Please note that this document set has been superseded by the March 2026 submission. This earlier version, previously provided directly to NatureScot, is therefore included for context only and should not be relied upon as being current.

Glen Earrach

**Covering Note - Response to NatureScot Requirements (a) and (b) – River Moriston SAC Further Information request (19 January 2026)**

**1. Purpose and scope of this note**

1.1 This covering technical note is provided to accompany Fishtek's February 2026 deliverables relating to fish passage and downstream smolt passage provisions at Dochfour Weir.

1.2 The note's purpose is to close outstanding elements of NatureScot's information requirements for the River Moriston SAC, specifically the requirements labelled (a), (b)(i) and (b)(ii) (as set out in NatureScot's letter requiring further information in relation to the River Moriston SAC).

1.4 This note does not introduce a new design and does not supersede Fishtek's concept design and technical narrative. It provides explicit confirmations, scenario framing, and management commitments that sit alongside Fishtek's design package.

**2. NatureScot requirements addressed**

2.1 NatureScot's River Moriston SAC information requirements (extract) require demonstration of:

**(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."

**(b)(i) Operation 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."

**(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."

2.2 The Fishtek deliverables provide the concept design basis and technical rationale. This covering note provides explicit statements and cross-referenced assurances in relation to the above tests.

**3. Construction-phase passage and disturbance management**

**NatureScot requirement (a)**

## 3.1 Continuity of passage during construction

3.1.1 It is the project's intention and requirement that upstream and downstream salmon passage at Dochfour Weir will be maintained throughout construction of the proposed adjustable weir and fish passage works.

3.1.2 The construction sequencing presented by Fishtek demonstrates the principle of maintaining passage through the following measures:

- retention of the existing upstream passage provision until a temporary alternative is in place;
- provision of a temporary fish pass during periods when the existing pass is unavailable; and
- replacement of temporary provisions with permanent arrangements once complete.

3.1.3 The temporary fish pass is intended to provide an unbroken continuity of upstream passage for migrating salmon during construction, with downstream passage maintained via the available downstream routes and temporary arrangements described by Fishtek, and by sequencing which avoids creation of periods with no available passage route.

3.1.4 The project will ensure there are no planned periods during which all upstream passage routes are simultaneously unavailable.

## 3.2 Temporary passage arrangements: functional assurance

3.2.1 Fishtek have issued a standalone Temporary Fish Passage Technical Note describing temporary passage provisions and the basis for their performance.

3.2.2 For the purposes of NatureScot requirement (a), the project confirms that temporary arrangements are intended to provide:

- appropriate attractant flows to ensure fish locate the temporary route; and
- depths and velocities that are passable by salmon at all relevant life stages for which upstream passage is required during the construction programme.

3.2.3 The temporary arrangements are based on practicable, established approaches used at this location and in comparable contexts, and are intended to be implemented such that the transition between existing, temporary, and permanent arrangements maintains passage continuity.

## 3.3 Alternative construction sequencing option to reduce reliance on temporary in-stream passage

3.3.1 In addition to the construction sequencing illustrated in Fishtek's Construction Sequencing drawing, the project notes that an alternative sequencing approach may be feasible which reduces, or potentially avoids, the requirement to install a temporary in-stream fish pass. This approach is briefly summarised below.

3.3.2 The purpose of this alternative sequencing is to further support NatureScot requirement (a) by:

- maintaining continuous upstream and downstream passage throughout construction; and
- reducing the duration and extent of in-stream works undertaken in proximity to the active passage route(s), thereby reducing disturbance risk and the potential for avoidance behaviour.

3.3.3 The alternative sequencing approach (Option 2) is summarised as follows:

**Step 1: Early delivery of downstream smolt routes independent of main weir works**
a) Construct Smolt Chutes 2 and 3 first, noting these can be progressed largely independently of the principal adjustable weir crest works.
b) This provides additional downstream route availability early in the programme and reduces reliance on the existing small chute and/or lock-adjacent route during later phases.

**Step 2: Construct the new upstream fish pass while retaining the existing upstream route**
a) Construct the new upstream fish pass in a manner that avoids disturbing the existing downstream routes and maintains a functioning upstream passage route at all times.
b) By completing the new upstream fish pass before the main weir crest works commence, upstream-migrating fish can be routed via the new pass and away from the principal construction activity at the weir crest, thereby reducing the likelihood of avoidance behaviour.

**Step 3: Undertake the remaining adjustable weir crest works once permanent passage routes are available**
a) After both the new upstream fish pass and the downstream smolt routes are in place, undertake the remaining works to the weir crest and associated elements.
b) During this stage, passage is maintained using the permanent routes, with construction controls applied to avoid unplanned restrictions or loss of access to those routes.

3.3.4 Notwithstanding final confirmation of programme logic, the project confirms that the governing requirement remains continuity of passage, and that the selected sequencing will ensure:

- no planned period where all upstream passage routes are unavailable;
- downstream passage routes remain available throughout construction (via existing and/or newly constructed routes); and
- disturbance controls are implemented proportionately to prevent avoidance behaviour, with particular focus on minimising in-stream works close to operative passage routes during periods when migration is anticipated / passage is required.

**3.4 Disturbance and avoidance management during construction**

3.4.1 NatureScot's requirement (a) explicitly includes disturbance management to avoid avoidance behaviour and to ensure passage is unimpeded.

Glen Earrach

3.4.2 The project confirms that construction disturbance will be managed through proportionate controls, to be secured and implemented through the project's construction management documentation and consenting commitments (including a Construction Environmental Management Plan, method statements, and any relevant HRA commitments).

3.4.3 At this stage, and for the purpose of closing the requirement in principle, the project commits that disturbance will be managed by:

- planning and sequencing works to minimise in-water activity during sensitive migration periods, where practicable within the programme;
- controlling noisy or high-disturbance activities near the weir where practicable, and scheduling such activities to reduce the likelihood of disturbance coincident with peak migration movement;
- applying controls on night-time lighting, access, and plant movement near the watercourse where these could influence fish behaviour; and
- maintaining clear, well-defined attraction flows to the operative passage route(s) **throughout periods when migration is anticipated / passage is required**, recognising that extreme flood conditions may result in pass submergence and are outside normal passage reliance (see Section 4.4).



**4. Upstream passability for relevant life stages and times of year**

**NatureScot requirement (b)(i)**

**4.1 Life stages within (b)(i) scope**

4.1.1 In line with NatureScot's request, the project explicitly considers the following Atlantic salmon life stages for **upstream passage** passability at Dochfour:

- grilse; and
- multi-sea-winter adults.

4.1.2 Downstream passage (including smolts and kelts) is addressed separately under Section 5 in response to NatureScot requirement (b)(ii).

4.1.3 Where performance is life-stage dependent, the project avoids reliance on generic terms (for example "salmonids") without specifying the relevant life stage.

**4.2 Hydraulic conditions and biological capability linkage**

4.2.1 Fishtek's optioneering report and technical appendices describe hydraulic parameters for the proposed fish pass options (including slot velocities, depths, and head drops) and provide references to published swimming capabilities and relevant criteria.

4.2.2 For the purpose of NatureScot requirement (b)(i), the project confirms the intended approach is that:

- proposed fish pass hydraulic conditions are set within published capability ranges for the relevant life stages and sizes expected at the site; and

- where conditions vary by loch level or operational state, the design incorporates tolerance and adaptability (including provision for operational adjustment where required) so that passability and attraction are maintained across credible operating ranges.

4.2.3 The passability case is established through:
- a hydraulic performance basis (depths, velocities, head drops and attraction flow characteristics); and
- an ecological and behavioural interpretation, supported by published evidence.

**4.3 Seasonal operability and "times of year"**

4.3.1 NatureScot require passability for relevant life stages and times of year. Fishtek's documents address performance across loch level variations and operational ranges which cover all seasons.

4.3.2 The project confirms that upstream passage provisions are intended to operate across the entire year, including key upstream migration periods.

**4.4 Flood and high-flow operation**

4.4.1 Fishtek have addressed flood / high-flow operation within their optioneering report (including confirmation that extreme flood events may result in pass submergence and that the fish pass is not relied upon as a controlled passage route in such conditions).

4.4.2 For the purposes of NatureScot requirement (b)(i), the project confirms that:
- the fish pass is designed and assessed for operation and passability across the representative operating range used for migration-relevant conditions; and
- Note that during spate flows, the Dochfour weir becomes flooded out, effectively becoming one large fish-pass. Hence whilst the new pass is designed to operate under the highest loch levels, it is anticipated that migrating fish will follow the large flows and pass over the weir.

**5. Downstream smolt routing and Caledonian Canal risk**

**NatureScot requirement (b)(ii)**

**5.1 Baseline context and the test to be met**

5.1.1 NatureScot's (b)(ii) test is that project-related changes in water levels and flows will not increase the number of smolts exiting Loch Ness via the Caledonian Canal, relative to the River Ness route, compared to baseline.

5.1.2 The project acknowledges that baseline smolt entrainment to the Caledonian Canal is a known issue, although data from the Moray Firth Tracking Project (Lothian AJ, 2022) suggests that the issue is greater in Loch Oich than at Dochgarroch. The requirement is therefore addressed by demonstrating that the proposed arrangements do not make this outcome more likely relative to baseline conditions.

**5.2 Smolt routing strategy at Dochfour**

5.2.1 Fishtek's concept package includes a downstream smolt passage strategy comprising multiple downstream route opportunities adjacent to the weir and canal interface.

5.2.2 For the purpose of (b)(ii), the project confirms that the intended effect of the downstream arrangements is to improve baseline conditions for downstream migrating smolts by:

- providing defined downstream routes in the vicinity of the weir that preferentially guide downstream movement; and
- reducing the likelihood that smolts are routed towards the canal through the combination of route provision and associated guidance measures (where proposed).
- providing a well-designed smolt chute immediately upstream of the Dochgarroch lock in the relatively still reach where the attractant flows to the chute will be dominant. This chute will not be closed off by the open lock gates (as with present arrangement) and will include a full safe routing all the way to the River Ness.
- By positioning the downstream chute slightly upstream of the lock gates, the swim-path for smolts is less likely to pass close to the lock gates, thus reducing the risk of entrainment. Note that the existing by-wash culvert exits directly in front of the lock and hence smolts are drawn right to the forebay of the lock.

5.2.3 In relation to implementation of behavioural measures as proposed in concept drawings (for example bubble-based guidance or other non-physical measures):

- These will be intended to guide and discourage canal entry, rather than to create a barrier to migration.

- Measures can be modified following the results of monitoring

**5.3 Transparent and justified realistic worst-case scenario basis**

5.3.1 NatureScot require evidence based on transparent and justified realistic worst-case scenarios for water levels and flows at, around and over/through the weir and lock gates.

5.3.2 For the purposes of this submission, the project's routing assessment is framed around the following scenario components:

- representative loch levels covering the credible operating range relevant to routing and attraction;
- representative River Ness flow conditions relevant to migration and attraction at the weir;
- representative adjustable weir operating configurations relevant to downstream routing; and
- representative lock gate operational states relevant to localised flows and attraction.

Glen Earrach

5.3.3 The intention is not to over-model highly improbable combinations, but to set out a clear, justified "realistic worst-case" basis and demonstrate that the proposed arrangements remain neutral or beneficial relative to baseline routing outcomes.

**5.4 Cumulative effects of Loch Ness water users**

5.4.1 NatureScot require consideration of the cumulative effects of all Loch Ness water users.

5.4.2 The project confirms that the worst-case framing for routing considers cumulative influences from significant Loch Ness water users, including:

- The baseline water movement, including SSE Foyers PSH operations;
- other current, consented and applied-for developments that can affect loch levels and level change rates at the scale relevant to routing.

5.4.3 The project further notes, for clarity of relative influence, that lock gate operations are not a material driver of loch water movement compared to PSH operation. Lock operations can, however, create localised and short-duration attraction flows in the immediate vicinity of the lock gates. The downstream routing strategy is intended to reduce canal-directed outcomes notwithstanding these localised effects.

**5.5 Climate change consideration**

5.5.1 NatureScot require that climate change is considered in the worst-case scenario basis.

5.5.2 The project confirms that climate change has been considered using the project's available climate guidance (as summarised by AECOM in accompanying note). This includes, for the purposes of this submission:

- consideration of a **1 in 200-year flood event including an allowance for climate change uplift** (as adopted within the project's climate scenario guidance); and
- consideration of **realistic worst-case low-flow / drought conditions** (based on the lowest credible historical flow conditions, with climate change adjustments applied as set out in the project's climate guidance).

5.5.3 The project's submission approach is to compare proposed arrangements against baseline behaviour under the same climate-influenced framing, to demonstrate that the proposed arrangements do not create an increased smolt routing risk to the canal relative to baseline.

**5.6 Precedent basis for smolt chute concept**

5.6.1 Fishtek's optioneering report provides a precedent example for a smolt chute arrangement (Figure 6-1), noting that the Dochfour application would be at larger scale.

5.6.2 For the purposes of the submission, the project confirms that the smolt passage concept is not presented as an untested novelty. It is grounded in established approaches used to provide safe, defined downstream routes at barriers, with the precedent example included as an illustrative basis and the Dochfour concept scaled and adapted to local hydraulic conditions and geometry.

**6. Conclusions**

6.1 This covering technical note, together with Fishtek's Optioneering Summary, concept drawing package, and Temporary Fish Passage Technical Note, is provided to demonstrate that the proposal can be constructed and operated without undermining the River Moriston SAC conservation objective to restore Atlantic salmon as a viable component of the site, in relation to the Dochfour weir interface.

6.2 Specifically, the combined package addresses NatureScot's requirements by:

- confirming continuity of upstream and downstream passage during construction, with temporary provisions and sequencing that avoid passage outage;
- committing to construction disturbance management to avoid avoidance behaviour, to be implemented through construction environmental controls and programme planning;
- confirming passability considerations for **grilse and multi-sea-winter adults (upstream passage)**, supported by published swimming capability evidence as referenced in the Fishtek documents; and
- setting out a transparent, justified realistic worst-case scenario framing for **smolt and kelt routing (downstream passage)** at and around the weir and lock gates, considering cumulative Loch Ness water users and climate change, and confirming that the proposed arrangements do not increase smolt losses to the Caledonian Canal relative to baseline.

6.3 It is the Applicant's view that the proposed implementation of both upstream and downstream fish passes will address known issues which are independent of any pump-storage hydro proposals and thus result in a significant improvement from the current situation. This is likely to be of overall benefit to fish stocks in the catchment.



**7. Document pack and cross-references**

The following supporting documents are provided alongside this covering note:

- Fishtek: Glen Earrach Energy Ness Weir Fish Passage Optioneering Summary
- Fishtek: Glen Earrach Energy Ness Weir Temporary Fish Passage Technical Note
- Fishtek: Concept drawings:
  - 0100-3540681-P02 – Location Plan, Site Plan, and Smolt Passage.pdf
  - 0101-3540681-P03 – Fish Pass General Arrangement.pdf
  - 0102-3540681-P03 – Fish Pass Typical Sections & Details.pdf
  - 0103-3540681-P02 – Construction Sequencing.pdf
- AECOM: 1 in 200 CC Technical Note (as referenced within Section 5.5 of this note and Section 7 of Fishtek's Optioneering Summary).

# Fish Passage Investigation

## Ness Weir, Loch Dochfour



**Client:** Glen Earrach Energy

**Date:** 11/02/2026

**Author(s):** Paul Gratton

FISHTEK

Fishtek Ltd
Unit 1a Webber's Way
Dartington
Totnes
TQ9 6JY

Phone: 01803 866680
E-mail: info@fishtek.co.uk
Web: www.fishtek.co.uk

| | |
|---|---|
| **Project Title** | 3540681 – Ness Weir Fish Passage Investigation |
| **Date** | 11/02/2026 |
| **Client** | Glen Earrach Energy |



**Revision Record**

| Revision | Date | Authors | | Checked by | |
|---|---|---|---|---|---|
| 001 | 26/01/2026 | Paul Gratton | | Toby Coe | |
| 002 | 03/02/2026 | Paul Gratton | | Toby Coe | |
| 003 | 11/02/2026 | Paul Gratton | | Toby Coe | |

## Summary

This technical note provides rationale for the selection of the preferred upstream and downstream fish passage solutions at Ness 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') 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 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 Ness 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 operational scenarios.

To support completion of the optioneering phase and concept design drawings, a Fishtek site visit was completed 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 Ness 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.

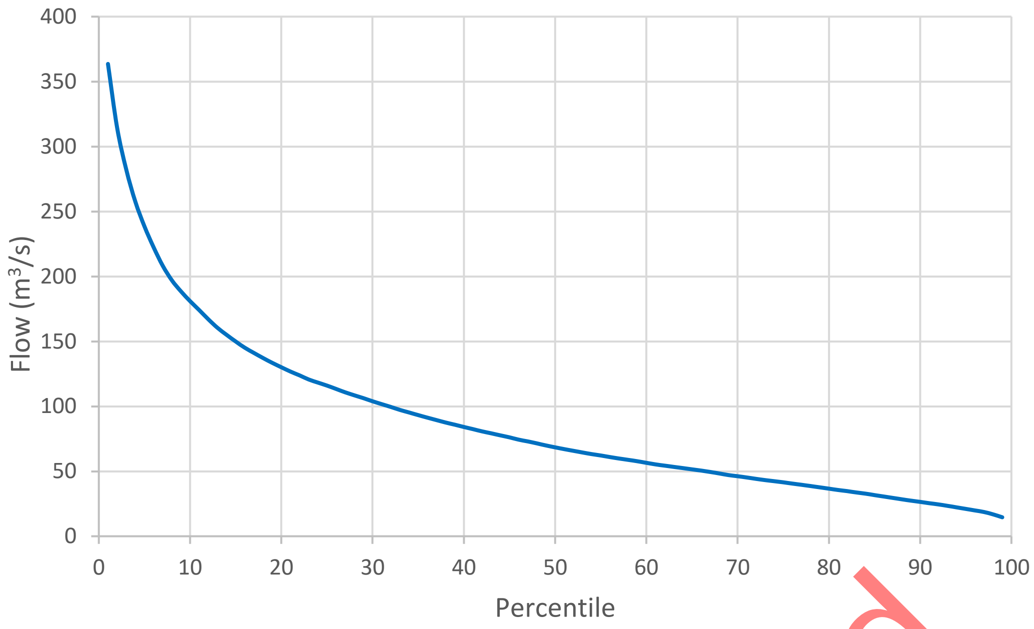



Figure 2-1. Flow duration curve for the River Ness at Ness-side (ID 6007), derived from the full period of record (1972 – 2024).

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 Ness 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.

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.

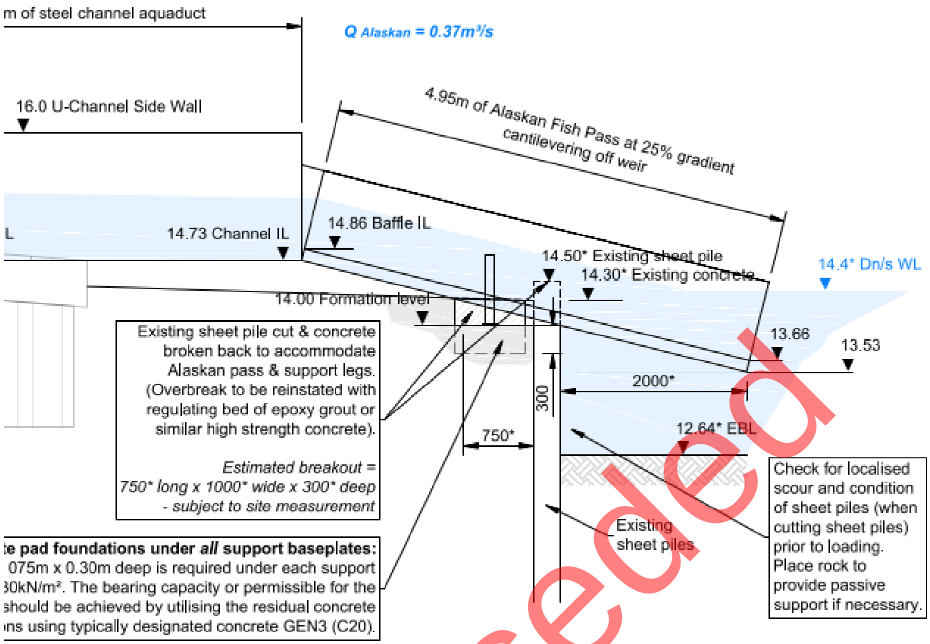



Figure 2-2. Extract from Fishtek design drawings for the temporary fish pass solution implemented during weir repair works in 2017, providing a downstream water level of 14.40 mAOD.



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. An extract from the modelling work showing the variability over a typical year (2023) is provided in Figure 2-3. These modelled levels indicate that for the majority of the year water levels in the loch are typically between a lower and upper level of 15.50 mAOD and 16.80 mAOD, respectively, equating to a 1.3 m maximum variation in upstream water level. These levels are akin to the Q95 and Q10 upper and lower operating flows across which a fish pass would typically be expected to function. Whilst further work will be required to fully define these upper and lower levels, for the current purpose of optioneering this 1.3 m range of variation is considered to be a suitable window over which any upstream fish pass would need to operate. 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.

**AI A2.1 Water Balance model results**

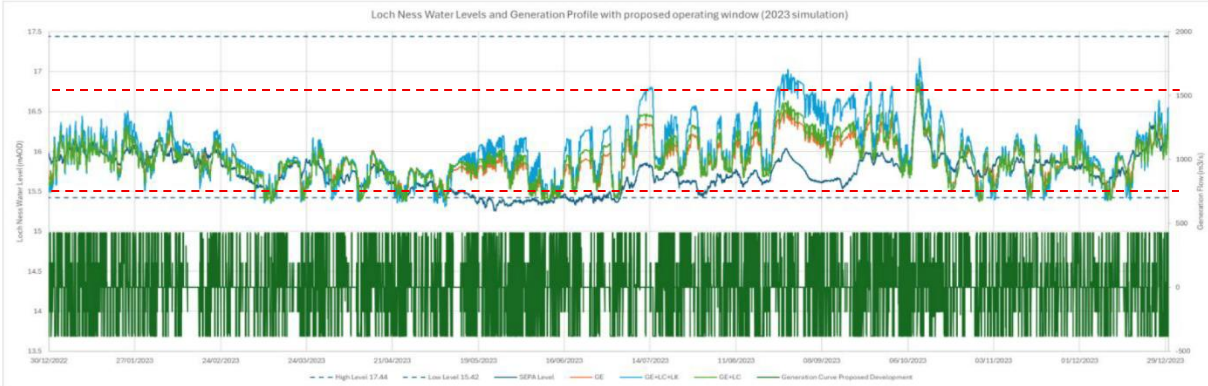



Figure A2-1 Entire year of 2023

Figure 2-3. Extract from AECOM hydraulic modelling of loch water levels in 2023 under various scheme scenarios. The majority of modelled water levels are within the 15.50 – 16.80 mAOD range, indicated by dashed red lines.

The available information therefore indicates a maximum head drop at the site of approximately 2.35 m based on the maximum typical future loch water level (16.80 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 Ness 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 these typical upper (16.80 mAOD) and lower (15.50 mAOD) bounds of loch water levels are considered adequate. However, further analysis of the relationship between loch level and downstream flow would 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 ~1.3 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. For grilse/MSW migratory salmonids larger head drops of 0.30 – 0.40 m per slot are typically acceptable, reducing to 0.20 – 0.25 m if passage of non-salmonid fish species is required. 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 very wide range of fish species, including migratory salmonids, lamprey and 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 maximum 0.24 m head drops between pools, two 0.6 m wide slots per baffle with a 1.8 m minimum water depth (increasing to a maximum of 3.1 m at the upper loch level), a vertical slot pass would convey a minimum flow of 2.70 $m^3/s$. If the fish pass were 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 would require pools measuring 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 3.1 m based on the *ca*. 1.3 m variation evident in modelled data across the anticipated operating window of the fish pass. Under this configuration the total discharge would increase to 7.2 $m^3/s$, with energy densities remaining below the 150 $W/m^3$ threshold.

Based on the assumed maximum head drop at the site (2.4 m), a vertical slot fish pass would require approximately 10 slots and nine pools with 0.24 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. Comparison of Shortlisted Upstream Options

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 Ness Weir.

| Option | Advantages | Disadvantages |
|---|---|---|
| Larinier super-active baffle pass | • Compact footprint due to steeper gradient<br>• Good functionality for grilse/MSW migratory salmonids<br>• Lower anticipated construction cost<br>• Moderately low on-going O&M requirements | • Complex arrangement required to accommodate variation in loch water level<br>• Reliance upon mechanical/electrical equipment to maintain functionality<br>• 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<br>• Likely to continue to provide effective passage conditions at loch levels below or above the agreed operating window<br>• Proven highly efficient multi-species passage for grilse/MSW salmonids and non-salmonids, including lamprey<br>• Moderately low on-going O&M requirements<br>• 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<br>• 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 Ness 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, 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 Ness Weir is essential to ensure that species requiring movement between marine and freshwater are able to complete their full life cycle and achieve future population recruitment. 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 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).

## 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.

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 accelerations, and in addition will compete poorly with the flows required for lock filling and during gate opening.

It is therefore considered that the current arrangements can be significantly improved by implementing a properly designed downstream pass with appropriate dimensions and attraction flow, assisted by behavioural screens to further guide fish to the entrances. Such improved arrangements are discussed below and are likely to reduce the residency time for smolts upstream of the weir, thus reducing predation opportunities and ensuring timely marine arrival, in addition to reducing the likelihood of smolts being drawn into the Dochgarroch Lock when it is opened.

## 6.3 Proposed measures

Effective measures to provide a route of downstream 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, typically not exceeding 1 m/s/m).

To meet these criteria, three separate downstream passage routes are recommended at the Ness weir site, comprising:

1) A lowered section of weir crest at the most upstream end of the service weir (directly adjacent to the existing SSE sluice gates); essentially replicating the existing lowered section of crest which would be occupied by the adjustable weir in future. It would be necessary to design the inlet to this channel in such a way that it provides appropriate flow dynamics and acceleration. This is likely to be achieved by a bellmouth opening in plan view and altering the upslope into the throat of the channel in long section view to meet the acceleration criteria. An additional small length of adjustable weir at the crest/throat of the channel would also be required to provide a defined flow volume across the future anticipated range of upstream loch water levels and in doing so could be designed to ensure that downstream passage is achieved across the majority of the future loch water levels (in common with the upstream fish passage arrangements).
2) A channel comparable to that 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 may be the preferrable as it will help isolate the construction works from the watercourse and minimises modification works required to the waste weir (which would have potential associated heritage implications).
3) A channel comparable to that outlined above, located immediately upstream of the Dochgarroch Lock gates. This would replace the existing pipe bywash route, which would become redundant and could be decommissioned. As an alternative to the bywash at this location, consideration could be given to providing passage via an Archimedes screw turbine. Archimedes screws have been demonstrated to provide safe downstream passage for a range of species and life stages, including smolts[4]. This approach would also provide a meaningful amount of clean electricity (*ca*. 50 – 100 kW output) with a near 100 % capacity factor.

These proposals are captured on the concept design drawings accompanying this report.

An example of a similar smolt chute arrangement is provided in Figure 6-1.



[4] Renardy, S., Ciraane, U. D., Benitez, J. P., Dierckx, A., Gelder, J., Silva, A. T., ... & Ovidio, M. (2023). Assessment of the attractiveness and passage efficiency of different fish passage solutions at a hydropower plant by combining fine scale 2D-telemetry and hydraulic numerical modelling. *Environments*, *10*(7), 107.

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



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

It is anticipated that the total sum of flow conveyed via these three downstream passage routes would need to equal or exceed the flow assigned to the upstream fish pass to provide sufficient attraction for migratory life stages to locate the channels without undue delay. 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). If each channel incorporates an adjustable weir structure at the crest similar to that proposed for the wider weir structure then it would be feasible to adjust the volume of flow conveyed via each route to ensure that the discharge does not create a competing flow for upstream migrating fish (which would distract from the fish pass discharge).

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. Whilst behavioural screens are not sufficiently effective to utilise in isolation, past studies[5] have demonstrated reasonable efficiency – particularly for smolts, suggesting that they are likely to improve deflection of fish towards the chute channel entrance. However, in the first instance the primary focus should be on ensuring that the fundamental design principles are achieved for each chute, i.e. creating appropriate entrance conditions and suitable attraction flow volumes

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 both in relation to a reduction in the mean delay fish are exposed to whilst attempting to pass the weir, in addition to a

[5] 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.

reduction in the percentage of smolts entering Dochgarroch Lock (the majority of which are essentially then lost from the population).

# 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[6].

## 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 |

It is highly likely that the entirety of the fish pass structure would become fully submerged under this scenario due to the increase in tailwater level in the River Ness downstream of Ness weir. Such a flow volume would be outside the anticipated operating window of the fish pass (typically a Q95 – Q10 flow exceedance window) and therefore this would not represent an event where effective operation of the fish pass would typically be expected or required. Furthermore, studies have shown that upstream migration of salmonids significantly reduces, or ceases, during extreme flood events[7]. This likely reflects the greater energetic expenditure that would be required to maintain upstream movement under high discharge/velocity conditions, compared to seeking refuge until flood flows recede.

[6] AECOM (2026). Technical Note: 1 in 200+CC level in Loch Ness Drought level in Loch Ness for fish pass design.
[7] Solomon, D. J. (2006). *Influence of river flow on salmonid migration in UK rivers*. In G. E. Petts & A. Maddock (Eds.), Hydroecology and ecohydrology: Past, present and future. Wiley.

It should also be noted that under these conditions the weir itself is likely to be largely drowned out, meaning that in the unlikely event that any fish were actively migrating, they would not be reliant upon the fish pass to move upstream.

### *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 |

For context the long term Q95 flow volume at Ness weir is 21.07 $m^3/s$ (Section 2.2). The minimum predicted 15 minute averaged flow is therefore approximately 55 % lower than the long term Q95, whilst the minimum predicted 24 hour averaged flow is approximately 40 % lower.

Under these scenarios the water level in Loch Dochfour (the upstream water level for the proposed fish pass) falls to a minimum of 15.29 mAOD for the 15-minute averaged flow. This level is approximately 200 mm below the minimum loch water level identified as the lower operating range of the fish pass – 15.50 mAOD (see Section 2.3). Under this scenario the proposed fish pass would remain fully operational; the depth of water in each slot ($H_1$) would reduce to 1.6 m, which would result in a modest reduction in fish pass discharge to approximately 2.29 $m^3/s$, compared to 2.70 $m^3/s$ at the lower end of the typical operating window. However, the fish pass discharge as a percentage of total river flow remains appropriate (~24 %) with the opportunity to provide additional supplementary flow via the auxiliary flow channels, if required.

## 7.2 Downstream passage

### *7.2.1 Operation during flood flows*

Under the modelled climate change flood flow scenarios the increase in loch water level is highly likely to result in the drowning of the proposed downstream passage routes. Under this scenario the structure would not be expected to pose an impediment to downstream migration due to the significant depth of water and volume of flow that would be passing over the entirety of the weir crest.

### *7.2.2 Operation during drought*

The proposals for downstream passage at the weir involve the creation of three dedicated passage routes (see Section 6.3). The inlet to each of these channels would comprise an adjustable weir crest section comparable to the main adjustable weir. Under the worst case drought scenario a minimum total flow volume of 9.6 $m^3/s$ is predicted, of which at least 2.3 $m^3/s$ would be conveyed via the upstream fish pass, leaving a total flow of 7.3 $m^3/s$ apportioned across the remainder of the site. The adjustable crests on each of the downstream chutes should be designed such that they represent a preferential flow route during low flow conditions to ensure that adequate flow is conveyed via each of the three channels before flow begins to spill over the main weir crest. Under this scenario the majority of available flow would be focused via four separate routes that can be utilised for downstream fish passage (i.e. the upstream fish pass and the three dedicated downstream chutes).

## 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 Ness weir (meaning that vast majority of the run of migratory fish into the Ness catchment upstream of Ness 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<br>• Reasonably low ongoing on-site maintenance requirements | • Limited data on species apportionment<br>• No accurate method of measuring fish<br>• Footage requires manual processing and ideally manual camera validation, which is labour intensive<br>• 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<br>• Potentially requires multiple cameras to capture the full width of the channel<br>• Likely to be blind spots in monitoring extent, therefore not providing full coverage<br>• 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<br>• Certain technologies (e.g. TiVA FC) automatically speciate and measure fish with a high degree of accuracy, minimising manual processing<br>• Camera footage and data can be viewed in real time and made accessible to public via online platforms<br>• Lifting and cleaning of equipment simplified due to deck and gantry arrangements | • Requirement for more infrastructure than other options<br>• Higher initial capital cost, though offset by limited ongoing requirement for footage processing<br>• 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.

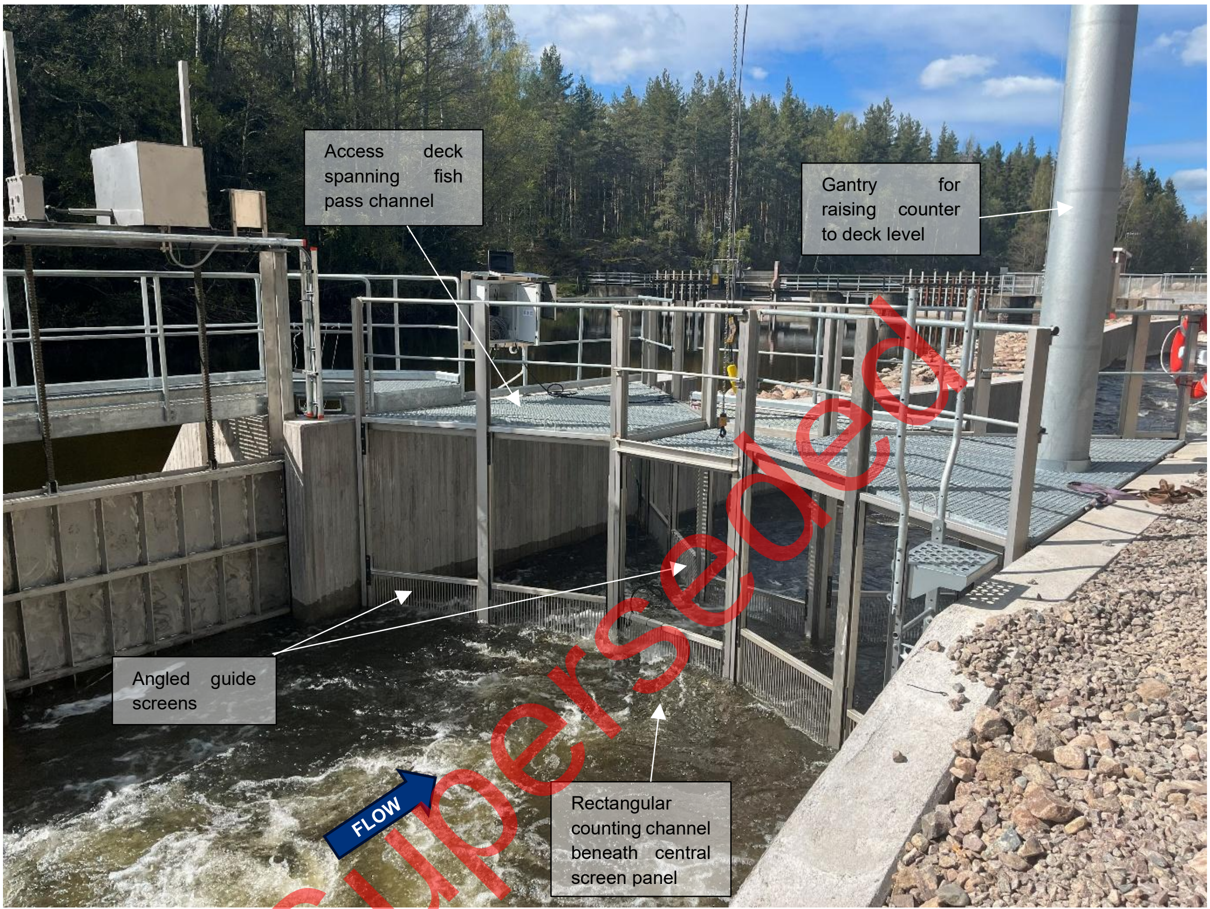





Figure 8-1. An example of guide screens and access deck infrastructure associated with a TiVA fish counter installation on a large fish pass in Sweden.

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 Ness Weir is detailed below.

- Head drop (H)

Maximum head drop: 0.24 m per slot at largest anticipated operating head (2.40 m).

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

- Total design flow:

4.53 – 9.06 m³/s (5 – 10 % of Qmean) at Q95; increasing as river flow increases thereafter. A minimum Q95 design flow of 6% of Qmean (5.44 m³/s) has been adopted at present

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

H1 (slot water depth) = 1.80 – 3.10 m

DH (head drop per slot) = 0.11 – 0.24 m

Number of slots = 2

Total vertical slot flow will therefore vary between a minimum of 2.70 m³/s (1.8 m H1 & 0.11 m DH) up to a maximum of 7.27 m³/s (3.10 m H1 & 0.24 m DH). Additional flow required to meet the minimum total design flow (5.44 m³/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:1.84 m/s at largest anticipated operating head

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

- Pool dimensions:

Minimum proposed pool volume: 6.6 m (W) x 5.6 m (L) x 3.10 m (D) = 114.6 m³

Minimum proposed pool volume: 6.6 m (W) x 5.6 m (L) x 1.80 m (D) = 66.5 m³

- 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: 17,105 watts

Maximum pool energy density: 149.3 W/m³

Minimum pool energy density: 43.7 W/m³

AECOM

# Technical Note

| Project name | Subject | Date |
|---|---|---|
| Glen Earrach PSH | 1 in 200+CC level in Loch Ness<br>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 250-300$m^3$/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

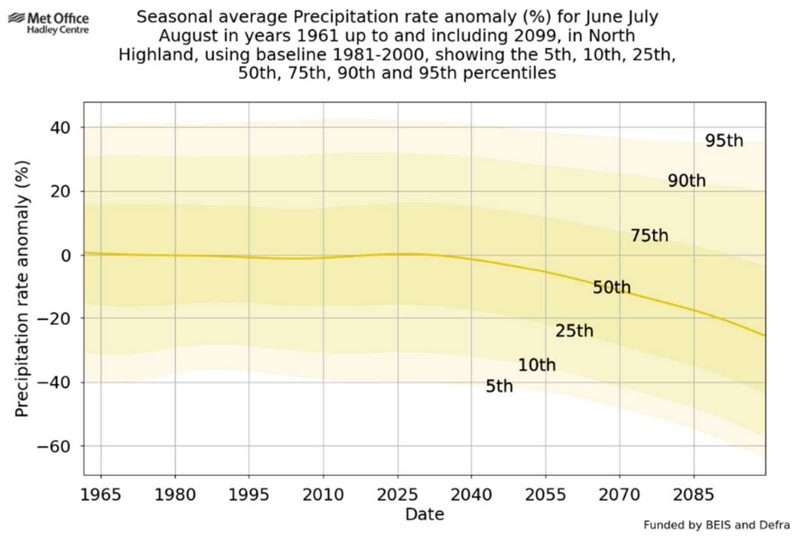



**Figure 1: UKCP18 precipitation rate anomalies**

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 |

FISHTEK

| Document | Ness Weir – Temporary Fish Passage Technical Note |
|---|---|
| Client | Glen Earrach Energy Ltd |
| Date | 11/02/2026 |
| Version | 1.0 |
| Author(s) | Paul Gratton |
| Reviewer(s) | Toby Coe |


## Summary

This technical note provides recommendations for temporary fish pass arrangements to maintain upstream and downstream passage during the construction phase of the proposed adjustable weir structure at Ness 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 downstream flow variation arising from level changes due to PSH activity in the River Ness downstream.

Alongside the main weir modifications, separate permanent works are also proposed to deliver an improvement 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 passage routes, consisting of chutes located on i) the upstream end of the service weir, ii) the downstream end of the waste weir and iii) immediately adjacent to the Dochfour Lock gates.

## 2. Anticipated construction sequencing

The high-level anticipated sequencing of the construction phase is detailed in Fishtek drawing no. 0103-3540681-P02 and is summarised below.

- Phase 1: Construction of two new downstream chutes/smolt passes, located at the downstream end of the waste weir and adjacent to the Dochfour Lock gates.
- Phase 2: Installation of a temporary fish pass at the upstream end of the service weir, adjacent to the existing lowered section of service weir crest 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.
- Phase 3: Construction of a new adjustable weir upstream of the crest of the existing waste and service weir.
- Phase 4: Construction and commissioning of a new permanent fish pass in the footprint of the existing bankside SSE sluice gate at the upstream end of the service weir.
- Phase 5: Decommissioning and removal of temporary fish pass and replacement with final permanent downstream chute/smolt pass.

The purpose of this technical note is to outline the proposed temporary fish pass arrangements to ensure that upstream and downstream fish passage remains possible for the entirety of the construction phase.

## 3. Temporary upstream fish passage proposals

Temporary fish passage facilities were installed at Ness weir in 2017 during previous construction works. Scottish Canals delivered repair works to Ness weir which involved sheet piling along the crest and toe of 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, meaning that this route temporarily ceased to convey flow 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 of the weir crest. Photographs of the previous temporary fish pass are provided in Figure 1 and Figure 2.



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

The previous fish pass was monitored via installation of video cameras at the upstream end of the lead-in channel. 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.

FISHTEK

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.



Due to the effective functionality of Alaskan Denil 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.

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 well within the swimming capability of the target salmon and sea trout life stages.

Subject to confirmation of the works programme for the construction of the adjustable weir, there may be benefit in constructing two identical Alaskan fish passes alongside each other to increase attraction flow for upstream migrating fish. Additionally, consideration could be given to forming a temporary notch through the crest of the weir adjacent to the temporary fish pass to provide additional supplementary attraction flow at the fish pass entrance.

FISHTEK

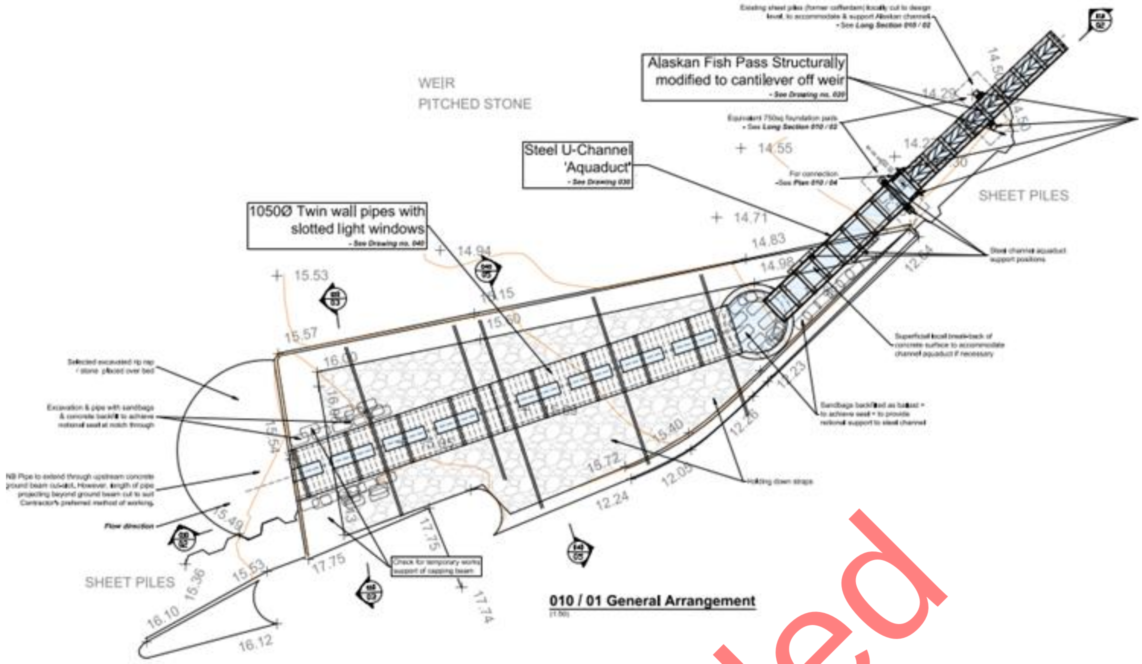
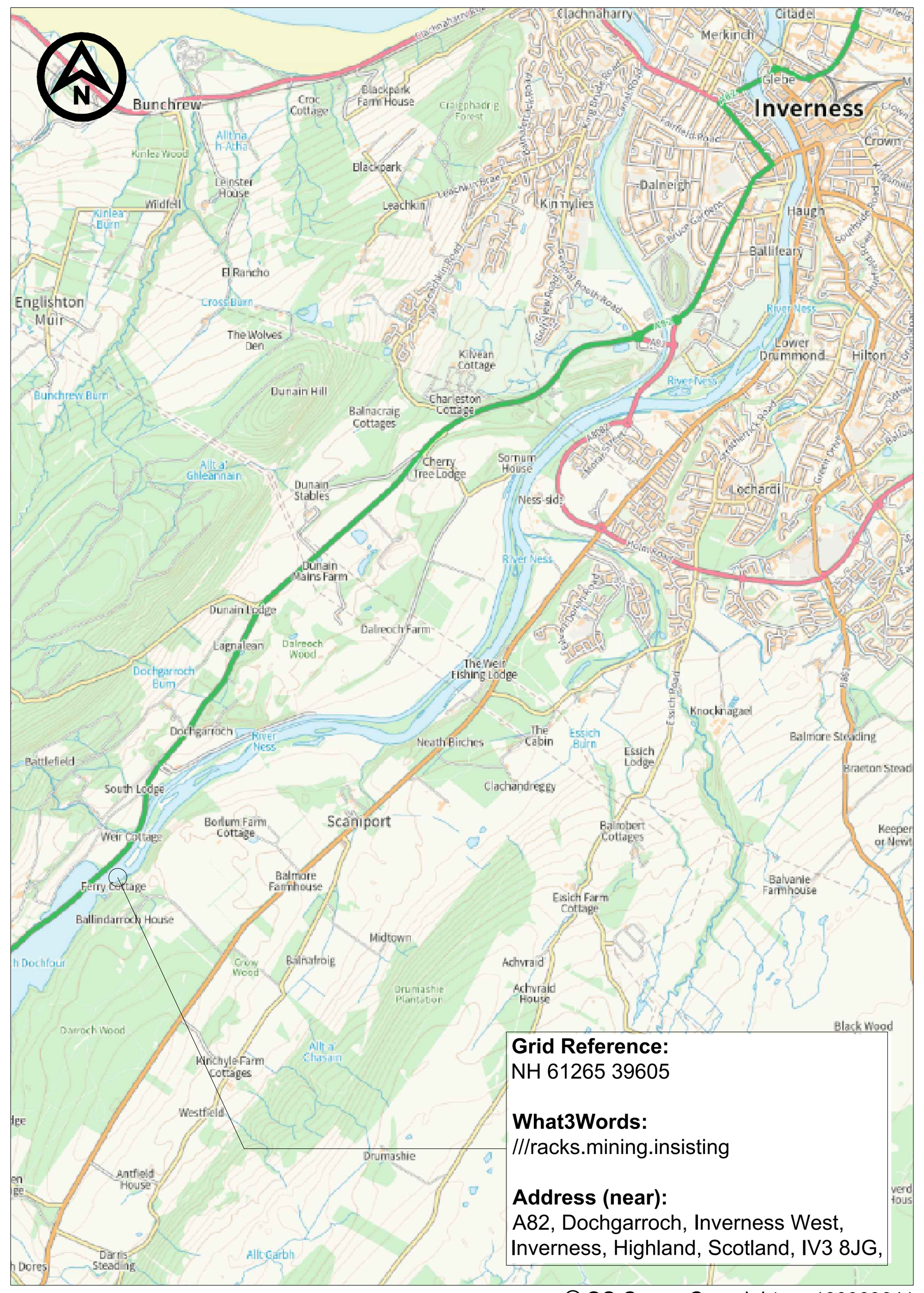



Figure 3. Extract from the Fishtek (2017) drawings, showing the general arrangement of the temporary Alaskan fish pass installed during the Scottish Canal weir repair works.

## 4. Temporary downstream fish passage proposals

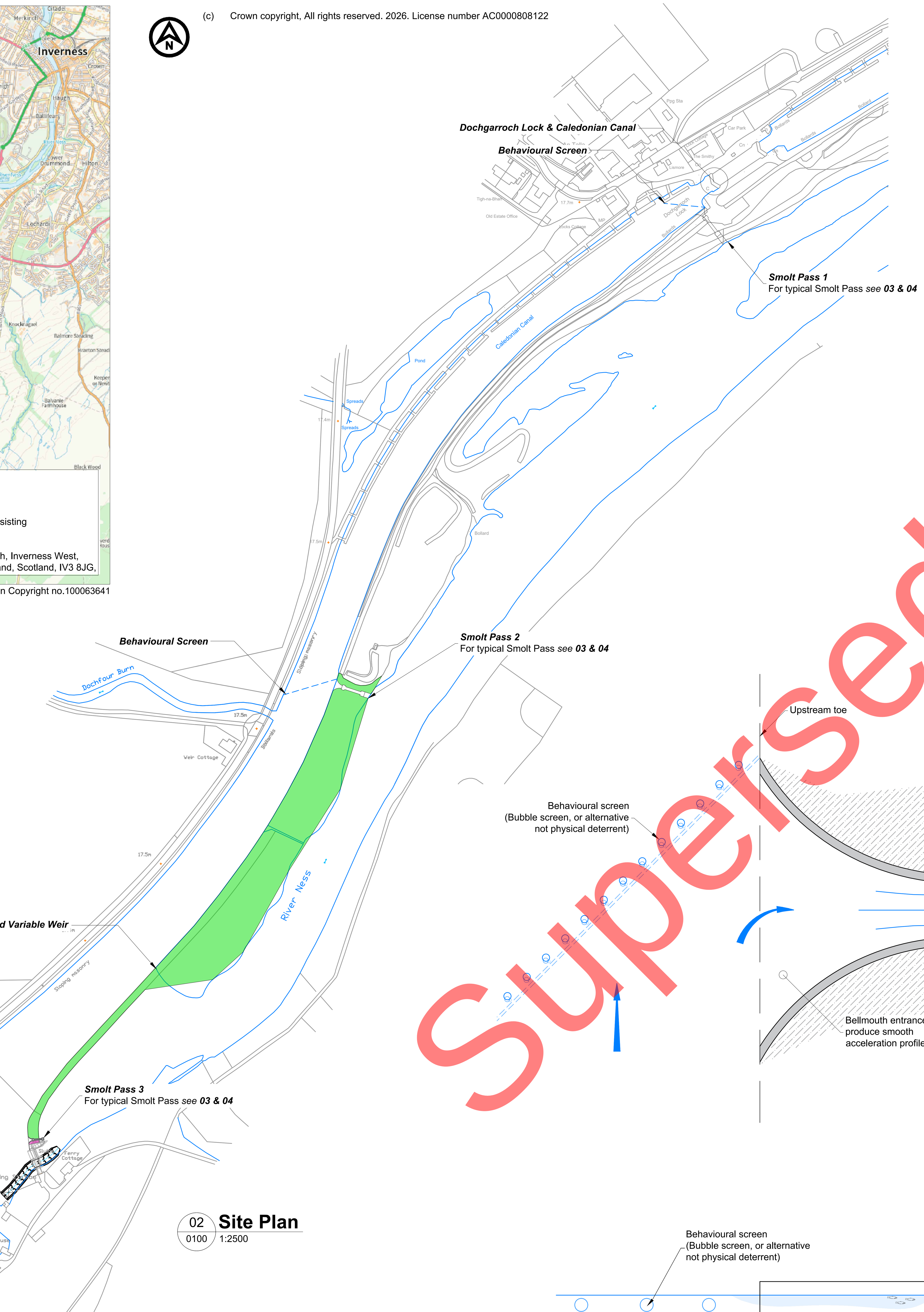
Under the proposed sequencing of construction works at the site, two new downstream passage routes would be constructed at the downstream end of the waste weir and adjacent to the Dochfour Loch gates during Phase 1 of the works. These downstream passage routes would replace the existing passage routes via two existing smolt chutes and the lowered section of weir crest on the service weir and would remain operational throughout the remainder of construction phase. As such, no arrangement for providing additional temporary downstream fish passage is considered necessary.



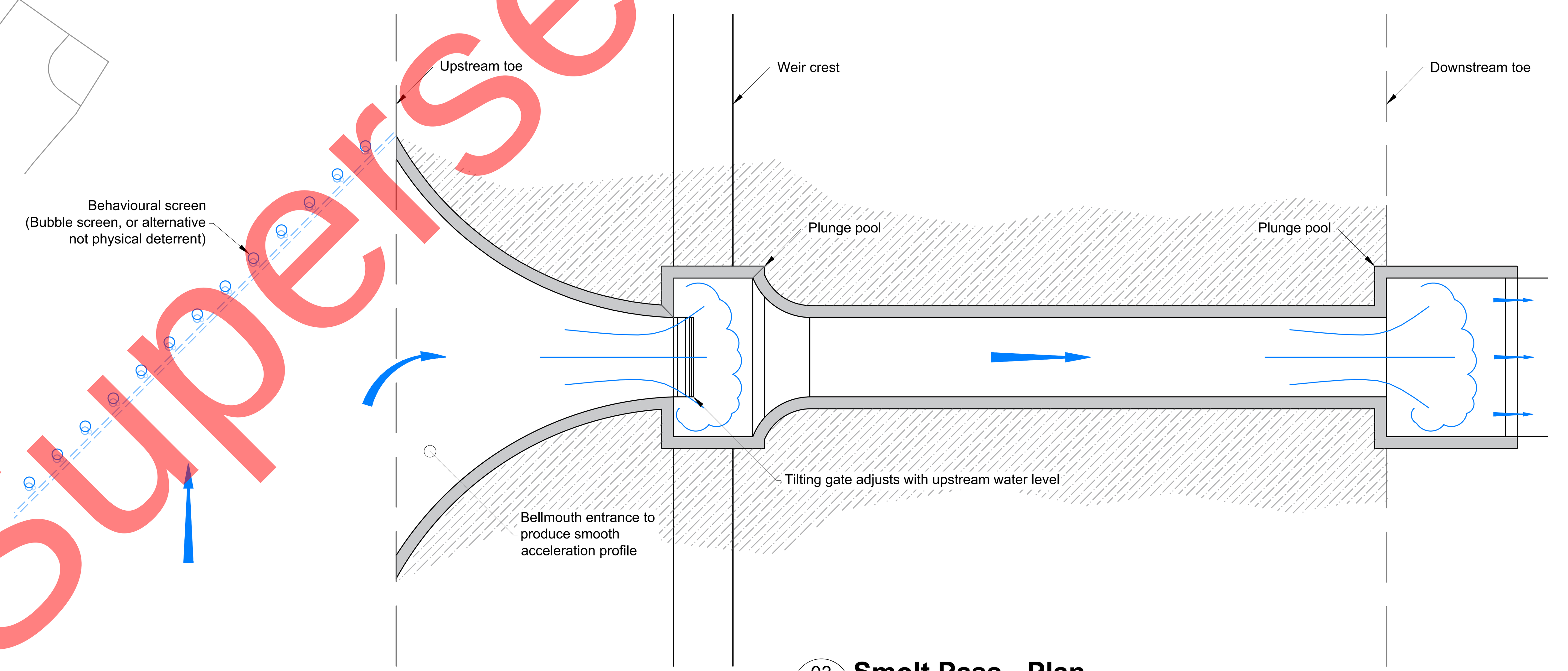



01 **Location Plan**
0100 NTS

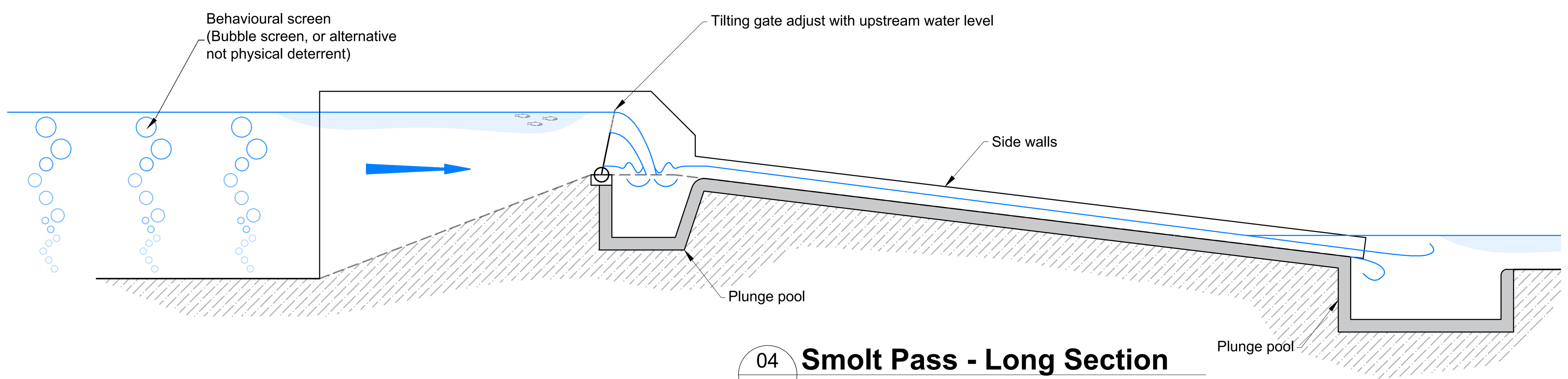





02 **Site Plan**
0100 1:2500




03 **Smolt Pass - Plan**
0100 1:50




04 **Smolt Pass - Long Section**
0100 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:

**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.

| Rev. | Date | Description | Auth. | Chkd. | Appr. |
|---|---|---|---|---|---|
| P0 | 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 | |
| © Copyright reserved | | Checked P. Gratton | |
| | | Approved P. Gratton | |

Scale: As Shown

Client: Glen Earrach

Designer: FISHTEK

Project:
Glen Earrach Energy
Dochfour Ness Weir
Fish Passage

Title:
Location Plan,
Site Plan and Smolt Passage

| Drawing No. | Project No. | Revision |
|---|---|---|
| 0100 | 3540681 | P01 |

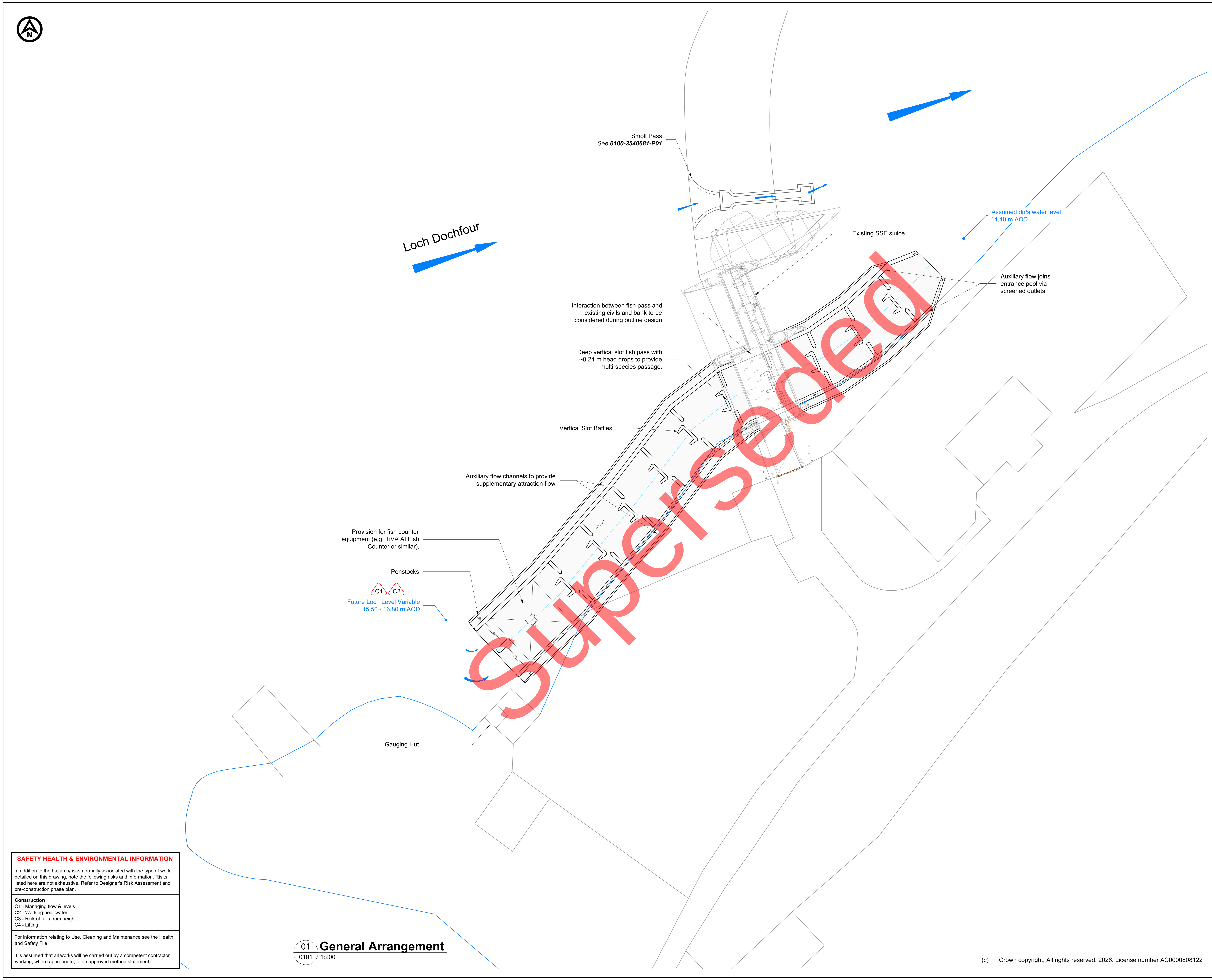
NOTES:

**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.




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

**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 | 06.02.26 | 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

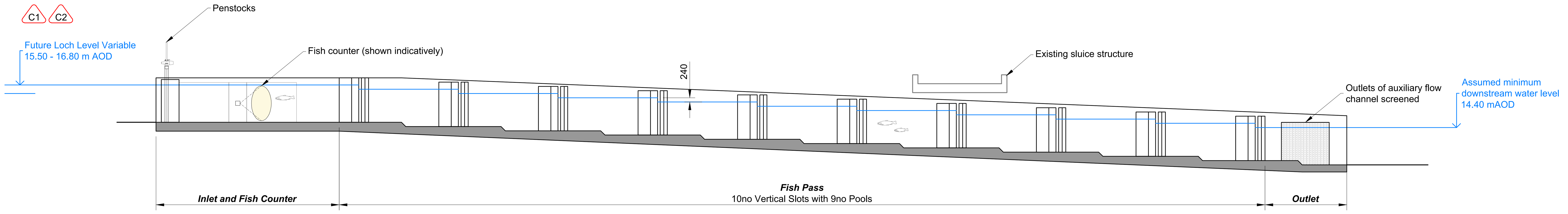
Client
Glen Earrach

Designer
FISHTEK

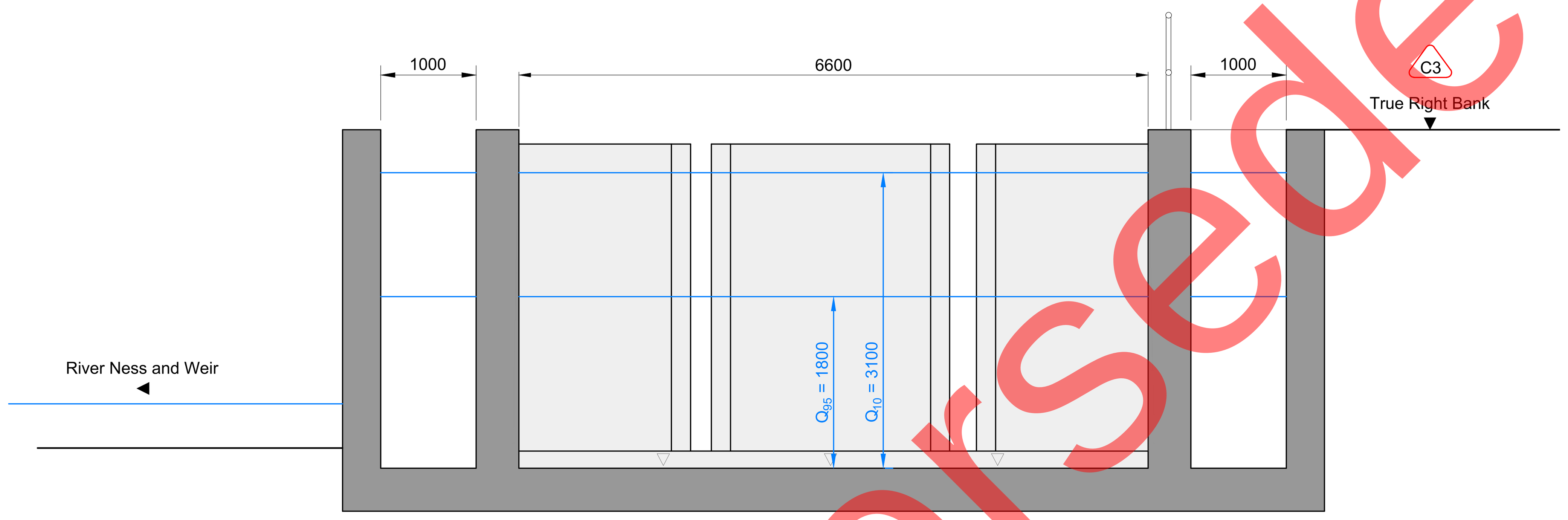
Project
Glen Earrach Energy
Dochfour Ness Weir
Fish Passage

Title
Fish Pass
General Arrangement

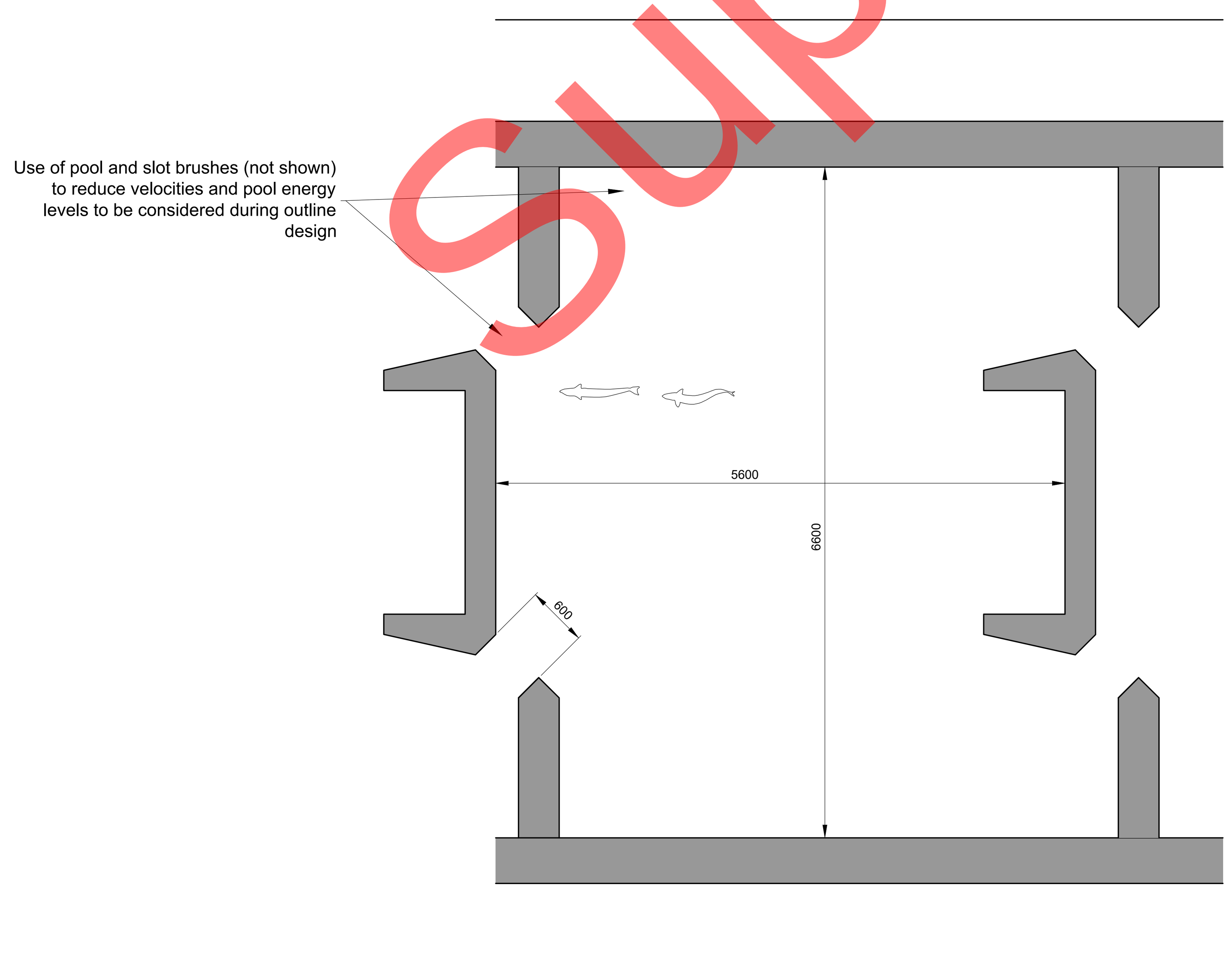
| Drawing No. | Project No. | Revision |
|---|---|---|
| 0101 | 3540681 | P03 |




## 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:

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.

| Rev. | Date | Description | Auth. | Chkd. | Appr. |
|---|---|---|---|---|---|
| P03 | 06.02.26 | 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

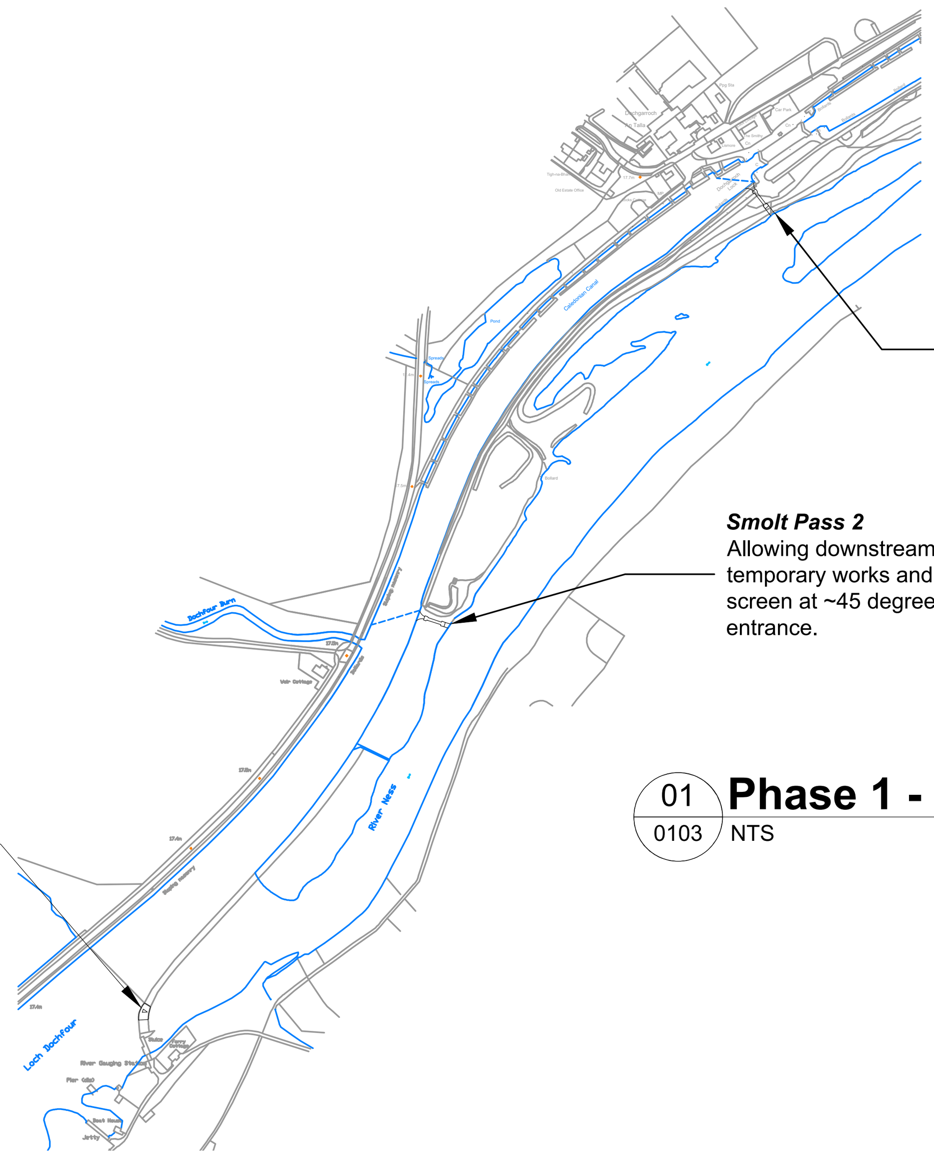
Designer
FISHTEK

Project
Glen Earrach Energy
Dochfour Ness Weir
Fish Passage

Title
Fish Pass
Typical Sections
& Details

| Drawing No. | Project No. | Revision |
|---|---|---|
| 0102 | 3540681 | P03 |

## 01 Phase 1 - Form Smolt Notches 1 & 2
0103 NTS

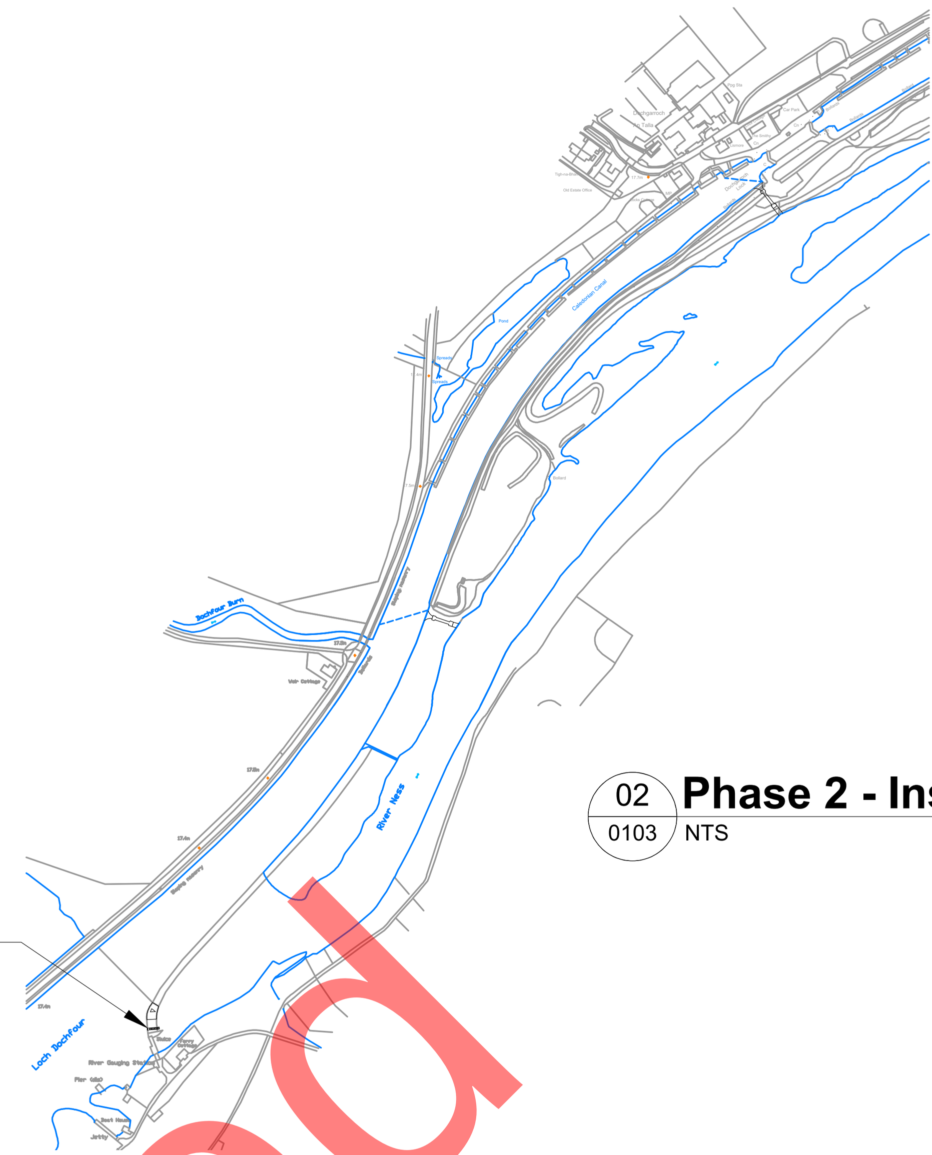


***Smolt Pass 1***
Allowing downstream smolt passage throughout temporary works and in permanent state. Behavioural screen at ~45 degrees encouraging smolts towards entrance.

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

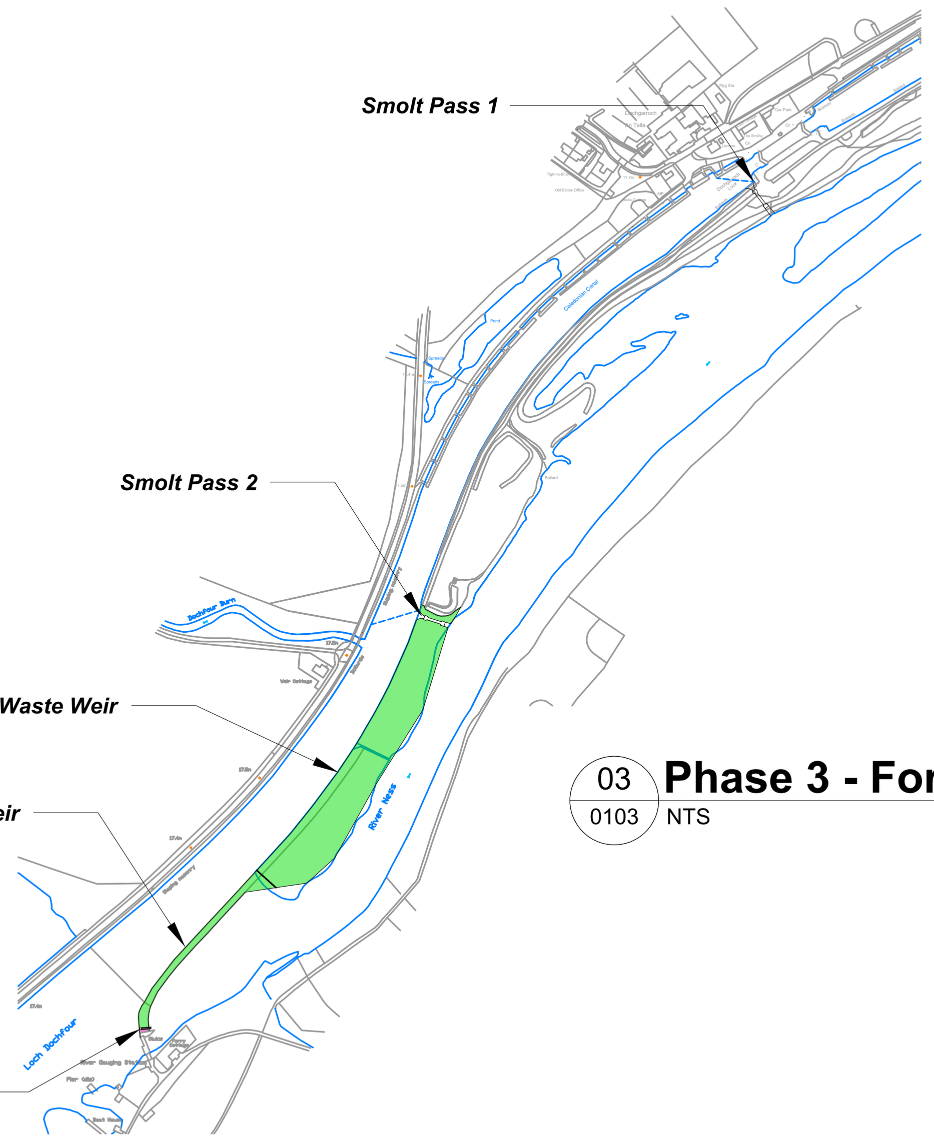
***Existing Fish Pass***
Allowing upstream fish passage during phases 1 & 2

## 02 Phase 2 - Install Temporary Fish Pass
0103 NTS



***Temporary Fish Pass***
Allowing upstream fish passage during Phases 3 & 4

## 03 Phase 3 - Form New Variable Crest Weir
0103 NTS



***Smolt Pass 1***

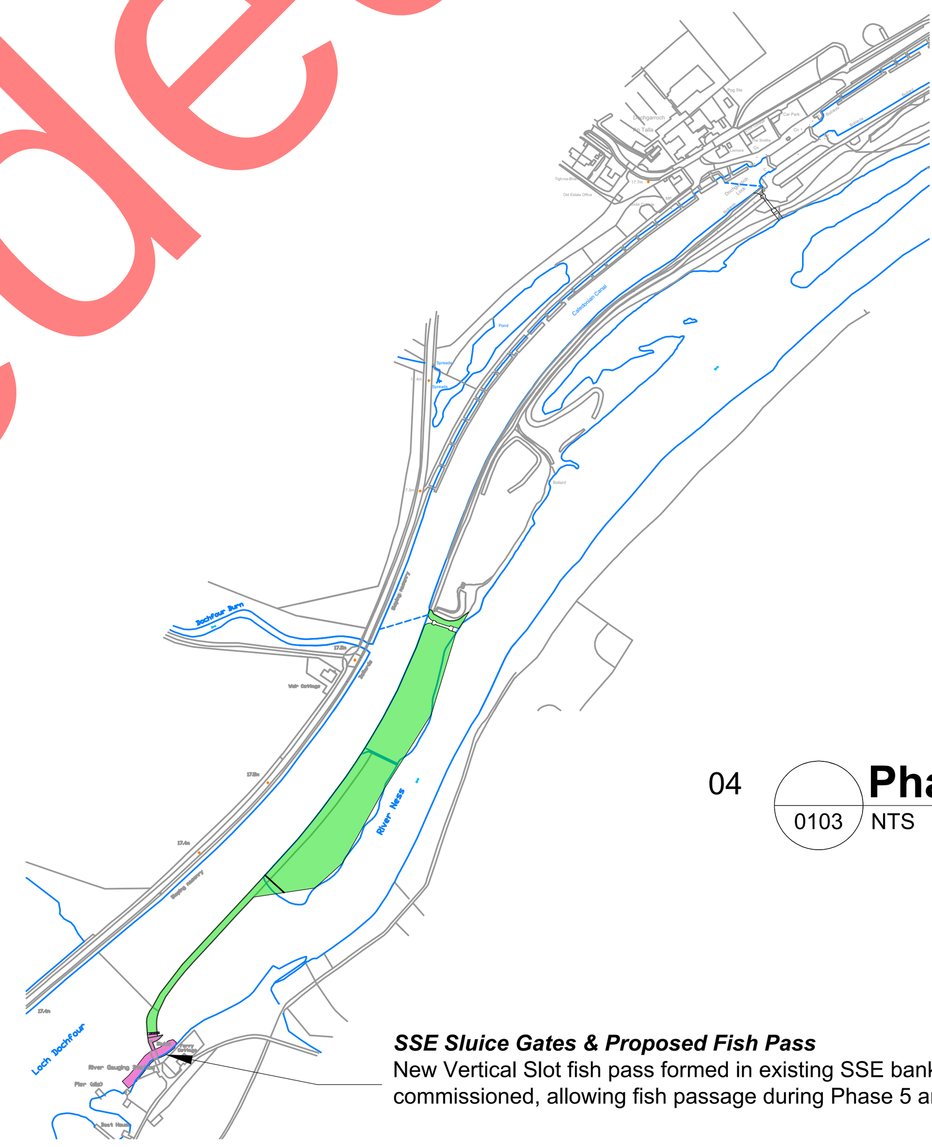
***Smolt Pass 2***

***Waste Weir***

***Service Weir***

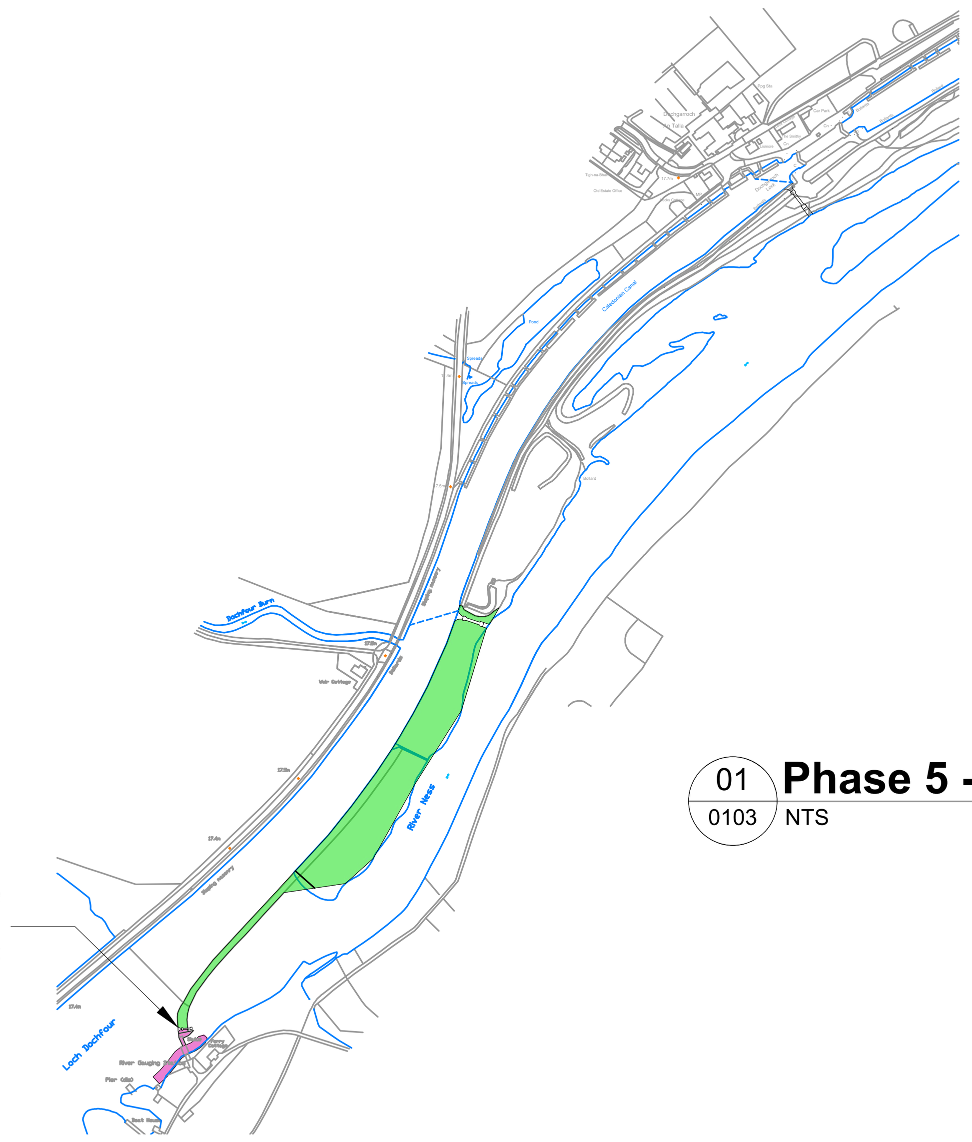
***Temporary Fish Pass***

## 04 Phase 4 - Form 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 5 and permanent state

## 01 Phase 5 - Replace Temp. Fish Pass with Smolt Pass 3
0103 NTS



***Smolt Pass 3***
Temporary fish pass removed and replaced with third smolt notch.





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. |
|---|---|---|---|---|---|
| P02 | 11.02.26 | FOR INFORMATION | MG | PG | MG |
| P01 | 20.01.26 | FOR INFORMATION | MG | MG | PG |

Status: Concept Design

Original Size: A1

Signatures:
Authored M. Giblin
Checked P. Gratton
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 | P02 |