Glen Earrach

Covering Note - Response to NatureScot Points (a) and (b) – River Moriston SAC

1. Purpose and Scope

1.1 On 19 January 2026, NatureScot submitted a further updated consultation response in respect of the application for section 36 consent and deemed planning permission for the Glen Earrach Pumped Storage Hydro Scheme (the 'Application'). The NatureScot response related specifically to impacts on the River Moriston Special Area of Conservation ('SAC'). It identified five areas on which NatureScot wished to receive further information listed as items (a) to (e) relating to the SAC.

The Applicant has been engaging with NatureScot on these matters, and in February 2026 it submitted draft additional information to NatureScot in response to NatureScot's response of 19 January 2026.

NatureScot's subsequent response (received on 25 February 2026) to the Applicant's February 2026 submission confirmed that point (c) hydropeaking effects on the River Ness flow regime and point (e) spawning habitat in the lower River Moriston have been satisfactorily addressed. In respect of point (d), NatureScot agreed that details of any non-physical deterrents can be finalised later in consultation with them, provided the downstream fish passage arrangements are designed to maintain or improve downstream passage independently of such measures.

1.2 Certain aspects of the information requested by NatureScot requires some further clarification or information beyond that provided in the draft additional information, which this response seeks to address. These aspects are reproduced below.

1.3 Point (a) — Construction phase:

"how access to the fish pass, smolt chute and sluice, or temporary alternative structures, will be maintained during construction of the variable weir and how disturbance will be managed to ensure upstream and downstream salmon passage at the weir is unimpeded. This should demonstrate that there will be appropriate attractant flows, that water depths and velocities will be passable by salmon at all appropriate life cycle stages, and that disturbance will not result in salmon avoiding the area."

1.4 Point (b)(i) — Operational phase passability:

"the design of the new weir and fish pass(es) will allow appropriate attractant flows, water depths and velocities to be passable by salmon at all the relevant life cycle stages and times of year for each structure based on known attractant flows, swimming capabilities etc."

1.5 Point (b)(ii) — Smolt routing:

"the changes in water levels and flows will not increase the number of smolts exiting Loch Ness via the Caledonian Canal (in which they are likely to perish), rather than the River Ness."

"Evidence should be based on transparent and justified realistic worse case scenarios for water levels and flows at, around and over/through the weir and lock gates, considering the cumulative effects of all Loch Ness water users and the effects of climate change."

1.6 This covering note and the enclosed accompanying documentation provide the Applicant's response to these outstanding matters. A detailed response to each specific matter raised in NatureScot's response of 25 February 2026 is provided in Appendix 1 to this covering note. The sections below provide a summary of how each principal point has been addressed.

1.7 This note is a covering note. The technical design information is set out in the accompanying supporting documents. This note explains how those documents provide the information requested by NatureScot.

1.8 NatureScot's response of 19 January 2026 letter also identified additional mitigation and modification points relating to the main Pumped Storage Hydro (PSH) scheme, including Construction Environmental Management Plans (CEMPs) for the lower control works and variable weir construction, operational curtailment during the smolt migration period, and intake screen mesh size. Those matters are noted and are accepted by the Applicant. These matters are therefore not within the scope of this note.

1.9 The relevant documents accompanying this note are listed in Section 7.

2. Point (a) — Construction Phase

Temporary upstream passage

2.1 NatureScot's response of 25 February 2026 assessment requested hydraulic evidence demonstrating that the temporary upstream fish pass will be passable by Atlantic salmon throughout the construction period. In response, the earlier February 2026 proposed Alaskan Denil arrangement has been replaced with two co-located Chevron side baffle fish passes, providing substantially greater attraction flow. The hydraulic design basis, including parameter-by-parameter comparison with published guidance, is set out in *Temporary Fish Passage Technical Note V*1.3

Passage continuity during construction

2.2 A detailed construction sequence is set out in the appended *Construction Disturbance and Fish Passage Continuity at Dochfour Weir* document and drawing *0103-3540681-P03 - Construction Sequencing*. This six-phase construction sequence maintains continuous upstream and downstream passage throughout, with sequential handover between existing, temporary and permanent arrangements.

Construction disturbance

2.3 NatureScot's 25 February 2026 response noted that the previous February 2026 submission did not provide evidence to demonstrate that construction disturbance can and will be kept below levels that would result in salmon avoiding the area. A standalone technical note *Construction Disturbance and Fish Passage Continuity at Dochfour Weir* has been prepared to address this specific topic. The note demonstrates that the works can be constructed without adverse effect on migrating Atlantic salmon of the River Moriston SAC, drawing on seasonal programming of activities that may cause disturbance, passage continuity, quantitative noise evidence and site-specific precedent. All commitments as noted in Section 5 of *Construction Disturbance and Fish Passage Continuity at Dochfour Weir* are stated as firm commitments which are proposed to be secured through the CEMP, method statements and planning conditions.

3. Point (b)(i) — Upstream Passability

Design parameters and published guidance

3.1 NatureScot's 25 February 2026 response requested explicit evidence linking fish pass design parameters to published guidance. Appendix 1 of the *Optioneering Summary* includes a summary table demonstrating how each key hydraulic parameter meets or exceeds the best practice requirements set out in the Environment Agency Fish Pass Manual (as referenced in Appendix 1 of the *Optioneering Summary*).

Loch levels and design range

3.2 NatureScot noted discrepancies between loch levels presented in the initial February 2026 submission and those in the AECOM September 2025 *2b. Addendum (Ness Woods SAC and Urquhart Bay Wood SAC) Water Levels* addendum. The design levels have been corrected and aligned with the long-term Q95 and Q10 levels derived by AECOM, giving an operating range of 15.40–16.50 mAOD. The correction and rationale are set out in the *Optioneering Summary*.

Climate change resilience

3.3 NatureScot advised that the fish pass design should account for projected future flows. Section 7 of the *Optioneering Summary* has been expanded to demonstrate that the vertical slot fish pass remains functional at the extremes of the climate change envelope, from the AECOM climate-adjusted drought scenario (median loch level 15.11 mAOD) through to the point at which rising tailwater levels progressively drown out the weir and the structure ceases to act as a barrier (and therefore including for the upper extreme the climate change envelope). There is no identified intermediate condition in which the fish pass would cease to function. The supporting AECOM climate change technical note is re-included.

4. Point (b)(ii) — Downstream Smolt Routing

Smolt pass hydraulic design

4.1 NatureScot's response of 25 February 2026 noted that no design dimensions had been provided for the downstream passage routes. The *Optioneering Summary* (Section 6.4) provides the hydraulic design basis for the three proposed smolt passes.

Attraction velocities and CFD modelling

4.2 NatureScot requested demonstration that the downstream passage routes would provide adequate attraction currents, citing Kundegorski et al. (2025). Adopting a precautionary approach, computational fluid dynamics (CFD) modelling of the most downstream smolt pass (adjacent to Dochgarroch Lock) has been undertaken by 4c Engineering and is provided as Appendix 2 to the *Optioneering Summary* (precautionary since this smolt pass represents the last opportunity to attract smolts prior to being affected by the Caledonian Canal). The modelling results are then interpreted in Section 6.4 of the *Optioneering Summary*, including an explanation of why the Kundegorski et al. threshold represents a conservative benchmark in this context.

Low-flow scenario correction

4.3 NatureScot noted that the low-flow value used in the February 2026 submission did not match the AECOM climate change technical note which was also provided as part of the February submission. This has been corrected and is addressed in the *Optioneering Summary* (Section 7.2.2).

Behavioural screening

4.4 NatureScot advised that non-physical deterrents cannot be relied upon in the absence of adequate attraction current, and that details can be finalised later provided the passage arrangements function independently of such measures. The Applicant agrees. The smolt passes are designed to function on the basis of appropriate inflow volumes and controlled acceleration. Behavioural measures are proposed solely as supplementary measures.

5. Applicant Confirmations

The following confirmations are provided by the Applicant to address specific elements raised by NatureScot that are not explicitly set out in the technical documents listed in Section 7, and to provide clarification in support of those documents.

Life stages and species

5.1 NatureScot has requested that passability for salmon at all relevant life cycle stages is demonstrated. The upstream fish pass has been designed for passage of grilse and multi-sea-winter adults, which are the life stages for which upstream passage at Dochfour Weir is required. Downstream passage provision addresses salmon and sea trout smolts, salmon and sea trout kelts, silver eel, and lamprey transformers. Where performance is life-stage dependent, the documents in Section 7 identify the relevant life stage rather than relying on generic terms.

5.2 The vertical slot fish pass has been designed to provide multi-species passage, including for lamprey and European eel, in addition to migratory salmonids. This goes beyond NatureScot's focus on Atlantic salmon of the River Moriston SAC.

Year-round operability

5.3 NatureScot has requested that it is demonstrated that the fish pass will be passable at all relevant times of year. The upstream fish pass is designed to operate across the Q95–Q10 flow range, which encompasses the vast majority of flows during the upstream migration period (January through August, with a low-activity period from September onwards) and aligns with recommended operational windows outlined in the Environment Agency Fish Pass Manual. The *Optioneering Summary* (Section 7) demonstrates that the pass remains functional beyond this operating window under both climate-adjusted drought and flood scenarios. The downstream smolt passes are designed to operate year-round to provide passage for non-salmonid species and life stages that migrate outside the primary smolt window, with the ability to manage flow allocation between upstream and downstream facilities seasonally via penstock-controlled auxiliary channels on the upstream fish pass and adjustable weir crests on each smolt pass.

Realistic worst-case scenario basis

5.4 NatureScot has requested evidence based on transparent and justified realistic worst-case scenarios for water levels and flows. The worst-case framing adopted for this submission is as follows:

- Low-flow / drought: the median minimum flow from AECOM's climate-adjusted drought analysis, based on the lowest flow recorded at Ness-side gauge over its 52-year record with climate change reduction factors applied. This gives a loch level of 15.11 mAOD, approximately 300 mm below the Q95 design level.
- High-flow / flood: the *AECOM 1-in-200 year event with climate change allowance* note, under which the weir and fish pass are fully submerged and the structure ceases to act as a barrier.
- The design operating range of 15.40–16.50 mAOD (Q95–Q10) is based on long-term modelled levels derived by AECOM under the proposed development scenario, in combination with Loch na Cathrach and Loch Kemp, together with the baseline which includes Foyers PSH.

Cumulative effects of Loch Ness water users

5.5 NatureScot requests that the cumulative effects of all Loch Ness water users are considered. The loch levels used as design parameters for the fish pass and smolt passes are derived from AECOM's hydrological modelling from Chapter 11 of the EIAR, along with associated appendices. This incorporates the cumulative effect of the proposed development operating in combination with proposed PSH schemes (Loch na Cathrach and Loch Kemp), existing Loch Ness water users, including SSE Foyers. The worst-case scenario framing described above is therefore inherently cumulative.

5.6 Lock gate operations at Dochgarroch are not a material driver of loch-wide water level variation compared to PSH operation. They can, however, create localised short-duration attraction flows in the immediate vicinity of the lock gates. The downstream smolt routing strategy addresses this by positioning Smolt Pass 1 upstream of the lock gates within the canal approach channel, so that the dominant flow cue intercepts downstream-migrating smolts and draws them towards the passage route before they reach the area influenced by lock operations. The objective is to minimise the number of smolts occupying the area immediately adjacent to the lock gates at any given time, thereby reducing the risk of entrainment during gate operations. In practice, this risk is further reduced by two factors: lock gate operations are of very short duration, limiting the temporal window during which any entrainment could occur; and smolt migration occurs predominantly at night, when lock operations are minimal or absent. The CFD modelling (Appendix 2 of the *Optioneering Summary*) demonstrates that under normal conditions the area immediately upstream of the lock gates is characterised by mean velocities well below any behavioural orientation threshold, with the dominant flow field directed towards the smolt pass inlet. With the correctly designed attractant flows at the smolt pass, the likelihood of smolts remaining in the gate area is materially reduced compared to the current arrangement.

Baseline improvement

5.7 It is the Applicant's view that the current passage arrangements at Dochfour Weir are sub-optimal for fish passage, as reflected by concerns identified by NatureScot and the NDSFB and in the findings of Chapter 9 of the EIA Report submitted in respect of the Application. The existing lowered crest section functions as an uncontrolled passage route without the managed hydraulics, defined slot geometry or dedicated auxiliary attraction flow of a purpose-designed fish pass. The existing smolt bywash channels are poorly designed and ineffective, and downstream-migrating smolts are at risk of delay and entrainment into the Caledonian Canal. The proposed permanent arrangements (a multi-species vertical slot fish pass with dedicated auxiliary attraction flow channels, three purpose-designed smolt passes with bellmouth inlets, and fish monitoring infrastructure) represent a significant improvement on this baseline. The NatureScot test under the information request at (b)(ii) is that the proposed arrangements will not increase smolt losses to the Caledonian Canal. The Applicant's position is that the proposed arrangements will materially reduce those losses.

6. Conclusions

6.1 This covering note, together with the accompanying documents, is provided to demonstrate that the proposed fish passage and variable weir works at Dochfour Weir can be constructed and operated without adverse effect on Atlantic salmon of the River Moriston SAC and thus without an adverse effect on the integrity of the SAC.

6.2 Indeed, it is the Applicant's view that the proposed fish passage arrangements represent a significant improvement on the current situation at Dochfour Weir, which is acknowledged by NatureScot, the NDSFB and supported by the findings of Chapter 9 of the EIA Report to be sub-optimal for salmon passage. The permanent vertical slot fish pass, dedicated smolt passes and fish monitoring facilities will address long-standing concerns about passage at this location and are expected to improve fish passage conditions at Dochfour Weir for salmon stocks in the Ness catchment.

7. Supporting Documents

The following documents are provided alongside this covering note:

- Fishtek: Fish Passage Optioneering Summary (Rev 004, March 2026)
- Fishtek: Temporary Fish Passage Technical Note (v1.3, March 2026)
- Fishtek drawings:
    - 0100-3540681-P03 – Site & Location Plan
    - 0101-3540681-P03 – Fish Pass General Arrangement
    - 0102-3540681-P03 – Fish Pass Typical Sections and Details
    - 0103-3540681-P03 – Construction Sequencing
    - 0104-3540681-P01 – Smolt Passage
    - 0105-3540681-P01 – Temporary Fish and Smolt Pass
- AECOM: 1 in 200 + Climate Change Technical Note
- Construction Disturbance and Fish Passage Continuity at Dochfour Weir (March 2026)

Responses to NatureScot's February 2026 assessment are provided as Appendix A to this covering note.

Appendix A – Responses to Points Raised by NatureScot in its Response of 25 February 2026

This appendix provides a point-by-point response to each matter raised in NatureScot's 25 Feb 2026 response to draft additional information submitted by the Applicant in February 2026, as it relates to the River Moriston SAC. NatureScot's original text and advice are reproduced in full in black. Responses, shown in blue, are provided by the Applicant, in consultation with Fishtek on technical fish passage matters, and are inserted directly beneath the relevant NatureScot text. Where a matter has been addressed through revisions to the supporting technical documents accompanying this submission (listed in Section 7 above), the response directs the reader to the relevant document.

Glen Earrach PSH: NatureScot assessment of draft additional information received February 2026

Our advice below is structured around the information packages you have supplied to address the various further information requirements we detailed in our responses of November 2025 for Urquhart Bay Woods SAC, and January 2026 for the River Moriston SAC.

1. River Moriston SAC

a. Information requirement: how **access to the fish pass, smolt chute and sluice, or temporary alternative structures, will be maintained during construction of the variable weir and how disturbance will be managed** to ensure upstream and downstream salmon passage at the weir is unimpeded. This should demonstrate that there will be appropriate attractant flows, that water depths and velocities will be passable by salmon at all appropriate life cycle stages, and that disturbance will not result in salmon avoiding the area.

Applicant response: *Temporary Fish Passage Technical Note v1.3* now includes further detail on the flow volumes and hydraulic operation of the temporary fish passage elements. The construction sequencing drawing *0103-3540681-P03* now includes clear detail how upstream and downstream passage will be maintained through the construction phase. The continuity of passage is also described in detail in the specific note *Construction Disturbance and Fish Passage Continuity at Dochfour Weir.*

NatureScot advice:
Upstream migration. **Further information is required:**

- to demonstrate that the proposed temporary Alaskan Denil pass will be passable by Atlantic salmon throughout the construction period. Evidence should explicitly draw on published guidance and research to detail each parameter (eg attractant flows, velocities, water depths) that needs to be considered in the design to ensure salmon passage; the range of values the fish pass will be designed to deliver for each parameter; and justify why these have been selected in relation to those recommended in the literature.

Reason: No hydrological or hydraulic information have been provided

Applicant response: *Temporary Fish Passage Technical Note v1.3* now includes further detail on the flow volumes and hydraulic operation of the temporary fish passage elements. The previously proposed design (Alaskan Denil type) in the February 2026 submission has been modified to provide an arrangement (twin Chevron side-baffle) which increases total attraction flow in line with best practice guidance for large rivers.

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Downstream migration. As this is proposed to rely on new permanent structures, see c below.

Construction disturbance. **Further information is required:**

- to demonstrate disturbance can and will be kept below levels that would result in salmon avoiding the area.

Reason: The draft additional information states that construction disturbance will be managed through 'proportionate controls' including some measures that will be implemented 'where practicable'. No information or evidence is provided to demonstrate that these measures can and will be deployed in a manner that ensures salmon do not avoid the area

Applicant response: please now see the appended *Construction Disturbance and Fish Passage Continuity at Dochfour Weir* document which addresses this specifically.

b. Information requirement: (i) the **design of the new weir and fish pass(es) will allow appropriate attractant flows, water depths and velocities** to be passable by salmon at all the appropriate life cycle stages and times of year for each structure based on known attractant flows, swimming capabilities etc.
(ii) **the changes in water levels and flows will not increase the number of smolts exiting Loch Ness via the Caledonian Cana**l (in which they are likely to perish), rather than the River Ness.
Evidence should be based on transparent and justified realistic worse case scenarios for water levels and flows at, around and over/through the weir and lock gates, considering the cumulative effects of all Loch Ness water users and the effects of climate change.

Applicant response: further detail has been added to the Fishtek *Optioneering Summary* demonstrating the adherence of the upstream fish pass to best practice guidance for salmon passage. Further evidence has been provided on the anticipated function of the smolt passes to demonstrate that a significant reduction in entrainment of smolts into the Caledonian Canal is anticipated. For completeness, and addressing NatureScot reference to flow 'over' the lock gates (in case this is of concern) the adjacent canal embankment crest level is approximately 18.2 m AOD. The cumulative maximum water levels modelled for Loch Ness, including all PSH operations remain well below this level. The crest level of the lock gates is higher again, meaning that the canal embankment would be overtopped before the lock gates in the extreme event of water at this level, therefore there is no plausible route to increasing flows over the lock gates.

NatureScot advice:
Upstream migration. **Further information is required**:

- to demonstrate that the proposed fish pass will be passable by Atlantic salmon at all times of the year and in projected climate scenarios. Evidence should explicitly draw on published guidance and research to detail each parameter (eg attractant flows, velocities, water depths) that needs to be considered in the design to ensure salmon passage; the range of values the fish pass will be designed to deliver for each parameter; and justify why these have been selected in relation to those recommended in the literature.

Applicant response: further information has been include in Appendix 1 of the Fishtek *Optioneering Summary* outlining how the proposed fish pass meets or exceeds best practice design guidance for salmon. Assessment of functionality under future climate scenarios has been expanded to demonstrate that the fish pass will remain operational in Chapter 7 of Fishtek *Optioneering Summary*.

- clarification or correction to account for the fact the loch levels associated with the River Ness Q95 and Q10 at the weir proposed to be used as design parameters are different to those presented in the Additional Information dated September 2025, and do not take into account the catchment area and climate change adjustments presented in AECOM's technical note. A justification of the chosen percentile from the probabilistic climate projections should be included.

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Applicant response: the correct levels have now been included in the Fishtek *Optioneering Summary*. The original stated levels were based on a single year of data, hence minor discrepancies compared to the long-term average levels.

Downstream migration. **Further information is required**:

- to demonstrate that the proposed downstream passage routes for smolts and kelts will provide attraction currents of at least 0.092m/s (the lower 95% confidence interval of the mean minimum directional water velocity required to initiate a behavioural response resulting in a direction of orientation change in wild smolts (Kundegorski et. al, 2025)).

Applicant response: additional evidence and outputs from CFD modelling (Appendix 2 of Fishtek *Optioneering Summary*) have been included to demonstrate how the final smolt pass nearest Dochgarroch Lock will function, including reference to the quoted velocity threshold. It is important to note that the results from Kundegorski et. al, 2025 are of limited relevance to this arrangement – reasons for this are now included the Fishtek *Optioneering Summary*.

- clarification or correction to account for the fact the reasonable worst case scenario low flow used in the Optioneering summary does not match the median worst case low flow scenario range presented in the AECOM climate change technical note.

Applicant response: this has now been corrected in the Fishtek *Optioneering Summary*.

In addition we advise:

- Whilst bubble screens could be useful as a non-physical method to direct smolts into the proposed chute, they cannot be relied upon to do so in the absence of adequate attraction current. This is because Leander et al. (2012), repeated in Nicula et al. (2026), has shown that bubble screens are less effective at night, whereas downstream migrating smolts migrate primarily at night in the early part of the migration season (Thorstad et al. 2012).

Applicant response: it is agreed that behavioural options could not be relied upon in isolation. However, there is a body of evidence to indicate that both bubble screens and strobe lighting can improve deflection of smolts into a bywash channel entrance. These are therefore viewed as supplementary measures intended to reduce delay. The effective functioning of the downstream passes is primarily reliant upon appropriate inflow volumes and controlled acceleration of flow, as detailed in the *Optioneering Summary*.

- the source for the statement on the need to avoid water velocities not “exceeding 1 m/s/m” at the proposed smolt chute should be provided.

Applicant response: the reference for this, and further information on the importance of acceleration, has been added to the Fishtek *Optioneering Summary*.

Reasons: See annex.

c. Information requirement: **How the predicted changes to the flow regime in the River Ness will affect migrating Atlantic salmon** at all life cycle stages, based on realistic worse case scenarios. This should include an assessment of effects known to be associated with hydropeaking, including stranding and associated mortality caused by increased predation; habitat alteration and loss caused by the repeated wetting and dewatering of the river bed; physiological stress and reduced growth through forcing fish to repeatedly move to seek shelter; and impeding migration. This assessment could usefully be based on the approach set out in Bakken et al (2023) , using selected criteria which match the River Ness most closely.

The assessment should also specify the proposed ramping rate and demonstrate how this will be managed to avoid adverse effects on migrating salmon (see Alfredsen et al 2022).

NatureScot advice: Based on the assessment submitted, **we agree that changes to the winter flow regime will not significantly impede downstream and upstream migration of salmon from the River Moriston SAC**.

We note that in the scoring matrix used, both the hydropeaking effect score and the vulnerability score are right at the upper limits of their impact categories. We are not clear exactly how the wetted area calculations were made. However, given that salmon from the River Moriston SAC will not be spawning in the River Ness, some of the factors assessed are of less relevance to this SAC hence further clarification would not alter our conclusion.

Applicant response: noted.

d. Information requirement: **the effects of the proposed acoustic barrier on salmon adults and smolts will not extend towards the weir in a manner which discourages or prevents access to the proposed new fish passes**.
   Alternatively or in addition, the applicant may wish to review in more detail based on evidence from elsewhere whether an acoustic barrier in this location is likely to be effective in delivering the intended benefits and worth including in the proposal.

Applicant response: behavioural measures (e.g. bubble screen, strobe lighting) are proposed solely as a supplementary measure to improve guidance of smolts into the entrance of the smolt pass channels. No measures are proposed which risk preventing fish from accessing the new fish passes.

NatureScot advice: **We agree that details of non-physical deterrent(s) can be finalised later in consultation with us, provided the new downstream fish passage arrangements at the weir are designed to maintain or improve downstream passage of Atlantic salmon smolts and kelts independently of the addition of any non-physical deterrents**.

Reason: we are unaware of any evidence that suggests non-physical deterrents are likely to be particularly effective for Atlantic salmon in water environments typical of Loch Ness. For example, bubble screens are of limited effectiveness in the dark (Leander et al (2021). As a consequence, whilst we agree it is worth exploring whether non-physical deterrents can improve the efficacy of measures proposed to maintain or improve downstream passage for smolts and kelts at the weir, we advise that the applicant will need to demonstrate that the new downstream fish passes will maintain or improve Atlantic salmon passage without the addition of non-physical deterrents of unknown and/or limited efficacy.

Applicant response: as above.

e. Information requirement: whether any **salmon spawning habitat in the lower reaches of the River Moriston will be adversely affected** by the operation of the proposed development and proposed variable weir alongside the other consented and proposed schemes in Loch Ness.

NatureScot advice: Based on the information provided, **we agree that the lower reaches of the River Moriston have very little, or any, spawning potential**.

Applicant response – noted.

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Annex: NatureScot advice additional detail

River Moriston SAC

Upstream salmon passage at the proposed seasonal weir during operation

Hydrology

The proposal is for a vertical fish slot pass. We have checked the calculations within the provisional hydraulic design based upon the proposed design range of upstream levels (Appendix 1) and confirm that these are correct. The design of the upstream fish pass uses a downstream water level which has been based upon the design drawing of the previous Fishtek temporary fish pass. We agree with the Fishtek conclusion that more monitoring or modelling data would be required at the outline design phase to support this value and ensure sufficient head is available to deliver the required velocities and depths through the fish pass.

NatureScot stipulated that it should demonstrated that the fish passage would be viable under a reasonable worst case scenario including the cumulative effect of all Loch Ness water users and the effect of climate change. The design range of the proposed fish pass has been such as to provide upstream passage across a Q95 - Q10 flow window and these have been estimated as occurring at the upstream (loch) levels of 15.50mAOD and 16.80mAOD. It is unclear how these levels have included the effect of both upstream users and climate change. Levels previously modelled by AECOM and presented in the document Glen Earrach PSH - Additional Information - Addendum (Ness Woods SAC and Urquhart Bay Wood SAC) - Water Levels - September 2025.pdf indicate that the annual long term L95 and L10 (which should correspond to Q95 and Q10 over the weir) are 15.40mAOD and 16.20mAOD respectively.

Applicant response: water levels presented in Section 2 of the Fishtek *Optioneering Summary* have now been included based on long term levels derived by AECOM. [Note that L10 is 16.50 mAOD rather than 16.20 mAOD as referenced in the above NatureScot comment].

These levels do not take into account the impact of climate change, an assessment of which has been provided in AECOM 1 in 200 CC Technical Note.pdf which would suggest a reduction in Q95 and an increase in Q10. In our view the fish pass design should be based on projected future Q95 and Q10 flows. If the climate changes as projected, variability will increase. Low flows are predicted to get lower and high flows get higher and the distribution of flows will widen. That means that the total time experienced within any fixed range of flows in the middle will steadily decrease as more time is spent towards the extreme). So if the fish pass is designed on flows based on the historical record then it would be reasonable to assume that in the future it would operate for less and less time under its designed parameters. All other things being equal, that could reduce the time it is available for fish migration. Future flow changes should therefore be accounted for in the design of the fish pass.

As such, it has not been demonstrated, in a clear manner, how the provisional design would deliver velocities and depths across the Q95 to Q10 range where that range has taken account of upstream water users and climate change.

Applicant response: analysis of the anticipated fish pass operation during future climate scenarios has been expanded in the Fishtek *Optioneering Summary* Section 7. The proposed vertical slot fish pass is inherently highly flexible from a hydraulic perspective and will remain fully functional at the predicted climate change adjusted median 15 minute and 24 hour minimum flow.

Fish ecology

There are established parameters that fish passes must be able to deliver in order for Atlantic salmon to pass through them effectively. For us to assess efficacy we need to see what parameters are being used (there are several examples in the literature of where all of this can come from, although Armstrong et al., (2004) appears to be the ‘go to’ manual that is most widely accepted. Other examples include Thorstad et al., 2011 and Schütz et al. 2024), and where these have come from. So ‘parameter’ (e.g. flow velocity in gaps between baffles etc), ‘value’ (e.g. what value will this design give us relative to the biological requirements of the fish and will allow safe passage), and ‘source’ (i.e. which guidance was used to derive this). In essence we need good evidence that the flows coming down the pass are sensible and backed up by best practice and evidence.

Applicant response: a summary table has been added to the end of the Fishtek *Optioneering Summary* Appendix 1 demonstrating how the proposed fish pass meets (and exceeds) best practice guidance. Whilst there are numerous literature sources, focus has been given to values presented in the Environment Agency Fish Pass Manual as this is the primary guidance document referred to in the UK during review and approval of fish pass designs.

Downstream salmon passage at the proposed seasonal weir during operation

Hydrology

There are no design dimensions given for the three downstream passage routes. The key in the document Location, Site plan and Smolt passage states that: “Full hydraulic design is required at outline design phase to ensure that species specific passage requirements are met.”. These have yet to be provided so no assessment of the viability of the proposed options can be made at this time.

Applicant response: the hydraulic design of these structures has been developed to inform sizing and flow rates of each smolt pass, as can be seen in drawing *0104-3540681-P01 - Smolt Passage*, supported by CFD modelling for the most downstream smolt pass as presented in Appendix 2 of the Fishtek *Optioneering Summary*.

Section 7.2.2 of the 3540681 Fishtek - GEE Ness Weir Fish Passage Optioneering Summary details how the downstream passage would deliver flows under a reasonable worst case scenario low flow and states that “Under the worst-case drought scenario a minimum total flow volume of 9.6 m3 /s is predicted”. This flow value does not correspond with the AECOM 1 in 200 CC Technical Note which indicates a median worst case low flow scenario ranging from 6.94 m3/s (15 minute averaged flow) to 8.75 m3/s (7 day averaged flow).

Therefore, it has not been demonstrated, in a clear manner, how the downstream flow passages would deliver sufficient velocities and depths for downstream passages under a reasonable worst case scenario.

Applicant response: the flows referenced in this section have now been included to align with the stated AECOM figures.

Fish ecology

The bell mouth design is intended to “minimise the risk of fish rejecting the route once located” and to “to achieve gradual rates of acceleration, typically not exceeding 1 m/s/m”. However there isn’t information to demonstrate that attraction velocities similar to that described by Kundegorski et al 2025 would be achieved. Neither is it clear where the need to avoid water velocities not “exceeding 1 m/s/m” at this location comes from. The applicants need to demonstrate that all three smolt migration passages will be both find-able and useable by smolts. It is important that smolts spend as little time in the smolt chutes as possible, in order to reduce predation pressure on fish located there.

Applicant response: further information on the acceleration requirements for the smolt chutes and associated references have been included in the Fishtek *Optioneering Summary* Section 6. CFD modelling has been undertaken for the most downstream smolt pass to demonstrate the hydraulic functioning of the structure and the flow cues in the canal inlet channel on the approach to the smolt pass.

The design plan also makes use of bubble screens as a non-physical method to direct smolts into the chute, but Leander et al. (2012), repeated in Nicula et al. (2026), has shown that bubble screens are less effective at night and downstream migrating smolts migrate primarily at night in the early part of the migration season (Thorstad et al. 2012).

Applicant response: as noted above, these measures are proposed solely as a supplementary measure to improve deflection of smolts towards the bywash channel entrance. We are not aware of any evidence to suggest that rates of smolt migration are worsened under any scenario by inclusion of bubble screens and therefore this is viewed as a sensible and pragmatic supplementary measure which may provide additional benefit but is not relied upon for the effectiveness of the passage arrangements. Daytime migration of smolts can be more prevalent lower in catchments and towards the end of the migration window (Sortland et al. 2025[1]). There are additional supplementary options during night time hours when bubble screens may be less effective – e.g. previous studies have demonstrated strobe lighting to provide effective deflection of smolts (Fjeldstad et al. 2012[2]).

Regardless, these are therefore viewed as supplementary measures intended to reduce delay. The effective functioning of the downstream passes is primarily reliant upon appropriate inflow volumes and controlled acceleration of flow, as detailed in the *Optioneering Summary*.

[1] Sortland, L. K., Aarestrup, K., & Birnie-Gauvin, K. (2025). Comparing the migration behavior and survival of Atlantic salmon (Salmo salar) and brown trout (Salmo trutta) smolts. *Journal of Fish Biology*, *106*(5), 1360-1376.

[2] Fjeldstad, H. P., Uglem, I., Diserud, O. H., Fiske, P., Forseth, T., Kvingedal, E., ... & Järnegren, J. (2012). A concept for improving Atlantic salmon Salmo salar smolt migration past hydro power intakes. *Journal of Fish Biology*, *81*(2), 642-663.

Fish Passage Investigation

Dochfour Weir

Client:	Glen Earrach Energy
Date:	12/03/2026
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Summary

This technical note provides rationale for the selection of the preferred upstream and downstream fish passage solutions at Dochfour Weir, forming part of the proposed mitigation for the Glen Earrach Energy pumped storage hydro (PSH) scheme in the Ness catchment, Scotland.

Contents

1. Background

Glen Earrach Energy Ltd ('GEE') is seeking to develop a pumped storage hydro (PSH) scheme in the Ness catchment, Scotland. The scheme proposes to enlarge the capacity of the Loch nam Breac Dearga to be used as the head-pond, with Loch Ness forming the tail-pond. During periods of operation the scheme would result in discharge of water into Loch Ness, which has the potential to raise loch levels and consequently flow volumes to the River Ness downstream.

As a future phase of enabling works associated with the PSH scheme, modifications to Dochfour Weir at the outflow from Loch Dochfour are proposed, incorporating an adjustable weir crest to maintain a 'natural' flow regime and mitigate potential downstream flow variation arising from level changes due to PSH activity in the River Ness downstream.

To achieve a net environmental benefit from the scheme, GEE are proposing to deliver improvements to upstream and downstream fish passage at Dochfour Weir. Fishtek were commissioned by GEE to appraise available options for improving fish passage at the site, identify a preferred fish passage solution and develop concept design drawings to demonstrate that the option could be feasibly delivered. To support identification of a preferred fish passage solution a review of existing baseline data has been undertaken, alongside modelled hydrological data of operational scenarios.

To inform the optioneering phase and concept design drawings, a site visit was completed by Fishtek on 23 January 2026, attended by Martin Giblin (Associate – Civil Engineering). Additionally, Fishtek staff also have familiarity with the site from delivering of previous work, including authoring fisheries environmental assessments in support of the Scottish Canals sheet piling repair works in 2017 (Paul Gratton) and the design of a temporary upstream fish passage solution that was implemented during the Scottish Canals piling repair works (Toby Coe and Mike Lakin).

2. Upstream Fish passage - Desktop review

A review of key data sources influencing the feasibility of fish passage solutions at the site is provided below. It should be noted that there are wider environmental and engineering constraints which would normally be captured within a full optioneering study that are not considered here. These include historical and environmental designations/constraints and the potential presence of utilities assets in proximity to the weir. Further consideration should be given to these aspects during design development.

2.1 Fisheries

The River Moriston, which drains into the northern shore of Loch Ness, is designated as a Special Area of Conservation (SAC), with freshwater pearl mussel (*Margaritifera margaritifera)* cited as a primary reason for site selection and Atlantic salmon (*Salmo salar*) cited as a qualifying reason for site selection. Provision of improved upstream passage for salmon (alongside sea trout, *Salmo trutta*) is therefore a key aim of the project. The main life stages for which upstream fish passage will be required are grilse (salmon/sea trout returning to freshwater after a single winter at sea) and multi-sea winter fish.

Subject to technical feasibility there is also an aspiration from GEE to deliver a fish passage solution that can provide multi-species fish passage for a wider range of non-salmonid species, including both European eel (*Anguilla anguilla*) and lamprey species. Distinction is therefore made within this technical note between options that would provide effective fish passage for grilse/MSW migratory salmonids only, versus options which provide passage for both grilse/MSW migratory salmonids and non-salmonid species.

2.2 River flows

River flows are a key determinant of the feasibility and required size of fish passage solutions at a given site. To ensure adequate attraction flow to the fish pass entrance there is a requirement to convey a minimum percentage of total river flow. Best practice guidance recommends a solution that provides 5 – 10 % of mean flow (Qmean), achieved at a Q95 river flow (EA, 2010[1]), with an acknowledgement that the lower end of this range is likely to be appropriate on larger rivers (such as the Ness).

Current river flows on the Ness are available from Ness-side gauging station (ID 6007), located approximately 4.5 km downstream of Dochfour Weir. A flow duration curve and a summary of key flow percentiles at Ness-side are provided in Figure 2-1 and Table 2-1., respectively. There is a negligible uplift in catchment area between the weir and gauging station and therefore no adjustment to the gauged data has been applied currently.

[1] Environment Agency (2010). Environment Agency Fish Pass Manual, Document – GEHO 0910 BTBP-E-E, 370 pp.

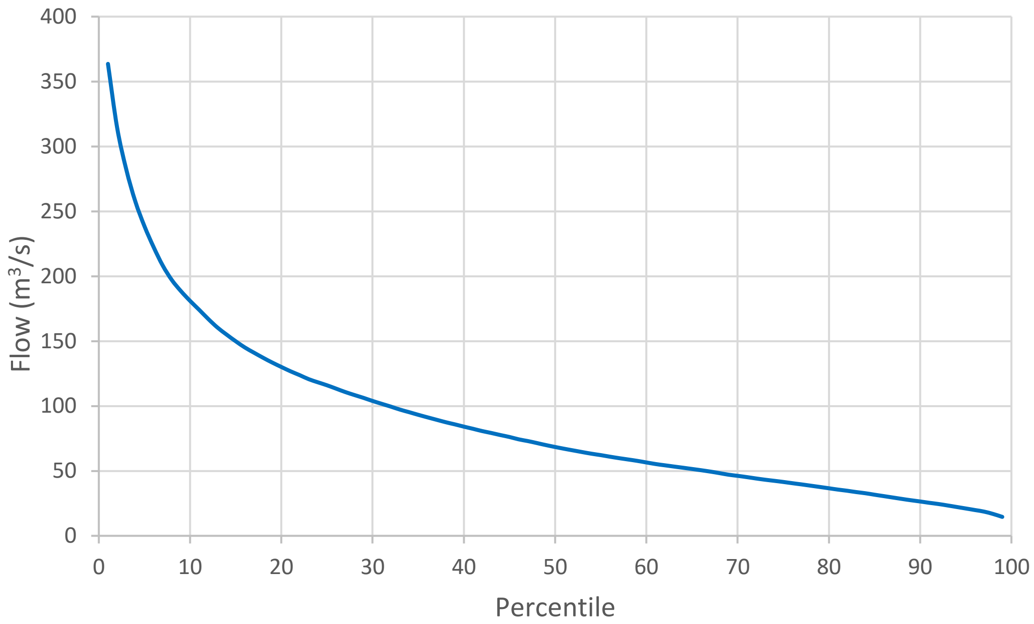

Figure 2-1. Flow duration curve for the River Ness at Ness-side (ID 6007), derived from the full period of record (1972 – 2024).

Table 2-1. Summary of key flow percentiles for the River Ness at Ness-side (ID 6007), derived from the full period of record (1972 – 2024).

Percentile	Flow (m^3/s)
5	238.53
10	181.00
20	130.10
50	68.46
70	46.21
95	21.07
99	14.61
Qmean	90.64

The mean river flow at the site is 90.64 m^3/s; as such there is likely to be a requirement for a fish passage solution at Dochfour Weir to convey between 4.53 – 9.06 m^3/s at Q95 (increasing thereafter) to provide effective attraction flow for upstream migrating fish. Depending on the final type and form of fish pass identified, there may be opportunities to deliver part of this flow via one or multiple auxiliary flow channels which discharge at the entrance to the fish pass. The benefit of this is that it can provide a more compact arrangement compared to conveying the entirety of the flow through the fish pass itself, where rules on energy densities thresholds (turbulence) typically need to be met.

2.3 Water levels

Upstream and downstream water levels at the site determine the total hydraulic head loss that would need to be accommodated within any fish pass solution, which in turn dictates the required gradient, dimensions and overall footprint of the fish pass.

2.3.1 Upstream

As a future phase of enabling works associated with the PSH scheme it is proposed to construct an adjustable weir structure immediately upstream of the existing fixed crest. The purpose of the adjustable weir is to maintain delivery of a ‘natural’ flow to the River Ness downstream during periods of PSH operation when the loch level may be elevated above the level that would be expected in the absence of the PSH scheme.

Future loch levels after commissioning of the scheme have been modelled as part of work completed by AECOM. These modelled levels indicate a future Q95 and Q10 upstream loch water level of 15.40 mAOD and 16.50 mAOD, respectively (Table 2-2). An extract from the modelling work showing the variability over a typical year (2023) is provided in Figure 2-2.

Table 2-2. Summary of AECOM modelling results for Loch Ness water levels under the proposed development, in combination with Loch na Cathrach and Loch Kemp. Relevant Q95 and Q10 levels are highlighted.

	Baseline Annual	GE , LnC + LK Annual	Baseline Winter	GE , LnC + LK Winter	Baseline Spring	GE , LnC + LK Spring	Baseline Summer	GE , LnC + LK Summer	Baseline Autumn	GE , LnC + LK Autumn
L95	15.50	15.40	15.70	15.40	15.55	15.40	15.45	15.60	15.45	15.40
L90	15.60	15.50	15.75	15.45	15.50	15.45	15.50	15.70	15.60	15.50
L80	15.65	15.65	15.80	15.60	15.65	15.55	15.55	15.80	15.70	15.60
L70	15.75	15.75	15.85	15.70	15.70	15.65	15.60	15.90	15.75	15.70
L50	15.80	15.95	15.95	15.90	15.80	15.85	15.70	16.15	15.85	15.90
L30	15.90	16.15	16.00	16.05	15.85	16.05	15.75	16.35	15.90	16.15
L10	16.05	16.50	16.15	16.3	15.95	16.40	15.85	16.55	16.05	16.50

These levels indicate a maximum 1.1 m variation in upstream water level across the Q95 – Q10 range. A further analysis of climate change scenarios has also been included later in this document (*Chapter 7, Climate Resilience*). The water level in the loch will ultimately fall below or above this typical range for a proportion of the year, although this would be outside the expected operating window of any fish pass (generally equivalent to Q95 – Q10 flows). A fish pass to designed to function across the Q95 – Q10 flow range would therefore provide an operating window that aligns with the key migration periods for upstream migrating salmon and sea trout on the Ness and meets recommendations in best practice design guidance[1].

AI A2.1 Water Balance model results

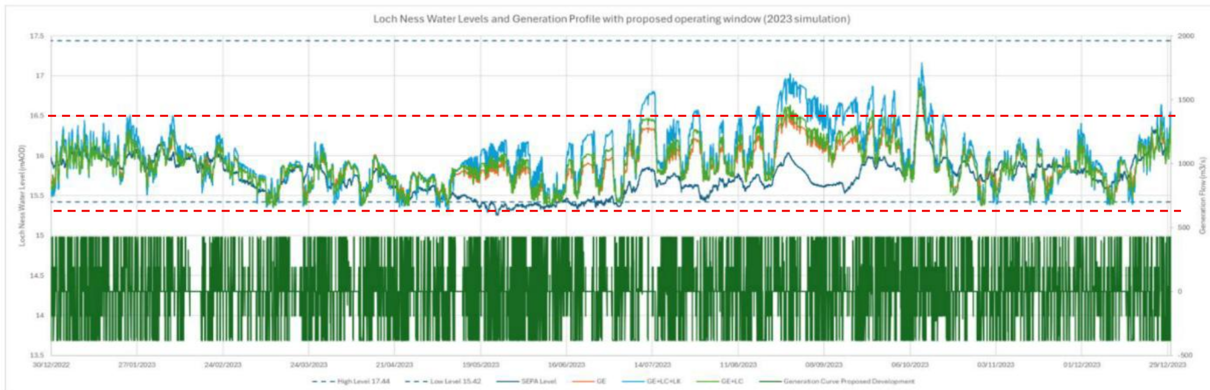

Figure A2-1 Entire year of 2023

Figure 2-2. Extract from AECOM hydraulic modelling of loch water levels in 2023 under various scheme scenarios. The Q95 (15.40 mAOD) and Q10 (16.50 mAOD) levels are shown for context.

2.3.2 Downstream

Detailed water level data immediately downstream of the weir has not currently been collected. However, a typical downstream water level is available from previous Fishtek design drawings of a temporary fish pass solution implemented at the site during Scottish Canal repair works in 2017 - 2018. This downstream water level is considered sufficient to inform the current appraisal of feasible fish passage options at the site. However, there would be a requirement to collect more detailed downstream water level data during a future outline design stage. Alternatively, there may be a need to model future downstream water levels depending on the exact operating philosophy and control proposals.

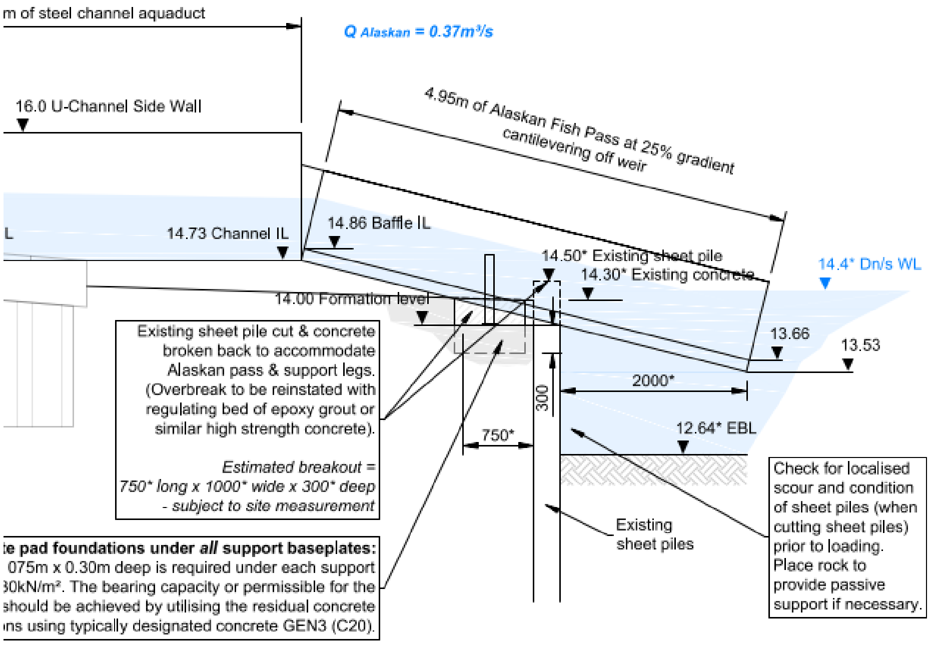

Figure 2-3. Extract from Fishtek design drawings for the temporary fish pass solution implemented during weir repair works in 2017, providing a downstream water level of 14.40 mAOD.

The available information therefore indicates a maximum head drop at the site of approximately 2.1 m based on the maximum typical future loch water level (16.50 mAOD) and the known downstream water level (14.40 mAOD).

There is ordinarily a requirement to provide upstream passage across a Q95 – Q10 flow window when designing a multi-species solution. At conventional barriers to migration these upper and lower percentiles normally correlate to particular water levels, as river levels rise in response to greater flow. However, due to the intention to manage upstream water levels to maintain a natural flow regime downstream of Dochfour Weir, it is possible that the water level in the loch may fall outside of this typical range despite flow volumes to the River Ness downstream remaining within the Q95 – Q10 window.

For the purpose of appraising feasible fish passage options the upper (Q10 - 16.50 mAOD) and lower (Q95 - 15.40 mAOD) bounds of loch water levels are considered adequate, in combination with the assessment of climate change impacts included in Chapter 7. However, further analysis of the relationship between loch level and downstream flow may be required during the outline design of the preferred option to better quantify the window of operation and reach regulatory agreement on an upper and lower operating loch level for the fish pass.

2.4 Upstream Passage - available options

The extent of variation in upstream water level at the site is relatively significant and in excess of what is typically observed at conventional river structures across the Q95 – Q10 flow range. As such, there are a significant number of fish passage options that would not perform well under the increase in upstream water level due to the manner in which they function hydraulically. Options such as rock ramps and brush passes would become drowned out at the higher loch levels, leading to excessive water velocities and a compromised operating window. Likewise, there are other options such as an Alaskan A and Denil passes which do function well under variable upstream water levels but would provide insufficient attraction flow volumes (likely only a fraction of the required flow target). Therefore, based on the anticipated hydraulic conditions at the site, potentially feasible multi-species fish passage options are considered to comprise either:

1) A Larinier fish pass, or;
2) A vertical slot pool pass.

Further information on the anticipated form of each option is provided in the following section.

3. Overview of Shortlisted Upstream Passage Options

3.1 Larinier super-active baffle pass

A Larinier fish pass comprises a sloping concrete channel (typically at a 15 % gradient), with herringbone style baffles of a specific geometry fixed to the base of the channel. The baffles create turbulence which reduces water velocities to a level sufficient for target fish species to swim upstream (Figure 3-1). The most common baffle configurations are 100 mm high x 600 mm wide units, or 150 mm high x 900 mm wide units. Multiple baffle units can be contained within a single channel to achieve the required flow rates. The maximum permitted depth of water over the baffles is 600 mm for 100 mm high baffles and 900 mm for 150 mm high baffles. Beyond this depth the hydraulic influence of the baffles begins to reduce and velocities increase to an unacceptable level.

Figure 3-1. An example of a two-flight Larinier fish pass designed by Fishtek, cutting through an existing weir structure.

To consider the likely required size of a Larinier fish pass a total target fish pass flow equivalent to 6 % of Qmean (5.44 m^3/s) has been assumed - i.e. towards the lower end of the 5 – 10 % range given the size of the River Ness. It would be feasible to convey approximately half of the flow via the Larinier fish pass itself and the remainder via a screened auxiliary flow channel discharging into a downstream entrance pool, equating to a required Larinier fish pass discharge of approximately 2.72 m^3/s.

The required flow could be accommodated within a 4.50 m wide Larinier (comprising five units of 150 mm high/900 mm wide baffles) with a 0.47 m water depth at the lowest loch levels. However, this arrangement could only accommodate a further 0.43 m increase in loch level before it becomes overcharged (i.e. water depth > 0.9 m), which is significantly less than the ~1.1 m future variation in loch levels across the anticipated operating window of the fish pass.

For a Larinier option to function across the required range of upstream water levels, it would be necessary to develop a solution comprising either:

- A series of three parallel ~4.5 m wide Larinier channels at staggered heights with individual penstocks at the upstream end. The penstock on each channel would automatically open and close in response to measured loch levels to maintain an effective fish pass across the full range of typical loch levels; or,
- An arrangement comprising a series of header pools and submerged orifices which then discharge into the Larinier fish pass. The purpose of the header pools and orifices would be to buffer the variation in loch water level as they provide a relatively stable discharge despite increasing upstream water levels. It is likely that multiple orifices at different invert levels would be required to accommodate the variation in upstream head, with penstocks automatically opening and closing the orifices based on measured loch levels. Similar arrangements exist on structures elsewhere that experience large fluctuations in upstream water level, including the fish pass on Spey Dam in Scotland.

3.2 Vertical slot pass

A vertical slot pass comprises a series of slots and pools which divide a large head drop across a structure into a series of smaller head drops (Figure 3-2). Deep slots typically extend to the full depth of the pools, with two slots commonly used to provide necessary flow volumes on larger rivers. The energy generated from the head loss across each slot is dissipated in the pool immediately downstream via recirculating flow eddies.

Figure 3-2. An example of a vertical slot fish pass designed by Fishtek at Diglis weir on the River Severn, which is comparable in size to the River Ness (mean flow *ca*. 95 m^3/s). Additional auxiliary attraction flow is conveyed via separate channels located between the concrete side walls and the outer sheet piling.

This type of fish pass inherently handles large variations in upstream water level well, as the depth of the slots can be increased as required to accommodate the range of upstream water levels.

The head loss across each slot (and therefore the overall gradient of the fish pass) is dictated by the target fish species. Best practice guidance recommends maximum head drops of 0.30 – 0.40 m per slot for grilse/MSW migratory salmonids, reducing to 0.20 – 0.25 m if passage of non-salmonid fish species is required[1]. The Diglis fish pass on the River Severn (Figure 3-2) has maximum head drops of approximately 0.23 m between pools and has been shown to provide effective upstream passage for a wide range of fish species, including migratory salmonids, lamprey and juvenile coarse fish down to ~10 cm length.

To consider the likely size of a vertical slot fish pass, the same flow requirements outlined for the Larinier above have been assumed; i.e. a vertical slot fish pass discharging 2.72 m^3/s, with the same volume also conveyed as additional auxiliary attraction flow to achieve a total fish pass flow equivalent to 6 % of Qmean.

Based on a minimum head drop of 0.11 m between pools at the lowest total head drop, two 0.6 m wide slots per baffle and a 1.8 m minimum water depth, a vertical slot pass would convey a minimum flow of 2.70 m^3/s. If the fish pass was designed to provide multi-species fish passage then it would be necessary to maintain energy densities in each pool below 150 W/m^3 across the operating window. To achieve this, each pool would need to measure approximately 5.6 m long x 6.6 m wide x 1.8 m deep (or equivalent to achieve the same total pool volume).

Under the upper loch level, the water depth would increase to approximately 2.9 m at Q10 based on the *ca*. 1.1 m variation evident in modelled data across the anticipated operating window of the fish pass. Under this configuration the total discharge would increase to 6.36 m^3/s, with energy densities remaining below the 150 W/m^3 threshold due to the increase in pool volume associated with the greater water depth.

Based on the assumed maximum head drop at the site (2.1 m), a vertical slot fish pass would require approximately 10 slots and nine pools with 0.21 m head drops to ensure multi-species fish passage. The fish pass is therefore likely to be in the order of 70 m in length.

4. Identification Of Preferred Upstream Fish Pass

A comparison of the key advantages and disadvantages of the two shortlisted fish passage options is provided in Table 4-1.

Table 4-1. Overview of key advantages and disadvantages for the two upstream fish passage options shortlisted for Dochfour Weir.

Option	Advantages	Disadvantages
Larinier super-active baffle pass	• Compact footprint due to steeper gradient • Good functionality for grilse/MSW migratory salmonids • Lower anticipated construction cost • Moderately low on-going O&M requirements	• Complex arrangement required to accommodate variation in loch water level • Reliance upon mechanical/electrical equipment to maintain functionality • Low efficiency for non-salmonid species; considered to be strongly sub-optimal for lamprey passage.
Deep vertical slot fish pass	• Accommodates wide variation in loch water level without reliance on mechanical equipment • Likely to continue to provide effective passage conditions at loch levels below or above the agreed operating window • Proven highly efficient multi-species passage for grilse/MSW salmonids and non-salmonids, including lamprey • Moderately low on-going O&M requirements • Ability to reduce slot velocities and pool energy densities further through the addition of brush substrate material[2]	• Larger footprint due to lower permitted gradient • Higher anticipated construction cost

Due to the proven ability for the vertical slot fish pass to provide multi-species fish passage for both grilse/MSW migratory salmonids and non-salmonid species, which aligns with the GEE aspirations for the site, it is recommended that this option is taken forward as the preferred upstream fish passage solution for the site.

The anticipated hydraulic operating conditions of a vertical slot fish pass at the site are summarised in Appendix 1. It should be noted that these figures are provisional given the early stage of investigation and would need to be refined at the outline design stage as part of the full hydraulic design of the structure.

[2] Kucukali, S., Alp, A., & Albayrak, I. (2023). Retrofitting vertical slot fish pass with brush blocks: Hydraulics performance. *Water*, *15*(6), 1155.

5. Upstream Fish Pass Location

As a general rule, the entrance to a fish pass should typically be positioned at the most upstream point of a weir and/or adjacent to the dominant attraction flow route, given that upstream migrating fish are likely to naturally move towards these locations.

At Dochfour Weir this represents the most westerly point of the weir adjacent to the two existing SSE sluice gates alongside the true right bank. At this location there are two potential areas where the fish pass could be accommodated (Figure 5-1), comprising either:

1) A location within the existing sluice gate bay adjacent to the true right bank, if it is determined that one or both sluice gates will become redundant following construction of the new adjustable weir structure; or,
2) At the most upstream point of the service weir between the existing fish pass route and the two SSE sluice gates.

Figure 5-1. Indicative overview of two potential locations for the vertical slot fish pass; comprising either the bankside bay of the existing SSE sluice gates (orange) or the most upstream section of the service weir (blue). White lines and arrows denote the centreline of the potential flow route and requirement for changes in direction (*not to scale*).

A vertical slot fish pass occupying the blue area will require one or two 180° changes in direction to accommodate the required number of pools and slots. Where changes of direction are required there is likely to be a requirement to provide reduced energy densities[1], requiring longer pools at each turn which will increase the overall length and complexity of the structure. There is also evidence that changes in direction of this nature can also reduce the efficiency of the fish pass[3].

In contrast it is likely to be feasible to accommodate a bankside vertical slot without requiring a 180° change in direction. More generally, this location is deemed preferred as the bankside position will facilitate easier construction and temporary works arrangements (negating the need to carry out construction more centrally on the loch/weir) and provides easier access for operation and maintenance

[3] White, L. J., Harris, J. H., & Keller, R. J. (2011). Movement of three non-salmonid fish species through a low-gradient vertical-slot fishway. *River Research and Applications*, *27*(4), 499-510.

of the structure from the adjoining river bank. Therefore, providing it is feasible to occupy one of the existing SSE sluice gate bays it is recommended that a vertical slot in this bankside location is progressed as the preferred upstream fish passage option for the scheme.

Preliminary hydraulic design of the proposed vertical slot fish pass is detailed in Appendix 1.

6. Downstream Passage

6.1 Passage requirements

Ensuring effective downstream passage for key migratory life stages at Dochfour Weir is essential to ensure that species requiring movement between marine and freshwater are able to complete their full life cycle and achieve sustainable and resilient populations. Due to the existing configuration of the weir and canal channel, pressure on downstream passage is arguably of comparable or greater significance than upstream passage. Identifying feasible and effective methods of improving downstream passage for key life stages is therefore an integral element of achieving a long-term sustainable fish passage arrangement at the site.

Based on the migratory fish species composition of the Ness catchment, it is envisaged that downstream passage would be required for the following key species/life stages:

- Salmon and sea trout smolts (juvenile life stage migrating to sea);
- Salmon and sea trout kelts (post-spawning adults returning to sea – typically more common for sea trout, with a lesser component of multi-year spawning evident in salmon);
- Silver eel life stage of the European eel (*Anguilla anguilla*) (pre-spawning migration of mature adults); and,
- Downstream migration of river lamprey (*Lampetra fluviatilis*) and sea lamprey (*Petromyzon marinus*) ‘transformers’ (juvenile life stage migrating to sea).

Given the historic concerns surrounding effective smolt passage at the site, alongside the presence of the River Moriston SAC upstream of Dochfour weir (under which salmon are designated), provision of effective downstream passage conditions for salmon smolts forms the primary focus of this section. However, providing that the identified solution(s) can function hydraulic across the Q95 – Q10 flow range it is anticipated that effective downstream passage would also be achieved for key life stages of non-salmonid species (e.g. eel, lamprey).

6.2 Current arrangements

The primary routes of downstream passage currently available at the site comprise:

- The existing lowered section of weir crest on the service weir;
- A smolt bywash channel/chute approximately half way along the waste weir; and,
- A smolt bywash pipe on the true right wing wall immediately upstream of the gates at Dochfour Lock at the head of the Caledonian Canal.

Depending upon specific flow and water level conditions, a proportion of smolts are also likely to pass over the crest of the service and waste weirs and the SSE sluice gates adjacent to the true right bank of the loch under the current arrangement, although the effectiveness of these routes are likely to be highly variable depending upon prevailing flow conditions.

The elongated length of the weir crest and the angle of the weir relative to the head of the canal channel means that downstream migrating life stages, including smolts, are at heightened risk of delay and/or entry into Dochgarroch Lock under the current arrangement. Whilst two routes exist for smolt migration, the small chute is considered poorly designed and likely to be ineffective due to inadequate attraction flow relative to the size of the reach and other flows. The second route comprises a bywash culvert located immediately upstream of the lock gates and this lacks the recommended features to control flow acceleration. In addition, this route is likely to perform poorly during lock filling cycles due to the proximity of the pipe entrance to the lock gates.

It is therefore considered that the current arrangements can be significantly improved by implementing properly designed downstream passage facilities with dimensions and attraction flow volumes that are proportionate to the significant size of the weir and river. Improvements to migration at the site are likely to reduce the migration delay that smolts are subjected to whilst attempting to traverse the weir, thus reducing predation pressure and ensuring timely marine arrival, in addition to reducing the likelihood of smolts being drawn into the Dochgarroch Lock when it is opened. Smolts drawn into the Caledonian Canal are likely to be subjected to high level of mortality, with few individuals successfully escaping to sea.

6.3 Proposed measures

Effective measures to provide a route of downstream smolt passage need to be i) appropriately located to allow fish to locate the route(s) without undue delay, ii) provide adequate flow volumes to be attractive across a range of loch levels and flow volumes relative to competing flow via other routes and iii) achieve suitable flow dynamics at the inlet to minimise the risk of fish rejecting the route once located (often achieved via a bellmouth profile inlet to channels to achieve gradual rates of acceleration).

Where smolts are subject to excessive rates of acceleration there is evidence of fish exhibiting avoidance behaviour and rejecting downstream passage routes[4]. An upper acceleration limit of 1 m/s/m has been shown to be acceptable for smolt passage without evidence of avoidance behaviour[5]. Whilst not formally captured in best practice fish pass design guidance, this upper bound of acceleration is acknowledged in the context of best practice bywash design for intake screening[6] and is routinely applied by the EA and the National Fish Pass Panel during review and approval of channels designed for the downstream passage of smolts. Additionally, studies have demonstrated improvements to smolt passage where radiused inlet structures have been retrofitted to existing bypass channels[7].

To meet these criteria, three separate downstream smolt passes are recommended at key locations across the site to provide opportunity for downstream passage across the Q95 – Q10 flow range, comprising:

1) A smolt pass in the canal inlet channel immediately upstream of the Dochgarroch Lock gates. An adjustable weir would be required at the crest of the smolt pass to ensure that the structure is capable of providing appropriate discharge and acceleration across the future range of Q95 – Q10 loch levels.
2) A replicate of the channel outlined above, located at the downstream end of the waste weir at the interface with the existing canal island. Constructing the channel within the land at the southern end of the canal island would be preferrable as it will help isolate the construction works from the watercourse and minimises modification works required to the waste weir (which has potential heritage implications).
3) A replicate of the channel outlined above, located at the upstream end of the service weir (directly adjacent to the abutment for the existing SSE sluice gates); essentially replacing the existing lowered section of crest which would be occupied by the adjustable weir in future.

[4] Ovidio, M., Dierckx, A., Bunel, S , Grandry, I, Spronck, C, & Benitez, J. P. (2016). Poor performance of a retrofitted downstream bypass revealed by the analysis of approaching behaviour in combination with a trapping system. River Research and Applications, 33, 27–36
[5] Haro, A., Odeh, M., Noreika, J. and Castro-Santos, T. (1998). Effects of water acceleration on downstream migratory behaviour and passage of Atlantic salmon smolts and juvenile American shad at surface bypasses. Trans. Am. Fish. Soc., 127 (1): 118-127.
[6] Environment Agency (2005). Screening for Intake and Outfalls: a best practice guide. Science Report SC030231, 154 pp.
[7] Ovidio, M., Renardy, S., Dierckx, A., Matondo, B. N., & Benitez, J. P. (2021). Improving bypass performance and passage success of Atlantic salmon smolts at an old fish-hostile hydroelectric power station: A challenging task. Ecological Engineering, 160, 106148.

Implementation of these three dedicated smolt passes would render the two existing sub-optimal smolt bywash channels redundant. It is recommended that these two channels are decommissioned alongside delivery of the downstream passage works.

An example of a similar smolt channel arrangement on the River Usk is provided in Figure 6-1. Whilst this structure is smaller than those proposed at Dochfour weir (reflecting the smaller size of the river), the overarching principles of attractant flow and gradual rates of acceleration remain the same.

Figure 6-1. An example of a newly formed smolt pass through Brecon weir on the River Usk, designed by Fishtek. Whilst the required smolt channels at Dochfour Weir would be of a greater scale, the same fundamental design principles regarding inflow behaviour and attraction flow apply.

In addition to these dedicated downstream passage routes, downstream migration would also be feasible via the new vertical slot fish pass adjacent to the true right bank[8], alongside the main crest of the weir itself subject to confirmation of the final design.

6.4 Hydraulic overview

6.4.1 Hydraulic summary

To provide adequate attraction flow into each of the smolt passes, a 3 m wide crest with a 0.6 m water depth is proposed. These dimensions would provide a discharge of 2.37 m^3/s through each smolt pass, equating to a combined discharge of 7.11 m^3/s across all three smolt passes.

To ensure that acceleration is adequately controlled on the approach to the crest, a bellmouth opening that narrows from 5 m at the inlet down to 3 m at the crest is proposed, alongside a gradual shallowing of the bed profile from 1.2 m deep at the inlet to 0.6 m deep at the crest. The resultant acceleration profile across the length of the inlet to each smolt pass is shown in Figure 6-2.

[8] Haraldstad, T., Johansen, K., Stranzl, S., & Lennox, R. J. (2025). Downstream Migration of Atlantic Salmon Smolts Through Fishpass Designed for Upstream Migration of Adult Spawners. *River Research and Applications*, *41*(9), 1982-1988.

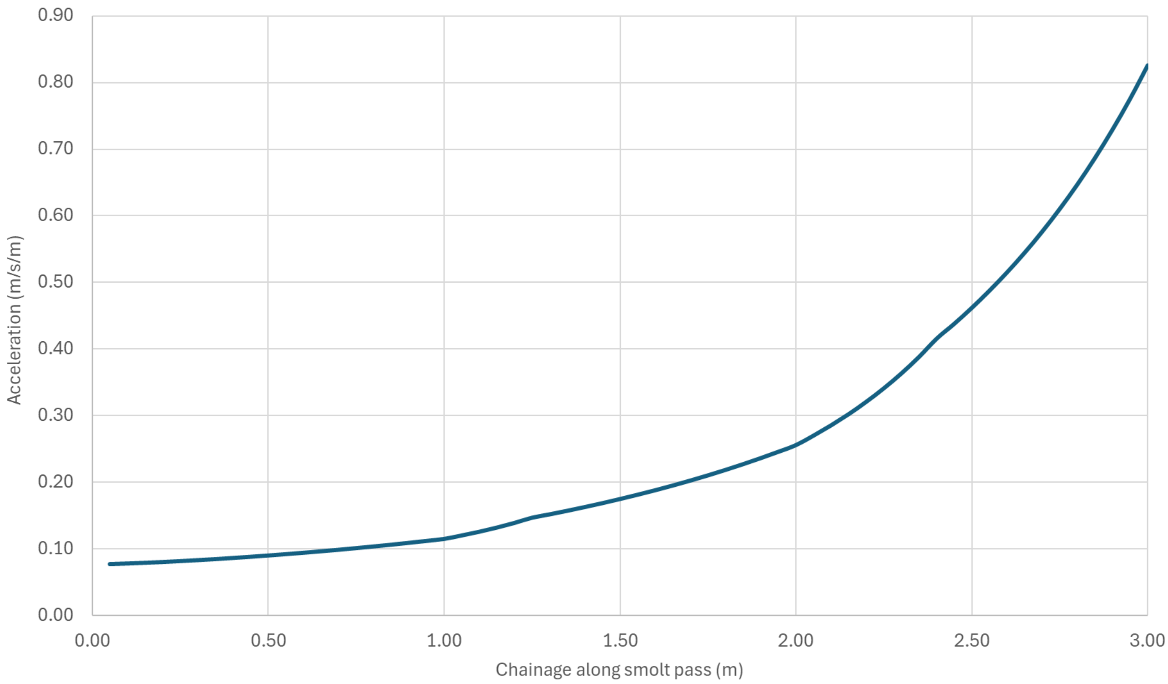

Figure 6-2. Acceleration profile along the length of the smolt passes based on the proposed bellmouth design, extending from the bellmouth inlet (0 m chainage) to the crest of the smolt pass (3 m chainage).

Although downstream migration of smolts occurs during a relatively constrained seasonal window of six to eight weeks each year, there would be benefit in ensuring that the downstream passage routes are open year round to cater for other migratory species/life stages that migrate outside of the smolt window (e.g. kelts and silver eel). The addition of an adjustable weir structure at the crest (similar to that proposed for the wider weir structure) will ensure that each smolt pass can function over the full Q95 – Q10 flow range, whilst allowing discharge to be controlled to ensure that a competing flow to the upstream fish pass does not occur during the main upstream migration periods (which may otherwise delay fish from locating the entrance to the deep vertical slot).

6.4.2 Hydraulic modelling

The proposed series of three strategically located smolt passes maximises the opportunity for fish to locate a suitable downstream passage route without undue migration delay. In the event that individual fish do not locate either of the two upstream smolt passes, the orientation of the weir is likely to result in a proportion of smolts moving down towards the Dochgarroch canal inlet channel. The siting of a final smolt pass at the downstream end of the canal inlet channel, adjacent to Dochgarroch Lock, is therefore proposed in the event that smolts do not locate the previous smolt notches in the wider section of loch upstream. Demonstrating the effective performance of this most downstream smolt pass is therefore important to demonstrate that the risk of smolts entering the Dochgarroch Canal channel is appropriately mitigated.

To understand flow dynamics in the channel immediately upstream of Dochgarroch Lock, computational fluid dynamics (CFD) modelling of the proposed smolt pass was undertaken by 4c Engineering. Bathymetric survey data was used to construct a digital model of the approach channel to Dochgarroch Lock. The proposed profile and dimensions of the adjacent smolt pass were incorporated into the model to provide an understanding of flow profiles and velocities on the approach to the smolt pass.

Previous research has identified a requirement for a minimum water velocity of 0.089 m/s (mean) to 0.092 m/s (95 % confidence interval) to achieve effective directional orientation of smolts towards a prevailing flow[9]. However, in interpreting these findings it is important to understand the context of the Kundegorski *et al*. (2025) results. During this study individual smolts were subject to a 20 cm/s water velocity in a flume, with the current then reversed 180 degrees. For each fish the lowest water velocity that initiated a behavioural response was recorded, defined as fish turning 180 degrees to reorientate with the new direction of flow. Such an extreme change in direction and orientation is likely to be of limited relevance at Dochfour due to the gradual change in flow paths on the approach to the smolt pass. This velocity threshold is presented as part of the modelling results to provide a conservative indication of behavioural triggers. However, given that fish are not required to undertake a 180 degree change of direction at any point on the approach or entry to the smolt pass, a lower figure may be more appropriate. Lower velocities down to 0.05 m/s have previously been shown to illicit subtle behavioural response in smolts during flow trials[10], which are potentially of greater relevance to smolts adjusting to gradual changes in flow paths. A second velocity equivalent to 50 % of the value identified by Kundegorski *et al*. (2025) is therefore shown in the modelling results to acknowledge the potential that smolts may identify and response to a lower velocity where such an abrupt change in orientation is not required.

Further details on the modelling approach and results are provided in Appendix 2. Key outputs from the modelling exercise are provided in Figure 6-3 and summarised as follows:

- Velocity streamline plots (bottom left) indicate a clear directional flow cue towards the inlet to the smolt pass, which spans the entire width of the channel upstream. On approach to the smolt pass entrance there is a clear velocity boundary between flow being drawn into the smolt pass and the area of slack water immediately upstream of the Dochgarroch Lock gates. This localised body of water is characterised by mean velocities of less than 0.02 m/s and is therefore well under the identified thresholds for behavioural orientation outlined above. These results indicate smolts are unlikely to be behaviourally motivated to enter the area of slack water in the immediate proximity of the lock gates and would remain within the dominant body of flowing water towards the smolt pass entrance.
- The velocity isosurfaces for the 0.092 m/s and 0.046 m/s thresholds at 0.3 m water depth (top right) project out into the wider channel inlet channel. The 0.092 m/s isosurface extends approximately 4 m into the channel, whilst the 0.046 m/s isosurfaces extends approximately 9 m into the channel. Critically, however, the streamlines discussed above indicate a gradual arcing of flow into the smolt pass across the full width of the channel. Individual fish would therefore not be required to undertake an abrupt change in direction or reorientation such as that assessed by Kundegorski *et al*. (2025). Therefore, whilst the proposed smolt pass provides sufficient flow for these velocity isosurfaces to extend into the main channel, the ability of smolts to locate the entrance is not considered to be dependent on encountering these velocity thresholds.
- The bellmouth inlet profile produces a gradual increase in velocity and controlled rates of acceleration between the inlet and crest (bottom right), sufficient to eliminate avoidance and rejection behaviour in smolts that can occur during rapid rates of acceleration.

[9] Kundegorski, M. E., Honkanen, H. M., Stephen, A., Torney, C. J., Killen, S., & Adams, C. E. (2025). Defining the water flow cues for navigation in migrating Atlantic salmon smolts. *Journal of Fish Biology*, *107*(1), 161-168.
[10] Veselov, A. E., Kazakov, R. V., Sysoyeva, M. I., & Bahmet, I. N. (1998). Ontogenesis of rheotactic and optomotor responses of juvenile Atlantic salmon. *Aquaculture*, 168, 17–26.

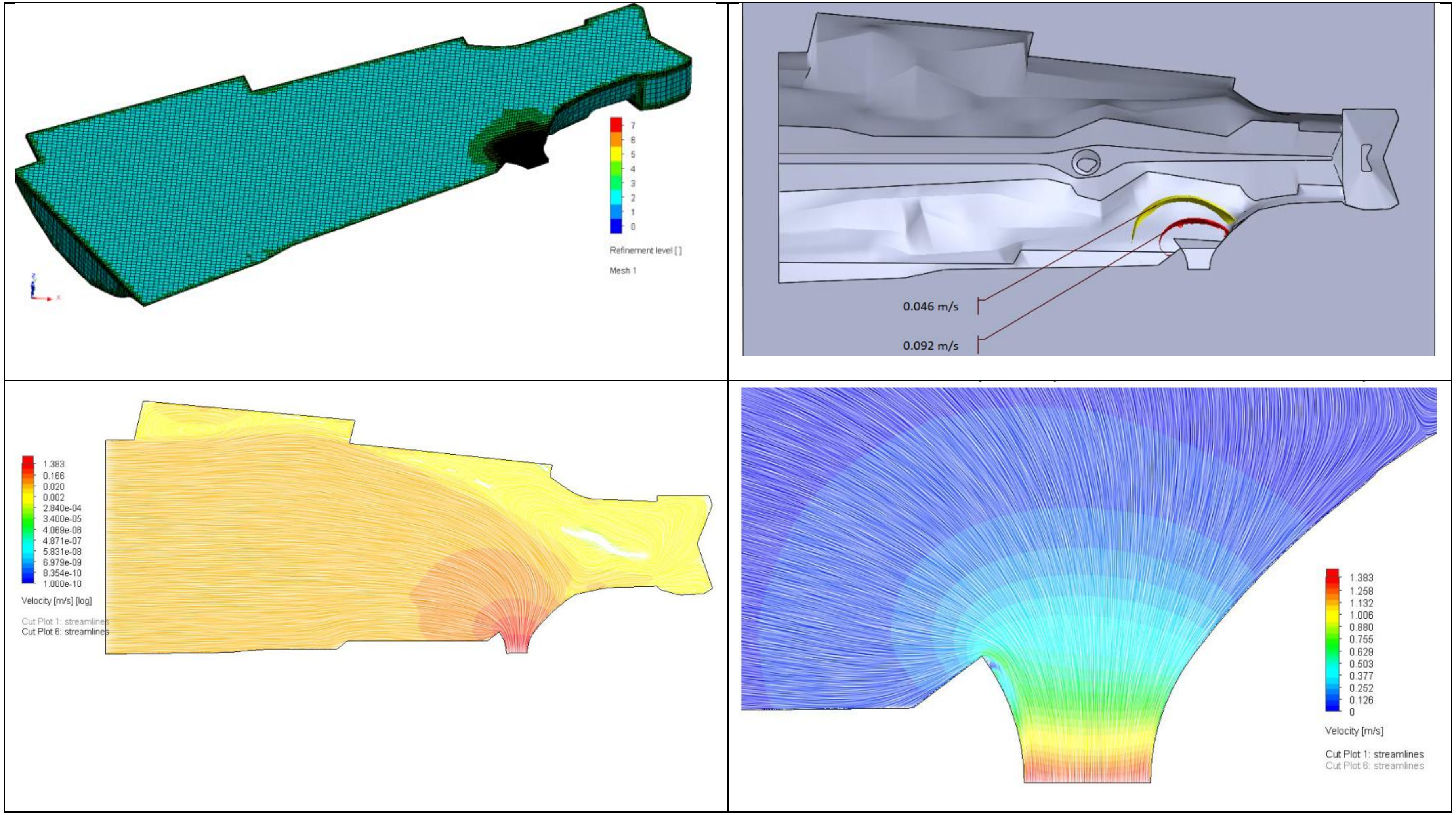

Figure 6-3. Summary of key outputs from the 4c Engineering CDF modelling of the canal inlet channel and proposed smolt pass, showing digital model construction and mesh refinement (top left), plan view of the channel showing the location of the identified smolt velocity thresholds (top right), plan view of the velocity streamlines (bottom left – note logarithmic scale) and detailed view of the streamlines at the inlet to the smolt channel (bottom right - note linear scale).

6.4.3 Supplementation with behavioural screening

For the downstream passage routes adjacent to the waste weir and the lock channel there is likely to be additional benefit in incorporating a behavioural screening technology angled at 45° to flow across the channel leading towards the bywash entrance. Past studies have demonstrated reasonable efficiency for diversion of smolts, including the use of bubble screens during daylight[11] and strobe lighting during hours of darkness[12]. Whilst behavioural screens are not sufficiently effective to utilise in isolation, these results suggest that they are likely to provide a beneficial supplementary measure to improve deflection of fish towards the entrance of the smolt pass channels and reduce migration delay. However, the primary focus should be on ensuring that the fundamental design principles are achieved for each smolt pass, i.e. creating appropriate entrance conditions and suitable attraction flow volumes.

6.5 Anticipated improvements

Previous studies have demonstrated that the retrofitting of dedicated downstream passage facilities can result in significant improvements to migration success and reduction in migration delay at weirs. For example, a radio tracking study of Atlantic smolts at a hydropower dam concluded that an angled screen and bywash channel (the latter not dissimilar in form to the proposed smolt passes at Dochfour) led to improved passage conditions[13].

Implementation of these dedicated downstream passage routes would be expected to result in a significant improvement to overall migration of smolts (alongside other migratory species/life stages) at the site compared to the existing arrangement. Improvements would be expected in the mean delay fish are exposed to whilst attempting to pass the weir, in addition to a reduction in the percentage of smolts entering Dochgarroch Lock (the majority of which are essentially then lost from the population).

[11] Welton, J. S., Beaumont, W. R. C., & Clarke, R. T. (2002). The efficacy of air, sound and acoustic bubble screens in deflecting Atlantic salmon, Salmo salar L., smolts in the River Frome, UK. *Fisheries Management and Ecology*, *9*(1), 11-18.
[12] Fjeldstad, H. P., Uglem, I., Diserud, O. H., Fiske, P., Forseth, T., Kvingedal, E., ... & Järnegren, J. (2012). A concept for improving Atlantic salmon Salmo salar smolt migration past hydro power intakes. *Journal of Fish Biology*, *81*(2), 642-663.
[13] Nyqvist, D., Elghagen, J., Heiss, M., & Calles, O. (2018). An angled rack with a bypass and a nature-like fishway pass Atlantic salmon smolts downstream at a hydropower dam. *Marine and Freshwater Research*, *69*(12), 1894-1904.

7. Climate Resilience

For fish passage options at the site to provide a sustainable long-term benefit there is a requirement to assess future climate change (CC) projections in relation to the functionality of both upstream and downstream fish passage facilities. This is considered in the following sections based upon available data and climate change scenario modelling work.

To inform potential future scenarios, additional modelling of climate change scenarios was undertaken by AECOM, comprising:

• *An agreed upper bound loch level based on a 1-in-200 year event with an appropriate climate change allowance.*
• *An agreed lower bound level representing a realistic prolonged low-flow scenario, based on the lowest flow recorded on the River Ness at Ness-side gauge over its 52 years of record.*

Further details on the modelling methodology are provided in the AECOM technical note[14].

7.1 Upstream passage

7.1.1 Operation during flood flows

The modelling results for loch level and River Ness flow for a 200 yr + CC scenario are provided in Table 7-1. These data indicate that the loch water level would be approximately 2.4 m higher than the 'typical' loch water expected for the upper end of the typical fish pass operating window (see Section 2.3).

Table 7-1. Modelling results for a 200 year + CC allowance scenario, showing total River Ness flow and upstream loch level (row 5) in comparison to measured historical large magnitude flood events (rows 1 – 4). Source: AECOM[6].

Return period	River Ness flow (m^3/s)	Loch Dochfour level
March 2015 event	697	17.07
Feb 1989 event	779	17.5
1890 event	890	17.6
200 year	906	17.97
200 year + CC (40%)	1269	19.32

Between the upper end of the typical operating window for the fish pass (Q10) and the extreme flood scenario described below, hydraulic conditions at Dochfour Weir would change progressively as river flows increase and downstream water levels in the River Ness rise. Available hydraulic information indicates that the existing weir begins to experience tailwater influence at approximately 16.2 mAOD, at which point the downstream river level begins to affect the upstream level at the structure. This level is below the typical upper operating level of the fish pass design range (approximately 16.5 mAOD), indicating that the transition toward drowned conditions begins within the upper part of the hydraulic range considered in the design. As flows increase beyond the Q10 design window, the downstream tailwater level increasingly influences the effective head difference across the weir. This progressively reduces the head drop across each slot within the vertical slot fish pass, with corresponding reductions in slot velocities and pool energy densities. Under such conditions the hydraulic environment within the fish pass typically becomes less energetically demanding for migrating fish. As downstream tailwater levels continue to rise the weir progressively drowns out, reducing the effective barrier presented by the

[14] AECOM (2026). Technical Note: 1 in 200+CC level in Loch Ness Drought level in Loch Ness for fish pass design.

structure. Once upstream and downstream water levels approach parity, fish passage is no longer dependent on the fish pass as migration can occur unimpeded across the weir crest in both the upstream and downstream directions. There is therefore no identified intermediate condition in which the fish pass would be expected to cease functioning while the weir continued to present a material barrier to upstream migration.

7.1.2 Operation during drought

The lowest anticipated flow volumes and loch water levels based on the lowest observed historical gauged flow event are summarised in Table 7-2 and Table 7-3, respectively.

Table 7-2. Summary of lowest observed flows (15 minute to 7 day average), recorded at Ness-side gauge with CC reduction factor and catchment area scaling factors applied. Source: AECOM[6].

Minimum average flow (m^3/s)	15 min	1 hr	6hr	12hr	24hr	3 days	7 days
Observed lowest flow	9.6	9.67	10.43	11.53	12.62	10.61	12.09
Catchment adjustment	9.32	9.39	10.13	11.20	12.26	10.31	11.74
10th centile	4.00	4.03	4.34	4.80	5.25	4.42	5.03
50th centile	6.94	7.00	7.54	8.34	9.13	7.68	8.75
90th centile	11.18	11.26	12.14	13.43	14.69	12.36	14.08

Table 7-3. Calculated water levels in Loch Dochfour for the flow volumes presented in Table 7-2, derived using the rating curve for Dochfour Weir. Source: AECOM[6].

Equivalent level in Loch Dochfour (mAOD)	15 min	1 hour	6hr	12hr	24hr	3 days	7 days
Observed lowest flow	15.29	15.29	15.31	15.34	15.37	15.32	15.36
10th centile	15.11	15.11	15.13	15.14	15.16	15.13	15.15
50th centile	15.21	15.22	15.23	15.26	15.28	15.24	15.27
90th centile	15.33	15.34	15.36	15.39	15.41	15.36	15.40

The median minimum flow with climate adjustment ranges between 6.94 m^3/s (15-minute average) and 9.13 m^3/s (one day average). This compares to a long term Q95 flow volume at Dochfour Weir of 21.07 m^3/s (Section 2.2).

Under these scenarios the water level in Loch Dochfour (the upstream water level for the proposed fish pass) falls to a median of 15.11 mAOD for the 15-minute averaged flow. This level is approximately 300 mm below the Q95 loch water level identified as the lower operating range of the fish pass – 15.40 mAOD (see Section 2.3). Despite projected drought levels falling below the Q95, vertical slot fish passes provide a significant degree of hydraulic flexibility compared to other types of fish pass and therefore under this scenario the upstream fish pass would continue to operate effectively. As a consequence of the reduction in loch level, the depth of water in each slot (H_1) would reduce to approximately 1.4 m, resulting in a modest reduction in fish pass discharge to approximately 2.10 m^3/s (compared to 2.70 m^3/s at Q95 loch levels). However, under the drought scenario the fish pass conveys a greater proportion of total river flow than the Q95 scenario and remains above recommendations for minimum fish pass discharge at low river flows[15]. It is therefore anticipated that the fish pass will continue to function effectively hydraulically and remain attractive to upstream migrating fish under the assessed drought scenarios.

[15] Larinier, M. (2002c). Location of fishways. In Larinier, M., Travade, F., Porcher., 2002: Fishways: biological basis, design criteria and monitoring. Bull. Fr. Peche Piscic., 364 suppl., 208p. ISBN 92-5- 104665-4.

7.2 Downstream passage

7.2.1 Operation during flood flows

Between the upper end of the typical operating window for the downstream passage facilities (Q10) and the extreme flood scenario described below, hydraulic conditions at Dochfour Weir would change progressively as river flows increase. As downstream tailwater levels rise, the head difference across the weir reduces and water depths across the structure increase. Under these conditions the dedicated smolt passes would progressively transition from operating as discrete controlled passage routes to conditions where increasing volumes of water pass over the wider weir crest. As tailwater levels continue to rise, the smolt passes themselves would become increasingly drowned and their hydraulic influence would reduce relative to the overall flow passing across the wider weir structure. In such circumstances the weir no longer acts as a significant barrier to downstream migration, as fish are able to pass over the crest with the dominant discharge. There is therefore no identified intermediate condition in which the dedicated smolt passes would cease to function while the structure continued to present a barrier to downstream movement.

7.2.2 Operation during drought

The proposals for downstream passage at the weir involve the creation of three dedicated smolt passage routes (see Section 6.3). The inlet to each of these channels would comprise an adjustable weir crest section comparable in operation to the main adjustable weir. Under the worst case drought scenario a median 1 day average minimum flow volume of 9.13 m^3/s is predicted, which would need to be apportioned between the upstream fish pass and the downstream fish passes to maintain continuity of upstream and downstream passage during drought events.

Under this drought scenario a flow of 2.10 m^3/s would be passively conveyed via the upstream fish pass based on the modelled water level. Based on the modelled median 1 day average minimum flow volume (9.13 m^3/s), a residual flow volume of 7.03 m^3/s would therefore remain to service the available flow routes. The inclusion of the penstock controlled auxiliary flow channels on the upstream fish pass, alongside the adjustable weirs on the three smolt passes, provide flexibility to apportion this residual flow between the fish passage structures as necessary to maintain functionality according to species specific requirements. The optimal flow allocation is likely to be dependent upon the seasonality of extreme drought events in relation to timings of key migratory life stages, with the following key considerations:

- During drought events coinciding with the key smolt migration window there would benefit in allocating the majority of the residual flow via the smolt passes to ensure that migration of smolts out of Loch Dochfour is not impeded. Under this scenario both the upstream fish pass and smolt passes would therefore continue to function effectively, balancing the passage requirement of different salmon life stages.

- During drought events across the remainder of the year there would be benefit in focusing the majority of the residual flow via the vertical slot fish pass and Smolt Pass 3. The location of Smolt Pass 3 adjacent to the vertical slot fish pass entrance would maintain a coherent route of downstream passage whilst providing supplementary attraction flow for upstream migrants.

Critically, the proposed form of the upstream and downstream migration facilities provides the necessary level of flexibility for flow to be reapportioned between structures as required depending upon these seasonal sensitivities. Likewise, this hydraulic flexibility will ensure that both the upstream and downstream fish pass facilities continue to function hydraulically at flows less than the climate adjusted one day median minimum flow, For example, the passage routes would remain functional at the 15 minute median minimum flow (6.94 m^3/s; Table 7-2).

The inclusion of a best practice fish counter at the top of the upstream fish pass (see Section 8) also provides the ability for real-time monitoring of operational decisions, with opportunity for refinement via adaptive management.

8. Monitoring Opportunities

Under the proposed vertical slot arrangement there are numerous potential options available to monitor the upstream and downstream movement of fish through the structure. This monitoring activity would provide highly valuable data on population trends for the Ness catchment given that the weir itself would be largely impassable to upstream migrating fish (therefore the vast majority of fish will move upstream via the fish pass) and there are no significant tributaries entering the Ness downstream of Dochfour Weir (meaning that vast majority of the run of migratory fish into the Ness catchment upstream of Dochfour Weir will be recorded). This data would prove valuable in determining conservation limits for the river, supporting condition assessments for the River Morriston SAC and identifying longer term trends in population dynamics. Furthermore, the inclusion of a counter provides opportunity to demonstrate the effectiveness of the mitigation measure within the context of the wider scheme and may provide useful data to allow refinement and improvement of the operation of the fish pass and wider site over the longer term.

Numerous monitoring options exist for fish passes, with the preferred approach being dictated by the species to be monitored, the physical space available to accommodate the counter structure and site-specific environmental conditions (e.g. water clarity/turbidity and extent of water level fluctuations). The most common monitoring options and the relative advantages and disadvantages of each are summarised in Table 8-1.

Table 8-1. Summary of the main available fish pass monitoring approaches and the relative advantages and disadvantages of each option.

Option	Description	Advantages	Disadvantages
1) Resistivity counter	A series of electrodes on the bottom and/or sides of the channel which detect a change in resistivity as fish swim over the electrodes.	• Relatively low upfront capital cost • Reasonably low ongoing on-site maintenance requirements	• Limited data on species apportionment • No accurate method of measuring fish • Footage requires manual processing and ideally manual camera validation, which is labour intensive • High ongoing operating costs due to validation
2) Video camera monitoring	Installation of one, or several, video cameras in the exit channel from the fish pass.	• Ability to utilise AI software to automatically speciate recorded fish, minimising manual processing	• Low effectiveness during high turbidity water • Potentially requires multiple cameras to capture the full width of the channel • Likely to be blind spots in monitoring extent, therefore not providing full coverage • Requires periodic cleaning of the camera lenses
3) Dedicated fish counter (e.g. TiVA FC or Vaki)	Installation of a dedicated fish counter with associated guide screens and lifting infrastructure	• Provides full coverage of the channel due to use of guide screens to direct fish through a counting tunnel • Certain technologies (e.g. TiVA FC) automatically speciate and measure fish with a high degree of accuracy, minimising manual processing • Camera footage and data can be viewed in real time and made accessible to public via online platforms • Lifting and cleaning of equipment simplified due to deck and gantry arrangements	• Requirement for more infrastructure than other options • Higher initial capital cost, though offset by limited ongoing requirement for footage processing • Periodic onsite presence required to clean counter and guide screens.

Out of the available options, installation of a dedicated fish counter (e.g. TiVA FC or similar) and associated guide screens and access deck infrastructure is considered to be the preferred approach. Although the upfront capital expenditure of this option will be somewhat higher, this arrangement is considered to provide the most robust count data of any available monitoring technique, has negligible requirements for manual processing of footage/data due to the use of AI software and provides the opportunity for effective online data sharing with stakeholders and the general public. An example of a comparable installation is provided in Figure 8-1.

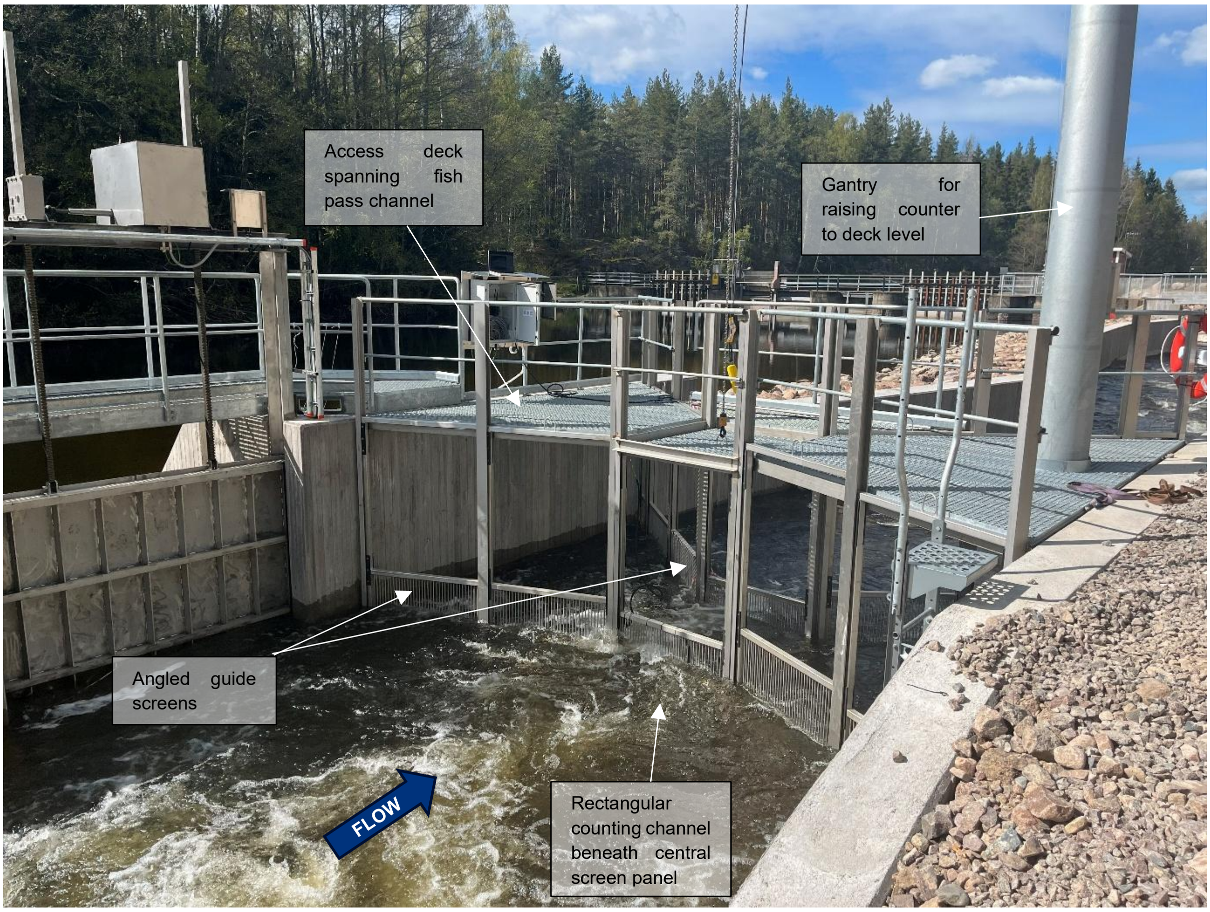

Figure 8-1. An example of guide screens and access deck infrastructure associated with a TiVA fish counter installation on a large fish pass in Sweden.

There would be a requirement to maintain the screens clear of debris throughout the year. This could either be achieved through manual cleaning of the screens or an automated arrangement (e.g. periodic automatic raking). Additionally, inclusion of an angled floating deflector on the inlet to the fish pass may be beneficial in reducing debris entrainment into the fish pass.

Providing the screens are maintained in an operable state then the monitoring arrangement would not be expected to result in any delay to migration or adverse impacts. Observation of fish behaviour from previous installations has demonstrated that fish readily locate the main unscreened attraction flow conveyed through the central counter tunnel.

Appendix 1 – Provisional Hydraulic Design

The anticipated hydraulic design of the proposed vertical slot fish pass at Dochfour Weir is detailed below.

- Head drop (H)

Maximum head drop: 0.21 m per slot at largest anticipated operating head (2.10 m).

Minimum head drop: 0.11 m per slot at smallest anticipated operating head (1.10 m).

- Total design flow:

4.53 – 9.06 m^3/s (5 – 10 % of Qmean) at Q95; increasing as river flow increases thereafter. A minimum Q95 design flow of 6% of Qmean (5.44 m^3/s) has been adopted at present, although the inclusion of auxiliary flow channels provides opportunity to increase flow significantly up to 10 % of Qmean, if required.

Flow per vertical slot given by the formula:

$$Q = Cd.b.H_1 (2gDH)^{0.5}$$

Where: Cd (coefficient of discharge)	= 0.85
b (slot width)	= 0.60 m
H_1 (slot water depth)	= 1.80 – 2.90 m
DH (head drop per slot)	= 0.11 – 0.21 m
Number of slots	= 2

Total vertical slot flow will therefore vary between a minimum of 2.70 m^3/s (1.8 m H_1 & 0.11 m DH) up to a maximum of 6.36 m^3/s (2.90 m H_1 & 0.21 m DH).

Any additional water required to meet the minimum total design flow (5.44 m^3/s) will be conveyed via two penstock controlled auxiliary flow channels on the outer sides of the vertical slot fish pass channel. Therefore, as the water level in the loch upstream of the fish pass rises and falls, it will be feasible to maintain adequate attraction flow to the fish pass by adjusting the volume of flow conveyed via the two auxiliary flow channels.

- Slot velocities

Maximum mean slot velocity: 1.83 m/s at maximum anticipated operating head

Minimum mean slot velocity: 1.25 m/s at minimum anticipated operating head

- Pool dimensions:

Maximum pool volume : 6.6 m (W) x 5.6 m (L) x 2.900 m (D) = 107.2 m^3

Minimum pool volume: 6.6 m (W) x 5.6 m (L) x 1.80 m (D) = 66.5 m^3

- Energy densities:

Maximum total energy (W) per pool at minimum head drop: 2,910 watts

Minimum total energy (W) per pool at minimum head drop: 13,097 watts

Maximum pool energy density: 122.2 W/m^3

Minimum pool energy density: 43.7 W/m^3

A comparison of the key hydraulic parameters for the proposed fish pass in relation to best practice design guidance for migratory salmonids[1] is provided in Table A1. Based on the proposed arrangement the design is considered to meet or exceed best practice requirements for each hydraulic parameter.

Table A1. Summary of key hydraulic fish pass parameters, showing best practice design requirements for migratory salmonids in comparison to the parameters associated with the proposed vertical slot design. Rows where the best practice requirements are met or exceeded are coloured green.

Parameter	Best practice guidance	Proposed fish pass
Head drop per slot	Maximum 0.30 m	0.11 – 0.21 m
Water velocity per slot	Maximum 2.4 m/s	1.25 – 1.83 m/s
Energy densities	Maximum 150 W/m^3	44 – 122 W/m^3
Total fish pass flow	4.53 – 9.06 m^3/s	Minimum 5.44 – 6.36 m^3/s

APPENDIX 2 – SMOLT PASS CFD MODELLING

File Note

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A	Initial release	09/03/2026	AR	AH	AH
B					
C					

Notes

This document describes the CFD analysis carried out by 4c Engineering for WestGlen Consult to illustrate the likely flow field generated by the smolt notch proposed by Glen Earrach Energy & Fishtek for the Dochgarroch Lock smolt pass.

Introduction

CFD modelling was undertaken to illustrate the likely flow field generated by the smolt notch proposed by Glen Earrach Energy & Fishtek for the Dochgarroch Lock smolt pass, under representative operating conditions.

The primary objective is to demonstrate the resulting attraction flow patterns in the vicinity of the entrance and their potential to guide fish towards the structure.

This analysis represents an optioneering-level assessment intended to validate the concept design and confirm that the proposed sizing is appropriate.

The model geometry represents the current conceptual smolt notch arrangement developed with Fishtek. The dimensions and flow assumptions applied in the model are based on the concept design parameters provided by Fishtek for this stage of the project. The configuration includes a 3 x 0.6m inlet with no tilting gate, connected to a chute with a maximum width of 5m and depth of 1.2m.

The model is based on the bathymetry provided to 4c Engineering of the canal at the location where the proposed smolt pass is to be constructed.

Methodology

No air–water interaction was modeled. The top water surface was assumed to be flat, and the simulation was configured as an internal analysis with a lid enclosing the entire water volume.

The model used in this CFD is shown in the figure 1, along with a map reference with the intended location for the smolt pass.

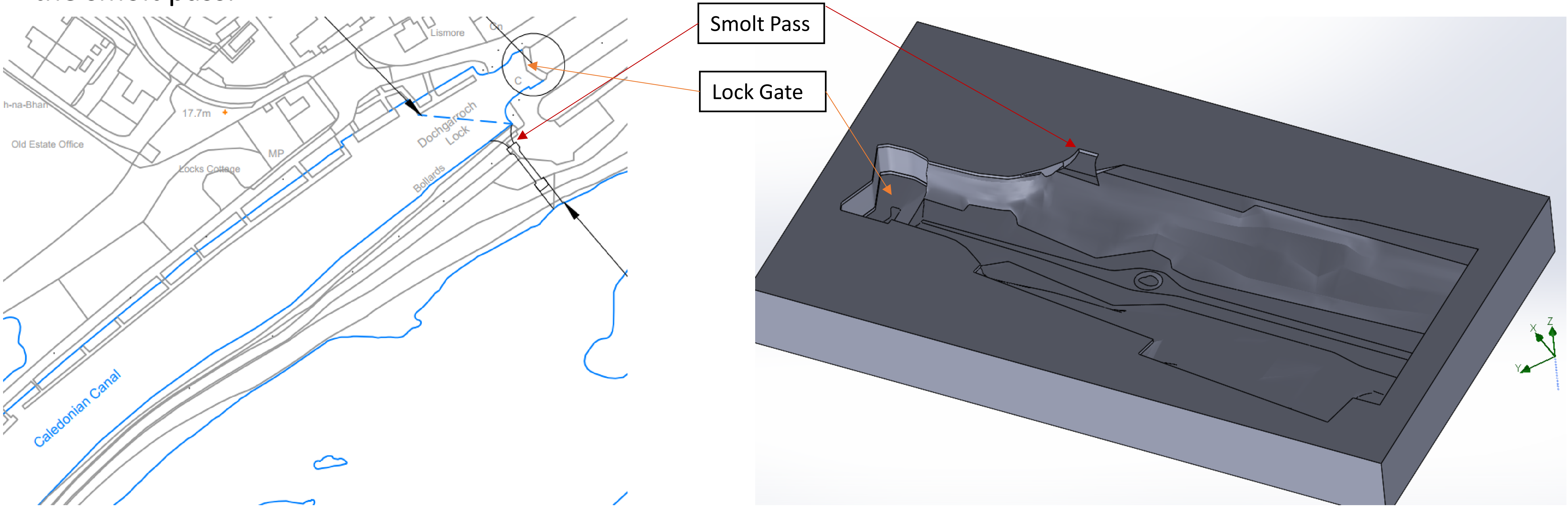


Figure 1 – CAD model used in the analysis and its geographical location.

Boundary Conditions

The inlet of the analysis is set as atmospheric pressure plus head of water:

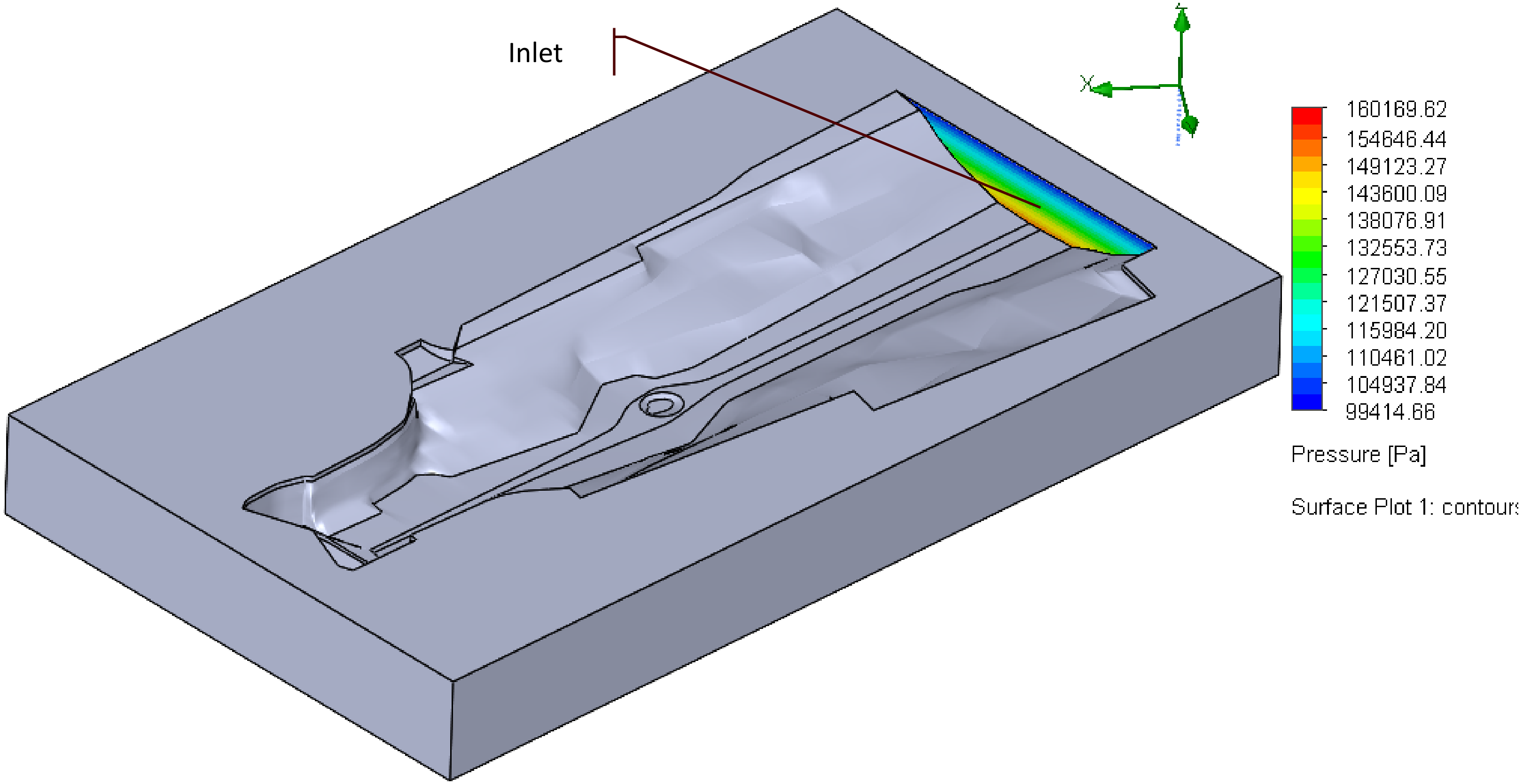


Figure 2 – Inlet of the analysis.

Boundary Conditions

The outlet of the analysis is set as a constant volume flow rate of 2.4 m^3/s (provided by Fishtek). This represents the assumed attraction flow through the smolt notch used for this conceptual assessment.

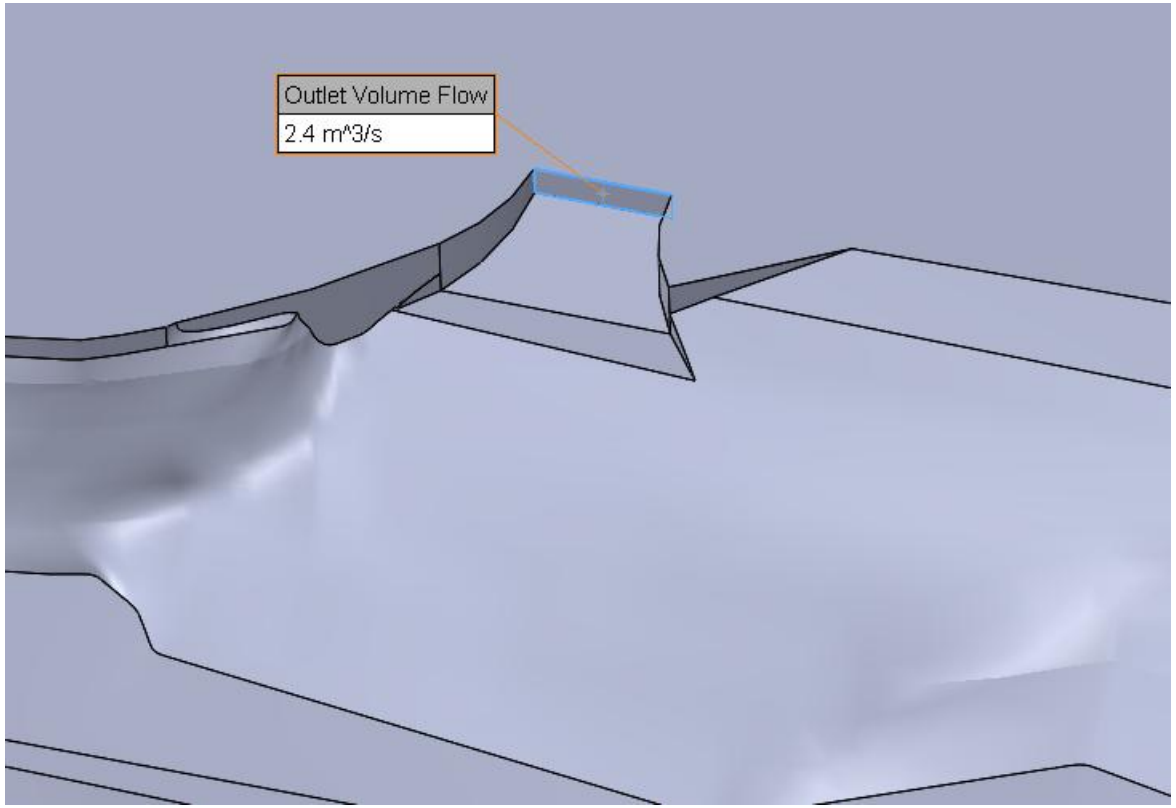


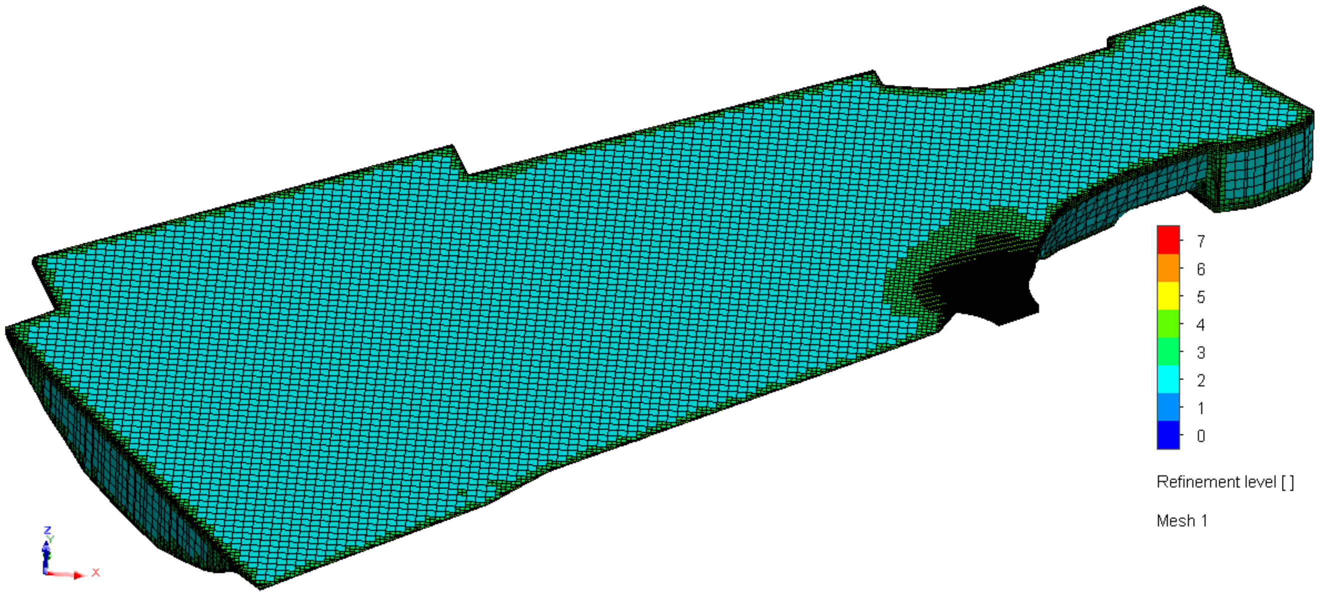
Figure 3 – Outlet of the analysis.

Meshing

A local mesh with increased cell density was manually generated in the vicinity of the bellmouth, where the steepest velocity gradients are anticipated.

In addition, three levels of automatic mesh refinement were enabled in the study using Flow Simulation's auto refinement algorithm, which incrementally refines regions exhibiting high flow property gradients.

This approach yields a computationally efficient mesh overall, while ensuring high spatial resolution in critical regions where it is required.



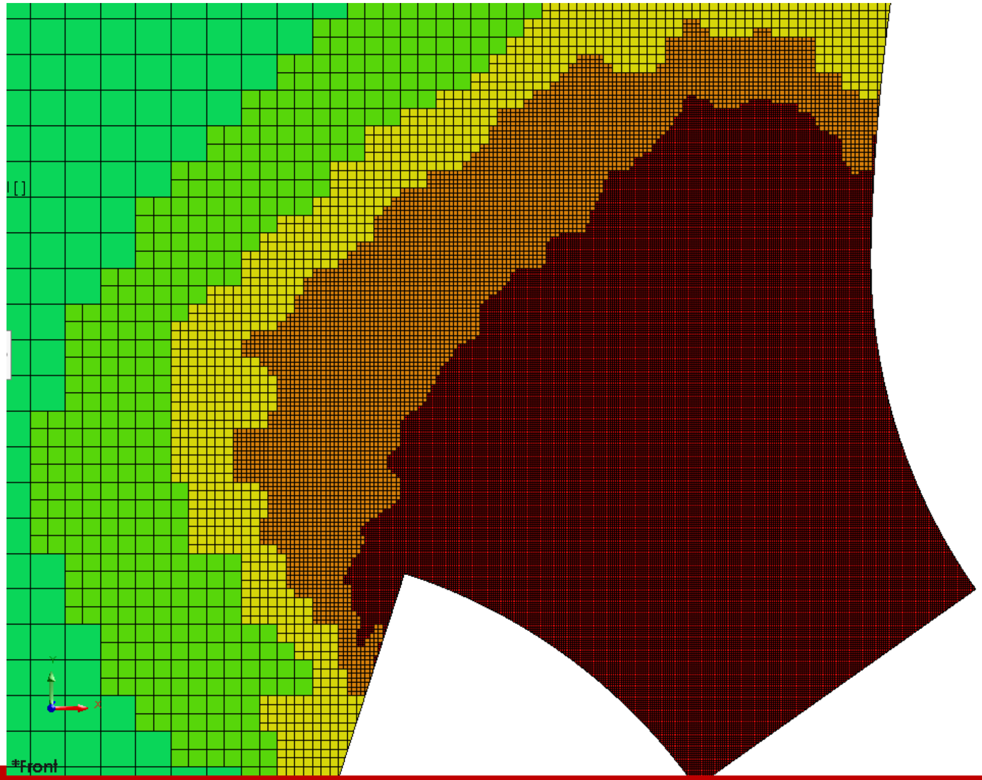


Figure 4 – Mesh used for the simulation.

Results

Results of this steady-state analysis are presented in the following slides.

Figures 5, 6 and 7 show velocity isosurfaces within the fluid domain. The volume of water enclosed between each isosurface and the outlet is subjected to velocities greater than the value associated with that isosurface. These plots are of particular interest as they illustrate the spatial extent of the influence of the smolt pass within the canal, highlighting attraction flows extending into the upstream basin from the bellmouth rather than being confined to the bellmouth itself.

Figures 8 to 11 present the overall flow field within the modelled fluid domain. These plots allow the flow transition from the canal towards the bellmouth to be assessed. The majority of the velocity increase occurs within the bellmouth, while velocities in the remaining parts of the basin remain very low. Therefore, a logarithmic velocity scale is included to enable visualization of the low-magnitude flows induced within the canal by the smolt pass.

Results

Velocity isosurfaces at 0.092 m/s and 0.046 m/s *(0.092 m/s is the lower 95% confidence interval of the mean minimum directional water velocity required to initiate a behavioural response resulting in a direction of orientation change in wild smolts (Kundegorski et. al, 2025))*:

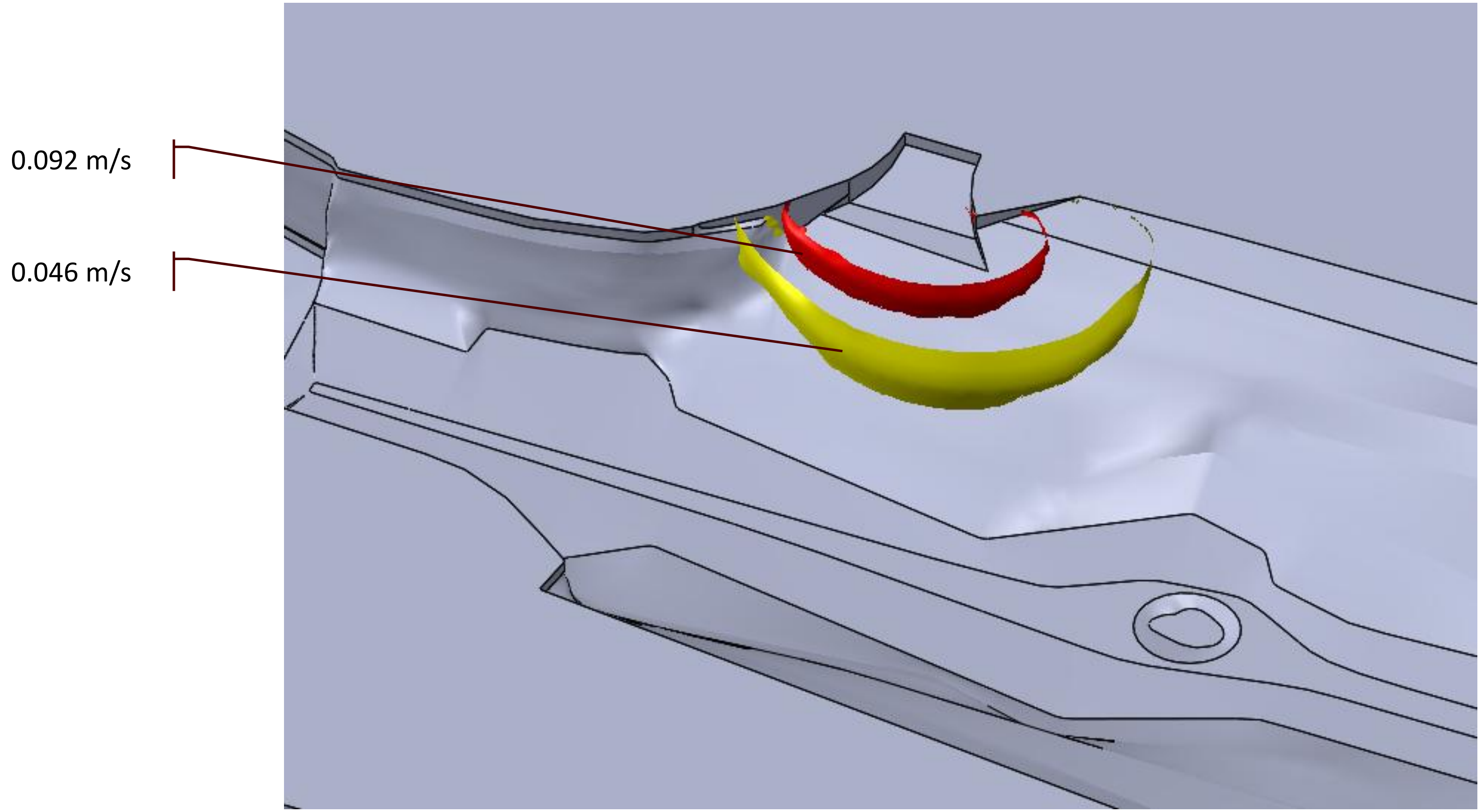


Figure 5 – Velocity isosurfaces at 0.092 m/s and 0.046 m/s.

Results

Velocity isosurfaces at 0.092 m/s and 0.046 m/s, top view:

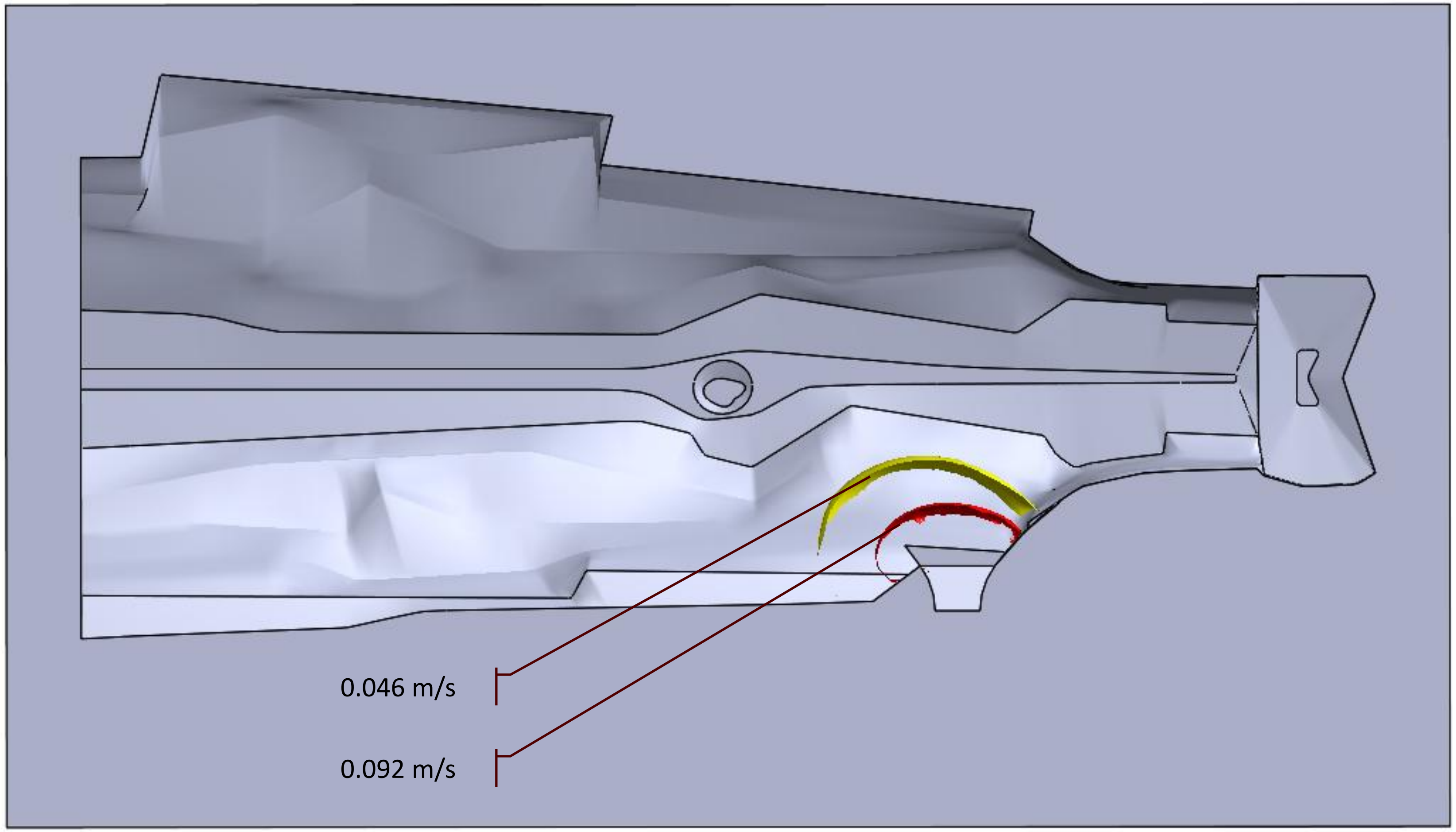


Figure 6 – Velocity isosurfaces at 0.092 m/s and 0.046 m/s, top view.

Results

Velocity isosurfaces at 0.092 m/s and 0.046 m/s, and velocity contours cut plot:

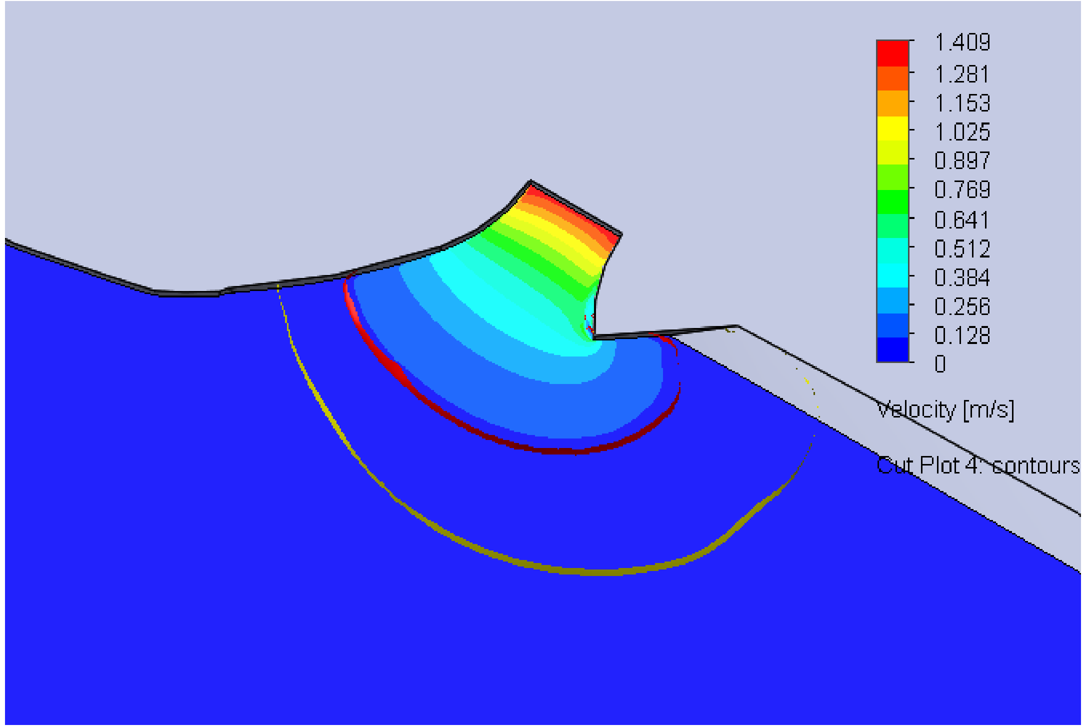


Figure 7 – Velocity isosurfaces and contours, top view, at the bellmouth area.

Results

Flow field using streamlines, colour-coded by velocity. Top View, 300mm depth:

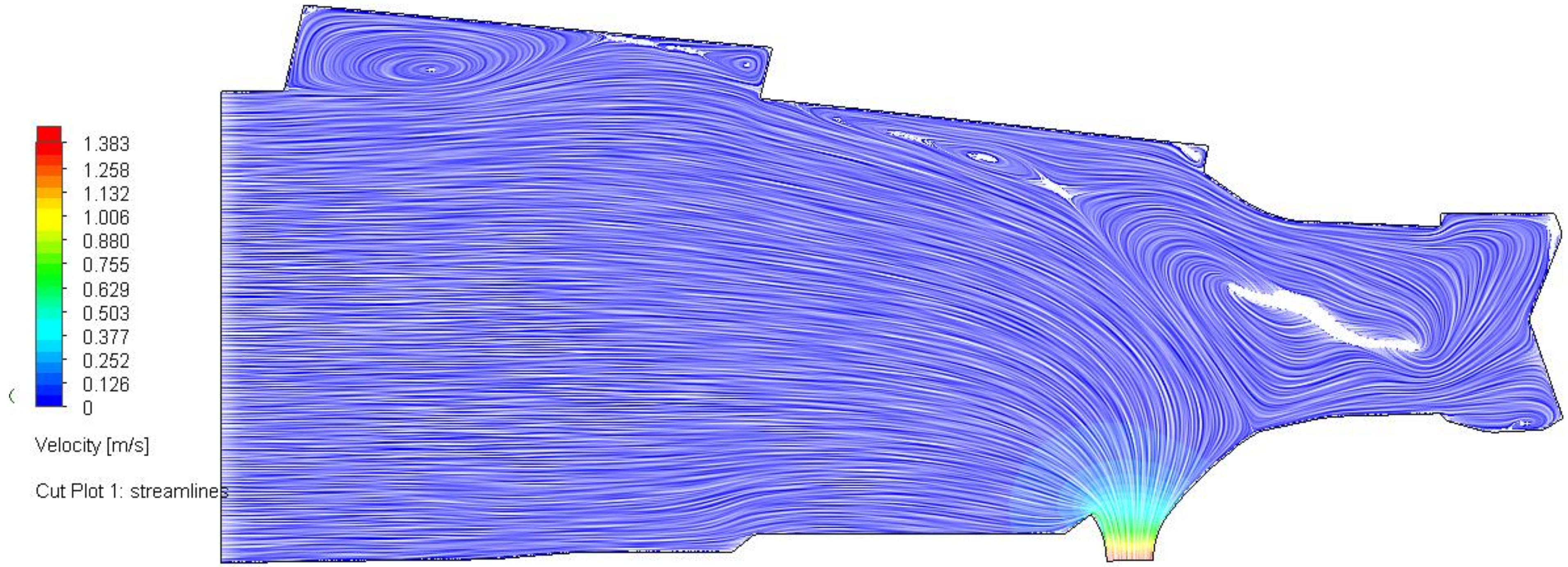


Figure 8 – Flow field using streamlines, colour-coded by velocity.

Results

Flow field using streamlines, colour-coded by velocity, zoomed in at bellmouth area. Top View, 300mm depth:

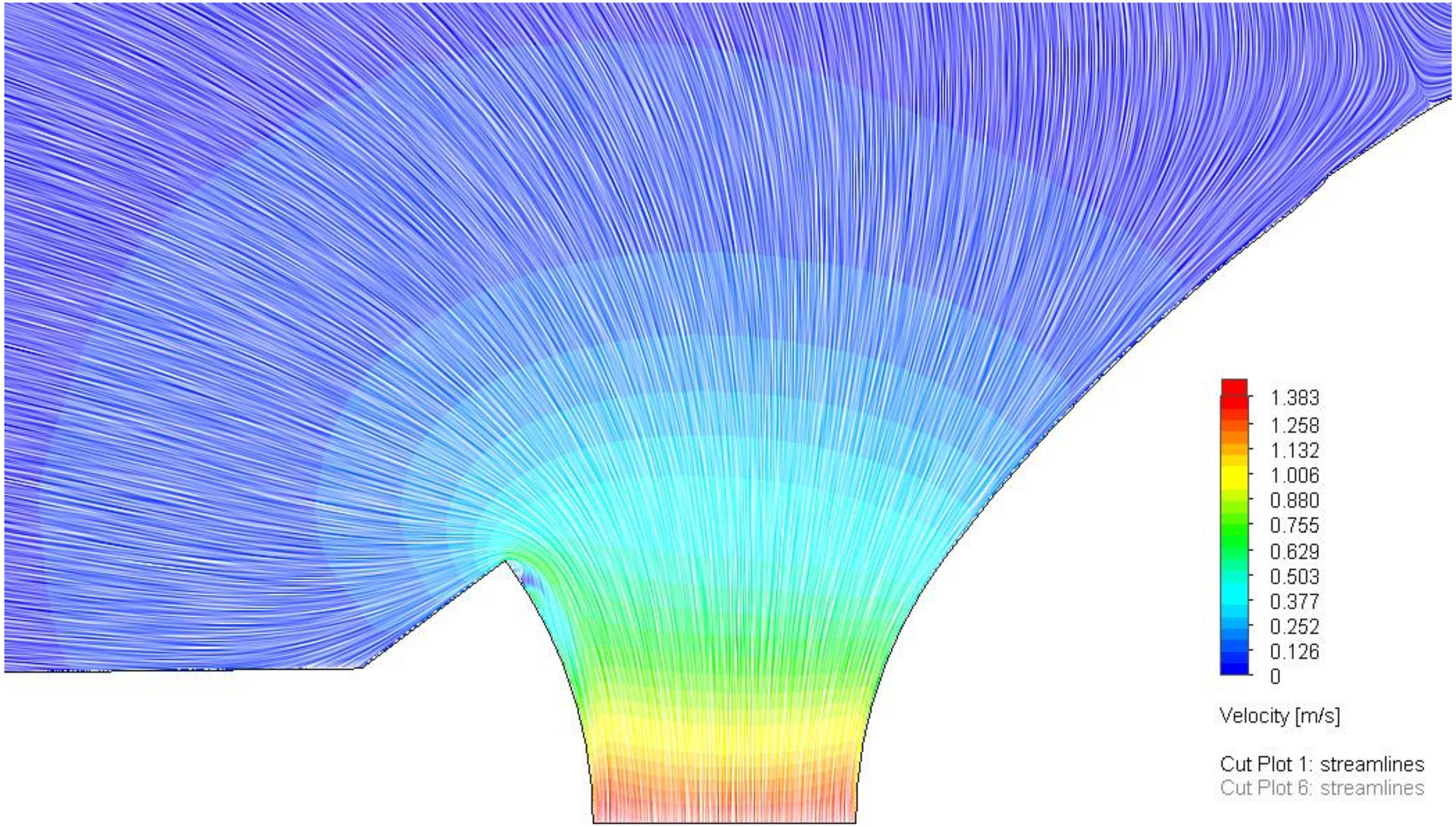


Figure 9 – Flow field using streamlines, colour-coded by velocity, at the bellmouth area.

Results

Flow field using streamlines, colour-coded by velocity – logarithmic scale. Top View, 300mm depth:

Figure 10 – Flow field using streamlines, colour-coded by velocity, on a logarithmic scale.

Results

Flow field using streamlines, colour-coded by velocity. Side section view:

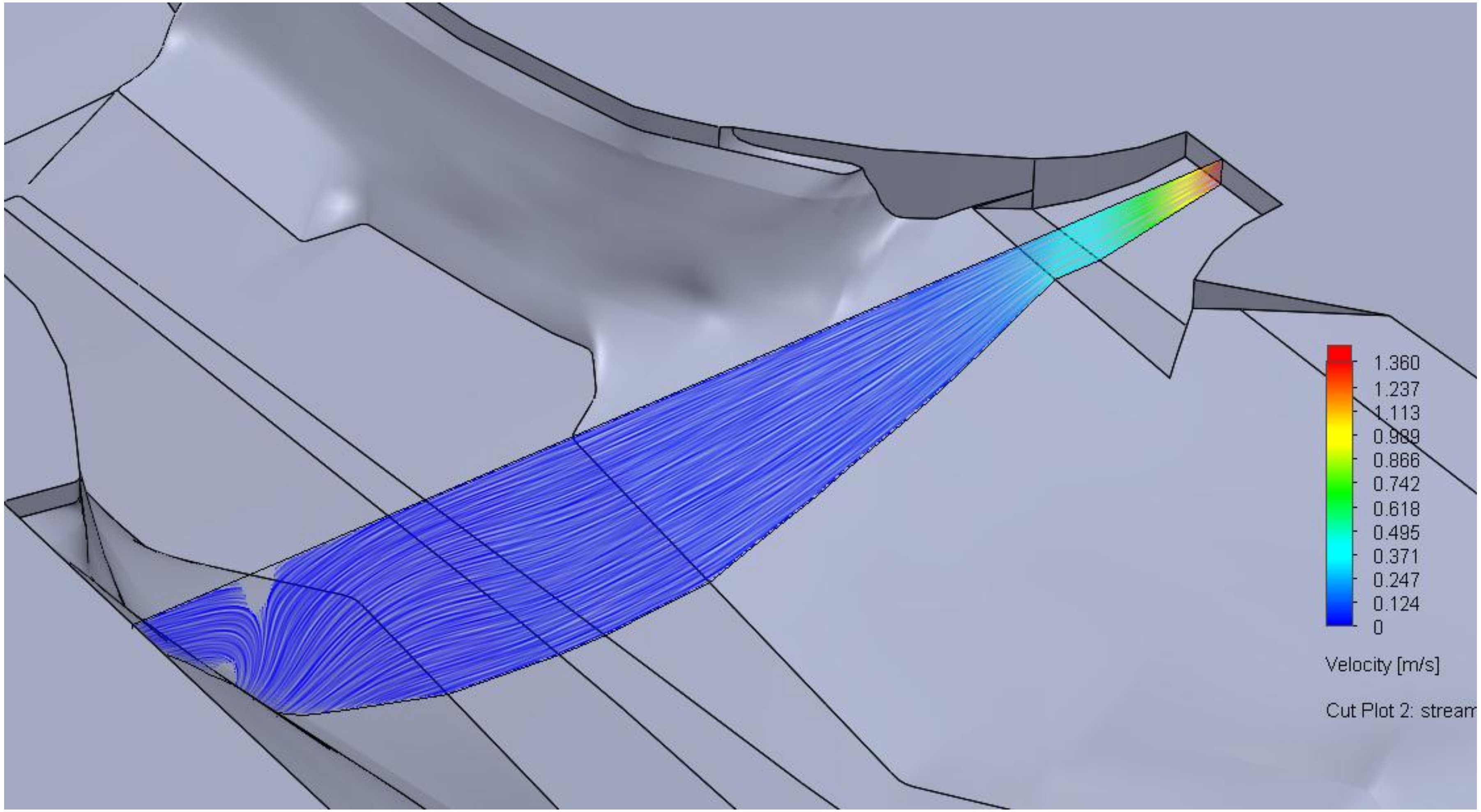


Figure 11 – Flow field using streamlines, colour-coded by velocity, on a side section view.

Results

Spatial acceleration was calculated manually by measuring the velocity at multiple points at known distances from the outlet and dividing the change in velocity by the distance between those points.

Acceleration values are shown in tables below (velocities measured at 300mm depth):

Distance from Gate	Velocity	Acceleration
[m]	[m/s]	[m/s/m]
0	1.409	
0.2	1.27	0.695
0.4	1.188	0.553
0.6	1.107	0.503
0.8	1.032	0.471
1	0.961	0.448

Table 1 – Spatial acceleration within the bellmouth.

For the analyzed scenario, spatial acceleration values are always below 1m/s/m. (*Haro, A., Odeh, M., Noreika, J., & Castro-Santos, T. (1998). Effect of water acceleration on downstream migratory behavior and passage of Atlantic salmon smolts and juvenile American shad at surface bypasses. Transactions of the American Fisheries Society, 127(1), 118-127.*)

Conclusions

- The simulated flow field appears realistic, with generally low velocity magnitudes throughout the domain, increasing locally within and immediately upstream of the bellmouth.
- The results indicate a coherent flow field directed towards the notch entrance, with attraction flows extending into the upstream basin from the bellmouth.
- Areas of higher velocity gradient occur locally near the bellmouth; however, the associated acceleration values remain within acceptable limits and are below the 1 m/s/m threshold provided by Fishtek.

Document	Dochfour Weir – Temporary Fish Passage Technical Note
Client	Glen Earrach Energy Ltd
Date	27/03/2026
Version	1.3
Author(s)	Paul Gratton
Reviewer(s)	Toby Coe

Summary

This technical note provides recommendations for temporary fish passage to maintain upstream and downstream passage during the construction phase of the proposed adjustable weir structure at Dochfour Weir at the downstream end of Loch Dochfour.

1. Background

Glen Earrach Energy Ltd ('GEE') are seeking to develop a pumped storage hydro (PSH) scheme in the Ness catchment. The scheme proposes to enlarge the capacity of the Loch nam Breac Dearga to be used as the head-pond, with Loch Ness forming the tail-pond. During periods of operation the scheme would result in discharge of water into Loch Ness, which has the potential to raise loch levels and consequently flow volumes to the River Ness downstream.

As a future phase of enabling works associated with the PSH scheme, modifications to Ness/Dochfour weir at the outflow from Loch Dochfour are proposed, incorporating an adjustable weir crest to maintain a 'natural' flow regime and mitigate potential variability in flow on the River Ness downstream arising from loch level changes due to PSH activity.

Alongside the main weir modifications, separate permanent works are also proposed to deliver improvements to existing upstream and downstream fish passage facilities present at the site, comprising:

- Construction of a new multi-species deep vertical slot fish pass at the upstream end of the service weir in the footprint of the existing bankside SSE sluice gate; and,
- Construction of three new downstream smolt passage routes, consisting of smolt passes located iii) immediately adjacent to the Dochfour Lock gates, ii) at the downstream end of the waste weir and iii) at the upstream end of the service weir.

2. Anticipated construction sequencing

The anticipated sequencing of the construction phase is detailed in Fishtek drawing no. 0103-3540681-P03 and is summarised below.

- Phase 1: Construction of two downstream smolt passes, located adjacent to the Dochfour Lock gates (Smolt Pass 1) and at the downstream end of the waste weir (Smolt Pass 2). These smolt passes are permanent structures, and form part of the overall improved fish passage provisions. Installation early in the programme will ensure that this part of the improved smolt passage arrangements are available before any other works start. This ensures that should the works cause smolts to be diverted into the canal reach, they can safely exit. Whilst both structures will initially be critical to forming part of the fish passage arrangement during the construction phase, they will ultimately become an integral part of the provision for cohesive passage at the site during the operational phase.
- Phase 2: Installation of a temporary fish pass and smolt pass at the upstream end of the service weir directly adjacent to the abutment for the SSE sluice gates to ensure that

upstream fish passage remains possible during subsequent phases of work when the existing passage route (lowered section of service weir crest) will be modified. Note that other than during the latter stages of Phase 4 and Phase 5, the existing upstream route of the lowered crest fish pass remains available.

- Phase 3: Construction of a new adjustable weir upstream of the crest of the existing waste and service weir, with the existing fish pass remaining operational.
- Phase 4: Decommissioning of the existing fish pass channel during construction of the final section of variable weir, allowing the variable weir to be commissioned.
- Phase 5: Construction of a new permanent vertical slot fish pass in the footprint of the existing bankside SSE sluice gate at the upstream end of the service weir.
- Phase 6: Decommissioning and removal of the temporary fish pass and replacement with final permanent downstream chute/smolt pass (Smolt Pass 3).

The purpose of this technical note is to outline the proposed temporary upstream and downstream fish pass arrangements that will be constructed during phase 2. The temporary passage arrangements will be relied upon as the primary means of upstream fish passage during phases 4 and 5 and an additional means of downstream fish passage, supplementing downstream passage routes that will be present via the main weir and Smolt Pass 1 and 2.

3. Overview of previous temporary fish passage

Temporary fish passage facilities were installed at Dochfour weir in 2017 during previous weir repair works commissioned by Scottish Canals. Sheet piles were driven along the crest and toe of the weir to stabilise the structure. During the latter phases of the project there was a requirement to pile along the crest and toe of the fish pass channel on the service weir. Consequently this route temporarily ceased to convey flow for the duration of the localised piling works and no longer provided a route for upstream passage.

With the agreement of stakeholders, including the Scottish Environmental Protection Agency (SEPA) and the Ness District Salmon Fishery Board (NDSFB), a temporary upstream fish pass was installed at the site prior to the piling works to the fish pass channel. The temporary fish pass comprised a single flight Alaskan Denil pass with an upstream lead-in channel formed from a large diameter pipe set in a lowered notched section adjacent to the service weir crest. An overview of the previous temporary fish pass is provided in Figure 1.

Figure 1. Photograph of the temporary fish pass installed at Dochfour Weir during the Scottish Canals piling repair works, facing downstream.

The previous fish pass was monitored via installation of video cameras at the upstream end of the lead-in channel (Figure 2). It is understood that processing and analysis of the video camera footage was undertaken by the NDSFB and demonstrated fish successfully exiting the fish pass.

Figure 2. Photograph of the upstream exit from the fish pass lead-in channel, shown during construction under low loch water levels. Sideways and overhead gantries and white boards were included in the design to allow video camera monitoring of fish exiting the fish pass.

An extract from the previous Fishtek design drawings for the temporary fish pass facility is provided in Figure 3. The previous fish pass was designed to convey a total flow of 0.37 m^3/s, which was deemed acceptable based on the duration that the fish pass was required to operate.

Under this discharge rate the fish pass would provide mean velocities of approximately 1.4 m/s, which is comfortably within the swimming capability of the target adult salmon life stages.

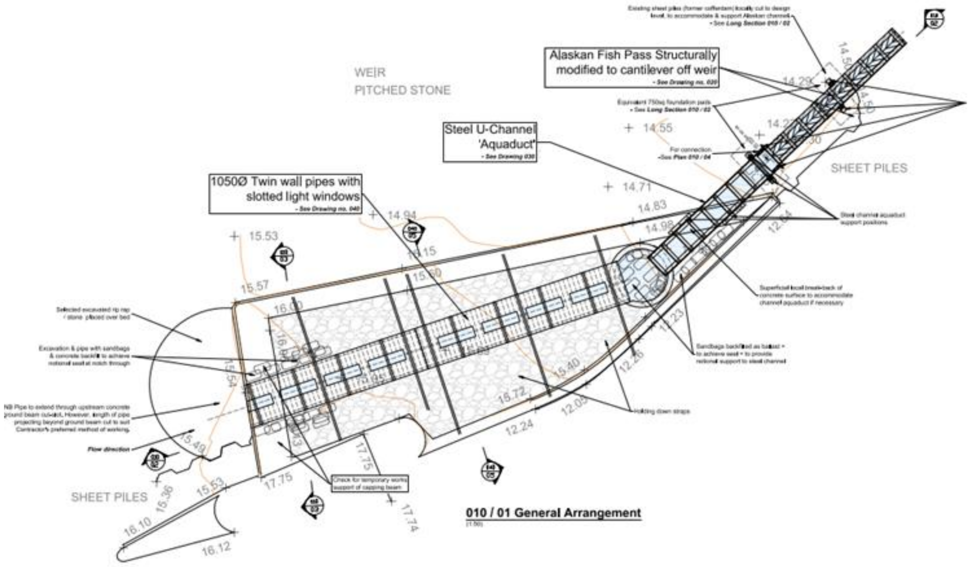


Figure 3. Extract from the Fishtek (2017) drawings, showing the general arrangement of the temporary Alaskan fish pass installed during the Scottish Canal weir repair works.

4. Proposed temporary fish pass arrangement

4.1 Overview

Due to the effective functionality of technical baffle passes for upstream migrating salmonids (grilse and multi-sea winter salmon and sea trout), and the stakeholder acceptance of this arrangement during the previous construction works, a similar arrangement is recommended during Phase 2 of the proposed construction sequence. However, several key modifications to are proposed to account for the longer duration over which the temporary fish pass is likely to be required to function. These changes comprise:

- Altering the type of technical baffle pass from an Alaskan Denil to a Chevron side baffle pass. The primary reason for this change is that Chevron side baffle passes are not width constrained in the same way as an Alaskan pass (where the internal width is fixed at a relatively narrow 350 mm). This allows a wider temporary fish pass to be installed, which can convey a significantly greater volume of flow than the previous arrangement.
- Provision for two co-located Chevron passes to further increase the attraction flow and the effective entrance width to ensure fish are able to locate the fish pass without undue delay.
- Provision for two temporary downstream smolt passes adjacent to the temporary upstream fish passes, comprising suitably sized pipes with appropriate inlet profiles to control acceleration. The pipes would be designed to terminate at the downstream toe of the weir such that the discharge from the smolt pass also provides supplementary attraction flow to the temporary upstream fish passes.

4.2 Hydraulic conditions

Discharge and velocity values for the proposed temporary fish pass have been calculated from rating equations established for side chevron baffle passes[1] detailed in the EA Fish Pass Manual[2] (Figure 5). The graphs require one, or both, of the following parameters:

- h_a - the upstream depth of water at the inlet to the fish pass before any acceleration of flow (i.e. the difference between the upstream hydraulic invert of the fish pass and the water level in Loch Dochfour).
- h – the water depth through the main fish pass. This is always shallower than the h_a value for a given flow as it is measured after flow has started accelerating through the fish pass.

The difference between the two parameters is illustrated in Figure 4.

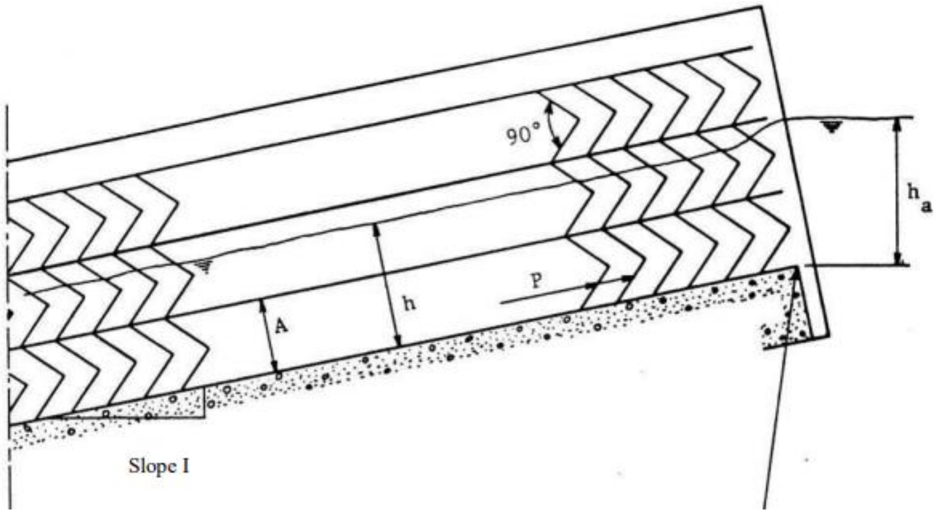


Figure 4. Long section through a Chevron side baffle pass, showing the difference between upstream head (h_a) and depth after acceleration of flow[1].

The graphs allow dimensionless flow (Q) to be calculated based on a known h_a or h, in addition to moving between h_a and h where only one of the two parameters is known.

A 20 % gradient is proposed for the temporary fish pass at Dochfour and therefore the rating curves for this gradient (solid circle symbols) have been used.

[1] Lariner, M., & Miralles, A. (1981). Etude hydraulique des passes a ralentisseurs (Hydraulic study of Denil fishways). Unpublished report, CEMAGREF. pp53

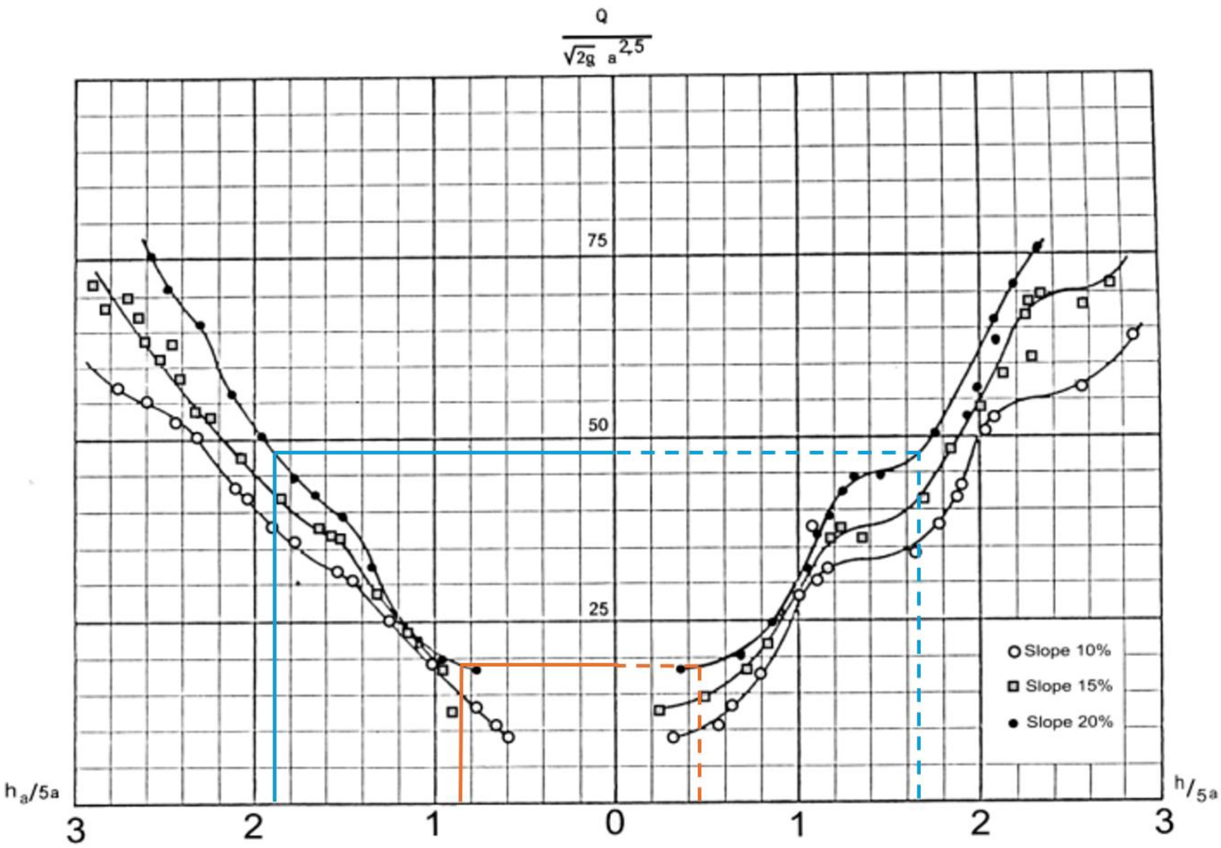


Figure 5. Dimensionless relationship between upstream head (h_a), mean depth in pass (h), and discharge (q) in a Chevron side baffle fishway at different gradients (after Larinier & Miralles, 1981). Overlaid to show i) left side: derivation of dimensionless Q for Q95 (orange solid line) and Q10 (blue solid line) for the corresponding h_a at each flow and ii) right side: calculation of the corresponding h for the h_a at Q95 (orange dashed line) and Q10 (blue dashed line).

The rating curves have been used to establish the discharge and velocity through the proposed fish pass under a Q95 and Q10 flow scenario – representing the lower and upper bounds of operation required for migratory salmonids. The calculations for each parameter are outlined below.

4.2.1 Discharge

<u>Q95</u>

- a (baffle thickness): 0.2 m
- H_a: 0.84 m
- $H_a/5a$ = 0.84 (Q95 X axis value on Figure 5)
- Corresponding Y value: 18

Chevron side baffle discharge (Q):

$$Q = Y \times \sqrt{2g} \times a^{2.5}$$

Where:

- *Y* = value derived from Larinier & Miralles, 1981 rating graph (18)

- g = gravitational acceleration (9.81 m/s^2)
- a = baffle thickness (0.2 m)

Therefore:

- Q95 flow (Q) = 18 * (2*9.81)^0.5 * 0.2^2.5
  = 1.43 m^3/s *(rounded 2 d.p.)*
- Total flow (two passes) = 2.85 m^3/s

Q10

- a (baffle thickness): 0.2 m
- H_a: 1.94 m
- $H_a/5a$ = 1.94 (Q10 X axis value on Figure 5)
- Corresponding Y value: 48

Chevron side baffle discharge (Q):

$$Q = Y \times \sqrt{2g} \times a^{2.5}$$

Therefore:

- Q10 flow (Q) = 48 * (2*9.81)^0.5 * 0.2^2.5
  = 3.80 m^3/s *(rounded 2 d.p.)*
- Total flow (two passes) = 7.61 m^3/s

4.2.2 Velocity

Water velocities in Chevron side baffle passes remain relatively constant across the water column compared to other types of baffle fish pass[2]. Given a uniform rectangular cross section of the fish pass channel it is therefore possible to calculate the mean velocity by dividing the total flow (Q) by the cross sectional area (A) (V = Q/A).

As flow accelerates down the Chevron side baffle fish pass, there is a reduction in water depth (h) relative to the initial upstream head at the inlet to the fish pass (h_a) (see Figure 4). The cross sectional area within the fish pass is therefore calculated by multiplying the h (depth after acceleration) by the channel width.

To derive h for a known h_a requires the reverse approach to that undertaken to determine dimensionless Q in Figure 5.

For the known y-axis value for a Q95 and Q10 flow, the corresponding x-axis value ($x=h/5_a$) is determined on the right side of Figure 5. The value is then converted into h through rearranging to h=x*5a. Given that a baffle thickness of 0.2 m is proposed for the temporary fish pass, 5 * 0.2 = 1, meaning the equation simplifies to h = x*1, or h=x. Under the proposed arrangement the corresponding h value is simply the x-axis value denoted by the dashed lines for the Q95 and Q10 flows in Figure 5. Therefore, the h_a of 0.84 m at Q95 results in a h (depth after flow acceleration) of 0.58 m, whilst the h_a at Q10 (1.94 m) reduces to a h value of 1.67 m.

[2] Environment Agency Fish Pass Manual (2010). Document – GEHO 0910 BTBP-E-E. 370 pp.

Q95 velocity

Mean velocity is calculated by dividing the total flow per fish pass by the cross sectional area of the fish pass flow, i.e. V = Q/A, where:

- Q95 Q = 1.43 m^3/s
- Q95 cross sectional area = 1 * 0.58 = 0.58 m^2

Therefore Q95 V = 1.43/0.58 = 2.47 m/s

Q10 velocity

- Q10 flow = 3.80 m^3/s
- Q10 cross sectional area = 1 * 1.67 = 1.67 m^2

Therefore Q10 V = 3.80/1.67 = 2.28 m/s

4.2.3 Summary

A summary of the hydraulic operation for the proposed temporary fish pass arrangement is outlined below. Calculations are based on two Chevron side baffle fish passes that are each 1.00 m wide and set to achieve a h_a (depth above upstream baffle) of 0.84 m at Q95. Based on the increase in upstream water level, the h_a on each fish pass would increase to 1.94 m at Q10.

- Number of upstream fish passes: 2
- Width per fish pass channel: 1.00 m

- Q95 depth per fish pass channel: 0.84 m
- Q95 discharge (total across two passes): 2.85 m^3/s
- Mean Q95 water velocity: 2.47 m/s

- Q10 depth per fish pass channel: 1.94 m
- Q10 discharge (total across two passes): 7.61 m^3/s
- Mean Q10 water velocity: 2.28 m/s

A summary of the hydraulic operation for the proposed temporary downstream fish pass arrangement is summarised below. Calculations are based on two 600 mm internal diameter pipes, set to achieve a Q95 water depth of 0.3 m at Q95. Upstream water levels would increase to above the pipe soffit at Q10, although both channels would continue to convey flow.

Q95 smolt pass discharge (total across two channels): 0.20 m^3/s

Q10 smolt pass discharge (total across two channels): 1.90 m^3/s

4.3 Comparison to best practice design guidance

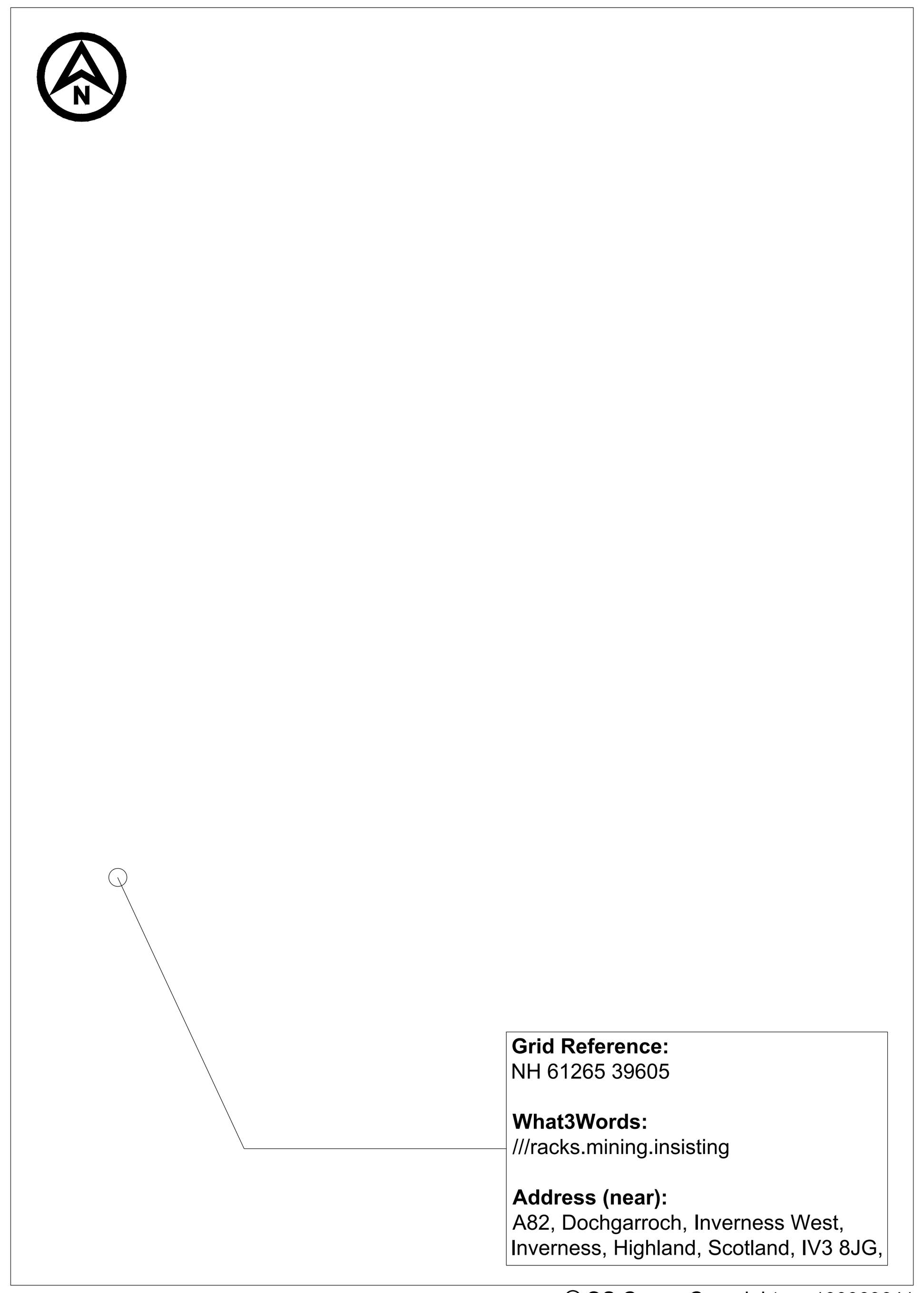
A strict upper velocity limit for Chevron side baffle passes is not stated in best practice guidance, although it is noted that velocities typically range from 1.7 – 2.5 m/s, with evidence of previous installations functioning well for migratory salmonids at sites with velocities up to 3 m/s [2]. The proposed temporary fish pass arrangement at Dochfour provides velocities of between 2.28 m/s (Q10) to 2.47 m/s (Q95) and therefore remains within, or below, these stated figures.

The total fish pass flow would be augmented by the additional discharge from the adjoining temporary smolt chute. The total flow of the temporary fish pass facilities would therefore be *ca.* 3.05 m^3/s at Q95, increasing to *ca.* 9.51 m^3/s at Q10. These flow volumes equate to approximately 14.5 % of the total Q95 discharge and 5.3 % of the Q10 discharge, respectively. Design guidance for large rivers of a size comparable to the Ness recommends a total fish pass discharge of 1 – 5 % of the competing flow during the migration period at sites where the fish pass entrance is optimally located [3]. Alternatively, a minimum discharge target equivalent to 10 % of the minimum river flow (Q95) can be applied[4]. The proposed temporary fish passage facilities meet this discharge target under both the low flow (Q95) and high flow (Q10) conditions.

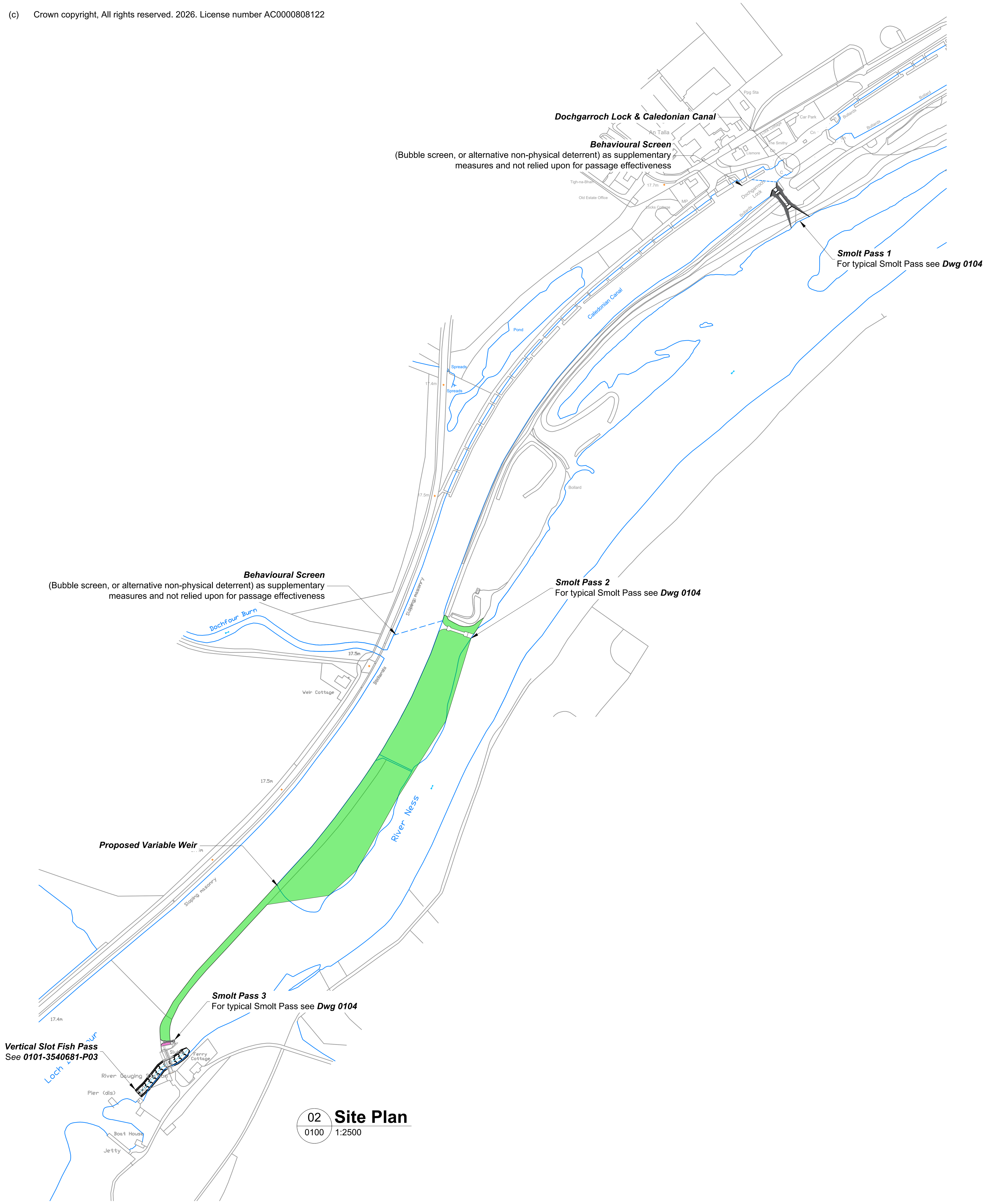
Whilst this arrangement provides appropriate attraction flows and water velocities to achieve an effective temporary passage solution, it is not considered a suitable permanent solution for the site due to the following reasons:

- Baffle passes require a moderate level of maintenance to ensure they remain clear of debris. Maintenance of the fish passes is not considered to be a significant burden during the construction phase given that the site will be adequately manned throughout. However, during the operational phase, the proposed permanent fish pass (deep vertical slot) represents a lower maintenance solution.
- Whilst velocities generated by the Chevron side baffle pass are appropriate for the upstream passage of salmon, this arrangement does not provide a multi-species passage solution for non-salmonid species (e.g. eel, lamprey) which is desirable over the longer-term operational phase of the scheme.

[3] Larinier, M. (1992). *Fishways—general considerations*. In D. V. Marmulla (Ed.), Fish passage facilities and obstruction of river migration (FAO Fisheries Technical Paper No. 209). Rome: Food and Agriculture Organization of the United Nations.
[4] Larinier, M. (2002c). Location of fishways. In Larinier, M., Travade, F., Porcher., 2002: Fishways: biological basis, design criteria and monitoring. Bull. Fr. Peche Piscic., 364 suppl., 208p. ISBN 92-5- 104665-4.



01 / 0100 **Location Plan**
NTS



02 / 0100 **Site Plan**
1:2500

SAFETY HEALTH & ENVIRONMENTAL INFORMATION

In addition to the hazards/risks normally associated with the type of work detailed on this drawing, note the following risks and information. Risks listed here are not exhaustive. Refer to Designer's Risk Assessment and pre-construction phase plan.

Construction
C1 - Managing flow & levels
C2 - Working near water
C3 - Risk of falls from height
C4 - Lifting

For information relating to Use, Cleaning and Maintenance see the Health and Safety File

It is assumed that all works will be carried out by a competent contractor working, where appropriate, to an approved method statement

NOTES:

1. DIMENSIONS:
- Are in millimetres unless otherwise stated.
- Marked thus (*) are approximate.
- All levels are in metres to Ordnance Datum.

2. SPECIFICATION:
All works to be carried out in accordance with the Civil Engineering Specification for the Water Industry (CESWI) 8th Edition, unless specified otherwise by the client.

3. DESIGN DEVELOPMENT:
Design intended to illustrate the general operating principles and demonstrate feasibility. Further hydraulic design development is required at outline design phase to ensure that species specific passage requirements are met.

4. WATER LEVEL DATA:
Additional downstream water level data required to inform outline design phase.

Rev.	Date	Description	Auth.	Chkd.	Appr.
P03	06.03.26	FOR INFORMATION	MG	PG	PG
P02	06.02.26	FOR INFORMATION	MG	PG	PG
P01	05.02.26	FOR INFORMATION	MG	PG	PG

Status
Concept Design

Original Size: A1

Signatures
Authored: M. Giblin
Checked: P. Gratton
Approved: P. Gratton

Scale
As Shown

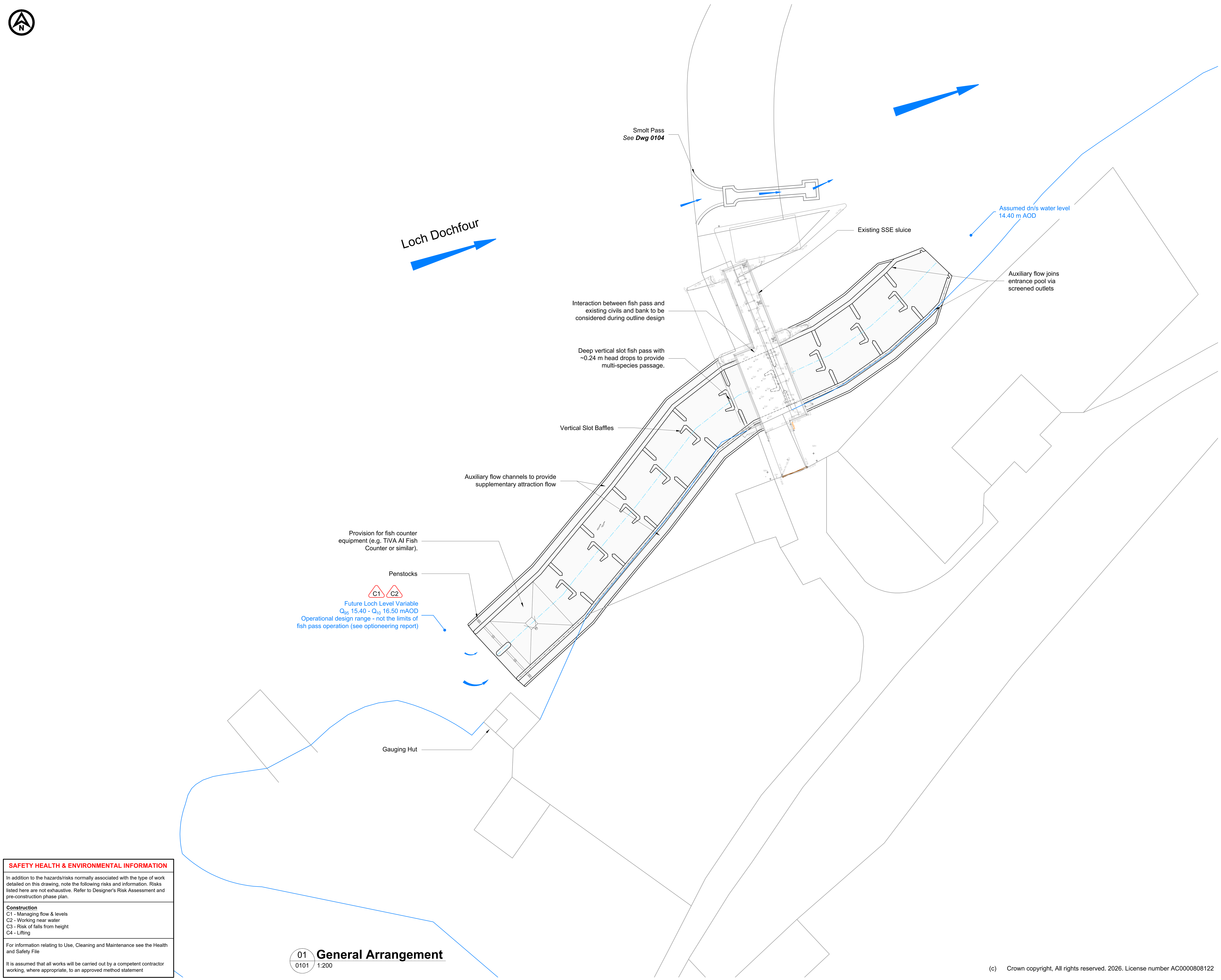
Client
Glen Earrach

Designer
FISHTEK

Project
Glen Earrach Energy
Dochfour Ness Weir
Fish Passage

Title
Site &
Location Plan

Drawing No.	Project No.	Revision
0100	3540681	P03



01 / 0101 **General Arrangement** 1:200

NOTES:

1. DIMENSIONS:
- Are in millimetres unless otherwise stated.
- Marked thus (*) are approximate.
- All levels are in metres to Ordnance Datum.

2. SPECIFICATION:
All works to be carried out in accordance with the Civil Engineering Specification for the Water Industry (CESWI) 8th Edition, unless specified otherwise by the client.

3. DESIGN DEVELOPMENT:
Design intended to illustrate the general operating principles to demonstrate feasibility. Full hydraulic design is required at outline design phase to ensure that species specific passage requirements are met.

4. WATER LEVEL DATA:
Additional downstream water level data required to inform outline design phase.

SAFETY HEALTH & ENVIRONMENTAL INFORMATION

In addition to the hazards/risks normally associated with the type of work detailed on this drawing, note the following risks and information. Risks listed here are not exhaustive. Refer to Designer's Risk Assessment and pre-construction phase plan.

Construction
C1 - Managing flow & levels
C2 - Working near water
C3 - Risk of falls from height
C4 - Lifting

For information relating to Use, Cleaning and Maintenance see the Health and Safety File

It is assumed that all works will be carried out by a competent contractor working, where appropriate, to an approved method statement

Rev.	Date	Description	Auth.	Chkd.	Appr.
P03	06.03.26	For Information	MG	PG	PG
P02	05.02.26	FOR INFORMATION	MG	PG	PG
P01	20.01.26	FOR INFORMATION	ES	MG	PG

Status: Concept Design

Original Size: A1

Signatures
Authored M. Giblin
Checked P. Gratton
Approved P. Gratton

Scale: 0 1:200 10 metres

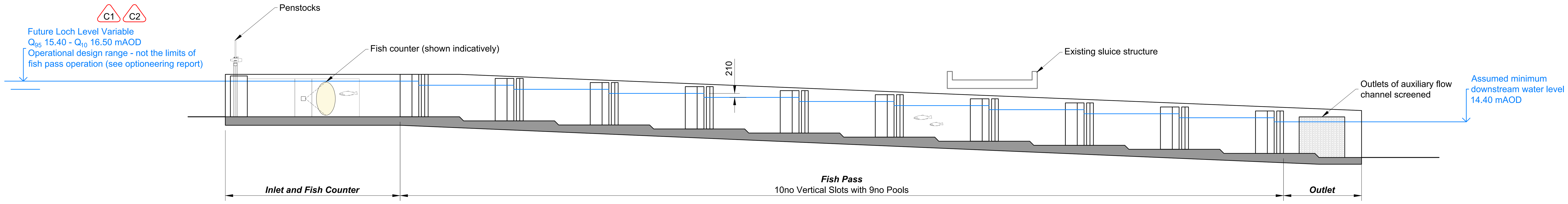
Client: Glen Earrach

Designer: FISHTEK

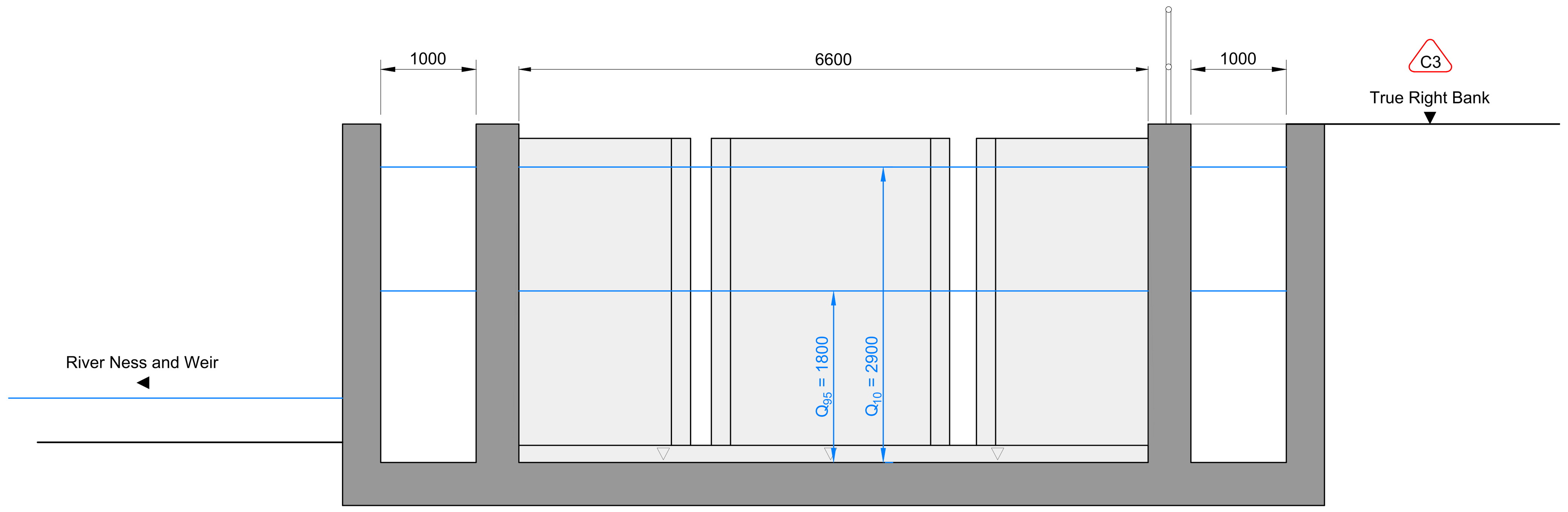
Project: Glen Earrach Energy Dochfour Ness Weir Fish Passage

Title: Fish Pass General Arrangement

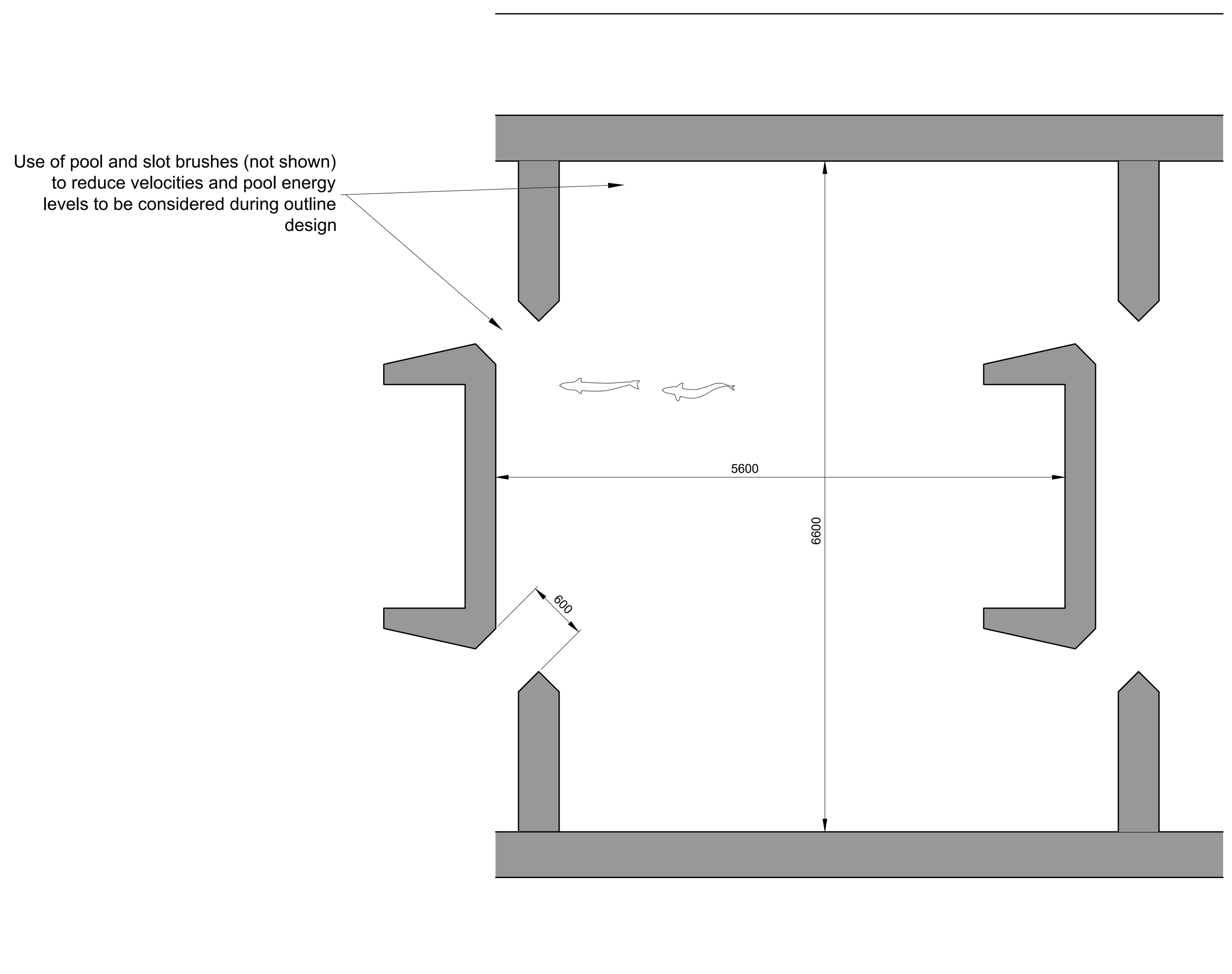
Drawing No.	Project No.	Revision
0101	3540681	P03



01 Typical Long Section
0102 1:150



02 Typical Cross Section
0102 1:50



03 Vertical Slot - Pool Dimensions
0102 1:50

SAFETY HEALTH & ENVIRONMENTAL INFORMATION

In addition to the hazards/risks normally associated with the type of work detailed on this drawing, note the following risks and information. Risks listed here are not exhaustive. Refer to Designer's Risk Assessment and pre-construction phase plan.

Construction
C1 - Managing flow & levels
C2 - Working near water
C3 - Risk of falls from height
C4 - Lifting

For information relating to Use, Cleaning and Maintenance see the Health and Safety File

It is assumed that all works will be carried out by a competent contractor working, where appropriate, to an approved method statement

NOTES:

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2. **SPECIFICATION:**
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3. **DESIGN DEVELOPMENT:**
Design intended to illustrate the general operating principles to demonstrate feasibility. Full hydraulic design is required at outline design phase to ensure that species specific passage requirements are met.

4. **WATER LEVEL DATA:**
Additional downstream water level data required to inform outline design phase.

Rev.	Date	Description	Auth.	Chkd.	Appr.
P03	06.03.26	FOR INFORMATION	MG	PG	PG
P02	05.02.26	FOR INFORMATION	MG	PG	PG
P01	26.01.26	FOR INFORMATION	ES	MG	PG

Status
Concept Design

Original Size: A1

Signatures
Authored M. Giblin
Checked P. Gratton
Approved P. Gratton

Scale
As Shown

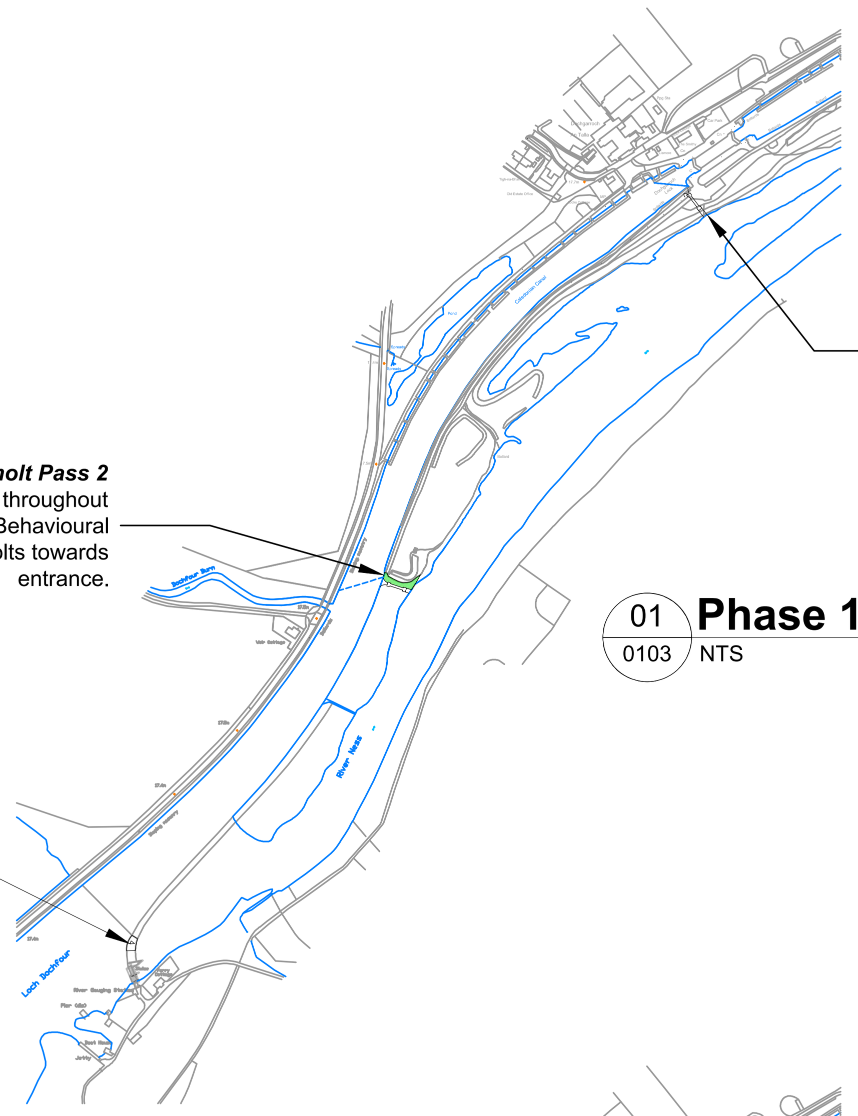
Client
Glen Earrach

Designer
FISHTEK

Project
Glen Earrach Energy
Dochfour Ness Weir
Fish Passage

Title
Fish Pass
Typical Sections
& Details

Drawing No.	Project No.	Revision
0102	3540681	P03

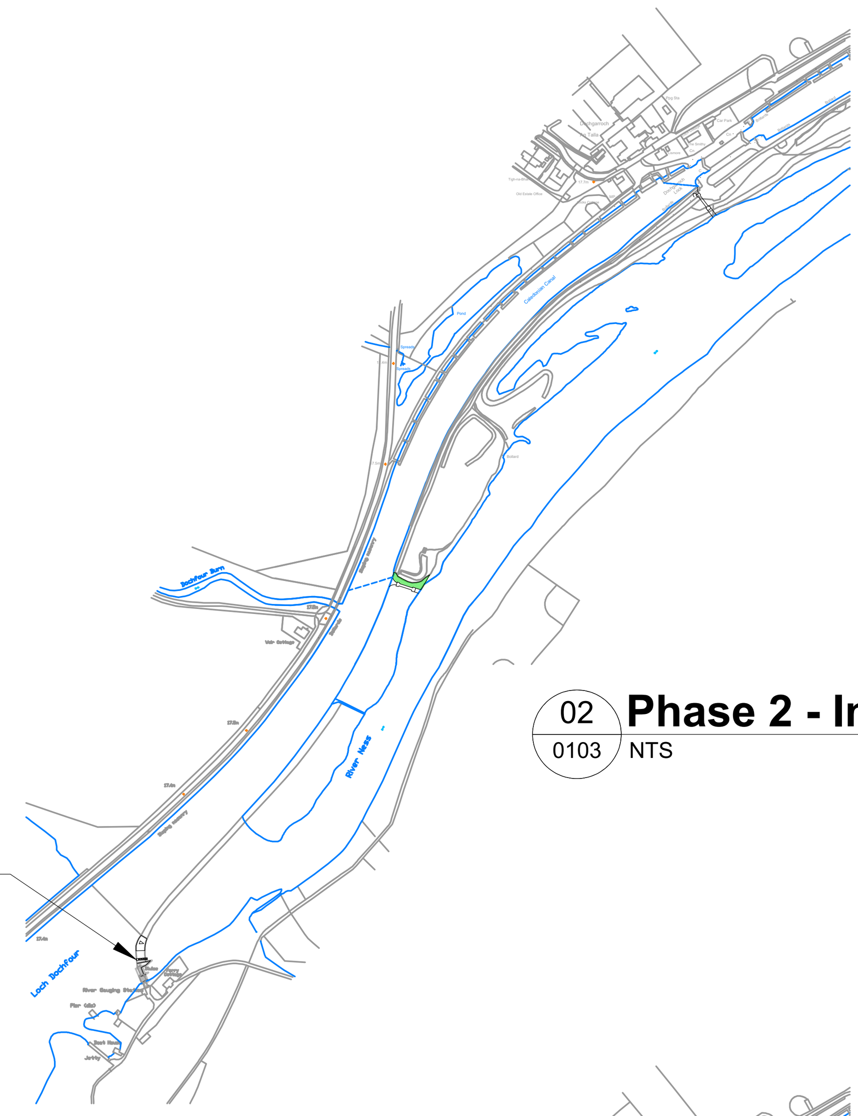


Smolt Pass 1
Allowing downstream smolt passage throughout construction works and in permanent state. Behavioural screen at ~45 degrees encouraging smolts towards entrance.

Smolt Pass 2
Allowing downstream smolt passage throughout construction works and in permanent state. Behavioural screen at ~45 degrees encouraging smolts towards entrance.

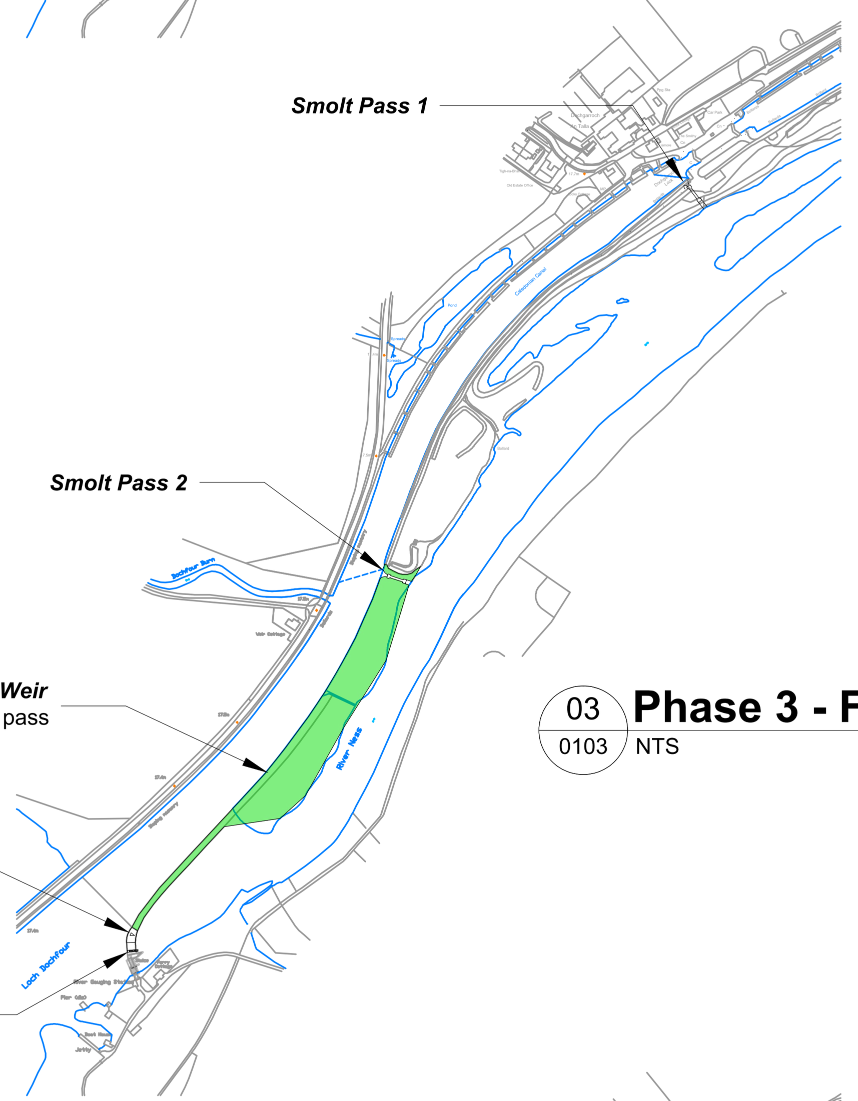
Existing Fish Pass
Allowing upstream fish passage during phases 1 - 3

01 Phase 1 - Form Smolt Passes 1 & 2
0103 NTS



Temporary Fish & Smolt Pass
Allowing upstream fish passage and downstream smolt passage during Phases 3 - 5.
See ***Dwg 105***

02 Phase 2 - Install Temporary Fish & Smolt Pass
0103 NTS



Smolt Pass 1

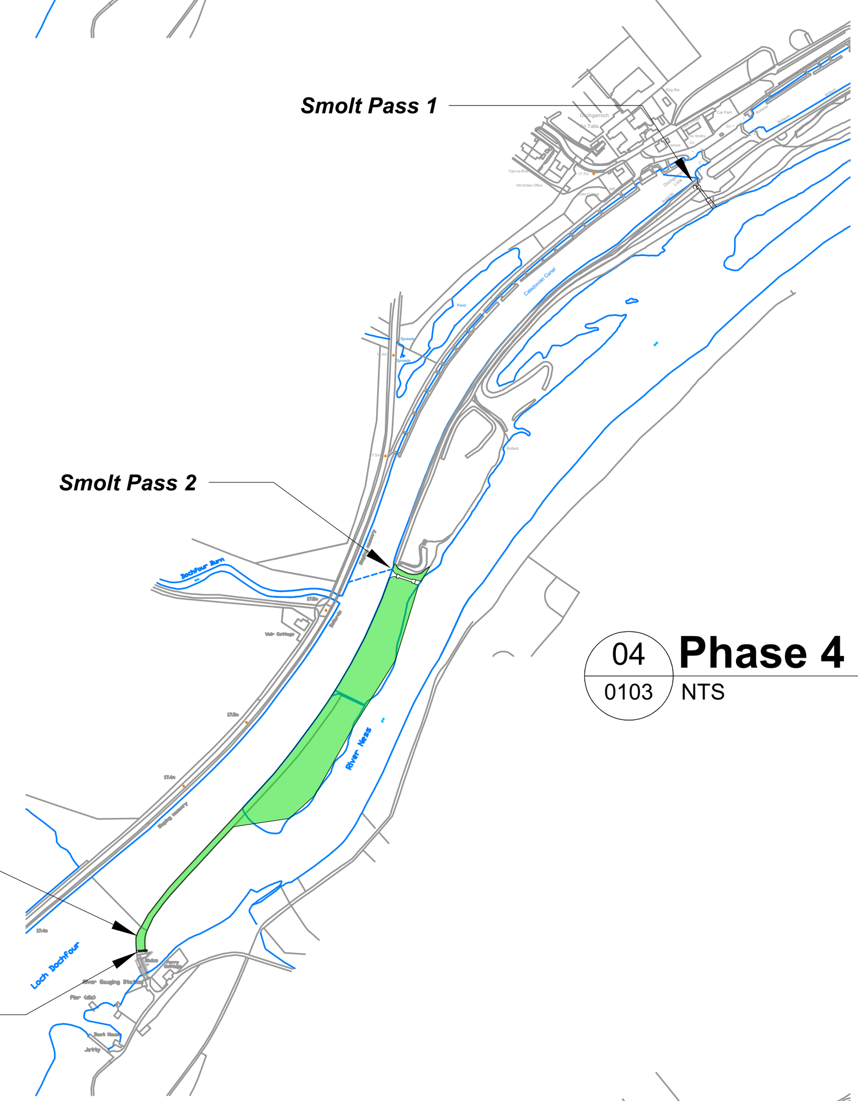
Smolt Pass 2

Variable Weir
Formed up to existing fish pass

Existing Fish Pass

Temporary Fish & Smolt Pass
Supplements existing fish pass in Phase 3

03 Phase 3 - Form New Variable Weir
0103 NTS



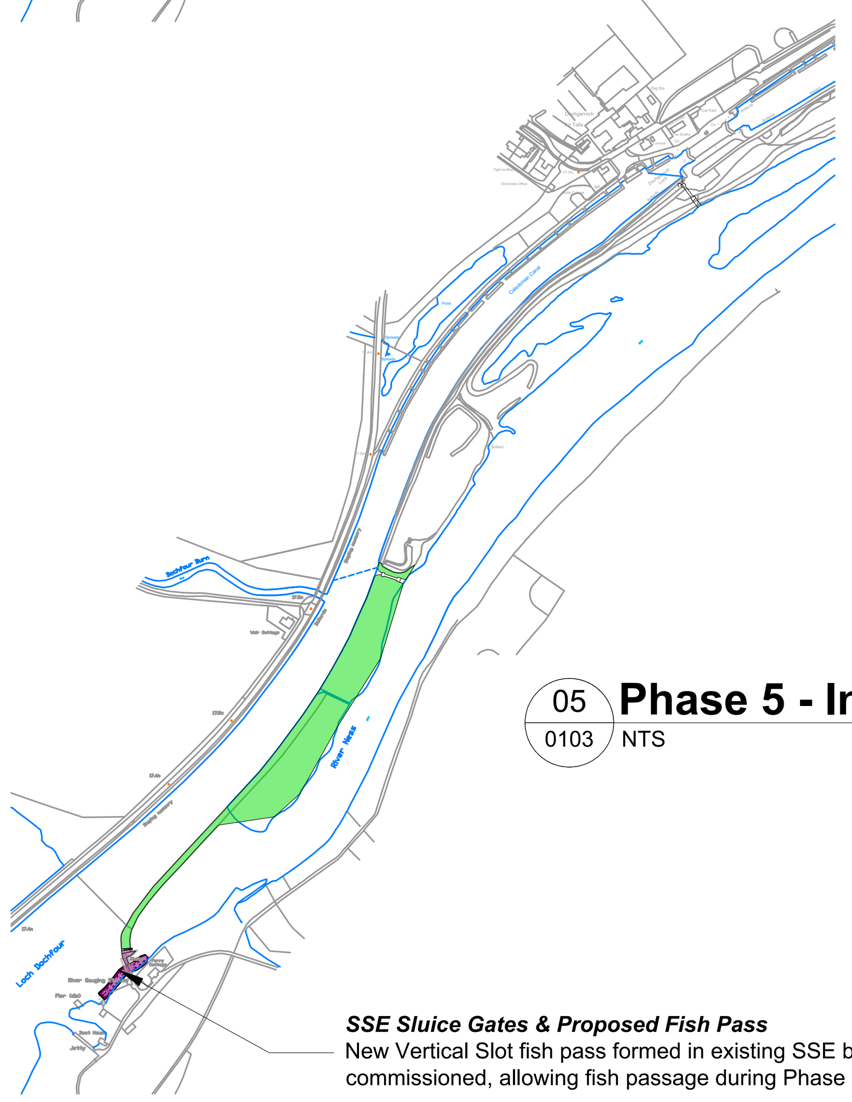
Smolt Pass 1

Smolt Pass 2

Variable Weir
Formed up to temp fish & smolt pass, removing existing fish pass

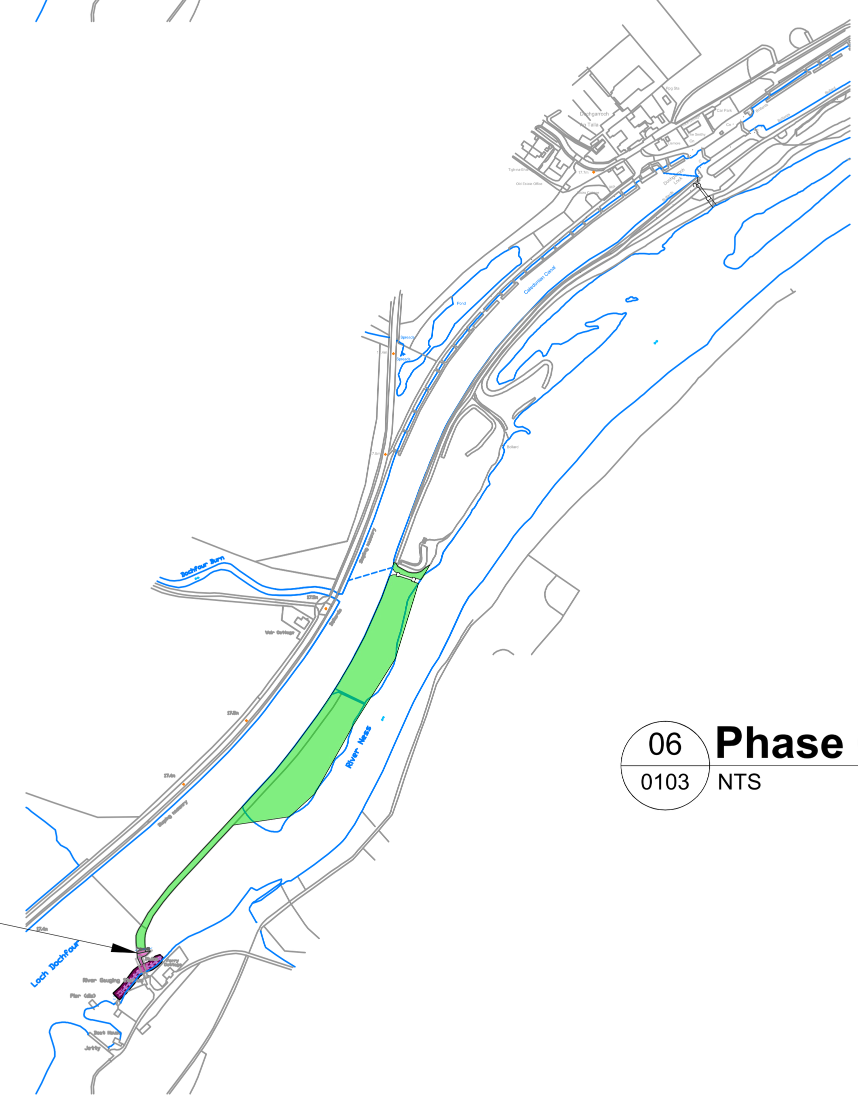
Temporary Fish & Smolt Pass

04 Phase 4 - Decommission Existing Fish Pass
0103 NTS



SSE Sluice Gates & Proposed Fish Pass
New Vertical Slot fish pass formed in existing SSE bankside sluice gate and commissioned, allowing fish passage during Phase 6 and permanent state

05 Phase 5 - Install Fish Pass
0103 NTS



Smolt Pass 3
Temporary fish & smolt pass removed and replaced with permanent Smolt Pass 3

06 Phase 6 - Commission Smolt Pass 3
0103 NTS

NOTES:

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3. DESIGN DEVELOPMENT:
Design intended to illustrate the general operating principles to demonstrate feasibility. Full hydraulic design is required at outline design phase to ensure that species specific passage requirements are met.

4. WATER LEVEL DATA:
Additional downstream water level data required to inform outline design phase.

SAFETY HEALTH & ENVIRONMENTAL INFORMATION

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Construction
C1 - Managing flow & levels
C2 - Working near water
C3 - Risk of falls from height
C4 - Lifting

For information relating to Use, Cleaning and Maintenance see the Health and Safety File

It is assumed that all works will be carried out by a competent contractor working, where appropriate, to an approved method statement

Rev.	Date	Description	Auth.	Chkd.	Appr.
P03	06.03.26	FOR INFORMATION	MG	PG	MG
P02	05.02.26	FOR INFORMATION	MG	PG	MG
P01	20.01.26	FOR INFORMATION	MG	MG	PG

Status
Concept Design

Original Size	A1	Signatures	
		Authored M. Giblin	
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		Approved P. Gratton	

Scale
Not To Scale

Client
Glen Earrach

Designer
FISHTEK

Project
Glen Earrach Energy
Dochfour Ness Weir
Fish Passage

Title
Construction Sequencing

Drawing No.	Project No.	Revision
0103	3540681	P03

NOTES:

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4. WATER LEVEL DATA:
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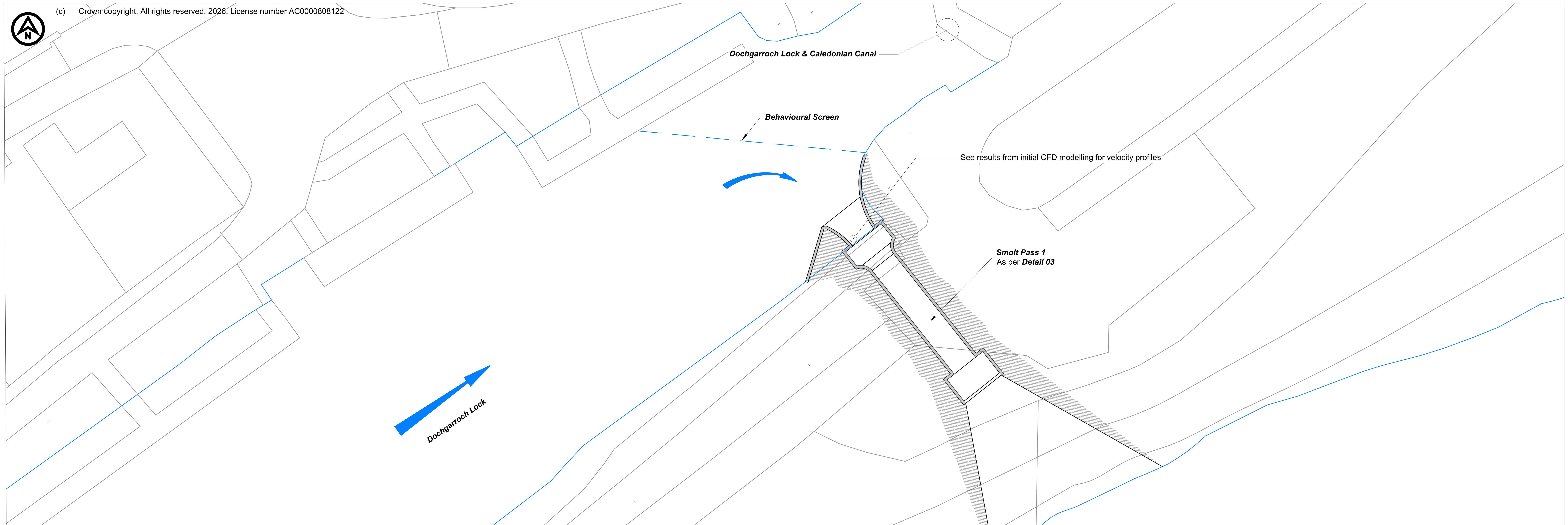
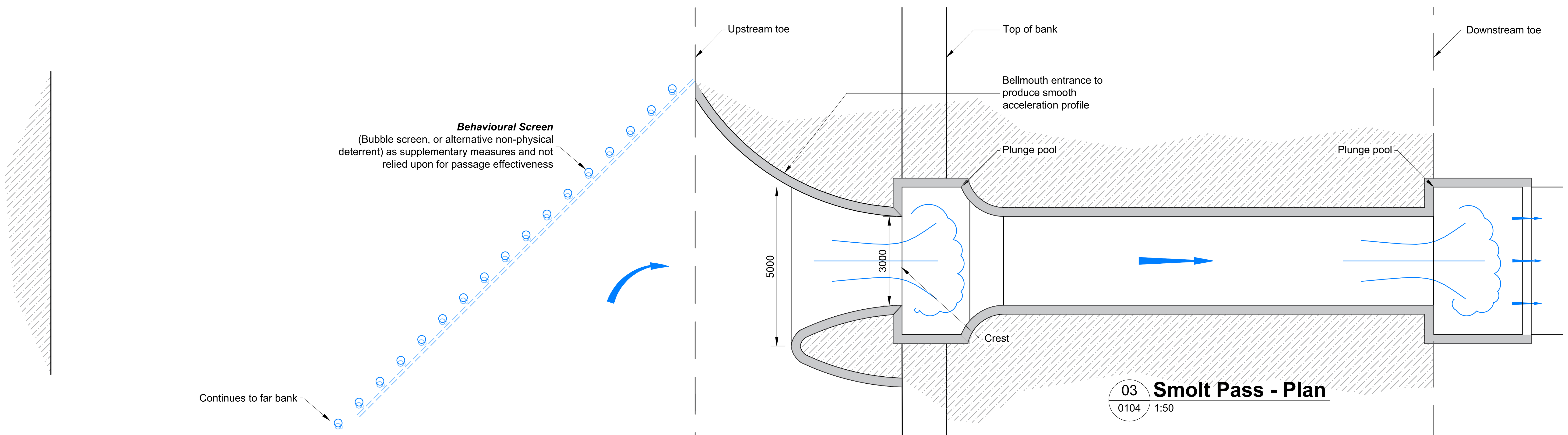
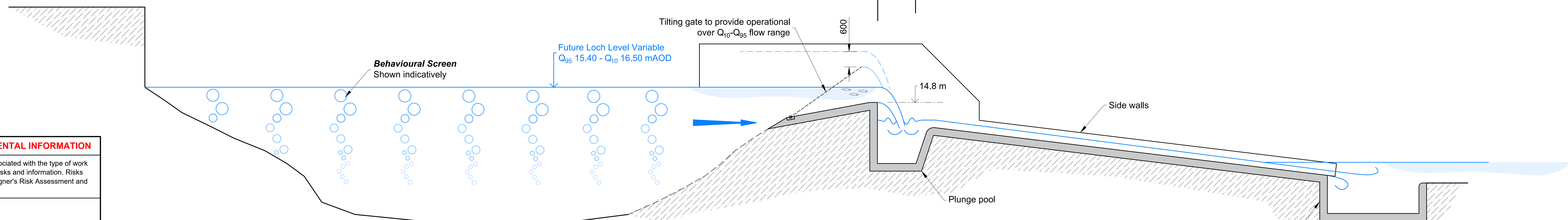


02 0104 **General Arrangement - Smolt Pass 1**
1:250



03 0104 **Smolt Pass - Plan**
1:50



04 0104 **Smolt Pass - Long Section**
1:50

SAFETY HEALTH & ENVIRONMENTAL INFORMATION

In addition to the hazards/risks normally associated with the type of work detailed on this drawing, note the following risks and information. Refer to Designer's Risk Assessment and pre-construction phase plan.

Construction
C1 - Managing flow & levels
C2 - Working near water
C3 - Risk of falls from height
C4 - Lifting

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Rev.	Date	Description	Auth.	Chkd.	Appr.
P01	06.03.26	FOR INFORMATION	MG	PG	PG

Status: Concept Design

Original Size	A1	Signatures	
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Scale: As Shown

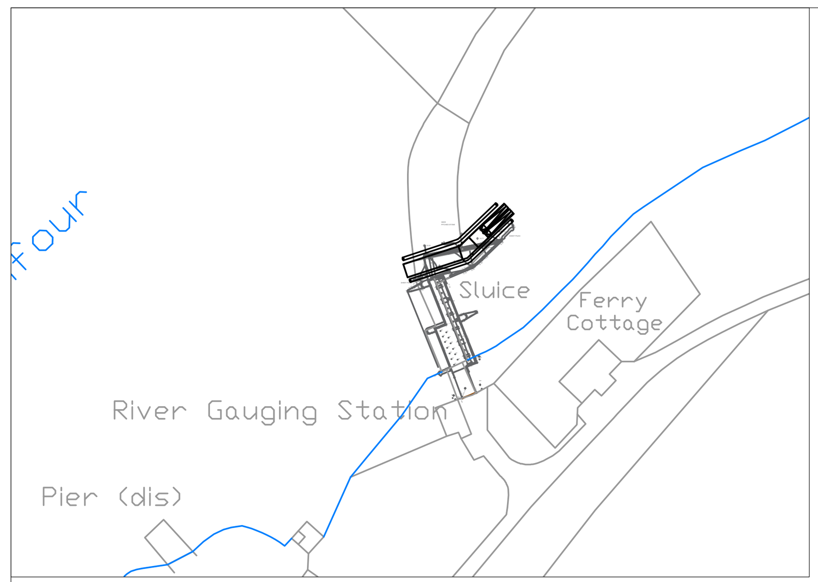
Client: Glen Earrach

Designer: FISHTEK

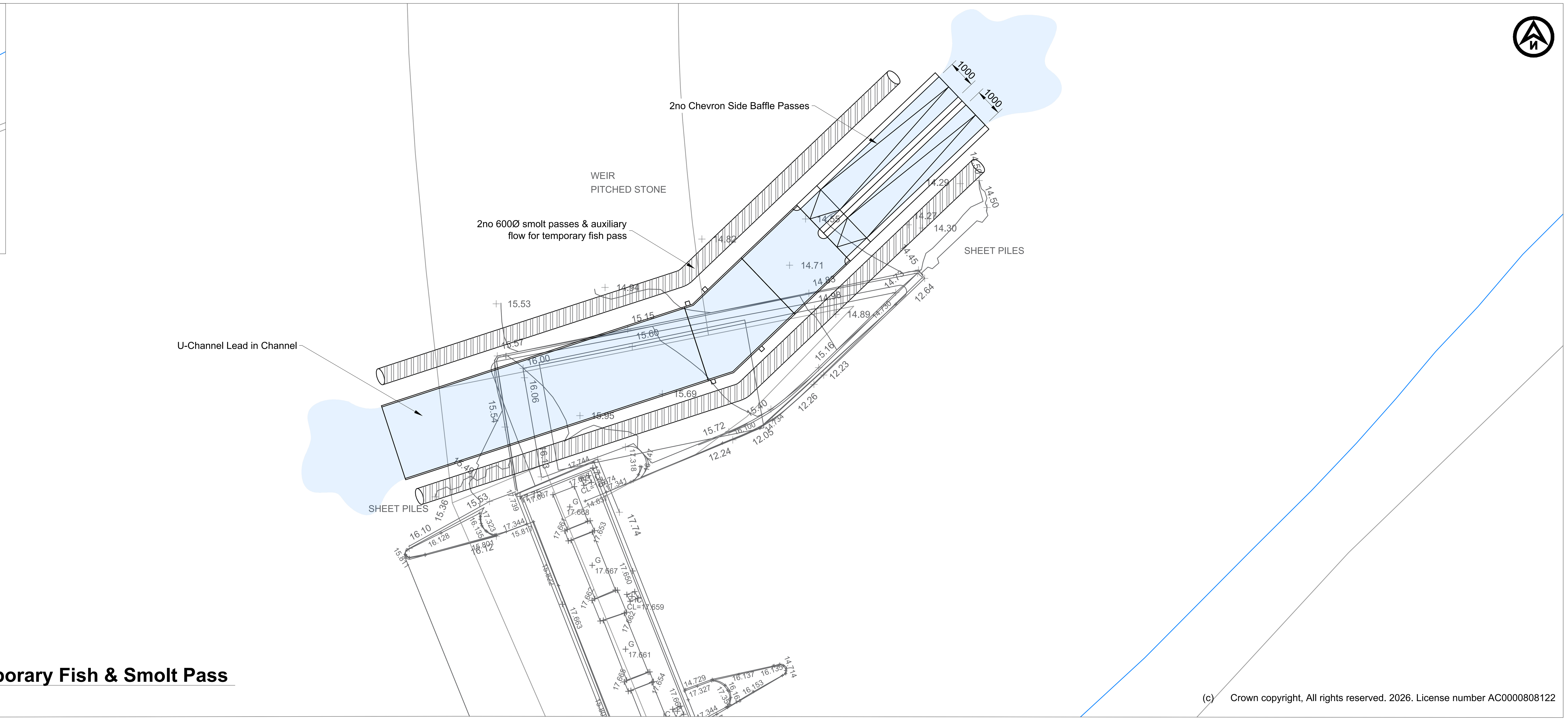
Project: Glen Earrach Energy Dochfour Ness Weir Fish Passage

Title: Smolt Passage

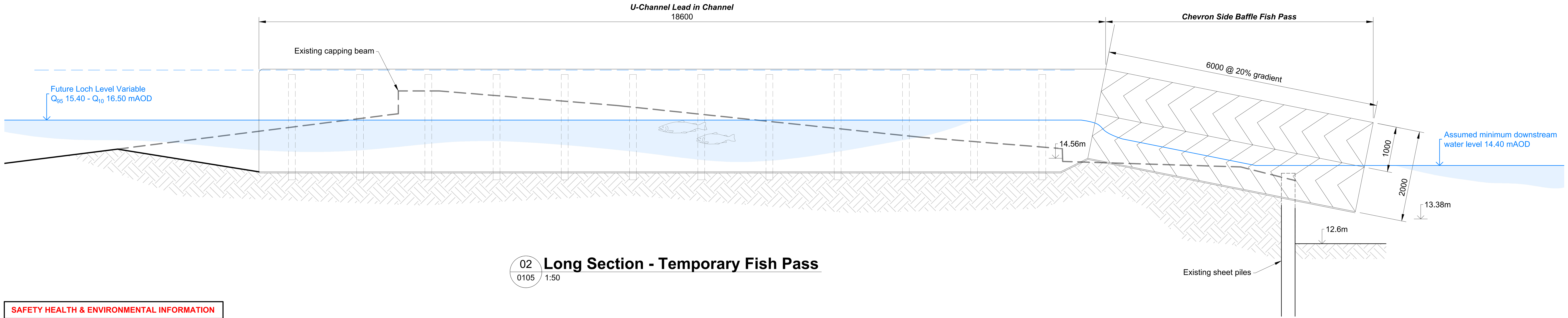
Drawing No.	Project No.	Revision
0104	3540681	P01



03 **Site Location**
0105 NTS



01 **General Arrangement - Temporary Fish & Smolt Pass**
0105 1:100



02 **Long Section - Temporary Fish Pass**
0105 1:50

SAFETY HEALTH & ENVIRONMENTAL INFORMATION

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C1 - Managing flow & levels
C2 - Working near water
C3 - Risk of falls from height
C4 - Lifting

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4. WATER LEVEL DATA:
Additional downstream water level data required to inform outline design phase.

Rev.	Date	Description	Auth.	Chkd.	Appr.
P01	10.03.26	FOR INFORMATION	MG	PG	PG

Status
Concept Design

Original Size	A1	Signatures	
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		Approved P. Gratton	

Scale
As Shown

Client
Glen Earrach

Designer
FISHTEK

Project
Glen Earrach Energy
Dochfour Ness Weir
Fish Passage

Title
Temporary Fish
& Smolt Pass

Drawing No.	Project No.	Revision
0105	3540681	P01

AECOM

Technical Note

Project name	**Subject**	**Date**
Glen Earrach PSH	1 in 200+CC level in Loch Ness Drought level in Loch Ness for fish pass design	05/02/2026

Introduction

The following information was requested by West Glen on 30/01/2026:

• An agreed upper bound loch level based on a 1-in-200 year event with an appropriate climate change allowance.
• An agreed lower bound level representing a realistic prolonged low-flow or drought scenario (is the 1-in-200 year approach + climate change also suitable for this, or are low flows predicted differently?)

These values will be used to frame the design envelope for fish passage and to demonstrate performance across realistic worst case conditions for NatureScot.

In a subsequent call, the second item was amended. NatureScot has asked that the fish pass operation is checked for realistic worst case scenario with climate change included, so it was agreed to represent the realistic worst case scenario based on the lowest flow recorded on the River Ness at Ness-side gauge over its 52 years of record.

These calculations do not include the impact of the variable weir.

1 in 200 year + climate change level in Loch Ness

Two methods to derive a 1 in 200 year + climate change level were considered:

1. Frequency analysis of Loch Ness recorded levels.

   Levels in Loch Ness have been recorded at Foyers since 2013, providing 12 years of annual maximum data to undertake a frequency analysis. At Fort Augustus, levels are available from Dec 1990 to May 2015, providing 24 full years of data. Robust return period estimates are generally thought to require twice the years of data, so this record length will only provide reliable estimates for up to a 1 in 6 year return period. Estimating a 1 in 200 year level from this amount of data would involve significant extrapolation and result in an extremely uncertain estimate. In addition, the appropriate additional depth to include to represent climate change is unknown. For these reasons, this method was discarded.

2. Estimating the 1 in 200 year flow in the River Ness, adding the appropriate 40% climate change increase for the region, then use the rating curve for Dochfour Weir to convert this to a level for Loch Dochfour.

The FEH statistical procedure was used to estimate the 1 in 200 year flow for the River Ness. This uses pooled data from hydrologically similar gauged catchments to extend the period of record available, reducing the uncertainty that results from extrapolating a single short record.

A 40% climate change uplift was added to the estimated 1 in 200 year flow in line with the recommended figure in *Climate change allowances for flood risk assessment in land use planning,* SEPA 2022 for the North Highland River Basin area.

The results are provided in the table below with some recorded events to provide context.

Table 1: Loch Dochfour level for 1 in 200 year + climate change

Return period	River Ness flow (m^3/s)	Loch Dochfour level
March 2015 event	697	17.07
Feb 1989 event	779	17.5
1890 event	890	17.6
200 year	906	17.97
200 year + CC (40%)	1269	19.32

Limitations/assumptions
The predicted level for the 200 year + CC event requires substantial extrapolation of the Dochfour weir rating curve well beyond any observed events. This has used a simple linear extrapolation which may not reflect the behaviour of the weir at such extreme flows. Extrapolation has used linear gradient between the most recent observed events of March 2015 and February 1989.

Note that Dochfour Weir becomes submerged by the River Ness levels downstream at higher flows, at which point the River Ness channel controls the levels in Loch Dochfour. Previous work predicts submergence starting at levels exceeding about 16.2mAOD, and a flow over Ness weir of 250-300m^3/s. Therefore at the 1 in 200 year +CC event high tailwater levels in the River Ness are likely to completely submerge the fishpass.

Drought level in Loch Ness

The realistic worst case scenario is represented by the level in Loch Ness that would discharge the lowest flow recorded on the River Ness at Ness-side gauge over its 52 years of record. Inspection of the gauged record for Ness-side revealed the minimum flow on record to occur on 1st July 1977. Unfortunately, neither the Foyers gauge nor Fort Augustus gauge were in operation at this time so the flow must be converted to level using the rating curve for Dochfour Weir.

Using the 15 minute recorded data for Ness-side, the lowest average 1 hour, 6 hour, 12 hour, 24 hour, 3 day and 7 day flows were extracted. The appropriate duration for fish pass design should be agreed with the designers and NatureScot.

SEPA has not published equivalent climate change adjustments for low flows, therefore UKCP18[1] model results were used to derive a suitable adjustment. UKCP18 does not provide climate change anomaly data for river flows so precipitation must be used as a proxy. Seasonal average precipitation rate anomalies (i.e. % adjustments) for June, July & August were downloaded for RCP 6.0 – the high emissions, low mitigation scenario up to the year 2100 for the North Highland River Basin area.

[1] UK Climate Projections (UKCP18) guidance and reports - Met Office

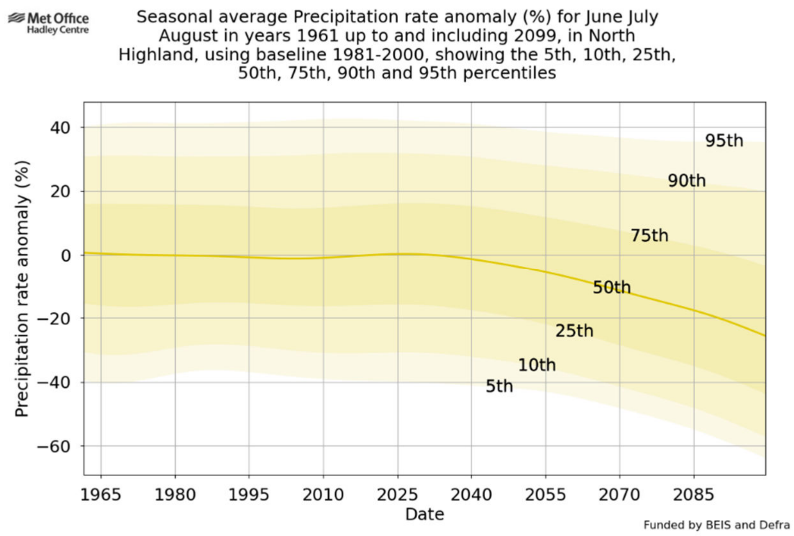

Figure 1: UKCP18 precipitation rate anomalies

The table below provides figures for the 10th, 50th and 90th centile for 2100.

Table 2: Climate change adjustments to precipitation (UKCP18)

	% anomaly in precipitation at 2100
10th centile	-57.13
50th centile	-25.52
90th centile	19.89

The adjusted flows are given in Table 3, with the equivalent levels in Loch Dochfour in Table 4.

Table 3: Flows over Dochfour Weir for "worst case" low flow scenario adjusted for climate change

Minimum average flow (m^3/s)	15 min	1 hr	6hr	12hr	24hr	3 days	7 days
Observed lowest flow	9.6	9.67	10.43	11.53	12.62	10.61	12.09
Catchment adjustment	9.32	9.39	10.13	11.20	12.26	10.31	11.74
10th centile	4.00	4.03	4.34	4.80	5.25	4.42	5.03
50th centile	6.94	7.00	7.54	8.34	9.13	7.68	8.75
90th centile	11.18	11.26	12.14	13.43	14.69	12.36	14.08

Table 4: Water levels at Dochfour Weir for "worst case" low flow scenario adjusted for climate change

Equivalent level in Loch Dochfour (mAOD)	15 min	1 hour	6hr	12hr	24hr	3 days	7 days
Observed lowest flow	15.29	15.29	15.31	15.34	15.37	15.32	15.36
10th centile	15.11	15.11	15.13	15.14	15.16	15.13	15.15
50th centile	15.21	15.22	15.23	15.26	15.28	15.24	15.27
90th centile	15.33	15.34	15.36	15.39	15.41	15.36	15.40

Glen Earrach

River Moriston SAC: Construction Disturbance and Fish Passage Continuity at Dochfour Weir

1. Introduction and Purpose

This technical note has been prepared to address the specific construction disturbance information request, identified by NatureScot in its 25 February 2026 response to draft additional information (submitted in February 2026) relating to the River Moriston Special Area of Conservation (SAC). NatureScot has requested that the Applicant:

> *"demonstrate disturbance can and will be kept below levels that would result in salmon avoiding the area."*

The purpose of this note is to address the question of whether the fish passage improvements proposed at Dochfour Weir - comprising the permanent vertical slot fish pass, three dedicated smolt passes, and the associated variable crest weir - can be constructed without adverse effects on migrating Atlantic salmon of the River Moriston SAC. It demonstrates that the works can and will be programmed and managed to avoid such effects, drawing on construction sequencing that maintains continuous upstream and downstream passage throughout, seasonal programming of disturbance-generating activities to periods of minimal migratory activity, quantitative evidence on salmon behavioural response to construction noise, and site-specific precedent from comparable works at this location. In particular, reinforcement works undertaken by Scottish Canals in 2017 involved substantial sheet-pile installation along the weir crest while a temporary Alaskan Denil fish pass was deployed to maintain upstream passage during construction; this precedent is discussed further in Section 6.

This document is not intended to provide a comprehensive construction method statement for the weir works, nor a full review of all construction environmental controls, pollution prevention measures, health and safety arrangements, or detailed contractor methodologies. Those matters will be developed and secured through the subsequent detailed design, construction planning and consenting process for the weir works. The present note is directed specifically to the matters raised by NatureScot in relation to the River Moriston SAC.

This document has been prepared by the Applicant, with Simon Grey and Peter MacDonald providing construction, project and engineering input, and with the fisheries science content reviewed and confirmed by Paul Gratton (Associate - Fisheries Science) of Fishtek.

The hydraulic and fish passage evidence on attractant flows, water depths and velocities during construction is provided separately in the supporting Fishtek documents. This note should therefore be read alongside the following:

- Fishtek Fish Passage Optioneering Summary (Rev 004, March 2026);
- Fishtek Temporary Fish Passage Technical Note (V1.3 March 2026); and
- Fishtek Construction Sequencing drawing (0103-3540681-P03).

2. Salmon Migration Profile at Dochfour Weir

The programming of construction works to avoid disturbance to migratory salmon requires a clear understanding of the seasonal migration profile at Dochfour Weir. The following is based on information provided by the Ness District Salmon Fishery Board (NDSFB).

2.1 Upstream Adult Migration

Information on salmon lifecycle timings in the Ness catchment is provided in *4a. Aquatic Ecology – Atlantic Salmon Assessment for River Ness,* submitted as Additional Information in September 2025. Additionally, the NDSFB advises (Consultation Response 4th August 2025) as follows:

> *"The peak migration period for salmon in the River Ness is the summer, with July and August being the most important months numerically. The Ness catchment has a significant spring run; indeed, it has the best early spring run in the Highlands. This run commences in January and extends through May, merging with the early summer fish in June. Few salmon enter the River Ness in September and October nowadays."*

The upstream adult migration therefore extends from some point in January through to August, with the spring component (January–May) merging into the summer peak (July–August). September and October see low numbers, and November and December are effectively outside the adult migration period.

2.2 Downstream Smolt Migration

The downstream smolt run at Dochfour Weir extends from April to mid-June. The current canal smolt sluice is operated from 1 April to 1 July (Advised by Scottish Canals, as noted in EIAR *Appendix 4.2 Consultation Tracker*). This is the period of highest sensitivity for downstream-migrating smolts.

2.3 Seasonal Migration Profile

Combining the upstream adult salmon and downstream smolt profiles, the seasonal migration activity at Dochfour Weir can be summarised as follows:

Period	Migration Activity	Construction Implication
January–March	Spring salmon run (upstream adults)	Early upstream migration present
April–mid-June	Smolt run (downstream) overlapping with spring/early summer adults (upstream)	Peak downstream migration period + upstream migration present
July–August	Peak upstream adult migration	High upstream migration activity
September–October	Low numbers of adults; few salmon entering the system (NDSFB)	Reduced migration activity
November–December	**No significant migratory activity**	**Preferred period for in-water construction works**

November–December represents the period when salmon migratory activity in the River Ness system is minimal. Late October and early January may provide shoulder periods of lower migratory activity, subject to confirmation by the Environmental Clerk of Works (ECoW). Taken together, this provides an available window of approximately 14 weeks (mid-October to mid-January) within which construction activities with the potential to cause disturbance may be undertaken.

Glen Earrach

3. Construction Sequence

The construction sequence is governed by three principles:

(a) that continuous upstream and downstream passage is maintained at every phase, with temporary arrangements providing continuity during the transition from the existing passage configuration to the permanent fish passage system;

(b) that the SSE sluice gates are retained in their level-control function until the variable crest weir is operational, after which one sluice bay will be taken out of service to allow construction of the permanent vertical slot fish pass, while the remaining sluice bay remains available to provide downstream passage opportunity, attraction flow and operational flexibility during the construction period; and

(c) that works with the potential to generate underwater noise disturbance (specifically impact piling) are programmed within the November–December core window (with late October and early January shoulder allowance, subject to ECoW confirmation of low fish activity).

The construction sequence proceeds through six main phases, delivered sequentially to maintain continuous upstream and downstream passage throughout the works. The temporary Chevron fish pass and permanent smolt passes installed early in the programme supplement the existing fish pass during the initial stages of variable weir construction. Once the existing lowered crest fish pass is decommissioned, the temporary Chevron fish pass becomes the operative upstream route until the permanent fish pass is commissioned.

The phases will be delivered over a multi-year programme. Activities with potential to generate significant underwater noise, particularly impact piling, will be confined to the November–December core window, with late October and early January shoulder periods used only where confirmed appropriate by the ECoW. Other works may proceed at other times, subject to avoidance of in-water activity during the smolt run (April to mid-June). The overall programme duration will be confirmed at detailed design stage and is expected to be approximately three years from commencement of Phase 1 to completion of Phase 6.

3.1 Phase 1: Construct Smolt Passes 1 and 2

This phase establishes the first elements of the permanent downstream passage system prior to any works taking place on the main weir crest. Two dedicated smolt passage routes are constructed at locations that are hydraulically suitable for downstream migration while remaining spatially separated from the principal upstream migration pathway at the weir.

Outcome:

- Two new downstream smolt passage routes are constructed: Smolt Pass 1 adjacent to Dochgarroch Lock, and Smolt Pass 2 at the downstream end of the waste weir, adjacent to the western side of the island between the canal and River Ness. These provide an immediate improvement on the current downstream passage situation, ensuring that smolts have defined, safe routes of passage before any works commence on the main weir structure.

- Completed ahead of any works on the main weir, so effective routes of downstream passage are implemented before any other construction activity begins.

Passage arrangements

- **Upstream passage:** via the existing lowered crest fish pass.

- **Downstream passage:** via the existing hydraulic routes over the weir and through the SSE sluices.

Timing & phasing

- To be completed between mid-September and mid-February. This avoids the smolt run (April to mid-June) and the main tourist season given the proximity of the Dochgarroch Lock works to the Jacobite Cruises base.

Noise and disturbance considerations

- Construction activities associated with Smolt Passes 1 and 2 are relatively localised and occur away from the primary upstream migration pathway at the weir.
- The use of precast modules minimises in-situ concrete works and reduces the duration of in-water construction activities.

Risk to salmon migration

No material effect on salmon migration is anticipated, subject to the seasonal controls set out above. Works are undertaken outside the smolt migration period and are spatially separated from the primary upstream migration pathway at the weir. Although the January–February portion of the window overlaps with the early spring adult run (Section 2), the Phase 1 works at Dochgarroch Lock and the downstream end of the waste weir are remote from the operative upstream passage routes. The existing lowered crest fish pass and both SSE sluices remain fully operational throughout this phase.

3.2 Phase 2: Install Temporary Chevron Fish Pass (Upstream) and Temporary Smolt Pass (Downstream)

This phase provides the temporary passage arrangements that maintain safe upstream passage, and supplement downstream passage during the construction of the variable crest weir and permanent fish pass. Two co-located Chevron side baffle fish passes are installed at the upstream end of the service weir, adjacent to the existing lowered crest section, together with two temporary downstream smolt passes at the same location. The installation requires excavation into the existing weir/sluice abutment structure to form the channel that will subsequently be used for Permanent Smolt Pass 3. The excavation required to install the Chevron passes therefore forms part of the permanent works rather than a temporary intervention.

The Chevron side baffle pass builds on the precedent of a temporary Alaskan Denil which was deployed during the 2017 Scottish Canals sheet-pile reinforcement works, this precedent is discussed further in Section 6 below. In respect of the Denil pass however, the Chevron arrangement represents a material upgrade in hydraulic performance. The wider channel geometry (1.00 m per pass, compared with the fixed 350 mm internal width of the Alaskan Denil) allows substantially greater attraction flow, while the co-location of two passes increases the effective entrance width available to migrating fish.

The Fishtek Temporary Fish Passage Technical Note (March 2026) provides the detailed hydraulic design basis for the Chevron arrangement, including parameter-by-parameter comparison with published guidance (Environment Agency Fish Pass Manual, 2010; Larinier, 1992; 2002). The combined fish passage flow at Q95 is approximately **3.05 m³/s**, representing an approximately eightfold increase in attraction flow compared with the temporary Denil arrangement used during the 2017 works (0.37 m³/s). Mean water velocities remain within the permitted maximum for Chevron side baffle passes across the full Q95–Q10 flow range.

Outcome

- Two Chevron side baffle upstream fish passes are installed, supplementing the existing lowered crest fish pass. During the early stages of variable weir construction (Phase 3), the existing lowered crest fish pass remains the primary upstream route and the Chevron passes provide supplementary redundancy. The Chevron passes subsequently become the operative upstream passage route once the existing lowered crest fish pass is decommissioned in Phase 4.

- Temporary Smolt Pass 3 (comprising two 600 mm diameter pipes) is installed at the same location (in the position of Smolt Pass 3), supplementing the two permanent smolt passes constructed in Phase 1.
- Both SSE sluices remain fully operational.

Passage arrangements

- Upstream passage: via the existing lowered crest fish pass. The Chevron passes are installed during this phase and become operational once installation is complete. The excavation and installation works do occur in close proximity to the existing lowered crest section; however, the works are programmed within the mid-October to mid-January window when upstream migratory activity is minimal (Section 2).
- Downstream passage: via Smolt Passes 1 and 2 (constructed in Phase 1) and the existing routes over the weir and through the SSE sluices, which remain fully operational.

Timing & phasing

- Installation of upstream temporary works will be completed within the mid-October to mid-January works window identified by NDSFB as having minimal migratory activity (Section 2), and outside the smolt migration period (April to mid-June).
- The installation of the temporary fish pass will require excavation into the existing weir structure, however once the temporary works are installed, this is isolated from the river and hence becomes non-critical in terms of migration timing. The October–January window provides sufficient duration for installation of the temporary works.
- The forebay to the temporary fish passes will subsequently accommodate Permanent Smolt Pass 3 (Phase 6), meaning the works contribute directly to the permanent infrastructure.

Noise and disturbance considerations

- The principal in-water activity during this phase will be the installation of a sheet-pile cofferdam upstream of the weir to allow the subsequent excavation into the existing weir/sluice abutment structure and placement of the prefabricated Chevron pass units and Temporary Smolt Pass pipework.
- The risk of noise disturbance is limited through: a) the use of low-impact piling techniques (shallow penetration into soft substrate for temporary works); b) the programming of the piling works to avoid the main migration periods, particularly the April – June smolt migration window; and c) the fact that in-water noise (if any) will be emitted upstream of the weir with very limited opportunity for transmission of aquatic noise downstream towards approaching salmon.
- Works are programmed within the non-migratory period (mid-October to mid-January), providing temporal separation between the excavation activities and the periods of upstream and downstream migratory sensitivity.

Risk to salmon migration

No material effect on salmon migration is anticipated, subject to the seasonal controls set out above. The in-water works are undertaken within the mid-October to mid-January period when migratory activity is minimal. Downstream passage routes via Smolt Passes 1 and 2 and the SSE sluices remain available. The 2017 works provide site-specific precedent that substantial construction activity can be undertaken at Dochfour Weir while temporary fish passage arrangements are in place. The Chevron design proposed here provides materially greater attraction flow and passage capacity than the Denil arrangement used in 2017.

3.3 Phase 3: Construct Variable Crest Weir (Up to Existing Fish Pass)

This phase involves the progressive construction of the new variable crest weir along the crest of the existing waste/service weir. The works are undertaken in stages, forming the new structure up to the location of the existing lowered crest fish pass.

Throughout this phase the existing lowered crest fish pass remains operational and continues to provide the primary upstream migration route. The temporary Chevron fish pass installed in Phase 2 provides supplementary upstream passage during this period and becomes the operative upstream route only once the existing fish pass is decommissioned in the subsequent phase.

Outcome:

- The variable crest weir is constructed progressively along the existing weir crest up to the location of the existing lowered crest fish pass.
- The SSE sluices remain operational during this phase and continue to perform the level-control function
- Although the variable crest weir units will be installed during this phase, they will remain in the lowered position. The effective crest level of the existing weir is therefore unchanged during construction. The crest would only be raised during the later transition stage once the full variable crest structure has been completed and commissioned.

Passage arrangements:

- Upstream passage: via the existing lowered crest fish pass, supplemented by the temporary Chevron fish pass installed in Phase 2.
- Downstream passage: via Smolt Passes 1 and 2 (constructed in Phase 1), Temporary Smolt Pass 3 installed in Phase 2, and the existing routes over the weir and through the SSE sluices.

Timing & phasing:

- Construction will progress from the northern end of the weir southwards towards the existing fish pass. For most of this phase the working area therefore remains spatially separated from the operative upstream passage routes.
- Where piling is required for the variable crest weir foundations, the following seasonal controls will apply:
  - Impact piling will be programmed within the November–December core works window, with late October and early January shoulder periods used only where confirmed appropriate by the ECoW.
  - Vibro-piling may be undertaken outside the core window but will not occur during the smolt migration period (April to mid-June).
- During the smolt migration season (April to mid-June), in-air construction activities such as formwork, reinforcement and concrete placement may continue during daylight working hours only. Smolt migration occurs predominantly at night; restriction to daylight hours therefore avoids the period of peak downstream movement.
- ECoW monitoring of smolt passage routes will be increased during the smolt season, with authority to suspend or modify works if monitoring indicates that construction activity is affecting smolt behaviour.

Noise and disturbance considerations:

- Most Phase 3 activities occur in air (formwork, reinforcement and concrete works along the weir crest), generating limited underwater noise, with flow over the existing weir crest providing attenuation between the working area and the downstream channel.
- The progressive southward movement of the workfront maintains spatial separation between construction activity and the operative passage routes for most of this phase.

Risk to salmon migration
No material effect on salmon migration is anticipated, subject to the seasonal controls set out above. The existing lowered crest fish pass remains the primary upstream migration route throughout this phase, supplemented by the temporary Chevron fish pass installed in Phase 2, while downstream passage remains available via Smolt Passes 1 and 2, Temporary Smolt Pass 3 and the SSE sluices. Activities capable of generating significant underwater noise are restricted to the non-migratory period, and the 2017 works at Dochfour Weir (described further in Section 6) provide site-specific precedent for substantial construction activity at the weir during periods when the River Ness system continued to support migratory salmon.

3.4 Phase 4: Decommission Existing Fish Pass and Complete Variable Crest Weir

This phase completes construction of the variable crest weir at the location of the existing lowered crest fish pass. As with the 2017 works, it will be necessary to install an upstream cofferdam to allow construction. Once the cofferdam is in place, the temporary Chevron fish pass installed in Phase 2 becomes the operative upstream migration route for the duration of this phase.
At the completion of this phase the variable crest weir is fully formed along the crest of the existing structure and is available to assume the primary level-control function for the River Ness and the Caledonian Canal. The existing SSE sluices are therefore no longer required for routine level control, allowing the decommissioning of one bay in Phase 5 for the permanent fish pass works while retaining one sluice as a controllable low-level outlet to provide operational flexibility.

Outcome
- The existing lowered crest fish pass is decommissioned and the new weir crest structure is formed.
- The temporary Chevron fish pass installed in Phase 2, and already in operation, becomes the operative upstream migration route.
- The variable crest weir is completed and becomes the primary structure controlling water levels.

Passage arrangements:
- **Upstream passage**: via the temporary Chevron fish pass.
- **Downstream passage**: via Smolt Passes 1 and 2 (constructed in Phase 1), Temporary Smolt Pass 3 (installed in Phase 2), and the SSE sluices.

Timing & phasing
- Construction of the variable crest weir through the lowered crest fish pass section will follow the same seasonal controls applied during Phase 3.
- Where piling is required for the upstream cofferdam and variable crest weir foundations, impact piling will be programmed within the November–December core works window, with late October and early January shoulder periods used only where confirmed appropriate by the ECoW. Vibro-piling may be undertaken outside this window but will not occur during the smolt migration period (April to mid-June).
- In-air activities such as reinforcement placement, formwork installation and concrete placement may continue outside the core window, provided that in-water disturbance is avoided during the smolt migration period (April to mid-June).
- During the smolt migration season (April to mid-June), in-air construction activities will be restricted to daylight working hours only, consistent with the controls applied during Phase 3.

Noise and disturbance considerations
- The principal in-water activity will be the installation of the temporary cofferdam. Once complete, the remainder of the work involves construction of the new crest structure and associated concrete works,

occurring largely in air above the weir crest with flow over the crest providing attenuation between the works area and the downstream channel.

Risk to salmon migration
No material effect on salmon migration is anticipated, subject to the seasonal controls set out above. The temporary Chevron fish pass provides the upstream migration route once the existing fish pass is removed, while downstream passage remains available via Smolt Passes 1 and 2, Temporary Smolt Pass 3 and the SSE sluices. Activities capable of generating significant underwater noise are restricted to the non-migratory period.

3.5 Phase 5: Decommission SSE Sluice Bay and Construct Permanent Upstream Fish Pass

Once the variable crest weir has been completed and is managing water levels, one of the SSE sluice bays can be taken out of service to allow construction of the permanent upstream vertical slot fish pass within that structure. The remaining SSE sluice bay remains available within the hydraulic system.

To enable construction of the permanent upstream fish pass, the selected sluice bay will be isolated using temporary cofferdams to create a dry working environment. The permanent vertical slot fish pass structure will then be constructed within the cofferdammed bay.

Outcome

- One SSE sluice bay is decommissioned and isolated using upstream and downstream cofferdams.
- The permanent vertical slot fish pass is constructed within the isolated sluice bay.
- The temporary Chevron fish pass remains the operative upstream migration route during construction of the permanent fish pass.
- The remaining SSE sluice bay continues to operate within the hydraulic system and provides a downstream passage route.

Passage arrangements

- **Upstream passage:** via the temporary Chevron fish pass installed in Phase 2.
- **Downstream passage:** via Smolt Passes 1 and 2 (constructed in Phase 1), Temporary Smolt Pass 3 (installed in Phase 2), and the remaining SSE sluice bay.

Timing & phasing

- Installation of the cofferdams will require sheet piling within the selected sluice bay. Depending on the detailed design, the sheet piles may be incorporated into the permanent works or removed following completion of construction.
- Impact piling associated with cofferdam installation will be programmed within the November–December core works window, with late October and early January shoulder periods used only where confirmed appropriate by the ECoW.
- It is anticipated that cofferdam installation can be completed within approximately four to six weeks of in-water works. The November–December works window therefore provides sufficient duration for these activities, with shoulder periods providing contingency.

Noise and disturbance considerations

- The cofferdam system isolates the construction area from the main river channel, allowing works within the sluice bay to proceed in a dewatered environment and providing hydraulic and acoustic separation from the migration pathway.

- Temporary works will be designed to withstand flood conditions and to allow rapid demobilisation of plant if rising water levels are forecast.

Risk to salmon migration

No material effect on salmon migration is anticipated, subject to the seasonal controls set out above. The temporary Chevron fish pass continues to provide the upstream migration route during this phase, while downstream passage remains available via Smolt Passes 1 and 2, Temporary Smolt Pass 3 and the remaining SSE sluice bay. Piling associated with cofferdam installation is restricted to the November–December non-migratory period.

3.6 Phase 6: Commission Permanent Upstream Fish Pass and Install Permanent Smolt Pass 3

Once construction of the permanent vertical slot fish pass within the former SSE sluice bay is complete, the new structure will be commissioned and brought into operation. The permanent fish pass then becomes the primary upstream migration route at the site.

Following commissioning of the permanent upstream fish pass, the temporary passage arrangements installed earlier in the construction sequence are removed and replaced with the permanent downstream passage infrastructure (Smolt Pass 3), supplementing the downstream passage infrastructure constructed during Phase 1. The forebay works installed for the temporary pass will include stop-log channels, thus allowing isolation of the flows for construction of the permanent works smolt pass in this location. This removes the need for further in-water work upstream of the weir.

Outcome

- The permanent vertical slot fish pass is commissioned and becomes the primary upstream migration route.
- The temporary Chevron fish pass installed in Phase 2 is removed once the permanent fish pass is confirmed operational.
- Temporary Smolt Pass 3 is replaced with Permanent Smolt Pass 3 in the same location.
- The permanent downstream passage system is therefore established, comprising Smolt Passes 1 and 2 together with Permanent Smolt Pass 3.

Passage arrangements

- **Upstream passage:** the permanent vertical slot fish pass is commissioned before the temporary Chevron fish pass is removed, ensuring continuous upstream passage.
- **Downstream passage:** Smolt Passes 1 and 2 remain operational throughout this phase. Temporary Smolt Pass 3 is removed and replaced with Permanent Smolt Pass 3 in the same location. The remaining SSE sluice bay continues to provide an additional downstream hydraulic pathway during this phase.

Timing & phasing

- Removal of Temporary Smolt Pass 3 and installation of Permanent Smolt Pass 3 will be undertaken outside the smolt migration period (April to mid-June).
- Unlike Smolt Passes 1 and 2, which are located adjacent to the Dochgarroch Lock visitor area and are therefore programmed within the mid-September to mid-February window to minimise tourism impacts, Smolt Pass 3 is located away from the main visitor activity area. The primary ecological consideration for these works is therefore avoidance of the smolt migration period.

Noise and disturbance considerations

- Removal of the temporary Chevron fish pass involves dismantling and extraction of prefabricated components, generating limited disturbance.

- Installation of Permanent Smolt Pass 3 involves construction activities broadly similar to those undertaken for Smolt Passes 1 and 2, including excavation and placement of precast pass components.
- Where the channel excavation undertaken in Phase 2 is sufficient to accommodate the permanent pass, installation may be limited to placement of prefabricated pass elements within the previously prepared channel. In this scenario disturbance to the river channel is minimal and of short duration.
- If additional excavation or other disturbance causing in-water works are required adjacent to the permanent upstream fish pass, these activities will be programmed from October onwards when upstream migratory activity is low.

Risk to salmon migration

No material effect on salmon migration is anticipated, subject to the seasonal controls set out above. Upstream passage is maintained through commissioning of the permanent fish pass before removal of the temporary Chevron fish pass. Downstream passage remains available via Smolt Passes 1 and 2 and the remaining SSE sluice bay during removal of Temporary Smolt Pass 3 and installation of Permanent Smolt Pass 3. The works required to remove Temporary Smolt Pass 3 and install Permanent Smolt Pass 3 are localised in extent and are programmed to avoid the smolt migration period (April to mid-June), with any excavation or other significant in-water disturbance adjacent to the upstream fish pass undertaken from October onwards when upstream migratory activity is reduced.

3.7 Summary: Passage Continuity Through Construction

Phase	Works	Upstream Passage	Downstream Passage	Phasing Constraint	Level Control
1	Smolt Passes 1 & 2 (Dochgarroch Lock and downstream end of the current waste weir)	Existing lowered crest fish pass	Existing lowered crest fish pass + SSE sluices fully operational. Note: works planned outwith the smolt window.	Mid-September to Mid-February	SSE gates
2	Install temporary Chevron (upstream) + Temporary Smolt Pass 3 (downstream)	Existing lowered crest fish pass	Existing lowered crest fish pass + Smolt Passes 1 & 2 + SSE sluices fully operational	Mid-October to mid-January (low migratory activity window)	SSE gates
3	Form new variable weir up to existing fish pass	Existing lowered crest fish pass remains operative; temporary Chevron fish pass supplements it during this phase	Existing lowered crest fish pass + Smolt Passes 1 & 2 + Temporary Smolt Pass 3 + SSE sluices	Piling restricted to Nov-Dec core window; additional controls during smolt migration season	SSE gates
4	Decommission existing fish pass / form variable weir through lowered crest fish pass	Temporary Chevron fish pass becomes the operative upstream route once the existing lowered crest fish pass is decommissioned	Smolt Passes 1 & 2 + Temporary Smolt Pass 3 + SSE sluices	Same seasonal controls as Phase 3; impact piling restricted to the November–December core window, with vibro-piling not undertaken during the smolt migration period	Transition from SSE sluices to variable crest weir
5	Decommission SSE sluice; cofferdam sluice bay; construct permanent fish pass	Temporary Chevron	Smolt Passes 1 & 2 + Temporary Smolt Pass 3 + remaining SSE sluice	Impact piling for cofferdam installation restricted to the November–December core window (with late October and early January shoulder periods only where confirmed appropriate by the ECoW).	New Variable Weir
6	Commission permanent fish pass; remove Chevron and Temporary Smolt Pass 3; install permanent Smolt Pass 3	Permanent fish pass commissioned before Chevron removed (sequential handover)	Smolt Passes 1 & 2 + remaining SSE sluice; Temporary Smolt Pass 3 removed and replaced by Permanent Smolt Pass 3	Removal of Temporary Smolt Pass 3 and installation of Permanent Smolt Pass 3 undertaken outside the smolt migration period (April to mid-June); if additional excavation or other significant in-water disturbance is required adjacent to the permanent upstream fish pass, these works will be programmed from October onwards.	New Variable Weir

4. Quantitative Evidence: Salmon Behavioural Sensitivity to Construction Noise

4.1 Behavioural response thresholds for piling noise

The principal disturbance pathway during construction is underwater noise from piling. Two piling methods are relevant to the proposed works, with fundamentally different noise characteristics.

Vibro-piling uses an oscillating mechanism to advance piles through the substrate by reducing friction. It produces predominantly continuous, lower-amplitude noise and is the preferred methodology for temporary works at Dochfour Weir, particularly for cofferdam sheet piles where deep driving or penetration through resistive substrate is not expected.

Impact (percussive) piling drives piles using repeated hammer blows. It generates high-amplitude impulsive noise and therefore has greater disturbance potential. Impact piling would only be required if ground conditions prevent vibro-driving, for example if resistive substrate is encountered during cofferdam installation or variable crest weir foundation works.

The EIAR Chapter 9 assessment (paragraphs 9.8.15 and 9.9.7) draws on Mason and Collett (2011) to establish quantitative thresholds for the behavioural response of Atlantic salmon to **impact piling** noise. The thresholds below represent a worst-case scenario: percussive driving of 1.8 m piles at 300 kJ blow energy. If vibro-piling is used, the noise levels and corresponding response zones would be substantially smaller.

Behavioural Response	Distance from Source	Implication at Dochfour
Potential auditory injury	~20 m	Within the immediate construction footprint only. Eliminated by soft-start procedure and bubble curtain positioned at minimum 30 m. Applies only to impact piling.
Strong avoidance reaction	~330 m	Extends into Loch Dochfour under the impact piling scenario. Impact piling, if required, is programmed within the November–December non-migratory window when salmon presence is minimal. During Phase 5 (cofferdam for permanent fish pass), the upstream cofferdam blocks the aquatic sound transmission pathway between the works area and the operative passage routes (temporary Chevron and smolt passes), providing acoustic isolation.
Detectable avoidance behaviour	~2.1 km	Low-magnitude behavioural response that is temporary and intermittent. Impact piling is programmed for the November–December period when migratory activity is minimal.

Source: Mason, T. & Collett, A. (2011). *MEP Impacts of Underwater Piling Noise on Migratory Fish.* Subacoustech Environmental Ltd. As cited in EIAR Chapter 9.

4.2 Seasonal programming and mitigation controls

The thresholds above apply to **impact piling**, which generates high-amplitude impulsive noise. All impact piling will therefore be programmed within the November–December core works window (with limited late October or early January allowance subject to ECoW confirmation of low fish activity). Impact piling will not be undertaken at other times of year.

Vibro-piling produces continuous lower-amplitude noise without impulsive peaks. As a result, disturbance zones are expected to be materially smaller than those shown in the impact-piling worst-case scenario, and continuous sound sources are generally associated with lower behavioural disruption in fish.

Where vibro-piling is used, works may occur outside the November–December window subject to the following controls:

- Vibro-piling will not occur during the smolt run period (April to mid-June).
- A bubble curtain and/or silt screen will be deployed at a minimum distance of 30 m from the piling location.
- A soft-start procedure will allow any fish in the vicinity to move away before full operational intensity is reached.
- ECoW monitoring will observe fish behaviour near operative passage routes, with records available to NatureScot and NDSFB.

This approach ensures seasonal restrictions are proportionate to disturbance risk: strict timing controls apply to impact piling, while vibro-piling retains programme flexibility subject to ecological safeguards.

Acoustic isolation during Phase 5

During Phase 5, the upstream cofferdam isolates the works area within the sluice bay from the main channel, removing the direct aquatic sound transmission pathway between the construction area and the operative passage routes (temporary Chevron and smolt passes). Construction activities within the coffer-dammed area therefore do not generate underwater noise in the main channel.

During Phase 3 (variable crest weir construction), most activities on the weir crest occur in air (formwork, reinforcement and concrete placement). Where piling is required for the weir foundations, the seasonal controls described above apply. The combination of temporal avoidance for impact piling, the lower disturbance profile of vibro-piling, and the predominantly in-air nature of Phase 3 works means that the impact-piling thresholds are not approached during periods when migratory salmon are present.

5. Firm Mitigation Commitments

The following measures are committed to by the Applicant and will be secured through the Construction Environmental Management Plan (CEMP), method statements, and planning conditions. These are stated as firm commitments representing measures that will be implemented.

5.1 Seasonal Programming

All impact piling at Dochfour Weir will be programmed within the core November–December works window, with a shoulder allowance extending to late October and early January subject to ECoW confirmation of low fish activity. This targets the period identified by NDSFB as having minimal migratory activity (Section 2). Impact piling will not be undertaken at any other time of year.

Vibro-piling, which generates continuous lower-amplitude noise without impulsive peaks, may be undertaken outside the core window subject to the controls set out in Section 4, including avoidance of the smolt run period (April to mid-June).

5.2 Piling Methodology

Vibro-driven piling will be used in preference to percussive piling to minimise underwater noise and vibration. Where percussive piling is required due to ground conditions, a soft-start procedure will be implemented using an initial blow energy of 150 kJ, increasing incrementally to operational energy (Mason and Collett, 2011; EIAR Chapter 9, paragraph 9.9.7).

For temporary cofferdams, piles will not require deep driving or penetration through resistive substrate. Piling techniques will be selected to minimise noise generation, particularly impact noise. The piling method employed determines the applicable seasonal controls as set out in Section 4.

5.3 Construction Working Pattern

Construction activities will be undertaken within standard daytime working hours. During the smolt migration season (April to mid-June), no night-time working will be undertaken in areas where artificial lighting could affect the watercourse or operative smolt passage routes (Section 5.7). Works will be programmed to minimise continuous disturbance within the water environment, with in-water works such as piling programmed efficiently to minimise the duration of each piling campaign and to provide extended quiet periods between successive campaigns.

5.4 Physical and Acoustic Barriers

A silt curtain and/or bubble screen will be deployed at a minimum distance of 30 m from the piling location during both impact and vibro-piling operations, exceeding the calculated auditory injury zone (~20 m) for the impact piling worst case. This provides both acoustic attenuation and a visual/physical deterrent to fish entering the immediate works area (EIAR Chapter 9, paragraph 9.9.7).

5.5 Ecological Clerk of Works

An ECoW will be employed for the duration of construction.

During impact piling operations (programmed within the November–December core window), the ECoW will have authority to halt or modify works in the event that fish are unexpectedly observed in the vicinity of the construction area, given that the timing is specifically designed to target a period of minimal migratory activity.

During vibro-piling operations undertaken outside the core window, the ECoW will monitor fish behaviour at the operative passage routes. The purpose of this monitoring is to confirm that vibro-piling is not causing avoidance behaviour at the passage routes, and to build an evidence base that can be shared with NatureScot and NDSFB. If monitoring indicates that fish are exhibiting sustained avoidance of the operative passage routes that can be attributed to vibro-piling activity, the ECoW will have authority to halt or modify the works methodology or timing. Monitoring records will be made available to NatureScot and NDSFB as part of the ongoing environmental management reporting.

5.6 Maintenance of Attraction Flows

Clear, well-defined attraction flows to the operative fish passage route(s) will be maintained at all times. The construction sequence (Section 3) ensures that at least one dedicated upstream route is available at every phase — initially the existing lowered crest fish pass (Phases 1–3, supplemented by the temporary Chevron fish pass from Phase 2), then the temporary Chevron fish pass as the operative upstream route (Phases 4–5), and finally the permanent vertical slot fish pass (commissioned in Phase 6 before the temporary Chevron is removed, ensuring sequential handover with no interruption to upstream passage). The construction sequence, including any temporary works will be designed to manage flows such that attraction flows to the operative upstream route will be maintained throughout, with supplementary flow through any available secondary routes.

5.7 Pollution Prevention and Lighting Controls

Pollution prevention measures will be implemented in accordance with SEPA Guidance on Pollution Prevention (GPP), including bunded fuel storage at least 50 m from the watercourse and spill kits at all works locations. Construction lighting will be directional, to avoid light spill into the watercourse, and will be turned off when not required (EIAR Chapter 9, paragraph 9.7.3).

During the smolt migration season (April to mid-June), no night-time working will be undertaken in areas where artificial lighting could affect the watercourse or operative smolt passage routes. This commitment reflects the predominantly nocturnal pattern of smolt migration and ensures that construction activity does not interfere with downstream passage during the period of highest smolt sensitivity.

6. Evidence from Comparable Works at Dochfour Weir

Substantial construction works have previously been undertaken at Dochfour Weir during the operational life of the structure. Two construction episodes are particularly relevant in considering the potential effects of disturbance on migratory salmon: the installation of the SSE sluice gates in 1972–73 and the Scottish Canals reinforcement works undertaken in 2017. These historical works provide useful site-specific context for the disturbance pathway considered in Section 4. In particular, they indicate that significant construction activity has previously occurred at Dochfour Weir while salmon migration through the River Ness system continued, with no obvious indication from available evidence that passage at the weir was prevented during the construction periods.

6.1 2017 Scottish Canals Sheet-Pile Reinforcement Works

In 2017, Scottish Canals undertook extensive reinforcement works along the crest of Dochfour Weir as part of a programme to extend the operational life of the structure (EIAR Chapter 9, paragraph 9.8.55). These works involved installation of an approximately 8 m deep sheet-pile wall along the crest of the weir and along the downstream toe of the existing fish pass. The spatial extent of piling was substantial and provides a relevant precedent for construction disturbance at this location.

During the 2017 works a temporary Alaskan Denil fish pass was installed to maintain upstream migration while construction was underway. Temporary passage arrangements were therefore implemented to maintain connectivity for migratory fish during the reinforcement works.

The 2017 works therefore provide site-specific evidence that substantial construction activity, including sheet piling along the weir crest, can occur at Dochfour Weir while temporary fish passage arrangements are in place.

The current proposals build on that experience but incorporate several enhancements. These include upgraded temporary passage arrangements and explicit seasonal programming of disturbance-generating activities, particularly impact piling, within periods of lowest migratory sensitivity. The 2017 works nevertheless provide a useful precedent for the scale and nature of construction activity that can occur at Dochfour Weir.

The 2017 works were undertaken with the agreement of statutory consultees including NatureScot, SEPA and the Ness District Salmon Fishery Board, and specifically were required to demonstrate that the Moriston SAC would not be impacted.

6.2 1972–73 SSE Sluice Gate Installation

The SSE sluice gates located on the southern (right bank) extent of Dochfour Weir were installed during construction works undertaken in 1972–73. Although detailed construction records are not available, it is highly probable that installation of the sluice gates required cofferdam isolation of the relevant section of the weir structure to allow in-the-dry construction of the sluice bays.

The scope of the 1972–73 works therefore provides precedent evidence that major structural modifications to the weir have previously been undertaken at this location. The works demonstrate both the feasibility of undertaking substantial construction activities at Dochfour Weir and the absence of any known long-term impacts on salmon migration associated with those works.

6.3 Rod Catch Evidence

The River Ness is not equipped with fish counters. However, rod catch data are widely used as an approximate proxy indicator of the number of fish entering a river system and therefore provide a useful contextual indicator when considering long-term trends.

Rod catch data for the Ness District (source: Marine Scotland) were examined for the periods surrounding both the 1972–73 sluice installation works and the 2017 reinforcement works.

1972–73 SSE sluice installation: The 1973 season, immediately following completion of the sluice gate installation works, was a strong year in terms of reported rod catches. Subsequent seasons do not show any sustained reduction relative to the pre-construction period.

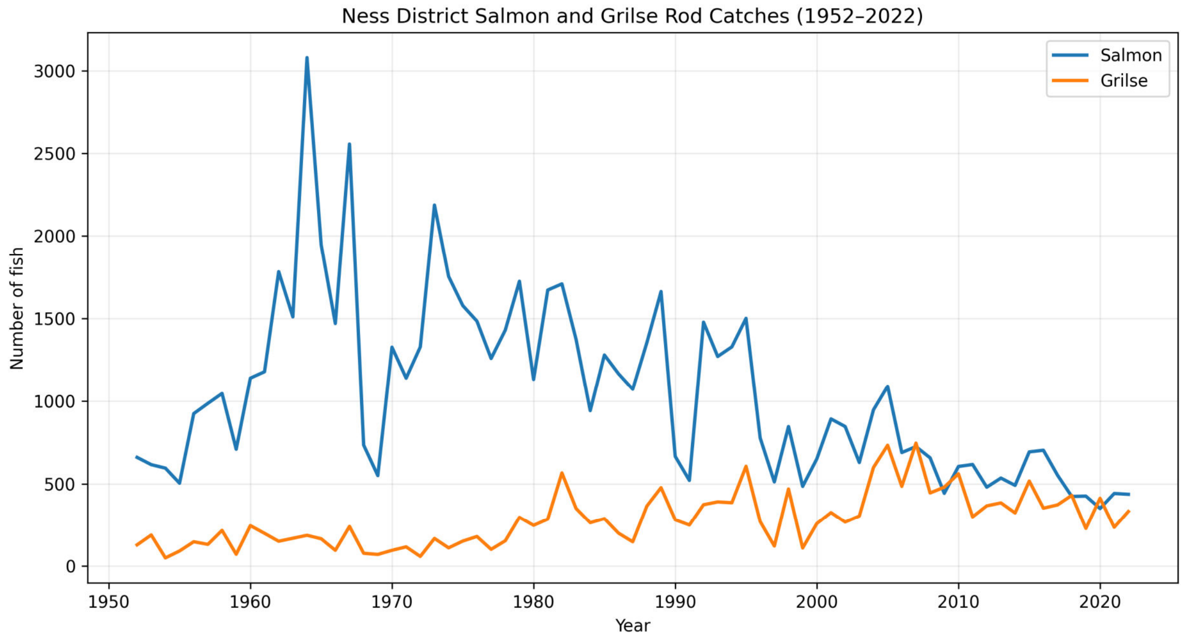

Figure 4: Ness District salmon and grilse rod catches 1952–2022 (long-term series). Source: Marine Scotland.

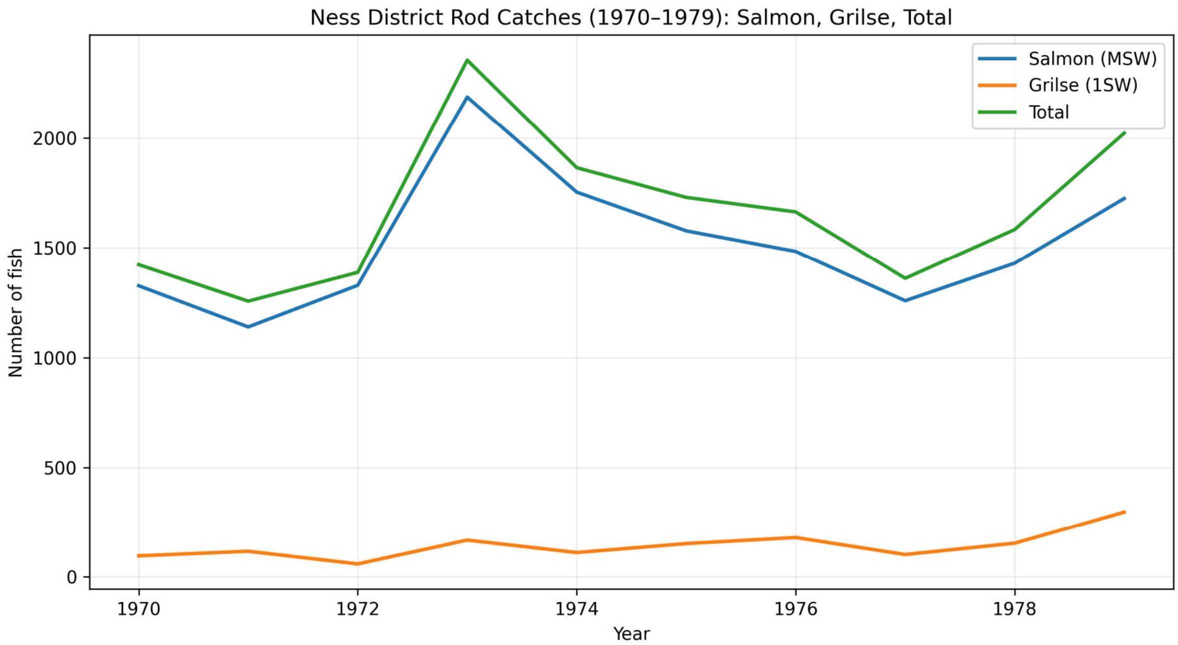

Figure 5: Ness District salmon and grilse rod catches 1970–1979 (detail). Note 1973 is a strong year; subsequent years show no decline attributable to the works. Source: Marine Scotland.

2017 Scottish Canals reinforcement works: The 2018 season following the reinforcement works recorded catches somewhat lower than 2017, but this is consistent with the established long-term decline and interannual variability observed across Scottish salmon rivers. The catch series does not show any step-change or departure from trend that could reasonably be attributed to the 2017 construction works.

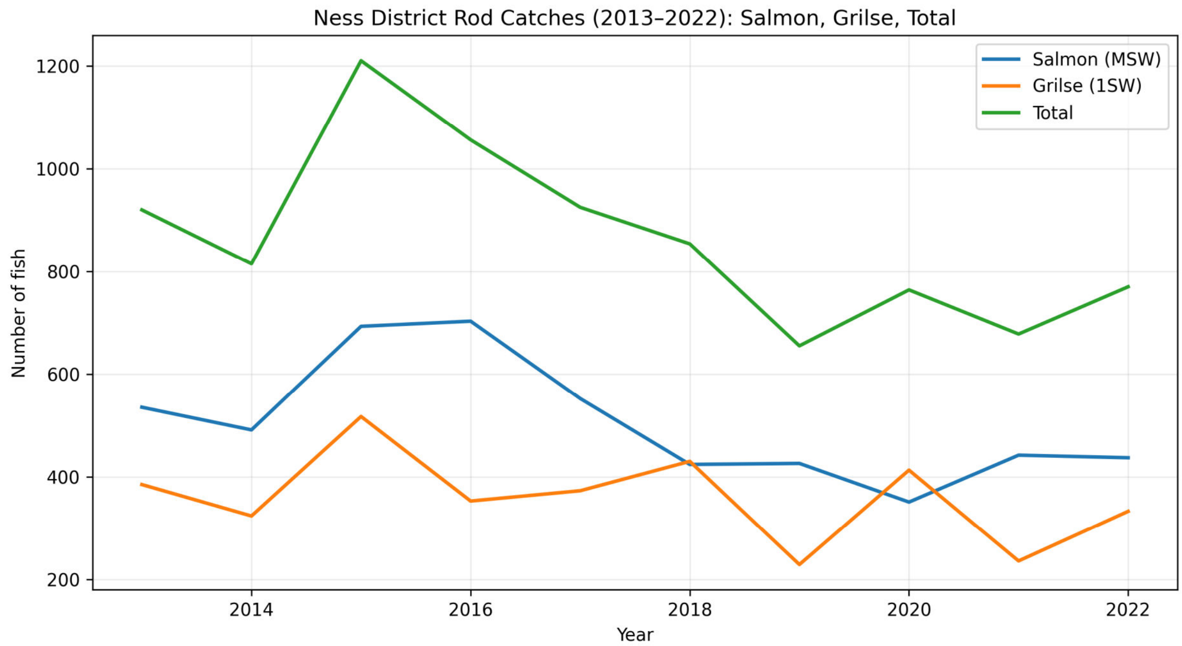

Figure 6: Ness District salmon and grilse rod catches 2013–2022 (detail). Note 2018 continues the trend; no step-change attributable to the 2017 works. Source: Marine Scotland.

Neither the 1973 season (following the sluice installation works) nor the 2018 season (following the 2017 reinforcement works) shows any obvious departure from the underlying catch trends that could be associated with construction activity at Dochfour Weir. Rod catch data are an imperfect proxy for run size, being influenced by factors including angling effort, catch-and-release practices and river conditions. These data are therefore presented as supportive context rather than as primary evidence of no effect. With that caveat, the available catch record is consistent with the view that the documented construction episodes at the site did not give rise to any evident population-level signal in migratory salmon returns.

7. Conclusion

NatureScot has requested that the Applicant demonstrate that disturbance can and will be kept below levels that would result in salmon avoiding the area of the works. The above information sets out how construction disturbance at the Dochfour Weir would be capable of being kept below levels that would result in Atlantic salmon avoiding the area of the works, as summarised below:

Temporal avoidance (Section 2; Section 5.1). All impact piling is programmed within the November–December core window when migratory activity is minimal, with vibro-piling subject to ecological controls including avoidance of the smolt run.

Passage continuity (Section 3). The six-phase construction sequence maintains continuous upstream and downstream passage throughout, with sequential handover between temporary and permanent arrangements ensuring that upstream and downstream passage routes remain available at all stages of the works.

Quantitative noise evidence (Section 4). Published thresholds for the behavioural response of salmon to piling noise confirm that, with the seasonal programming and physical mitigation measures committed to (Section 5), disturbance does not approach levels capable of causing salmon to avoid the operative passage routes during periods when migratory fish are present.

Site-specific precedent (Section 6). Two previous episodes of major construction at Dochfour Weir provide site-specific context that substantial construction activity has previously occurred at this location while the River Ness system continued to support migratory salmon, supported by rod catch return data showing no obvious adverse signal following either episode.

These controls are secured as firm commitments (Section 5) to be implemented through the CEMP, method statements and HRA conditions. In each case, the preceding sections demonstrate both that the measures *can* be deployed — drawing on quantitative evidence, published guidance and site-specific precedent — and that they *will* be deployed, through commitments that are definitive rather than contingent on practicability.

The hydraulic evidence demonstrating that the temporary and permanent passage arrangements will deliver appropriate attractant flows, water depths and velocities for salmon at all relevant life stages is provided in the companion Fishtek submissions (Fishtek Temporary Fish Passage Technical Note, March 2026; Fishtek Fish Passage Optioneering Summary, Rev 004, March 2026).

It is also relevant to note that the fish passage arrangements proposed as part of the variable weir project represent a significant improvement on the current situation at Dochfour Weir, which is acknowledged by the EIAR (Chapter 9 paragraphs 9.8.57 and 9.8.57), NDSFB and NatureScot to be sub-optimal for salmon passage. The permanent vertical slot fish pass, designed for multi-species use with dedicated smolt passes and fish monitoring facilities, will address long-standing concerns about passage at this location. These improvements represent a long-term enhancement to fish passage conditions at Dochfour Weir and are additional to the conclusion above that construction disturbance itself is expected to remain limited.

On this basis, the Applicant considers it is demonstrated that construction disturbance at Dochfour Weir would be kept below levels that would result in Atlantic salmon avoiding the area of the works.

8. References

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