2026

# Proof of Evidence

CASE REFERENCE: ENV/3378112

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# 1. General

I have been asked to provide my professional opinion regarding some technical and regulatory matters arising from the Environment Agency's proposed licence variation for the Old Walls hydro-electric scheme. My report considers the likely engineering, operational and cost implications of the proposed changes.

## a) Experience and qualifications

I am a Chartered Mechanical Engineer and have worked continuously in the field of micro-hydropower in England for over 20 years. As the proprietor of a specialist hydropower engineering business, I have been responsible for the design and delivery of numerous schemes, with particular involvement in the mechanical and civil engineering aspects of hydropower developments, including intake structures, screening systems and associated infrastructure.

In addition to my professional practice, I have contributed to the development of industry guidance and standards. I am a former Council Member of the British Hydropower Association and was a member of the industry panel on the British Hydropower Association/Environment Agency Working Group established to develop the Environment Agency's Hydropower Good Practice Guidelines. I am also the author of a technical manual on hydropower development published by Taylor & Francis.

My evidence is informed not only by practical experience in the design and operation of hydropower schemes, but also by direct involvement in the development of national industry guidance and engagement with the Environment Agency on hydropower policy and good practice.

## b) Relationship with Objector and involvement with Old Walls Hydro

I am the son-in-law of the Objector and I live nearby to the Old Walls Hydro scheme. I was not involved in the design or construction of the system, and do not have any role in its day-to-day operation. I occasionally assist on repair tasks or paperwork tasks but this is a minor and occasional role.

## c) Layout and function of the hydro scheme

See Appendix C, Drawing 1022 300 – 302 for the locations of the features described.

*Intake area – refer to drawing 301.*

The hydro scheme abstracts water from the West Webburn. This abstraction is effected using a number of features of the intake area. A deep pool of water, referred to as the Weir Pool is created in the West Webburn by Old Walls Weir. The crest is relatively flat to ensure that when water level is at a regulated level controlled by the scheme, all of the reserve flow is travelling via the notch, and at times when the water surface is above this regulated level, excess flow spills evenly over the weir across its length. The weir is fitted with a notch which has a dual purpose. One is providing a feature which can accurately pass a certain flow of water when the upstream water level is maintained at a given height. The size of the notch was chosen to provide a suitable measurement device for flows at or somewhat above the agreed reserve flow – up to around 70 l/s. The second purpose is to direct the reserve flow into the Fish Pool, which is a small pool part way up the face of the weir, which is intended to provide assistance to migrating fish. The Weir Pool includes a water level gauge to allow visible demonstration of the water level without reference to any control equipment.

From the Weir Pool, a channel leads off toward the hydro plant. It passes through a flood control wingwall and sluice gate structure. These have two purposes. The first is to provide the facility to hold back flows when they are exceptionally high in the weir pool. The walls extend to 1m above the weir crest level and ensures that at all times water is constrained within the banks of the river, unless it is allowed for flow through the sluice. The sluice can be manually operated to limit the water level in the leat during a flood event. The second function of the sluice is to allow the leat flow to be stopped entirely for maintenance activities. The sluice does not have a role in the normal day-to-day modulation of flows pursuant to the license conditions; this is achieved by the turbine flow control valves entirely, under normal conditions.

Water then flows through a 25mm Kelt screen (if deployed) and under the access bridge.

The area downstream of the sluice gate forms a spillway. This is an important structure. The leat is largely unlined and if water overtopped it, it could be easily damaged. It is therefore necessary to ensure there is a way of preventing overtopping of the leat bank. As described a sluice can be used to hold back flood water but this requires active intervention. The spillway is a passive device and the long length of spill (around 34m) allows a large volume of water to overspill without a large increase in water surface height. This device is placed at the head of the leat so that water thus spilled is quickly returned to the river. This is only possible with a very level leat such as Old Walls. Spilling at this location therefore happens in times of flood flow if the gate is not lowered. Water spilled over the spillway drops into an unlined channel which reconnects with the river shortly downstream.

In the main leat, near the downstream end of the spillway is a housing containing a head sensor. This device is the way the turbine control system measures the water level in the weir pool and therefore ensures a correct reserve flow is left. It returns ‘low’, ‘normal’ or ‘high’ readings dependant on level, the ‘normal’ window or ‘deadband’ being 20mm.

From here water flows down the leat. Due to the features described the water level remains approximately the same in all circumstances, and the flow speed varies dependant of flow volume. This ensures no head is wasted and the leat maintains wetted area at all flows.

*Forebay and powerhouse area – refer to drawing 302*

The leat flows 460m toward the forebay area. The function of the Forebay is to allow the water to enter the penstock pipe to the turbine. The entrance to the pipe is protected by a large area 10mm automatic trash screen. This has two functions. Firstly, it protects the turbine from debris and protects people and animals from risk of falling in. Secondly it stops fish from accessing the pipe. The large surface area ensures a slow approach velocity allowing fish to swim normally to avoid the screen, and adjacent to the screen near the surface is an associated pipe entrance which allows small fish (specifically downstream migrating Smolt) a simple route to egress back to the river.

At the Forebay a sluice gate is located, this is rarely operated but is placed to allow maintenance of the forebay, penstock or turbine without emptying the leat.

After flowing down the penstock, water enters the turbine through an automatically controlled guide vane (flow control valve) which the control system actuates to maintain the correct water level at the intake head sensor. This is how the abstraction is normally regulated. Water flows through the turbine under pressure, generating mechanical power to run the generator, and is then discharged into a pit under the powerhouse, where it then is able to flow through the short tailrace into the river. Located in the tailrace is steel frame, into which the 35mm outfall screen is seasonally deployed. To the North of the powerhouse, upstream below Ponsworthy Mill weir, the fish bywash pipe discharges into a deep section of river to allow downstream smolt migration to continue.

*Existing reserve flows*

As part of efforts to understand the describe fully the existing arrangements, a short period of water level measurement at the weir pool has been carried out. Full details are appended in Appendix B "Residual River Flow Assessment". The work, in relatively low flows, shows typical reserve flow in the river is better understood as being around 60 l/s in normal operation, falling lower or rising higher in as river flows vary slightly, and the turbine adjusts to compensate. A flow as low as 25 l/s was not observed and when the license holder explaining the setting, this was described as a lower bound which flows must never fall below even in fast changing river states.

# 2. Screening Arrangements

## a) Intake screening

The screening arrangements anticipated by the EA as described in their statement of case located "at the head of the leat" on the river frontage are significantly different in nature to the existing arrangements. The principle of screening at this location naturally places all of the mechanical equipment in an area of highly energetic flow in high flows, and highly elevated water levels.

*Design and installation*

Careful design would be necessary and would be a staged process.

**Pre-construction tasks**

- Typically a feasibility and optioneering process would be carried out to consider the technology types to be deployed.
- Following this an outline design would need to be worked up, to allow proper interaction with the EA to ensure that the design would be compliant with the license.
- The design would need to be put through planning permission, either now, or after detailed design
- A Flood Defence Consent or Ordinary Watercourse Permit would be required for the construction activity including the temporary works
- Detailed design would need to occur, this would include
    - Detailed structural design of the reinforced concrete structure
    - Mechanical and electrical design in collaboration with the screen supplier
    - Design of the access and construction arrangements on this constrained site
    - Ancillary design – power supply route, SCADA
    - Safety, Health and Environment aspects of long-term operations need to be designed in. This will be challenging because this is an area of water partially owned by others and where children regularly swim. I am not clear if it can be made adequately safe because of these factors.
- A tendering exercise for the contractor would need to occur, leading to award of a contract.

**Construction tasks**

The key **enabling works** would need to be carried out

- Power supply to site
- Access road from Lizwell Gate and tree felling in proximity of the intake
- Provision of site facilities
- Installation of water retaining temporary works
- Removal of access bridge and demolition of existing intake structure
- Provision of crane pad or similar

Main **civil work** activity

- Excavation of river edge area and existing intake area to facilitate casting of new concrete base slab
- Construction of water retaining walls and structures to accommodate screen units
- Backfilling and making good

**Mechanical and electrical works**

- Installation of screen units
- Electrical activity and control and instrumentation installation

**Fencing and guarding**

- Sufficient safeguards need to be installed to protect third parties in this location

**Commissioning** activity

The challenges of installing a safe and reliable screen in this location should not be underestimated.

*Operation and maintenance*

Due to the location of the screen, operation and maintenance has the risk of being challenging. To some extent this can be mitigated by careful design, but there are likely to be events whereby even with careful design the system needs to be shut down during high flows and only restarted after a start-up routine.

Operation would typically need to be wholly automated due to the hazardous position in an extremely highly energetic location. There would need to be a regular programme of maintenance to the screens, and it would be necessary to anticipate facilities to physically lift and remove the screen units for the maintenance since screeners on the river frontage typically are not dewatered to allow maintenance. This would require lifting equipment, either temporary or permanent.

*Challenges likely to arise in designing, acquiring, installing, operating and maintaining a screen in accordance with proposed condition 9.4*

Engineering river-frontage screens is inherently more difficult usually than screens set back from the point of abstraction, typically due to the difficulty in dewatering the screens. However, in this case, because the screen is being proposed to become both of smaller aperture, and to be located in an energetic location with poor access and little space, the difficulties will be unusually challenging.

The design task will be drawn out. Any designer will be particularly concerned to avoid the screeners being damaged in flood conditions or being inundated with gravels and cobbles. These are quite site-specific concerns and the design activities outlined will need to anticipate this throughout, including various washout arrangements. The concerns of the EA in terms of screen approach velocity are more easily anticipated, but in likelihood it would be necessary to have more than 3.5m$^2$ of wetted screen, and this will not be able to be deeper than around 1m in this location I believe. As such the screen will end up being 3.5m wide as a minimum and need to extend up 1m above normal level to cope with flood flow water levels.

There is limited space to accommodate this scale of screen, along with construction activities, and therefore some need to create more level ground will exist. Access down Jordan Lane is only suitable for cars, so an alternative access will be required from Lizwell Gate. Temporary works will need to be installed to allow access to the riverside and to enable excavation, and the structure will end up retaining significant ground, and it will be challenging to retain access whilst providing enough space to lift screens in and out for maintenance.

The location of the site in a National Park and in proximity to other landowners raises a serious question as to whether it would be possible to get planning consent for the proposed screen, especially once the necessary bywashing, washout and safety fencing has been designed.

Screens are available to achieve the required standards, from firms such as Hydrolox and GoFlo.

Maintenance would be possible if design is carried out correctly, but as described it will be more onerous than maintaining a set-back screen.

*Likely costs of designing, acquiring, installing, operating and maintaining the screens.*

The EA publishes some cost estimates for various control assets, and these appear to have been referred to in the Cost-Benefit analysis, but these estimates seem to deviate a long way from what is a realistic whole-project value.

Despite the overall project being modest in scale there are a range of unavoidable costs imposed by external factors which mean the project will require substantial professional input and carry costs with large, fixed elements.

**Regulatory costs** – imposed by planning legislation and environmental permitting.

**Engineering costs** – necessary to design a safe intake and screen.

**Site-specific costs** – arising from constrained access, riverside working and temporary works.

**Operational costs** – continuing obligations to inspect, maintain and repair the screening facility.

Recent installations of a similar design and flow capacity which the EA may be aware of include Lopwell screen upgrade by Fishtek for South West Water, or historically Abbey Weir by Hydroplan for South West Water.

The following high-level estimate is detailed further in a breakdown for each activity, and rounded to nearest £5k

| Cost Category | Typical Activities | Indicative cost |
|---|---|---|
| Investigations, consents and design | Surveys, optioneering, EA liaison, Ecology, planning, FDC, landowner discussions etc | £80k - £175k |
| Site establishment, access, temporary & enabling works | Access track, welfare, power cofferdam, pumping, shoring | £80k - £145k |
| Civil structure | Shuttering, steel fixing, concrete | £45k - £55k |
| Screen Supply | Supply of screen system | £150k |
| Mechanical and Electrical installation | Cranage, power, instrumentation | £35k - £75k |
| Fencing and making good | Safety fences, screens, backfilling | £15k - £30k |
| Commissioning and hand over | Commissioning, training, documentation | £15k - £30k |

This equates to a cost range of £420k - £660k which I believe to be expected for this work to be delivered by a competent team to a reasonable quality.

Break downs of the headings described above are given below:

**Investigations, consents and design cost derivation**

| Activity | Cost range | | Basis |
|---|---|---|---|
| | **Low** | **High** | |
| Feasibility and optioneering | £3k | £6k | Fishtek comment[1] |
| Outline plan & EA consultation costs | £5k | £15k | professional judgement |
| Planning inc. professional costs | £10k | £30k | professional judgement |
| Ordinary Watercourse Consent including professional costs | £8k | £12k | professional judgement |
| Detailed civil & structural design, inc. GI | £15k | £25k | professional judgement |
| Mechanical design | £10k | £20k | professional judgement |
| SCADA, instrumentation, control design | £10k | £15k | professional judgement |
| Temporary works design (water retaining & ground retaining) & landowner consent | £10k | £25k | professional judgement |
| Principle designer and CDM roles | £5k | £15k | professional judgement |
| Tender documentation | £5k | £10k | professional judgement |
| Total | £81k | £173k | |

**Site establishment, access and temporary works cost derivation**

| Activity | Cost range | | Basis |
|---|---|---|---|
| | **Low** | **High** | |
| Site establishment, power to temp. outlet welfare | £10k | £12k | 10m$^2$ unit, container, 300m power, 6 wk, SPONS[2] |
| Access track (700m) for construction traffic | £10k | £40k | material cost & judgement |
| Cofferdam, overpumping, pollution control, fish rescue, inc. removal after task | £30k | £40k | professional judgement |
| Groundworks to provide access and machine pad or scaffold | £10k | £20k | professional judgement |
| Demolition & disposal of existing structures | £15k | £20k | professional judgement |
| Excavation | £5k | £15k | professional judgement |
| Total | £80k | £147k | |

[1] Fishtek Consulting proposal for optioneering, email, Toby Coe to Chris Elliott, 21 May 2026 14:56

[2] SPONS Civil Engineering and Highway Price Book, 40th Edition, 2026

**Civil works cost derivation**

| Activity | Cost range | | Basis |
|---|---|---|---|
| | **Low** | **High** | |
| Circa 40m$^3$ RC structure | £45k | £55k | SPONS p. 177 (RC tanks) |

**Screen supply cost derivation**

| Activity | Cost range | | Basis |
|---|---|---|---|
| | **Low** | **High** | |
| 3.5 x 2m – 6mm automatic band screen with screenings bywashing arrangements | £150k | £150k | Go Flo estimator[3] |

**Mechanical and Electrical installation cost derivation**

| Activity | Cost range | | Basis |
|---|---|---|---|
| | **Low** | **High** | |
| Screen installation activity (cranage, fixing) | £7k | £14k | professional judgement |
| SCADA equipment supply | £20k | £40k | professional judgement |
| Electrical installation inc. SCADA installation and permanent kiosk | £10k | £20k | professional judgement |
| Total | £37k | £74k | |

**Fencing and making good cost derivation**

| Activity | Cost range | | Basis |
|---|---|---|---|
| | **Low** | **High** | |
| Safety fences, screens including installation noting non-industrial setting | £10k | £20k | professional judgement |
| Backfilling structure, permanent landscaping inc. removal of temporary access / pads | £5k | £10k | professional judgement |
| Total | £15k | £30k | |

[3] https://gofloscreens.co.uk/budgetary-pricing-calculator/

**Commissioning activity cost derivation**

| Activity | Cost range | | Basis |
|---|---|---|---|
| | **Low** | **High** | |
| Commissioning task | £5k | £10k | professional judgement |
| Provision of O&M manuals | £5k | £10k | professional judgement |
| As-builts | £2k | £4k | professional judgement |
| Training | £2k | £4k | professional judgement |
| Total | £14k | £28k | |

### *Comparison of the proposed screen operational costs with existing screen operational costs*

Operational costs are likely to be a different order of magnitude to the current arrangement. The current screen is located in a location protected from flood flows and debris load and is therefore lightly built, safe to access at all times and simple to dewater for inspection or repair. Screenings fall into a pile outside the leat. By contrast screening at the river edge will require the screens to be removed to inspect and repair, will be of heavier construction and will have more associated debris management arrangements to allow for clearing of heavy debris from them and bywashing of screenings. The positioning will mean it would not be possible to access the screen mechanics during times of high flood flows and therefore some activities would need to wait for water levels to reduce before they could be addressed, which would have a knock-on reduction in production.

I expect the following tasks or measures will need to be carried out to ensure continuing effective operation.

| Cost Category | Typical Activities | Indicative cost |
|---|---|---|
| General inspection | Monthly activity to check operation | £2k |
| Servicing | Annual scheduled service | £5k |
| Screen cleaning / bywash cleaning | Ad hoc manual intervention | £1k |
| Reactive work or downtime during/ after flooding | SLA or call-out costs, assumed downtime cost | £4k |
| Electrical testing, utilities | Telecoms, power, testing, personnel | £1k |
| SCADA support contract | Typical software maintenance, Instrumentation budget | £3k |
| Insurance | Assumed uplift in insurance costs | £1k |
| Total | | £17k |

This assumes planned servicing is done at times the plant is shut down due to low flows (i.e. no generation loss).

The existing screen would need to be retained for safety and to protect the turbine, so all of the above costs are effectively additional costs.

## b) Outfall screening

### *Work required to design and install a 25mm screen*

The 25mm screen suggested could follow the design and positioning of the existing 35mm screen so is in principle possible. There is an associated point related to outfall flow velocity which I will address at the same time as they are interrelated. It is this aspect which is likely to incur most cost.

The existing outfall may have a maximum flow velocity which exceeds 0.5m/s marginally. It would require measurement of outfall water level when the turbine is just satiated, i.e. the river is as low as it can be with the turbine at full flow. This will produce the lowest water level at which the turbine flow is at its maximum. This flow wasn't available during the time this investigation occurred, looking at the weed growth on the walls and personal comments from the license holder confirming the approximate water height on the wall, it appears the water depth at the outfall at satiation is around 0.6m, which in a 2.1m wide channel would result in a flow velocity of 0.8/(0.6*2.1) = 0.63m/s. Therefore, to achieve a lower velocity a moderate degree of bed lowering will be required, assumed to be 200mm along the outfall channel. This is a fairly small operation, but the bedrock is notably hard.

As such the screen will need to be enlarged, since it relies on the water flowing through the lower part of the device to remain clean, and water level rising too high above the centre axle will tend to hold it stationary, so it cannot simply be lowered.

**Pre-construction tasks**

- An outline design would need to be worked up, to allow proper interaction with the EA to ensure that the design would be compliant with the license.
- It is uncertain whether Planning Permission is required, but given it will be an engineering activity deepening the channel it may well be necessary
- A Flood Defence / Ordinary Watercourse Consent would be required for the construction activity including the temporary works
- Detailed design would need to occur, this would include
  - Minor structural design
  - Design of new screen & seeking fabrication quotes
  - Safety, Health and Environment aspects of long-term operations need to be designed in

**Construction tasks**

The key enabling works would need to be carried out

- Provision of site facilities
- Installation of water retaining temporary works & leakage treatment
- Safe pedestrian access to worksite

Main civil work activity

- Breaking of hard bedrock using drills and hydraulic feather and tare or similar
- Construction of new cill under screen location

Mechanical works

- Installation of screen unit
- Electrical activity and control and instrumentation installation

*Operation and maintenance*

This O&M would be similar to the current activity. General repairs might be expected to happen after similar durations of operational time, and therefore the effect would be to require maintenance around four times as frequently compared to the seasonal deployment. A redesigned larger screen with finer gap mesh would be heavier, but it is likely that the existing access arrangements for lifting equipment would continue to work.

*Any challenges like to arise from the design, acquisition, operation and maintenance of a 25mm outfall screen*

I do not consider that the conditions proposed would result in an installation which was technically challenging.

*Likely costs of design, acquisition, operation and maintenance of a 25mm outfall screen*

**Capital expense items:**

| **Cost Category** | **Typical Activities** | **Indicative cost** |
|---|---|---|
| Investigations, consents and design | Survey, outline design, EA liaison, planning, FDC/OWC, bespoke fabrication design | £10k - £20k |
| Site establishment, access , temporary & enabling works | Safe scaffold access, cofferdam, pumping | £5k - £10k |
| Civil work | Bed lowering with drill and hydraulic Feather and tare, cast concrete cill | £10k - £12k |
| Screen Supply | Supply of screen system | £3k - £5k |

This is likely to sum up to between £28k to £47k, as indicated this is largely for the bed-lowering works.

*Operational Expense*

Some operational expense of the screen will flow from the loss of power output from the turbine, a calculation for this is appended to this report. The screen installed in the tailrace it relatively free-spinning but since it fits in a fabricated frame and includes a mesh it will cause a small head loss (i.e. to operate it, there will be a minor backing-up of water on the upstream side). Due to the unusual design, it is difficult to calculate, but site observations suggest around 50 – 70mm differential occurs currently. The new screen would be finer, but this would be compensated by larger cross-sectional area, so I will use 60mm or 0.06m in the calculation below.

A rough calculation indicates that this will cause a loss of around 1.2MWh / annum, a cost of around £0.3k per annum.

The cost of maintenance will be relatively small, and since the screen is already removed and reinstalled annually, that part is not an additional cost.

Assuming there is increased wear and tear, and power output lost as described, the annual cost of this condition might be an additional £1k per annum in total.

*Comparison with existing outfall screen costs*

I have attempted to describe in the foregoing only the additional cost to the operator, given the time required to deploy and remove and need for minor repairs, it might be suggested that the current cost is already £1k per annum.

# 3. Measurement and control of abstraction

## a) How abstraction at Old Walls Hydro is currently measured and controlled pursuant to the current abstraction licence.

*The difference between measurement and control of abstraction*

There are two elements to how abstraction is controlled and measured. The most critical is the control aspect, it requires continuous measurement of the reserve flow and this is how the system determines how to modulate itself. Measurement of abstracted flow is important for reporting purposes but this is not part of the control loop.

In simple fundamental terms, the water level in the weir pool is maintained at a fixed level by the hydropower system, to ensure that the reserve flow notch remains at all times above the minimum required level, thus ensuring the reserve flow requirement is met. What is not left in the river flows to the turbine and power output is used as a metric to assess the volume of water used by the turbine. This is an extremely common method to control and measure abstraction by hydropower systems.

*Operation of the leat*

Whilst most systems use similar processes in principle, there are differences from site-to-site. Old Walls is unusual in that the leat is modern and is completely level when there is no flow. For this reason it operates effectively like a pipe; if water is not passed via the turbine, the water level in the leat rises, and inhibits inflow, the weir pool water level rises and the water flows over the weir. As such, despite being an open leat, and not having a sluice continuously moderating the flow, the flow is already automatically measured and adjusted. The only time this is not the case is when water levels are very high and the turbine is unable open further to pull the level down, at this time the spillway can pass water. This is to protect the leat from overflowing at other points. This overspill is unusually placed at the intake to allow such water to quickly flow back to near the toe of the weir.

*Detail of control methodology*

The detail of the control is as follows: The control system continuously monitors the water level at the inlet head sensor. This is positioned in the inlet area downstream of the access bridge. The water level here is usually the same as the weir pool, and never higher. This sensor reports either 'low', 'normal' or 'high' water level. This provides a clear indication if the turbine is permitted under the license to increase its flow or whether it needs to decrease it. As described in the flow report, 'normal' water level is a level where the notch in the weir is passing approximately 60l/s. If the water level is showing 'normal' the control system will make no adjustments. If the water level is showing 'low' or 'high' the control system will open or close the turbine control valve incrementally by perhaps 1% of its full opening. This change at the turbine will feed back up the leat, cause the water level to change and regain the 'normal' level.

Measurement of abstracted flow is carried out by measuring the percentage opening of the turbine at a set time weekly or daily, and using an agreed correlation between power and flow to calculate a value for abstracted volume. The relationship between opening and flow was determined by the license holder and the EA at the time of commissioning.

The control system is looking at the weir pool water level, and making decisions on turbine flow based on this. However these measurements are never reported back to the EA, and instead a different but related figure of the abstracted flow is reported. This is an important reason why the EA hydrologist could not be expected to have a clear handle on the reserve flow left. By having only figures for abstracted flow, and no direct measurement of total river flow, any attempt to work out the actual resulting flow left in the river was clouded in uncertainty. However, that uncertainty should not be interpreted as uncertainty which would limit the existing system's ability to reliably and certainly ensure the flow left in the river was sufficient, it is just that the EA do not collect this information. This situation is true of the majority of hydropower licenses in my experience.

A separate report has been compiled to measure the actual observed reserve flow.

## b) Proposed measurement of water abstracted

ISO 748:2021 is the recognised international standard for determining discharge in open channels by the velocity-area method. The licence condition, however, requires continuous abstraction measurement by recording head through an intake control structure. Continuous head-based measurement is generally achieved using a calibrated stage-discharge relationship, for which ISO 748 provides the calibration discharge measurements but does not itself specify the design or operation of a permanent head-discharge gauging installation. The wording of the proposed condition therefore appears to conflate the method used to establish the rating curve with the method used for continuous operational measurement. In other words, the referenced standard and the proposed technical solution do not appear to match each other.

The conditions proposed for flow measurement are not convenient as worded. There is a requirement to have a stage – discharge curve, which inherently implies a head loss, which will cause a loss to the output of the hydro plant, and will require adaptations to the operation of the hydro scheme. The EA, in their statement of case, have indicated there may be other ways to accurately measure the abstracted flow. I agree and suggest that the existing correlation to turbine control valve opening is sufficiently accurate. If there is an absolute need to fully record all water abstracted even during floods, it would be far more simple to retain the existing measurement arrangements and just automate the operation of the inlet sluice to constrain flows during a flood.

*Required works for proposed conditions 7.1*

The intake control structure as described will form not only a weir, flume or other structure with a stage – discharge curve, but will also require an upstream active control to moderate flows, since the installation of this arrangement will mean the turbine no longer controls inflowing water. In addition the new structure will lower the water level in the majority of the leat, which will lead to a higher flow velocity to maintain the overall volumetric flow rate. This will increase scour and therefore may require some leat scour protection to be installed, such as a concrete lining. The design and scope of the measurement structure therefore needs to take into account other works.

The work required would therefore be

Design activities

- Design of the technical form of the structure
- Integrating this into planning permission application as described elsewhere
- Investigating and designing the required scour protection to the leat
- Designing the inlet control sluice and its control system and interaction with the existing system

Construction activities

- Assume preliminaries and site set up is covered under other inlet works occurring at same time
- Prep work including fish rescue from the leat as it is drained
- Construction of a reinforced concrete (floor and wall) section of leat, including a basin downstream to dissipate energy of water
- Procurement and installation of water level measuring equipment
- Shotcrete or other site-applied scour protection further downstream as required (design work needed)

*Operation and maintenance of structure*

This is a simple device to maintain fundamentally. There may be other aspects which flow from this requirement which require maintenance. Maintenance activities are likely to centre around ensuring the water level recording equipment is checked and repaired after flood or lightning and how the inlet gate (which must be an integral part of this specific method of flow measurement) is maintained.

Such work is likely to be addressed sufficiently via an annual service, although depending on the inlet screening arrangements post-flood work could be required if the structure is compromised.

*Challenges in taking this approach to flow measurement*

If the intent is to measure all water abstracted at a position upstream of the spillway there will be little space to position this device since the spillway starts close to the intake sluice, and it is unlikely to conform to any recognised standard. The spillway may need to be redesigned and reconstructed.

*Likely costs*

As this work would be located near the screening area the costs of planning, consenting and setting up the work site itself can probably be taken to be a part of the costs already indicated for the intake screens. Design costs are therefore only intended to capture the technical design. The cost of the upstream sluice and its control gear should be included as it is part-and-parcel of the control methodology.

**Capital expense items**

| **Cost Category** | **Typical Activities** | **Indicative cost** |
|---|---|---|
| Design | Technical design, planning, scour investigation, instrumentation | £4k - £8k |
| Acquisition | Flume structure, measurement equipment, inlet sluice and control | £25k - £45k |

| | | |
|---|---|---|
| | system | |
| Install | RC structure, place and grout flume and gate | £10k - £20k |
| Mechanical & electrical | Electrical installation, commissioning | £8k - £12k |
| | | |
| Total | | £47k - £85k |

*Note I have not priced for the protection against scour for the leat in general. This is difficult to predict without more information but could cost from a few thousand pounds to tens of thousands. I have also not allowed for the reconstruction of the spillway which may be needed.*

**Operational expenses**

| **Cost Category** | **Typical Activities** | **Indicative cost** |
|---|---|---|
| Servicing | service and calibration | £2k - £3k |

There is then a value of lost generation from introducing a water level drop. This is open to interpretation but could easily require 500mm of head to operate it.

In a similar basic calculation to the energy loss calculation carried out for the outfall screen, this would appear to potentially cost (Annual Energy Capture x fraction of lost) – 427MWh x (0.5 / 16) = 13MWh, 13,000kWh, or around £2,800 when a value of 21.4p per unit is used.

*Will this work improve efficacy and accuracy of measurement and control*

In theory this approach would allow for the measurement of all flows abstracted, and could improve accuracy, although as already discussed reporting of abstraction does not provide a great deal of clarity about actual reserve flows.

However, the time period over which the flows occur over the spillway is actually quite occasional, and given are only at times of high flow, may not have any ecological impact whether occurring or not, and whether measured or not. Furthermore the automation of the intake gate could very easily have logic added to ensure flood waters are automatically kept out, so simply automating the sluice gate would probably remove the apparent inaccuracy the EA are concerned about.

*Does this structure allow conformance with license conditions 6.1 and 9.2?*

It potentially does, if river water level sensors and leat water sensors are used, and the appropriate logic is designed into the control system.

*Does this structure allow conformance with license conditions 8.1?*

It potentially does, if leat water sensors are used, and the appropriate logic is designed into the control system.

# 4. Opinion about the accuracy of the cost-benefit analysis in the statement of case

I believe that the EA cost-benefit analysis (core document reference – CD16) does not accurately reflect the real magnitude of the costs the license conditions proposed entail. It appears that all the conditions proposed are predicated on the basis that they provide better protections to the environment than the current conditions, and that this is largely focussed on the perceived improvement to the environment for migratory fish. As such, it would seem reasonable that all the associated costs leading from the physical changes proposed should be considered. The EA's cost-benefit analysis states at the top of page 2 that a total cost is expected to be £73.9k in year 1, with various other small costs through the life of the scheme.

The £61.1k capital cost of an automated sluice gate does seem to capture the likely magnitude of that aspect – I have suggested that along with a flume it could cost £47k - £85k, with an annual maintenance cost of £2k – £3k, along with a loss of £2.8k of generation.

The cost for riverside 6mm screening is in my view multiple orders of magnitude wrong, unless I misunderstand what is being allowed for. There appears to be an allowance of £12.8k for an automated 6mm intake screen and the river bank, with an allowance for operational costs of £100 per annum, and a repair in year 20 of £6.4k, as described at the top of page 2.

In my opinion, based on a number of recent schemes this is a highly technical, multi-stage process. As outlined in section 2)a) of this Proof of Evidence I assess it will cost between £420k and £660k to design and implement, and then have an overhead of £17k per annum to operate and maintain.

The costs of the outfall screen and bed deepening have not been included in the EA analysis. As set out in section 2)b) of this Proof or Evidence I believe this will cost £28k to £47k to install, cause an additional £1k per annum maintenance cost, and reduce generation slightly too.

Overall, the capital costs in my view for this bundle of measures (inlet screening, revised flow control and measurement and outfall screening changes and channel deepening) will be between £495k and £792k, with annual operational costs of £20k.

There has been no consideration of the cost of the reduced generation leading from the higher reserve flow and imposition of proportional take, this was explicitly excluded on page 1 of the EA cost benefit analysis.

A cursory look at these figures reveal that if generation was reduced by around 75%, as is approximately true for this proposal, the scheme income will fall from around £90k per annum to around £22k, and therefore the scheme is highly unlikely to be able to continue to operate at all.

*Appendix A*

**Tailrace screen loss value calculation**

To assess the loss of generation a simple calculation can be done to approximately quantify this. This is an approximate scaling, but gives a useful result on limited information available. Annual energy production averages around 427MWh. If we assume currently this is achieved with the screen deployed 25% of the time, and without the screen 75% of the time, and assume that the output scales linearly with total head, and that the net head without the screen is 16m, the current output could be expressed as:

$427 = (.25*x*(16-0.06))+(.75*x*16)$

Where x is a coefficient which rolls in all the other factors and efficiencies of the system

Solving gives

$x = 26.712$

Multiplying up by the new net head applicable 100% of the time,

$x * 15.94 = 425.8$MWh, thus the loss calculated this way is around 1.2MWh or 1200kWh. The value of this will be the total of the export and generation rates per kWh, likely to be around (10p + 11.4p) = 1200 * .214 = £260 per annum

*Appendix B*

**Residual River Flow Assessment**

On Stream Energy, Old Walls, Ponsworthy, Newton Abbot, Devon. TQ13 7FA

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# Residual River Flow Assessment

# Old Walls Hydropower Scheme

# Flow Gauging Exercise

June 2026

Prepared for:
M R Fursdon

Prepared by:
On Stream Energy

Date:
June 2026

**Our details**

| | |
|---|---|
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| Address for correspondence | Old Walls, Widecombe-in-the-Moor, DEVON, TQ13 7FA |
| Named contact | Chris Elliott |
| Phone numbers | 01364 631543 / 07760 249738 |
| Email | chris@on-stream.co.uk |
| This document reference | 1xxx DOC 0x r0 professional report |

**Site details**

| | |
|---|---|
| Site Name | Old Walls Hydropower |
| Client reference | 1042 |
| Site address | Waterleat Lodge, Widecombe-in-the-Moor, TQ13 7FA |
| Site contact | Miles Fursdon |
| Phone numbers | [redacted] |
| Email | [redacted] |

**Report details**

| | |
|---|---|
| Scope of work | Assessment of volume of water left flowing over weir |
| Revision | r0 |
| Author | Chris Elliott CEng IMechE |
| Checked | Barnaby Philcox-Booth |

# Contents

# Executive Summary

This report presents the results of a flow gauging exercise undertaken during June 2026 to determine the actual residual flow passing into the depleted reach whilst the Old Walls Hydropower Scheme was operating.

Water level measurements were recorded continuously over approximately five days during a period of relatively low, gradually declining river flow. These measurements were converted into discharge using the stage-discharge relationship adopted by the Environment Agency when the scheme was commissioned.

During the monitoring period:

- calculated residual flow ranged from approximately **53 l/s to at least 70 l/s**
- typical residual flow was approximately **60 l/s**
- the licensed minimum residual flow of **25 l/s** was not approached during the monitoring period.

The monitoring demonstrates the behaviour of the hydro control system during stable low-flow conditions and provides evidence of the actual reserve flow maintained in the river, rather than simply the minimum flow permitted by the abstraction licence.

# 1. Introduction

The purpose of this investigation was to objectively quantify the flow remaining in the river downstream of the abstraction whilst the hydropower scheme was operating.

The assessment forms part of a wider programme of work to understand the practical operation of the flow control arrangements under real operating conditions.

# 2. Scope

This report covers

- survey of the control notch and weir crest
- installation of temporary water level monitoring equipment
- conversion of measured water levels to discharge
- comparison of observed flows with the licensed residual flow
- interpretation of the behaviour of the turbine control system.

# 3. Background

The hydro scheme under investigation consists of a Run-of-River hydro plant, fed from a weir on the West Webburn River. The weir is located at the head of an open leat which flows for 460m to a forebay tank with pipelines running to two crossflow turbines. The abstraction is controlled using a water level sensor near the weir pool, which ensures the correct water level in the weir pool is maintained. This is practically achieved by a valve control unit which is connected to the head sensor and modulates the turbine valve opening to control the flow through this. Due to the design of the leat, closing the turbine inhibits water from flowing into the intake area, thus compliance with the license is achieved by turbine opening modulation. Reserve flow in the river is maintained via a notch in the weir crest, which, assuming the water level is above an agreed level, will maintain compliance with the stated reserve flow in the scheme's operating license.

In this case the documentation agreed at the time of commissioning refers to a 25 l/s reserve flow and a level in the reserve flow notch to achieve this of 0.077m (77mm).

This work is intended to provide a more complete record of the water level in the immediate upstream weir pool when the control system is modulating the flow and validate the current weir and notch form.

At the time of the work, flow was low and the small turbine was in use.

# 4. Methodology

## 4.1. Survey

To establish a clear understanding of the form of the weir a simple crest survey was completed, taking spot levels of the highest part of the weir section at 500mm spacings along the weir crest, and within the reserve flow notch itself. All levels are relative to a local datum, noting that the important measurement is the notch level relative to the weir crest generally, and the gauge board and head sensor.

The weir was found to be reasonably level with a maximum variation of around 50mm across its length, except locally to the abstraction point where some debris was accumulated.

The notch was carefully measured, and it was found to be close to the original specification. The as-built arrangements called for a 800mm wide notch, with a depth of 150mm, allowing a level of 77mm in the notch to achieve the minimum reserve flow.

The notch was found on average to be 9mm deeper than the as-built arrangement. It is assumed that the action of steady erosion has caused this, based on the physical appearance of the notch substrate material, which was cement based, and with partially raised sand texture implying minor erosion from the original finish.

The survey is appended in Appendix 1

## 4.2. Level Measurement

The measurements were taken with a 0 – 2000mm range 4 – 20mA SUP – P260 compensated pressure sensor manufactured by Supmea. This has a stated supplied accuracy of better than 0.3% full range (6mm) and in combination with the logger allows for a 1mm resolution. The logger used was an Ashridge Engineering TOR – 3N single channel analogue logger, and this was deployed taking measurements of level every 5 minutes. The reported level is the instantaneous level at the point of measurement.

As the devices together have a 1mm resolution but potential 6mm accuracy deviation, and were supplied without calibration certificates, a calibration exercise was done, measuring water levels with a calibrated Fukuda FRE - 205 rotary laser. This exercise was to measure the later level using this device on installation, during deployment and prior to removal to allow the recorded levels to be compared to the logged levels. Agreement was such that it appears reasonable to state the 1mm precision measurements fully, expecting them to be correct to around + / - 3mm.

Logging proceeded from 22 – 25$^{th}$ July 2026

## 4.3. Flow Calculation

As described the data collected was water level in the weir pool, and this is then converted via a stage – discharge relationship to a flow figure.

ISO 3846 (formerly BS 3680 – 4) covers useful rating curves and derivation, but for clarity the relatively simple rating curve proposed by the regulator at licensing stage is used here for clarity.

The stage – discharge relationship was taken to be

$$Q = 1.705 \times C_d \times b \times h^{1.5}$$

Where

| | |
|---|---|
| $Q$ | flow in $m^3s^{-1}$ |
| $C_d$ | dimensionless coefficient of discharge, proposed to be 0.855 to match original hydrologist's figure |
| $b$ | notch width in m |
| $h$ | water depth in m from notch base to water surface level at a distance back from the notch |

There are some simplifications in this approach, but as long as these are understood this relationship is sufficiently accurate to be useful. h, as stated is a simple surface water depth. This it taken some way back from the notch, in a deep area, when compared with the notch depth and whilst abstraction flows were relatively small, and for that reason all flow speeds were relatively low at the point of water surface level measurement and therefore the velocity element of the head has been ignored. The notch width measurement has not had any correction for edge effects, since the edges are relatively low relative to the notch width, and slightly irregular in form. The 0.855 coefficient of discharge is simply adopted from the original hydrologist's work since it is a reasonable figure for a form of notch such as this. It would not be valid for instance at very low notch depths, but all measured depths in this work are above such shallow flows.

Uncertainty has not been addressed.

# 5. Survey Results

The survey found the weir crest to be generally consistent with the original construction drawings. Local erosion has increased notch depth by approximately 9 mm but no significant alteration to the hydraulic geometry was identified.

## 5.1. Monitoring Results

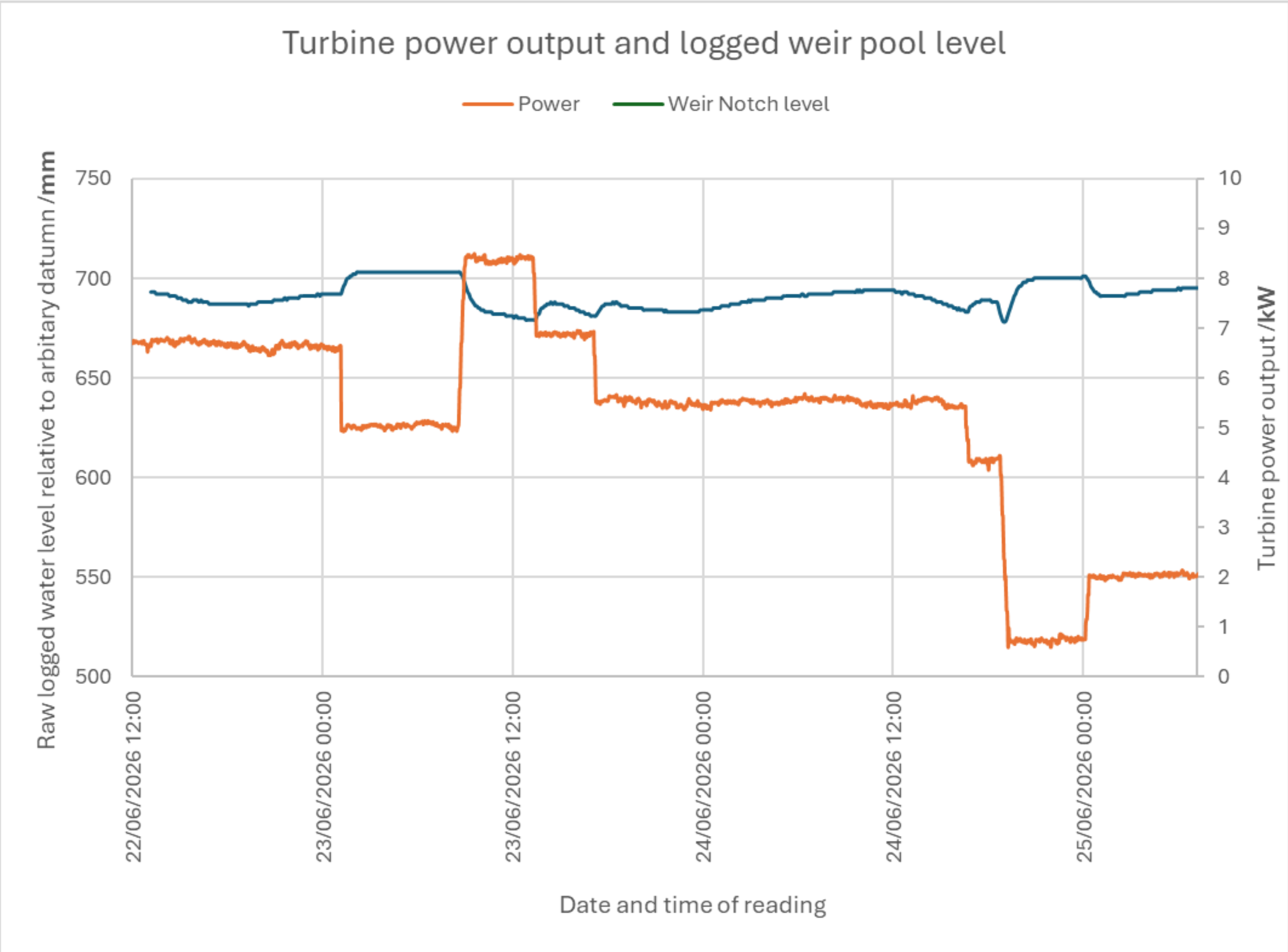


*Figure 1 - Water level and turbine power across period of logging*

The monitoring resulted in the above traces of water level and turbine output. The turbine control steps in approximately 1.2kW increments of power. Using an approximate conversion of p = 9.8 x η x h x Q, the implied increment of flow is 1.2 / (9.8 x 0.8 x 16) = 10 l/s. This is for the small turbine which was in use at the time of this data collection exercise. The larger turbine is likely to have slightly different operating characteristics and in likelihood a larger incremental change in flowrate in response to a control valve position change. This is discussed later.

During the period of measurement, in addition to the normal operation two unusual events occurred.

Firstly lightning in the early hours on 23rd June resulted in the head sensor being incapacitated. The action of the control system protected the river flow by defaulting to low level reading and throttling the turbine back, until in the morning the relevant fuse was replaced.

Secondly on the afternoon of 24th June a plug in a pipe which passes through the weir was displaced by children playing in the weir pool. The effect is that the turbine output falls, this was noted and as a result the system operated in a manual until the flow through the weir was stopped.

These two events result in two periods where the reserve flow went to a level interpreted as 70 l/s, although as described, this figure will be a minimum as the notch became full. For this reason this report will not calculate the mean flow, as this is somewhat skewed by these figures.

## 5.2. Residual Flow Assessment

The river water level data is then presented as a histogram showing the distribution of water flows which as described have been converted from a depth to a volumetric flow rate.

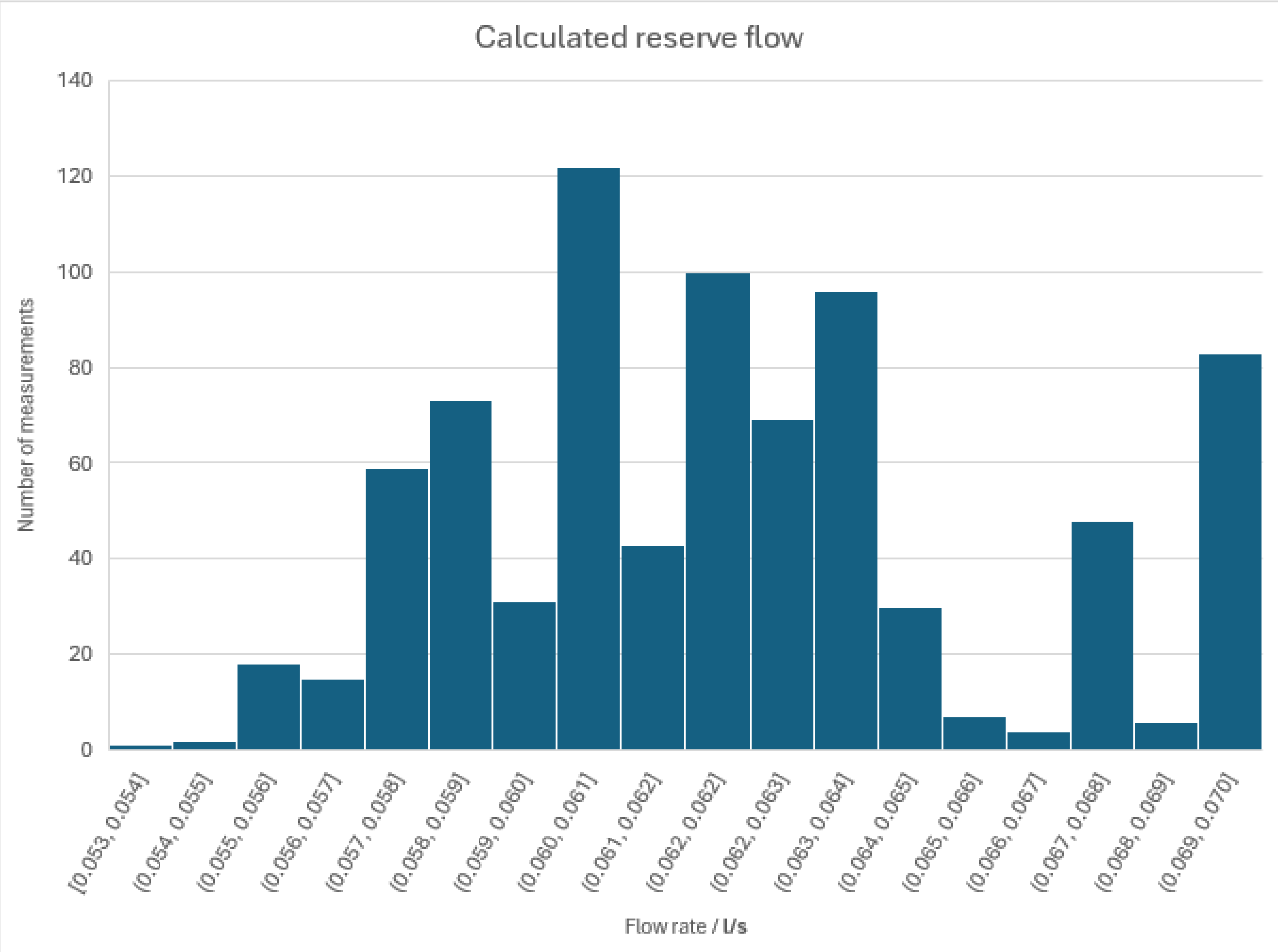


*Figure 2 - Calculated reserve flow histogram*

During the period of measurement, the lowest calculated flow through the notch is 53 litres per second and is calculated as up to 70 litres per second at maximum. The histogram exhibits a clear modal peak at approximately 60 l/s, indicating that this is the most frequently occurring residual flow during the monitoring period. This is an important characterisation because as described this shows the most frequent flow observed and is not skewed by the two periods of higher flow, and so is interpreted as best describing what the normal settings of the sensor and controller cause the flow to be.

The 70 litres per second figure is a minimum value for this period of higher readings, as this is the point at which the notch becomes full and the flow starts to spill across the longer weir face, as such a very minor increase in water level will cause a significantly larger flow. Because of the difficulty modelling this, we state it as 70 litres per second to be conservative.

These figures were measured during a time of relatively low flow with the water level decreasing slowly and therefore show the operation of the control system of the turbine at a period of simple operation.

Logging is ongoing to capture some behaviour at times of rapid change of flowrate, such as in the rising limb of a hydrograph, shortly after rain, and on a higher flow but falling limb, where the turbine is transitioning from full power to less than full power.

It is expected from theoretical analysis that these circumstances will demonstrate times where the water level and hence flowrate in the depleted reach will either reduce for a short period to closer to the licensed minimum flow or increase temporarily during an increasing flow situation.

This analysis demonstrates what the actual reserve flow in the river is across the sampled period as opposed to what the minimum possible licenced reserve flow could be. It provides a much more nuanced picture with a typically higher reserve flow, and a variation in flow rate which reflects the real-world engineering of the site and demonstrates that the control system is apparently set up in a conservative manner.

## 5.3. Summary statistics

| **Statistic** | **Residual Flow** |
| --- | --- |
| Minimum | 53 l/s |

The histogram exhibits a clear modal peak at approximately 60 l/s, indicating that this is the most frequently occurring residual flow during the monitoring period.

| Statistic | Residual Flow |
|---|---|
| Maximum recorded | ≥70 l/s |

# 6. Discussion

## 6.1. Behaviour of control system

The physical arrangement of the head sensor is a set of three metal prongs within a housing, which are electrically joined once they are immersed in water. By having different prong lengths the control system can interpret low, normal and high levels. The prong lengths mean that the 'normal' window is +/- 10mm from the nominal setpoint, and the water, if in at this height is considered to be correct. If the water level falls further the turbine sees 'low' and compensates by shutting slightly. As described elsewhere this modulation appears to be by around 10 litres or around 1.2kW.

## 6.2. Interpretation of measured flows

Using the previously described stage – discharge relationship, and the demonstrated 60 l/s modal flow, we can make the following calculations based on the design of the head sensor:

h = ( 0.060 / ( 1.705 x 0.855 x 0.8))^2/3 = 0.138m depth in notch is 'typical'

Applying the 10mm deadband either side of the setpoint, suggests that the 'normal' window is from 0.128 to 0.148mm notch depth, equating to flows varying from

Q = 1.705 x 0.855 x 0.8 x 0.128 = 53 l/s

to

Q = 1.705 x 0.855 x 0.8 x 0.148 = 66 l/s

A control response would happen if flows deviated from these values.

This theoretical approach seems to match observed behaviour quite well.

## 6.3. Limitations

- Only low-flow period measured. This was thought to be useful because it demonstrates the detail in this important circumstance, but other periods were not addressed due to time constraints.
- Only the characteristics of the control system in charge of the small turbine was logged in this time period. To fully characterise the control response it will be necessary to log when the large turbine is in use.
- Largely logged on a hydrograph falling limb. It would be helpful to accurately observe the point on a rising flow where the turbine opens, as both times the power went up during the logged period it was in response to the control system being reset from a manual or failsafe state back to an automatic state.

- Two unusual operations during period of measurement. These are understood to be very infrequent situations but are useful observe the response of the control system, which has in each case defaulted to a low-power output.
- No flood response has been observed, it would be informative to see to what extent increased flows pass the point of abstraction during periods of rapidly increasing flows.
- No rapid recession. It would be important to capture the reserve flow during times of relatively quick recession of flows, for instance from 1000 to 800 l/s flow in the river, when the turbine is transitioning from full to a slightly restricted flow, and where maintaining the reserve flow is requires a rapid response.
- Monitoring is still continuing.

# 7. Conclusions

The monitoring demonstrates that throughout the monitoring period the measured residual flow exceeded the licensed minimum residual flow.

The minimum calculated residual flow during the monitoring period was approximately 53 l/s.

The typical residual flow was approximately 60 l/s.

The monitoring therefore indicates that, under the observed operating conditions, substantially more water remained within the depleted reach than the minimum flow required by the abstraction licence.

# 8. Recommendations

Continue monitoring during

- rising hydrograph
- falling hydrograph
- turbine start-up
- turbine shut-down
- high flows

*Appendix C*

**Site drawings**


Notes

1. The site is centred on approximate Ordnance Survey grid coordinates SX747270
2. All dimensions are in metres unless stated otherwise.
3. All levels are in metres relative to local datum .

Legend

| | |
|---|---|
| Watercourse | Watercourse |
| +1.234 | Existing site level |

| Revision | Date | Revision description | Drawn | Checked | Approved |
|---|---|---|---|---|---|
| 1 | 10/07/26 | Issue for Proof of Evidence | CJE | BPB | MRF |
| 0 | 30/06/26 | Initial issue for client review | CJE | BPB | - |

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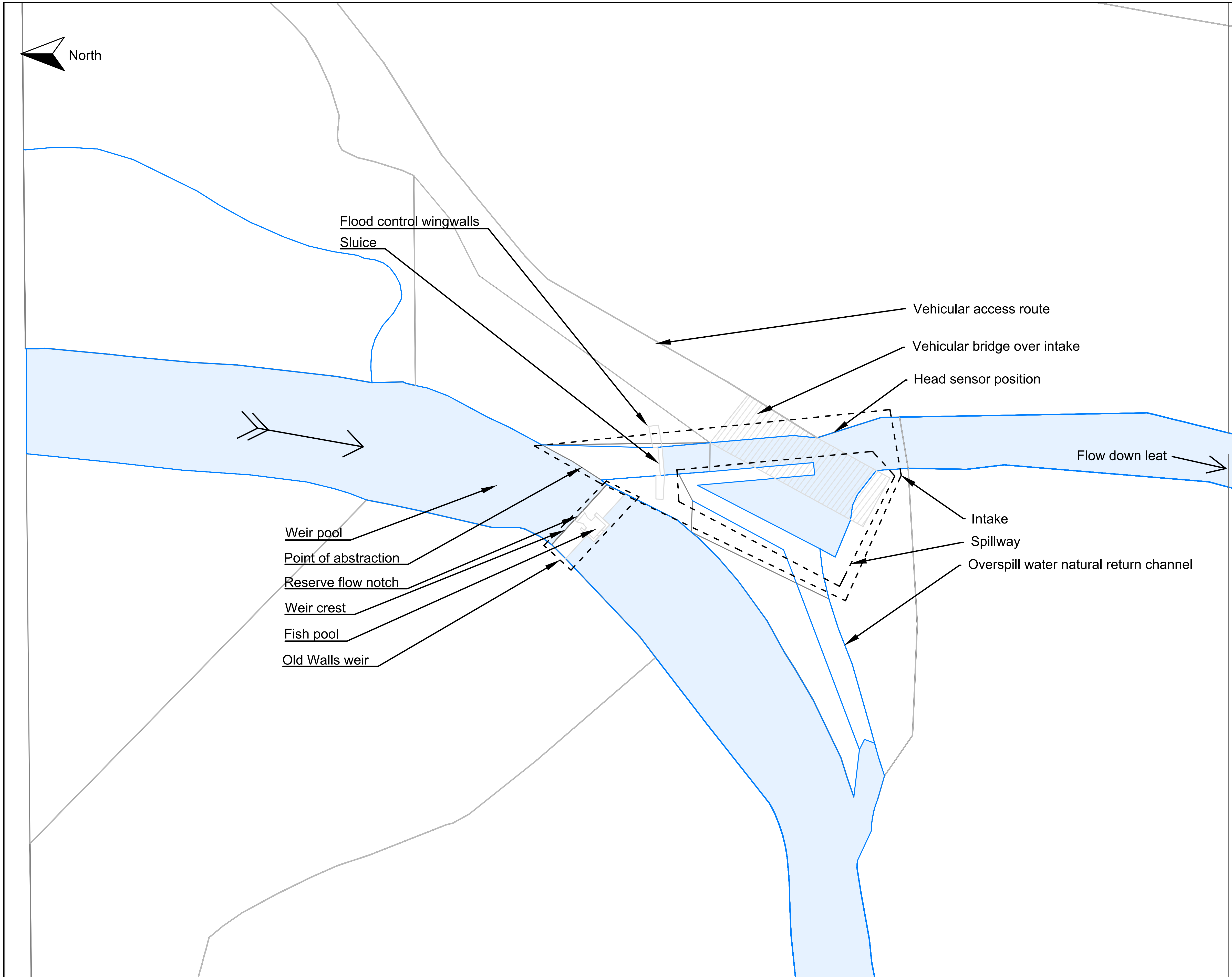
Client
M R Fursdon

Project
RSA appeal

Drawing Title
Site overview

| Drawing No. | Revision | Status | Scale at A3 |
|---|---|---|---|
| 1022 300 | 0 | For Review | 1:500 |
| **Drawn by** | **Checked by** | **Approved by** | **Date** |
| CJE | BPB | MRF | 30/06/26 |




# 1022 301 Intake layout

Scale 1 : 50



Notes

1. The site is centred on approximate Ordnance Survey grid coordinates SX747270
2. The drawing is based on an ordinance survey map, with modifications to show schematically the layout of the site. As such it is not a detailed topological survey and may not be dimensionally correct, but it is presented to show the general layout and to ensure consistent language is being used for the different features of the system.
3. All dimensions are in metres unless stated otherwise.
4. All levels are in metres relative to local datum .

Legend

| | |
|---|---|
| (blue line) | Watercourse |
| +1.234 | Existing site level |

| Revision | Date | Revision description | Drawn | Checked | Approved |
|---|---|---|---|---|---|
| 1 | 10/07/26 | For issue | CJE | BPB | MRF |
| 0 | 30/06/26 | Initial issue for client review | CJE | BPB | - |

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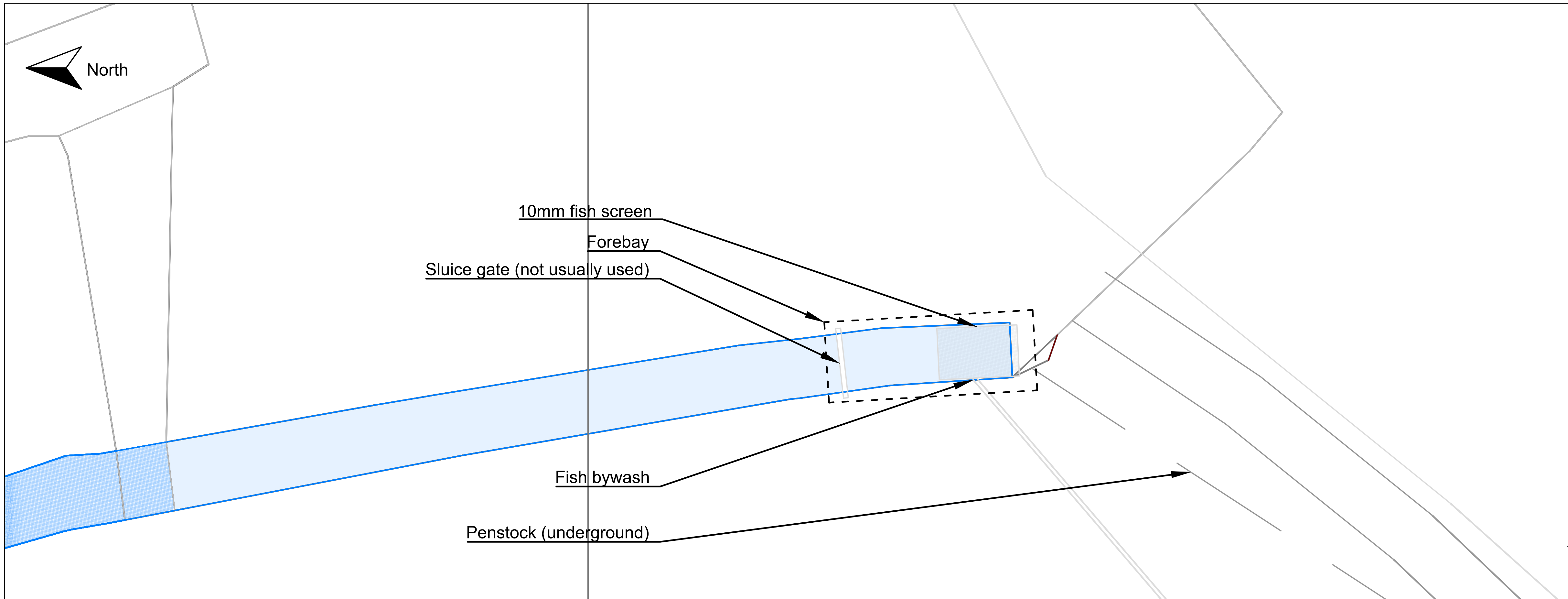
Project
RSA appeal

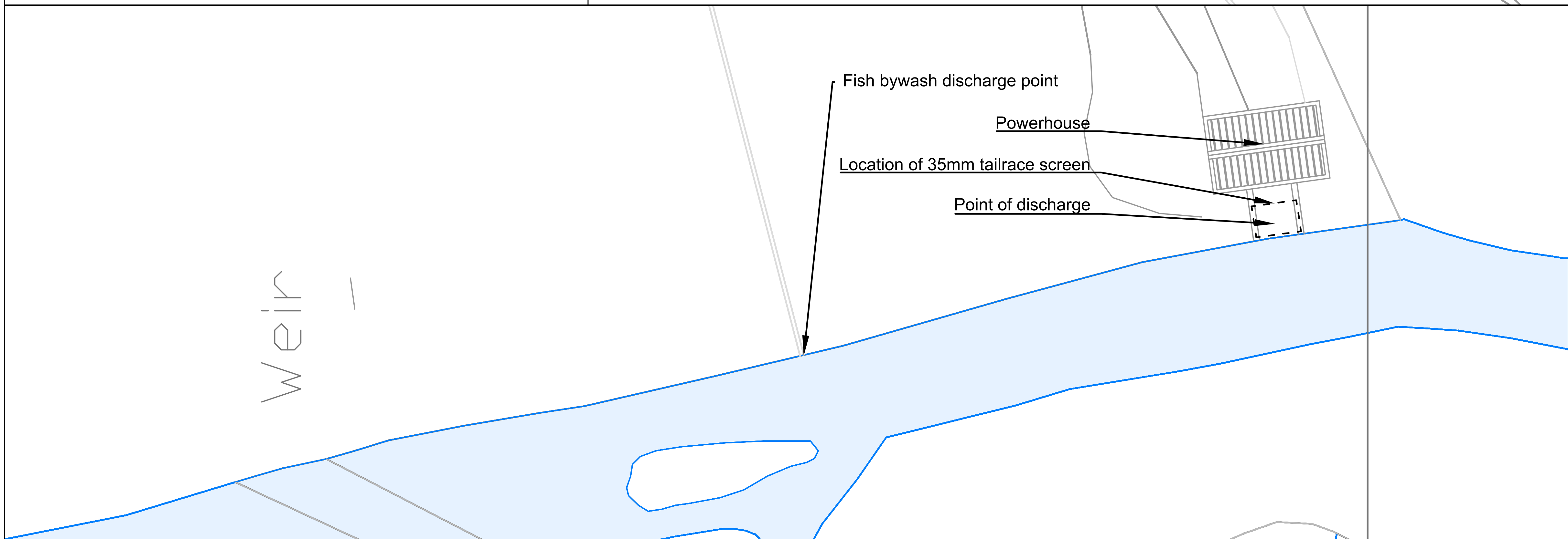
Drawing Title
Intake details

| Drawing No. | Revision | Status | Scale at A3 |
|---|---|---|---|
| 1022 301 | 1 | For inquiry | 1:50 |

| Drawn by | Checked by | Approved by | Date |
|---|---|---|---|
| CJE | BPB | MRF | 30/06/26 |




## 302 - 1 Forebay layout
Scale 1 : 50




## 302 - 2 Powerhouse / outfall layout
Scale 1 : 50

Notes

1. The site is centred on approximate Ordnance Survey grid coordinates SX747270
2. The drawing is based on an ordinance survey map, with modifications to show schematically the layout of the site. As such it is not a detailed topological survey and may not be dimensionally correct, but it is presented to show the general layout and to ensure consistent language is being used for the different features of the system.
3. All dimensions are in metres unless stated otherwise.
4. All levels are in metres relative to local datum .

Legend

| | |
|---|---|
| ——— | Watercourse |
| +1.234 | Existing site level |

| Revision | Date | Revision description | Drawn | Checked | Approved |
|---|---|---|---|---|---|
| 1 | 10/07/26 | For issue | CJE | BPB | MRF |
| 0 | 30/06/26 | Initial issue for client review | CJE | BPB | - |

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Client
M R Fursdon

Project
RSA appeal

Drawing Title
Forebay and outfall details

| Drawing No. | Revision | Status | Scale at A3 |
|---|---|---|---|
| 1022 302 | 1 | For Review | 1:50 |
| **Drawn by** | **Checked by** | **Approved by** | **Date** |
| CJE | BPB | MRF | 30/06/26 |