proximity to the Site, to obtain detailed information regarding the suitability of watercourses for fish species. Detailed information obtained from the fish habitat surveys will provide an accurate and robust baseline on which to base the Environmental Impact Assessment (EIA).

The purpose of the FHS were to:

- Provide a baseline fisheries habitat report to assess Fish Utilisation Potential (FUP) and Fish Habitat Quality (FHQ) of watercourses within and in close proximity to the Site, including an assessment and searches for lamprey (*Lampetra sp.*) and freshwater pearl mussel (*Margaritifera margaritifera)* habitat. Assessment criteria is based on various characteristics recorded within surrounding habitats detailed in section 3.3;
- Determine the requirement for further surveys (including targeted electrofishing surveys); and
- Use the baseline information for future comparison studies, potentially required during the Development construction and post-construction phases.

2 HABITAT REQUIREMENTS

Habitat requirements of species covered within this report are presented below.

2.1 Salmonids

The physical habitat requirements of juvenile salmonids (brown/sea trout (*Salmo trutta*) and Atlantic salmon (*Salmo salar*)) have been subject to a considerable amount of detailed study[4],[5],[6],[7]. Atlantic salmon and brown trout spawn in late autumn and early winter, depositing their eggs in redds which they excavate in gravel and pebble substrates.

[4] Crisp, D.T. 1993. The environmental requirements of salmon and trout in fresh water. Freshwater Forum, 3(3): 176-201.

[5] Hendry, K & Cragg-Hine, D. 2003. Ecology of the Atlantic Salmon. Conserving Natura 2000 Rivers Ecology Series No. 7, English Nature, Peterborough.

[6] Klemetsen, A., Amundsen, P-A, Dempson, J.B., Jonsson, B., Jonsson, N., O'Connell, M.F. and Mortensen, E. 2003. Atlantic salmon Salmo salar L., brown trout Salmo trutta L. and Arctic charr Salvelinus alpinus (L.): a review of aspects of their life histories. Ecology of Freshwater Fish, 12, 1-19.

[7] Youngson, A & Hay, D. 1996 The Lives of Atlantic Salmon. An illustrated account of the life-history of Atlantic salmon. Swan Hill Press, Shrewsbury.

Spawning depth can range from 5 cm to 90 cm[8], but it is likely that habitat is selected on the basis of suitable substrate and flow rather than depth per se.

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 as alevins, absorbing nutrient from the remaining yolk sac. On emergence, usually between March and early May, young fry disperse from the redds and set up territories which they defend aggressively. Salmon fry prefer fast flows (>20 cm/s) and favour areas with surface turbulence (riffle habitat). They require a rough bed of pebble, cobble and gravel.

Brown trout fry prefer areas of relatively low velocity water near the streambed and often inhabit slower flows than salmon fry. Cover from stones, plants or debris is required and good cover is essential for maintaining high fry densities.

Atlantic salmon that have survived their first winter (parr) prefer deeper water than fry (typically 15-40 cm) and a coarser substrate often consisting of pebbles, cobbles and boulders. Brown trout parr generally favour areas of relatively low current speed where cover is available. Juvenile brown 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.

2.2 Lamprey

A review of lamprey ecology is provided by a study by Maitland in 2003[9]. Adult lamprey aggregate to spawn and extrude their eggs into 'nests' excavated in the riverbed. Suitable spawning substrate varies between species. Brook lampreys spawn in areas of coarse sand and gravel while the larger species select areas of gravel, pebble and cobble. 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 feed on fine particulate matter such as diatoms, algae and bacteria. Ammocoetes spend several years in this muddy nursery habitat before metamorphosing (or transforming) from larval to adult form. The larvae of river and brook lamprey are indistinguishable from one another. Following transformation, it becomes possible to distinguish between them on the basis of morphology and colouration[10]. Upstream migrating lampreys may be prevented from reaching spawning grounds by both natural and man-made barriers. They find it very difficult to ascend barriers, so can be prevented from moving upstream by relatively low vertical barriers.

[8] Neary, J.P. 2006. Use of Physical Habitat Structure to Assess Stream Suitability for Brown Trout: A Case Study of Three Upland Scottish Streams. Ph.D. Thesis, University of Stirling, October 2006.

[9] Maitland, P.S. 2003. Ecology of the River, Brook and Sea Lamprey. Conserving Natura 2000 Rivers Ecology Series No. 5. English Nature, Peterborough.

[10] Gardiner, R. 2003. Identifying Lamprey. A field key for Sea, River and Brook lamprey. Conserving Natura 2000 Rivers Ecology Series No. 5. English Nature, Peterborough.

2.3 Freshwater Pearl Mussel

Freshwater pearl mussels are found in fast flowing rivers, with detailed studies on Scottish freshwater pearl mussel populations suggesting that optimum water depths of 30-40 cm and optimum current velocities of 0.25-0.75ms^{-1} at intermediate water levels are most suitable[11].

Riverbed substrate characteristics are considered to be the best physical parameters for describing freshwater pearl mussel habitat[12]. Freshwater pearl mussels prefer stable cobble/boulder dominated substrate with some fine substrate that allows the mussels to burrow[13]. Adult and juvenile mussels tend to have similar habitat 'preferences', although adults are found over a wider range of physical conditions and juveniles appear to be more exacting in their requirements and sensitivity to environmental disturbance[10]. Juvenile mussels require fine stable sediments, particularly clean sand and gravel.

Freshwater pearl mussels live buried or partly buried in the beds of clean, fast-flowing unpolluted streams and rivers and subsist by inhaling and filtering for the minute organic particles on which they feed[11]. Of specific importance to freshwater pearl mussel survival are levels of silt, suspended solids, calcium and chemical compounds / minerals generally associated with enrichment (eutrophication) (i.e., nitrate, phosphate)

Freshwater pearl mussels have a short parasitic larval phase on the gills of suitable host fish. The larvae (glochidia) of freshwater pearl mussels are host-specific and can only complete their development on Atlantic salmon or brown trout, with the preferred host being juvenile fish (fry and parr) of these species[14]. The presence of freshwater pearl mussels in any river therefore depends on salmonid host fish availability. It is usually considered necessary for migratory salmonids to be present within a catchment for freshwater pearl mussels to be present. This is typically the case, however occasionally, where historical river captures have occurred, freshwater pearl mussel populations are sometimes isolated from present day migratory salmonids (e.g., by impassable waterfalls and have survived this isolation by utilising host resident brown trout). Thus, all sites capable of containing native salmonids can potentially hold freshwater pearl mussel populations[13].

3 METHODS

3.1 Desktop Study

A detailed desktop study was undertaken to identify species present, watercourse classifications and any statutory, non-statutory or designated/classified sites, relevant to the aquatic environment, within 2km of the Site.

The following web-based sources were utilised for this:

- NatureScot website[15] – information provided covered the location of any designated sites, statutorily protected species or habitats

[11] Hastie, L.C., Boon, P.J. and Young, M.R. 2000. Physical microhabitat requirements of freshwater pearl mussels M. margaritifera (L). Hydrobiologia 429: 59-71.

[12] Cosgrove, P.J. Hastie, L.C. 2000. Conservation of threatened freshwater pearl mussel populations: river management, mussel translocation and conflict resolution.

[13] Cosgrove, P.J. Hastie, L.C. and Young, M.R. 2000. Freshwater pearl mussels in peril. British Wildlife 11: 340-347.

[14] Young, M.R. & Williams, J.C., 1984. The reproductive biology of the freshwater pearl mussel Margaritifera margaritifera (Linn.) in Scotland I. Field Studies. Archive für Hydrobiologie 99: 405-422.

[15] https://sitelink.nature.scot/home (accessed online 28/12/2023)

- Scottish Environment Protection Agency (SEPA) website[16] – information provided covered classified and designated waterbodies under the Water Framework Directive (WFD) and Freshwater Fish Directive (FFD)
- National Biodiversity Network (NBN)[17] – information provided covered localised species records, and focused on legally protected and ecologically significant species
- Scotland's Environmental Web[18] – managed by the SEPA, information provided covered environmental information and data on Scotland's environment
- Marine Scotland[19] – National Marine Plan Interactive - Obstacles to Fish Passage (SEPA WMS)
- Google Earth[20] – satellite imagery provided detailed maps used during fieldwork

3.2 Dates and Survey Conditions

Fisheries Habitat Surveys were conducted between the 24th to 26th of October 2023. Survey weather conditions consisted of moderate/high water levels and clear water clarity. Light rain / fog reduced visibility during the site visit.

3.3 Fisheries Habitat Survey Methods

A FHS was carried out by Leigh Kelly BA MRes MIFM (Member of the Institute of Fisheries Management) of Mhor Environmental Ltd (Scottish Fisheries Co-Ordination Centre (SFCC) Qualified Electrofishing Team Lead and Salmonid Habitat Surveyor). Monitoring information collected following field surveys was used to undertake a detailed assessment of fish habitat quality and utilisation potential, for each survey location (Table 2).

A combination of methods developed by Hendry and Cragg-Hine[21] and those developed for the river/fisheries habitat surveying[22],[23] were adopted. During the field survey each watercourse and surrounding habitats were characterised and assessed according to the following criteria:

- Predominant channel substrate and flow-types
- Habitat features
- Modifications to the channel and banks
- Channel vegetation types
- Vegetation structure of the banks and banktop
- Land-use.

The habitat was then defined as described in Table 1 below.

[16] www.sepa.org.uk (accessed online 20/12/2023)

[17] www.searchnbn.net (accessed online 20/12/2023)

[18] https://map.environment.gov.scot/sewebmap/ (accessed online 20/12/2023)

[19] https://marinescotland.atkinsgeospatial.com/nmpi/ (accessed online 20/12/2023)

[20] http://earth.google.co.uk (accessed online 20/12/2023)

[21] Hendry K, Cragg-Hine D (1997) - A Guidance Manual. APEM Ltd, Fisheries Technical Manual 4, R & D Technical Report W44, Version 1.0/07-97. R & D Project 603.

[22] Environment Agency (2003) - River Habitat Survey in Britain and Ireland. Field Survey Guidance Manual: Environment Agency, Bristol.

[23] SFCC (2007) - Fisheries Management SVQ – Habitat Surveys Training Course Manual.

Table 1: Fisheries Habitat Classification

Habitat Type*	Classification
Spawning habitat	Stable gravel approx. 20 cm deep (up to 90 cm deep[7]) that is not compacted or contains excessive silt. Substrate size with a diameter of 1.3 to 10.2 cm.
Salmon fry (0+) habitat	Shallow (<20 cm) and fast flowing water indicative of riffles and runs with a substrate dominated by gravel and cobbles.
Salmon parr (1+) habitat	Riffle-run habitat that is generally faster and deeper than fry habitat (15-40 cm). Substrate consists of boulder, cobbles and gravels.
Trout fry (0+) habitat	Slow to medium flowing shallow water with a substrate dominated by pebbles and smaller cobbles, often concentrated at stream margins.
Trout parr (1+) habitat	Variety of substrate sizes; undercut banks, tree roots, big rocks; deeper, slower water.
Lamprey spawning habitat	Stable gravel up to 30 cm deep that is not compacted or contains excessive silt (but may contain some sand). Substrate size varies from gravels to pebbles.
Juvenile lamprey habitat	Optimal: Stable fine sediment or sand ≥15 cm deep with low water velocity and the presence of organic detritus/plant material. Sub-optimal: Shallow sediment (<15 cm deep), often patchy and interspersed among coarser substrate.
Eel habitat	Variety of habitats including streams, rivers, and muddy or silt-bottomed lakes during their freshwater stage.
Freshwater pearl mussel	Small sand patches stabilised amongst large stones or boulders in fast-flowing streams and rivers.
Riffle	Fast flow with significant turbulence and generally less than 10 cm deep, broken standing waves at surface and audible.
Run	Fast flow with limited turbulence and generally less than 30 cm deep, unbroken standing waves at surface and silent.
Glides	Smooth laminar flow with little surface turbulence and generally greater than 30 cm deep.
Pool	No perceptible flow. Shallow pool ≤0.3 m – Deep pool >0.3 m
Flow constrictions	Physical features providing a narrowing of the channel resulting in increased velocity and depth.
Obstructions to migration	Impassable falls, weirs, bridge sills etc. shallow braided river sections preventing upstream migration during low flows.

** If significant amounts of different habitat types were found to co-exist in the same section, these habitat classifications were adequately described. For example, in the case of salmonids, fry and parr habitat is classified as juvenile habitat. Where parr habitat is mentioned this refers to habitat that has principally been identified as habitat more suited to parr than fry, however habitually contains a lower quantity of fry habitat and habitat which is suited to both fry and parr. Habitat characteristics for Lamprey adopted Maitland (2003)[24]. Habitat characteristics for freshwater pearl mussel were also recorded adopting methods by Hastie (2003)[25].*

3.4 Survey Locations

A total of fourteen locations were assessed for fisheries habitat potential based on professional judgment and potential impact zones within the catchment. A control site (Millstone burn) was included in the survey locations. Survey locations were selected using

[24] Maitland, PS (2003). Ecology of the River, Brook and Sea Lamprey. Conserving

[25] Skinner, A, Young M & Hastie L (2003). Ecology of the Freshwater Pearl Mussel. Conserving Natura 2000 Rivers Ecology Series No. 2 English Nature, Peterborough.

a combination of desktop study and onsite observations. A walkover survey was carried out from downstream to upstream direction, on all survey locations, to assess for accessibility for fish migration. During the walkover, habitats were characterised and split into sections detailing specific fish habitat suitability and fish utilisation potential.

Survey locations are presented in Table 2 (below).

Table 2: Fisheries Habitat Survey Locations

Watercourse	Survey Location ID	Downstream Limit	Upstream Limit	Tributary / Confluence
Millstone burn (Control)	WB01	NN 84321 04524	NN 84324 04492	Flows into Allan Water Allan Water Catchment
Buttergask Burn	WB02	NN 87719 08520	NN 87712 08507	Flows into Allan Water Allan Water Catchment
Carim Burn	WB03	NN 85575 05243	NN 85520 05121	Flows into Buttergask Burn Allan Water Catchment
Unnamed tributary Burn of Ogilvie	WB04	NN 85884 05069	NN 85901 05004	Flows into Burn of Ogilvie Allan Water Catchment
Unnamed tributary Burn of Ogilvie	WB05	NN 87035 06225	NN 87034 06153	Flows into Burn of Ogilvie Allan Water Catchment
Burn of Ogilvie	WB06	NN 87140 06332	NN 87127 06323	Flows into Allan Water Allan Water Catchment
Burn of Ogilvie	WB07	NN 89022 08429	NN 88998 08389	Flows into Allan Water Allan Water Catchment
Danny Burn (upper)	WB08	NN 88532 06450	NN 88525 06431	Flows into Allan Water Allan Water Catchment
Danny Burn (mid)	WB09	NN 88702 06788	NN 88695 06775	Flows into Allan Water Allan Water Catchment
Danny Burn (lower)	WB10	NN 89068 07957	NN 89054 07924	Flows into Allan Water Allan Water Catchment
Glen Burn	WB11	NN 88712 06783	NN 88714 06756	Flows into Danny Burn Allan Water Catchment
River Devon	WB12	NN 89817 04430	NN 89784 04391	Flows into Upper Glendevon Reservoir (Dam) River Devon Catchment
Medaff Burn	WB13	NN 88952 03193	NN 88919 03048	Flows into River Devon River Devon Catchment
Alva Burn	WB14	NS 88356 96288	NS 88400 96342	Flows into River Devon River Devon Catchment

See Appendix A for photographs.

4 RESULTS

4.1 Desktop Study

4.1.1 *Designated Sites*

From NatureScot Sitelink and Scotland's environmental web, no designation or non-designated sites associated to the aquatic environment were recorded within 2km of the Development.

4.1.2 *Water body Classification*

Two watercourses (River Devon and Allan Water) within or close to the Site are classified and designated under the Water Framework.

The latest available information is detailed below and presented in Table 3:

- **River Devon** is a river (ID: 4501), in the River Devon catchment of the Scotland river basin district. The main stem is approximately 26.0 kilometres in length. The water body has been designated as a heavily modified water body on account of physical alterations that cannot be addressed without a significant impact on water storage for public drinking water.
- **Allan Water** is a river (ID: 6833), in the Allan Water catchment of the Scotland river basin district. The main stem is approximately 11.7 kilometres in length. The water body has been designated as a heavily modified water body on account of physical alterations that cannot be addressed without a significant impact on the drainage of agricultural land.

Table 3: Water Classification Data (2021 data) [26]

2021 Parameters	River Devon (ID: 4501)	Allan Water (ID: 6833)
Overall status	Moderate	Moderate
Fish	Moderate	Moderate
Fish Barrier	High	Moderate
Physical condition	Good	Good
Overall Hydrology	Moderate	Moderate
Water quality	Good	Good

4.1.3 *Species Records*

No fish species records from NBN Gateway are available in any of the watercourses within the Site. However, various records of Atlantic salmon, brown/sea trout, lamprey sp., and European eel are available within 2km of the Site.

No records for freshwater pearl mussel were identified within 2km of the Site although further information is confidential and was not available. Therefore, it cannot be confirmed if the records are associated to the watercourses surveyed.

Marine Scotland's National Marine Plan Interactive tool verified that Atlantic salmon were present downstream of Cauldron Linn falls on the river Devon, at least 200m upstream of the A9 culverts on the Burn of Ogilvie and Danny burn and likely present above the A9 culvert on the Buttergask burn. These records contradict 'Obstacles to Fish Passage' data available on the same website.

[26] https://www.sepa.org.uk/data-visualisation/water-environment-hub (Accessed online – 20/12/2023)

Atlantic salmon were also present downstream of the Alva falls.

4.1.4 *Marine Scotland – Obstacles to Fish Passage*

Various waterfalls / barriers to fish migration were identified during the desktop study and field survey.

The latest available information is detailed below and presented in Table 4:

Table 4: Obstacles to Fish Passage [27]

Watercourse	Associated Survey Location ID	Impassable Barrier	Barrier details / location
Millstone Burn (Control)	WB01	Yes	3 impassable barriers including a long culvert under the A9. All barriers are downstream of the survey location.
Buttergask	WB02, WB03	Yes	2 impassable barriers including a long culvert under the A9. One barrier is downstream of the Site and survey location.
Burn of Ogilvie	WB04, WB05, WB06, WB07	No	The culvert under the A9 is classified as passable - situation has been improved by having a permanent height of water flow through culvert. Fish spawning above it in 2007. Natural limit to migration recorded downstream of Site.
Danny Burn	WB08, WB09, WB10, WB11	Yes	2 impassable barriers (1 reclassified to passable) 1. Road culvert, very long. Fish data suggests >80% decrease in salmon densities upstream of culvert. Lack of resting places, inadequate water depth and high flow rate considered main issues, changed to impassable 29/9/16. Originally classified as impassable by Forth rivers trust, reclassified as passable by SEPA fish ecologists following site visit January 2022. 2. 1.5m high two step weir with no fish pass. The first barrier is downstream of the Site and survey location.
River Devon	WB12, WB13	Yes	Various barriers throughout the upper reaches including the 13m waterfall at Cauldon Linn and 3 dams. All barriers were downstream of the Site and survey location.
Alva Burn	WB14	Yes	Various falls ranging from 4m to 23m in height. All barriers are downstream of Site. All barriers were upstream of the survey location.

[27] https://marinescotland.atkinsgeospatial.com/nmpi (Accessed online – 28/12/2023)

4.1.5 *Aerial Photography/Habitats*

The analysed aerial photography displayed a range of habitat types are adjacent to the Site. These range from extensive area of peatland, farmland, lochs, waterfalls, steep-sided hills, road, and bridges.

4.2 Fisheries Habitat Survey Results

A summary of the prominent habitat characteristics recorded during the FHS (October 2023) are presented in Table 5.

Table 5: Fisheries Habitat Survey Results

Survey Location ID	Fish Utilisation Potential	Fish Habitat Quality	Plate No.	Characteristics
WB01 (Control) Millstone burn	High	Moderate / Good	**1-2**	**Juvenile trout habitat**. **No access for migratory fish.** Impassable barrier downstream of site. Flow type predominantly glide/run sequences with small step pool at top of section. Average wet width ranging between 3-4.8m. Depth ranging from <10-60cm. Cobble substrate with gravel/silt in margins. Bedrock in places. Moderate instream fish cover. Bridge upstream of survey section. Land use is grazing and scrub adjacent to watercourse. Suitable lamprey and eel habitat present. Freshwater pearl mussel habitat not recorded.
WB02 Buttergask burn	Moderate/High	Moderate	**3-4**	**Juvenile salmonid habitat**. Upstream of A9 culvert. Brown trout observed below bridge. Flow type predominantly run with sections of glide and pool. Deep pools were recorded upstream. Average wet width ~2.5m. Depth ranging from 20-80cm. Cobble/boulder substrate with areas of pebble/gravel. Bedrock recorded upstream. Good instream cover. Land use is scrub and rock/scree. Limited eel habitat present. Freshwater pearl mussel or lamprey habitat not recorded.
WB03 Carim burn	Low/moderate	Poor/moderate	**5-6**	**Salmonid parr habitat (if present)**. **No access for migratory fish.** Flow type changes to fast flowing in this section - predominantly run. Wet width ~0.75m. Depth ranging from 20-50cm. Cobble substrate throughout with accumulation of pebble/gravel. Poor instream cover. Land use is moorland. Blocked culvert downstream. Freshwater pearl mussel or lamprey habitat not recorded. Impassable barrier recorded downstream of survey location.
WB04 Tributary	Low	Poor	**7**	**Not considered suitable for migratory fish.** Flow type predominantly cascade. Wet width approx. <0.5 m. Approximate depth = 10cm. Predominately bedrock substrate. Poor instream cover. Very steep channel. Considered above natural limit for fish migration.

Survey Location ID	Fish Utilisation Potential	Fish Habitat Quality	Plate No.	Characteristics
WB05 Tributary	N/A	N/A	**8**	**Unable to survey due to steep bank – health and safety risk.** Considered above natural limit for fish migration.
WB06 Burn of Ogilvie (upper)	High	Good	**9-10**	**Juvenile salmonid habitat**. 2.8km upstream of A9 culvert. Flow type predominantly run with sections of glide. Average wet width ~3.2m. Depth ranging from <10-50cm. Cobble/boulder substrate with areas of pebble/gravel. Bedrock recorded instream. Good instream cover. Land use is moorland and scrub. Limited eel habitat present. Freshwater pearl mussel or lamprey habitat not recorded.
WB07 Burn of Ogilvie (lower)	High	Good	**11-12**	**Salmonid adult and parr habitat**. Directly upstream of A9 culvert. Flow type riffle, run, glide sequences. Wet width ranging from 3.8 – 4.3 m. Depth ranging from <10-30cm. Predominantly cobble substrate with boulder and gravel/pebble in places. Good instream cover. Land use is grazing. Limited eel and lamprey habitat present. Freshwater pearl mussel not recorded. Three-pipe culvert downstream is potentially impassable in low flow. Gabion basket on left bank.
WB08 Danny burn (upper)	High	Good	**13-16**	**Juvenile salmonid habitat.** Upper reaches of Danny burn. Flow type predominantly run with small cascade. Average wet width ~4.2m. Depth ranging from 10-60cm. Predominantly cobble substrate with pebble/gravel and limited boulder. Good instream cover. Land use is moorland. Potential spawning habitat recorded within survey section. Limited eel habitat present. Freshwater pearl mussel and lamprey habitat not recorded. Culvert at A9 reclassified - passable to migratory fish. Waterfall downstream – considered passable. Forestry log bridge downstream – potentially impassable.
WB09 Danny burn (mid)	High	Good	**17-18**	**Juvenile salmonid habitat.** 10m upstream from confluence. Flow type predominantly run with glide and step pool. Wet width ranging from 2.9-3.4 m. Depth ranging from 30-60cm. Cobble substrate with boulder and gravel/pebble in places. Good instream cover. moorland and grazing. Limited eel habitat present. Freshwater pearl mussel and lamprey habitat not recorded. Culvert at A9 reclassified - passable to migratory fish.
WB10 Danny burn (lower)	High	Good	**19-20**	**Salmonid adult and juvenile habitat.** 500m upstream of A9 culvert. Flow type run/riffle/glide sequences. Average wet width ~4.2m. Depth ranging from <10-50cm. Predominantly cobble substrate with pebble/gravel and boulder. Good instream cover. Land use is moorland with native

Survey Location ID	Fish Utilisation Potential	Fish Habitat Quality	Plate No.	Characteristics
				woodland planted. Limited eel and lamprey habitat present. Freshwater pearl mussel not recorded. Culvert at A9 reclassified - passable to migratory fish.
WB11 Glen burn	Moderate	Good	**21-23**	**Juvenile salmonid habitat.** Confluence with WB09. Flow type predominantly run/riffle sequences with small step pools. Average wet width ~2.1m. Depth ranging from 10-40cm. Good mixture of cobble/boulder substrate with areas of pebble/gravel. Good instream cover. Land use is bracken, moorland, and felled forestry. Limited eel habitat present. Freshwater pearl mussel or lamprey habitat not recorded. Culvert at A9 impassable to migratory fish. Large falls recorded upstream – considered impassable (plate 23).
WB12 River Devon	High	Good	**24-26**	**Adult and juvenile salmonid habitat.** **No access for migratory fish.** Upstream of the cauldron falls and 3 impassable dammed reservoirs. Flow type predominantly glide. Wet width ~6.2m. Depth approx. <20-50cm. Predominately boulder/cobble with bedrock substrate. Accumulation of pebble/gravel in places. Good instream cover. Considered likely to support populations of brown trout.
WB13 Glen burn	Low	Poor	**27-28**	**Not considered suitable for migratory fish.** Flow type predominantly run and cascade. Wet width approx. 0.75 m. Approximate depth 10cm. Predominately bedrock substrate. Poor instream cover. Very steep channel. Considered above natural limit for fish migration.
WB14 Alva burn	High	Good	**29-31**	**Salmonid adult and juvenile habitat.** 50m upstream of the confluence with the river Devon. Flow type run/riffle/glide sequences. Average wet width ~4.2m. Depth ranging from <10-50cm. Predominantly cobble substrate with pebble/gravel and boulder. Good instream cover. Land use is moorland with native woodland planted. Potential spawning habitat recorded within survey section. Limited eel and lamprey habitat present. Freshwater pearl mussel not recorded. The survey location is downstream of the various impassable barriers recorded on this watercourse.

5 EVALUATION OF RESULTS

5.1 Fisheries Habitat Survey (Salmonid Fish)

The FHQ and FUP of the sampling locations ranged between poor and good and low to high, respectively. However, the connectivity between the watercourses throughout the catchment is significantly affected by barriers to fish migration. The barriers throughout the river Devon located downstream of the Site, are considered impassable. Therefore, it

is considered highly unlikely migratory fish species will be present within the upper reaches of this watercourse. The long box culverts under the A9 are classed as impassable on the Buttergask burn (WB02) and Danny burn (WB10) however, it is considered possible that salmon could ascend these barriers during optimal flow conditions.

Habitat connectivity is integral to survival of migratory salmonids; successful migration upstream and downstream is required to support populations of migratory fish species[28] [29]. Therefore, it is considered that at sampling locations upstream of the barriers, where suitable habitat was recorded (WB01, WB03, WB08, WB09, WB11, WB12 and WB13), only resident brown trout are likely to be present. An electric fishing survey would be required to determine the presence/absence of fish at these locations.

Survey locations WB02 and WB10 are both directly upstream of the A9 culverts and based on the conflicting data presented by Marine Scotland and the potential that salmon could ascend the culverts, it is recommended that an electric fishing survey is undertaken prior to construction to determine the presence/absence of migratory fish at these locations.

The survey location downstream of the barriers on the Alva burn (WB14) was classified as good and is considered likely to support populations of Atlantic salmon and brown/sea trout.

Potential spawning habitat was recorded within WB08 and WB14.

Survey location WB04 was classified as poor and therefore not suitable for fish. WB05 was not surveyed due to health and safety risk, however survey locations WB06 and WB07 will provide enough data to assess population density and any significant impact from the Development.

5.2 Lamprey Suitability

Within the selected sampling locations, there were few areas of suitable habitat for juvenile lamprey (i.e., fine, soft substrate in well oxygenated, slow flowing water). Although not optimal, the watercourses downstream of the barriers represent an important part of their respective catchment areas. Therefore, should the Development progress, due care should be taken to ensure no damage is done to fish populations or to fish habitat (including water quality).

5.3 Freshwater Pearl Mussel Suitability

Limited suitable habitat for freshwater pearl mussel was identified during the habitat survey of sampled watercourses. It is considered unlikely that freshwater pearl mussel are present.

5.4 Potential for Impact to Fish Populations

The potential for fish species and their habitats to be affected by the Development mainly occurs during the construction and decommissioning phases. During the construction phase potential impacts may include siltation from ground disturbance, accelerated or exacerbated erosion, hydrological changes, accidental pollution and the inadvertent obstruction or hindering of the upstream/downstream passage of migratory fish.

During the operational phase, concerns for the aquatic environment may include the effects of poor road drainage, accelerated levels of erosion, fish access and the maintenance of silt traps and road crossings. Potential risks during the decommissioning phase are considered as likely to be broadly similar to those in the construction phase.

[28] Hendry K & Cragg-Hine D (2003). Ecology of the Atlantic Salmon. Conserving Natura 2000 Rivers Ecology Series No.7.English Nature, Peterborough.

[29] Willem B. Buddendorf, et al (2019). Integration of juvenile habitat quality and river connectivity models to understand and prioritise the management of barriers for Atlantic salmon populations across spatial scales. STOTEN 655, 557-566.

The potential effects from the Development may potentially impact on the surrounding fish populations by inadvertently causing direct mortality of juveniles and adults, changes in food availability, avoidance behaviour resulting in unused habitat, blocking of migration routes to spawning beds, or the accidental damage of instream and riparian habitats.

The associated construction activities with building a wind farm, such as ground disturbance, deforestation and flocculant use could reduce water quality further. Various pollution prevention measures would be required to minimise the potential for impact on the water environment.

6 RECOMMENDATIONS

The watercourses surveyed form part of the Forth catchment RBMP site which is classified as having good to moderate ecological status and is protected through local planning policy and in part national law. The catchment offers areas of suitable habitat for a number of protected fish species (Atlantic salmon and brown/sea trout).

To ensure compliance with relevant environmental legislation and implementation of good working practices, the following recommendations are provided.

6.1 Avoidance

Avoidance measures should include (all sites):

- Fish rescue – removal of fish from the temporarily isolated and dewatered working areas (i.e., those required for culvert installation); and
- In-channel work must not be carried out when fish are likely to be spawning in the affected surface water, or in the period between spawning and the subsequent emergence of juvenile fish (October to June). Liaise with the Forth District Salmon Fishery Board prior to works.

6.2 Pollution Prevention and Culvert installation

It is recommended that a pollution prevention plan is provided and that Guidance for Pollution Prevention (GPPs)[30] are adhered to during works. Particular attention should be paid to "GPP 5: Works and maintenance in or near water" and "GPP 21: Pollution incident response planning and GPP 22: Dealing with spills".

Watercourse crossing should be kept to a minimum and culvert design should be in-line with best practice and authorised under The Water Environment (Controlled Activities) (Scotland) Regulations 2011 (as amended)[31].

6.3 Monitoring of Aquatic Ecology

To provide baseline data for future monitoring, it is recommended that fully-quantitative electrofishing surveys are completed, pre-construction, at various survey locations (including but not limited to – WB01, WB02, WB03, WB06, WB07, WB08, WB09, WB10, WB11, WB12, WB13 and WB14). An additional control site should be added if fish densities are low at WB01.

Change in fish numbers alone may not provide compelling evidence of Development impacts without corroborating evidence from control sites, monitoring of freshwater invertebrates or hydrochemistry, and/or direct observations of pollution incidents. Nevertheless, the inclusion of fish as part of a spatially harmonised aquatic monitoring

[30] Guidance for Pollution Prevention (GPPs) - Full list | NetRegs | Environmental guidance for your business in Northern Ireland & Scotland

[31] https://www.sepa.org.uk/media/34761/car_a_practical_guide.pdf (accessed online 28/11/2021)

programme remains worthwhile as salmonid species sensitive to water quality changes and are present in most streams within the Site.

6.3.1 *Recommended Surveys*

As part of an ongoing monitoring assessment of potential impacts which may occur as a result of the Development, it is recommended that pre-construction (baseline) fish fauna surveys are undertaken. Should results of the baseline surveys indicate salmonid populations, it is recommended that a construction and post-construction fish fauna monitoring plan is produced (utilising suitable survey sites plus a minimum of one control site).

The suggested monitoring schedule would include the following:

- Fish fauna – annually during construction (summer) and post-construction Year 1 (summer) and Year 2 (summer); and

It is also recommended that the Environmental Clerk of Works with knowledge of the water environment is appointed during major works. The Environmental Clerk of Works should undertake water quality monitoring as part of their role.

APPENDIX A: PHOTOGRAPHS

	
Plate 1 – WB01 (downstream)	***Plate 2 – WB01 (upstream)***
	
Plate 3 – WB02 (downstream)	**Plate 4 – WB02 (upstream)**
	
Plate 5 – WB03 (downstream)	**Plate 6 – WB03 (upstream)**

	
Plate 7 – WB04 (above natural limit for fish migration)	**Plate 8 – Example: Burn of Ogilvie Tributary (steep bank)**
	
Plate 9 – WB06 (small island downstream)	**Plate 10 – WB06 (upstream – adjacent to tributary)**
	
Plate 11 – WB07 (downstream)	**Plate 12 – WB07 (upstream)**

	
Plate 13 – WB08 (facing upstream)	**Plate 14 – WB08 (potential spawning habitat)**
	
Plate 15 – WB08 (step falls downstream)	**Plate 16 – WB08 (log bridge downstream)**
	
Plate 17 – WB09 (downstream)	**Plate 18 – WB09 (facing upstream)**

Plate 19 – WB10 (downstream)

Plate 20 – WB10 (upstream)

Plate 21 – WB11 (downstream)

Plate 22 – WB11 (upstream)

Plate 23 – WB11 (impassable barrier)

Plate 24 – WB12 (downstream)

	
Plate 25 – WB12 (upstream)	**Plate 26 – WB12 (dam – impassable barrier)**
	
Plate 27 – WB13 (downstream)	**Plate 28 – WB13 (upstream)**
	
Plate 29 – WB14 (downstream)	**Plate 30 – WB14 (upstream)**

	
Plate 31 – WB14 (potential spawning habitat)	**Plate 32 – WB14 (Alva falls)**