

**Archimedean Screw
Hydropower scheme at
Charlestown Weir**

**DESIGNER'S ENVIRONMENTAL
SUSTAINABILITY ASSESSMENT**

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Executive summary

The design of the proposed scheme has taken account of the latest regulatory guidance for best practice hydropower schemes. Consideration is given in turn to those areas of greatest interest in EA licensing. An operating regime is proposed which has been intentionally designed so as to have least environmental impact while still allowing a viable hydropower scheme. The proposed regime is as protective as EA default guidance, or more so, and exceeds guidance in terms of minimum residual flow and maximum abstraction. This regime seeks to minimise change to the natural environment, while also providing for a best practice fish pass alongside the hydropower system to allow fish to move freely past what is now an impassable obstruction. Other aspects of scheme layout and technical design are detailed to minimise or mitigate environmental detriment.

Introduction

Renewable energy developments benefit the environment through carbon emissions reduction, but must also demonstrate sustainability in wider environmental terms. The present document summarises how the proposed scheme addresses environmental considerations as noted in the Environment Agency (EA) Good Practice Guidelines (2009) on environmental assessment of low-head hydropower, as modified in guidance to 2016.

Using an Archimedean screw turbine is identified as having low negative impact on fish. This is recognised in latest EA guidance, where the default position is that screws meeting standard criteria are considered for implementation without any fish exclusion screening.

This document is laid out with respect to areas of principal interest to the EA, but serves as a summary of relevant environmental issues and how the project design addresses these.

EA licensing and consents

The Irwell is a main river, therefore Environmental Permits for the works in the river will be required from the EA as Lead Local Flood Authority. Planning permission is being sought from Salford City Council.

Application is made to the EA for grant of licence to change the status quo, as follows:

- Build a new intake structure at the riverbank, to act as a new point of abstraction
- Admit agreed amounts of flow - by gravity fall - through this intake via an open channel.
- Control the flow rate of this abstraction by managing the rotation speed of an Archimedean screw turbine – by means of a variable-speed control system and its software parameters - allowing the water to fall back to the river via the screw and thereby generating electricity.
- Maintain an acceptable residual flow over the weir at all times. The proposed regime is for Q95 HOF or 1.632m³/s which will be split between the fish pass (0.85m³/s) and the weir (0.78m³/s)
- Condition these changed flows based on continuous recorded input from a level sensor at the intake.
- Construct a 2 flight best practice larinier fish pass co-located with the screw turbine.

The EA will consider whether these proposals meet its definitions to be conditioned as an Impoundment licence or a Full Abstraction Licence for the hydropower system as a whole. The abstracted flow here will be used for hydropower, therefore this does not seem to meet the definition of “without intervening use” which defines a Transfer licence. A unit charge is inapplicable for hydropower abstraction.

In the event that any time-limited form of licence were to be required, it is foreseen that the licence review date may be the next CAMS end date. However, if the environmental risk of this proposal is considered to be low, the EA is invited to exercise its discretion (as explained when time-limited licences were introduced) to grant a “long-term” licence to the subsequent CAMS end date.

EA PLEASE NOTE: If the EA decides to issue an abstraction licence WITHOUT an impoundment licence, or vice versa, **the EA is asked to supply a formal letter stating that whichever licence type is NOT issued is (in the EA’s opinion) formally “NOT required”**. The issue of such a letter in this case is required by OFGEM as a prerequisite (as proof that no further application is outstanding for another type of licence) before it will consider the hydropower scheme as eligible to receive income.

Environmental Impact Assessment (EIA)

For hydropower schemes which are less than 0.5 MW (5 times larger than proposed here), statutory EIA is only invoked where there is also a concern the scheme must demonstrate no significant risk of environmental damage to designated protected sites such as a SSSI. The applicant is therefore not submitting an Environmental Statement in the terms defined for statutory EIA, but will consider all environmental issues in detail in this assessment.

Water Framework Directive

In considering a proposal for a hydropower scheme, the EA will have regard to the EU Water Framework Directive (WFD). The EA has a legal duty to ensure that all existing and new modifications do not risk preventing the waterbody achieving its status objective, nor causing a deterioration in its current status. The submission is therefore expected to make a case for how this scheme design complies with the intent of the WFD, in the light of criteria in 2012 EA GPG Appendix 2.

By following latest EA guidance for hydropower schemes, and as detailed in this and supporting documents, the current proposal takes reasonable practical steps to mitigate its negative impact, and will have no detrimental impact on the WFD status of the river. The EA typically considers that the significance of impact on WFD quality elements should be assessed at a waterbody scale (except for critically sensitive habitats). As considered below, quality impact is unlikely to be significant even locally, and its significance at a waterbody scale low or zero.

Hydromorphology and geomorphology

See WFD and Hydrology assessments for detail.

Rivers act as a conduit not only for water, but also for gravels and sediment. The river has evolved in response to a combination of natural and anthropogenous processes.

The proposed scheme is not anticipated to have any significant impact on bedload gravel or sediment movement through the catchment. The proposed abstraction of a minority of the river's flow during medium flow conditions will not reduce the river's ability to mobilise and propel bedload material along the channel during those high flows in which this process occurs. Suspended sediment will continue to move through the natural channel and in future through the hydropower intake channel in proportion to the flow of water in each case. Sediment will not be screened or settled out of the hydropower intake channel and will remain within the water column to pass freely through the Archimedean screw turbine.

Coarse woody debris and leaf material likewise will not be screened out at the entrance to the hydropower intake. Only the largest sticks and branches will be stopped at the debris screen and will then be fended off into the natural channel by the operator at cleaning intervals - a maintenance activity whose continuance is assured by the need to maintain the efficient operation of the system. The smaller elements of materials that pass into the intake with abstracted flows will pass on through the hydropower intake and pass safely through the screw. The majority of flow does not approach the hydropower intake, and material borne in rest of the river will pass on down the natural channel as at present.

While weirs form an obstruction to natural processes, having persisted for many years this in itself can contribute locally to the variety of form in a river. The weir at Charlestown is

such a case, with a slow pool upstream and more turbulent flow downstream adding to other natural riffles

Flow Regime

See Hydrology and Fisheries assessments for detail.

The project fisheries consultant proposed a minimum residual flow of Q95 or 1.632m³/s which will be split between the fish pass (0.85m³/s) and the weir (0.78m³/s). Up to 11.5m³/s will then be abstracted through the hydropower system when sufficient water is available.

Water quality

As noted above, quality is among elements assessed for compliance with the Water Framework Directive (WFD). It is anticipated that present information will be sufficient to conclude that this scheme design does not prejudice the attainment of water quality objectives.

The proposal will redistribute some flows away from the weir as described, this being subject to a licensed regime derived specifically to protect rivers from abstractions of this sort based on best-available knowledge of impacts. All water will remain available in the catchment, depleting only the weir itself. Oxygenation continues to take place, now at the screw as well as the weir. Sediment, not screened out, is allowed to move through the system as before.

No detrimental impacts on water quality have been reported by the EA from around a hundred similar micro-hydropower sites operating under the EA's regulatory guidance for Archimedean screws. Several hundred other small hydropower schemes have been in operation on watercourses in England, over an increasing depth of time, with no evidence of negative impacts on water quality. Impact of the present scheme is unlikely to be significant even locally, and its significance at a waterbody scale is low or zero.

Water resources

Pending the EA responding to a request for confirmation, it is understood that there are no competing licensed abstractions in this area that will be derogated or otherwise disadvantaged by this proposal. The proposal poses no detriment to wells or boreholes. No flow gauging sites or flow measuring structures are present within the area affected. A requirement to maintain suitable main-channel flow is met by an agreed residual flow. This scheme has no effect on distribution of flow in the wider catchment, beyond the intake and outflow, and hence also no impact on the Adelphi gauging station or others.

The volumes of water licensed for use by the system will be measured as per EA WR standard conditions for hydro schemes, by calculation from generation output using a conversion factor which is derived at commissioning and advised to the EA.

For national water management purposes, under an abstraction licence the EA seeks to apply a maximum limit to the quantity of water that may be abstracted per year – the “annual quantity” - as well as the instantaneous flow. At this site there is no particular reason to cap the annual quantity to less than 365 days’ equivalent of maximum design flow, but any reasonable amount will be acceptable. The key result is that any proposed arbitrary administrative cap on the annual quantity must not prevent the scheme from using its agreed daily quantity if that agreed quantity happens to be available on any day. EA Hydropower specialists have previously assured us that this is not the intention of the annual quantity, and the value of annual quantity should not be set so as to cause a conflict. (If the scheme is to be licensed with an impoundment licence only, it is not necessary to specify this notional limit at all.)

Environmental Management

An Environmental Management System is now a requirement when obtaining an EA Environmental Permit to construct the scheme. This has been submitted to the EA as part of the application, and covers all areas of environmental risk during works.

Responsibility for running the scheme on a day-to-day basis, and any maintenance program for the site, will lie with the applicant. Their personnel or contractor will maintain the system on a regular basis in the interests of maintaining their income to recoup their capital investment. This scheme does not have unusual technical complexity – i.e. its operation does not necessitate integration with other sluice gates or channel controls -

therefore a formal management plan for the hydropower scheme does not seem to be a proportionate requirement, as all relevant conditions can simply be included in the licence.

The system's operation "fails safe" – i.e. when the relevant level threshold cannot be maintained, or in a fault condition, the hydropower sluice closes passively on loss-of-signal and abstraction to the turbine ceases.

If the scheme is to be licensed with a full Abstraction licence, the standard EA hydropower conversion sheet will be completed to ensure correct reporting of abstracted flows; even with an Impoundment licence - where the legislation itself does not require annual reporting - the same effect can be achieved via licence a condition, if there is a particular concern to monitor this. Equipment calibration documents, efficiency specifications, etc can be supplied upon installation. If the EA wishes to make visual inspections of compliance with a minimum water level, installing a visible staff gauge close to the the relevant level sensor (typically at the intake) is often conditioned in the licence. The foregoing standard provisions are typically deemed adequate to meet requirements of EA Environmental Management (Enforcement).

Ecology

Refer to Ecological Appraisal report.

The scheme is designed with features and a proposed flow regime which are intended to minimise detriment to local ecology and nearby designations and their features of interest.

Specific aspects of potential interest include:

- Fish, including eels and lampreys: see Fisheries section, below. Proposed changed flow regime is designed with specific regard to mitigating impact for fish and their habitat, with concomitant similar mitigated impact (via limited flow reductions) on other species.
- crayfish: no impact anticipated. Found likely absent.
- benthic macroinvertebrates: no significant impact anticipated – bed conditions unchanged (except for small works footprints at intake and outflow). Standard silt and pollution control conditions for river works to be followed during construction.
- aquatic macrophytes: no impact anticipated – depths and flows are not being modified to such an extent that local aquatic plant assemblages likely to be deprived. Plants further afield are not impacted by the changed regime.

- otters:
 - o potential for transit – small areas of riverbank are implicated, passage around these changed areas remains open for transit, opposite banks are not affected
 - o holts and lay-up areas – not found at initial survey, ecologist finds unlikely at this public location
- water vole: no impact - likely not present:
 - o Water level variation will be slightly moderated during scheme operation, but will continue to vary, so habitat implications are not changed.
- nesting birds: relevant habitat clearance outside of March-August (or only after ecologist checks for nests) will avoid any detriment.
- bats: no roost potential on site. Conditions for daytime working / lighting during works will avoid any detriment to foraging.
- other vegetation: no significant impact anticipated – loss of locally typical bank vegetation within a small footprint – footprint of works is mostly grass / some scrub.
- invasive species: River works contractors follow standard guidance and standard methods for dealing with the most common invasives, as per EMS.
- Designated sites: None

The potential presence of protected species is not only seasonally-determined but can change from year to year. Ecology assessment identifies a need to check for specific species prior to construction, and provide mitigation measures as appropriate. Due consideration will be given to the protection of wildlife during works and to the appropriate eradication of any undesirable invasive flora and fauna discovered.

Fisheries

Refer to Fisheries technical assessment and to Hydrology assessment for flow regime.

Habitat

Refer to Fisheries & WFD technical assessment. A survey was conducted to assess the hydrology and morphology of the weir pool and the area immediately downstream. Depths and velocities were measured across a series of transects and sediment samples taken. Substrates were classified for each sampling location and the predominant benthic composition was identified. The data was used to assess how the installation may result in

morphological and hydrological changes within the weir pool and the area downstream and how this may in turn impact fish habitat.

The weir pool offers very little spawning habitat, largely as a result of deep water and poor substrate availability. There are limited rheophilic and phytophilic spawning opportunities within the weir pool. It was found that although the proposed scheme will result in slight changes in the hydrological profile of the weir pool, it is unlikely that this would have an impact upon the availability of rheophilic or phytophilic spawning habitat, as the limited habitat available is over 100m downstream of the turbine outfall. Energy densities from the turbine and fish pass should dissipate rapidly within the large weir pool, and therefore velocities downstream will be unaffected.

Sediment release from the construction works is minimised by working within the cofferdam and filtering all pumped water back to the river.

Downstream passage / Intake screening

The proposed flow regime maintains downstream passage over the weir, through the Archimedean screw, and down the new fish pass.

EA guidance allows that it is not necessary to exclude fish from an Archimedean screw turbine, provided that the screw complies with a guidance matrix based on research evidence, which sets limits on blade tip speed (a function of rotation speed, number of blades, and diameter) and on minimum diameter; and which requires that it is equipped with correctly affixed and maintained compressible rubber bumpers on the leading edges.

Larger-diameter screws such as proposed here comply with EA guidance thresholds. Where – as proposed here - larger-diameter screws are implemented with steel troughs (rather than rough or erodible concrete troughs) and are operated under a variable-speed control system (which keeps all chambers full of water at all times), the risk of damage to fish is logically less likely than in other cases (where smaller quantities of water are injected into screws at higher fixed speeds and/or with more irregular trough surfaces).

Research has been carried out regarding potential damage to fish passing through Archimedean screw turbines. Most of this research has considered salmonid smolts which move downstream through the screw. Potential differences in the implementation of different screws, such as those above, may help to explain the variation in the low

incidence of scale loss which is attested in some research on live smolts passing through screw turbines. The system proposed for this site adopts all the above known measures to minimise this impact while still permitting that fish may pass through the screw. This remains in keeping with EA national licensing practice at the present time.

The intake structure is designed to accommodate a screen of bars at 200mm spacing. This will admit fish which opt to enter the screen to follow this route, but will ensure that inflow velocity at the screen is low enough to remain escapable across the flow regime.

Upstream fish passage

The weir currently forms an impassable barrier to fish and therefore a new best practice fish pass at this site would result in improved fish migration and lead to an overall improvement in WFD status. The new fish pass will improve connectivity for a significant stretch of the lower Irwell and contribute to the Irwell Catchment Restoration Plan's goal of opening up the Irwell basin to fish migration and improving the WFD status of the river.

A 1.8 m wide multi-species Larinier fish pass and eel pass will be installed as part of the scheme. In order to conform to best practice guidelines, the pass will discharge 6% of the Qmean flow at the site across the HOF, a flow of 0.85 m³/s. The pass entrance will be co-located with the turbine outfall in order to maximise attraction flow. Furthermore, the entrance to the pass and the turbine outfall discharges as close to the toe of the weir as possible.

Timing of works

The EA prefers that works within the river should if possible be carried out outside of the main migratory period for relevant fish populations. Works for this project will take place within dewatered cofferdams and/or will then proceed behind a closed sluice. The EA is invited to indicate any ecological "best season" to minimise river impacts, so contractors can consider how works might be scheduled around this.

Trees

There are no trees affected

Noise

The generating equipment will be housed in a concrete building to provide for flood protection and noise insulation. The scheme is also set down behind a flood bank, so it is not expected that there will be any impact on neighbouring properties.

Recreation and amenity

Operational impacts of the proposed development are limited to the weir itself. No formal rights of way are affected, but an existing well used path along the top of the flood bank will be retained, by moving it approx. 5m further away from the river.

Third-party recreational or amenity interests are affected only insofar as the development will reduce river flow, over the weir itself only.

The intake is in deep water and is screened to exclude human access. The open channel is covered over with a secure mesh deck for operator access. The discharge point is also in deep water. As is typical for Archimedean screw hydropower schemes, the discharge is not screened. When the screw is operating, the release of large volumes of water repels swimmers or canoeists from the immediate vicinity of the screw.

Potential environmental risks in construction

Ecological risk from pollution of the watercourse is managed by precautions during works. The following risk factors have been identified and clear prevention and mitigation measures are contained in the project construction method statement.

- Fuel/Oil Spillage resulting in soil contamination
- Fuel/Oil Spillage resulting in contamination of water course
- Contamination of watercourse with cementitious material
- Contamination of watercourse with chemicals
- Contamination of watercourse with sediments due to run off from excavations

These risks are familiar to construction contractors using construction materials and manual or mechanical plant in rivers. Clear prevention and mitigation measures compliant with EA guidance are put forward in a project Environmental Management System (EMS). This serves to influence the Construction Method Statements (CMS) which are written in collaboration with the contractors when the latter are engaged.

During works, water flow through the works will be excluded by piled or bagged cofferdamming below, and by closing off the intake above, removing connection to the watercourse. Where oils are required for operation, PANOLIN environmentally low-impact products are used.