Archimedean Screw
Hydropower installation at
Bullhouse Mill

ENVIRONMENTAL SUSTAINABILITY ASSESSMENT

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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 noted in the Environment Agency's 2009 Good Practice Guidelines on the environmental assessment of low-head hydropower.

Applying the design principles of the present scheme, the Archimedean screw design in question is identified as having low impact on fish, and has been deployed in schemes cited by the EA as exemplifying sustainable hydropower design:
http://www.environment-agency.gov.uk/news/110199.aspx

EA licensing and consents

Application has successfully been made for an EA abstraction licence NE/027/0005/007 for the flow into the leat.

EA representatives from Flood Defence and Water Resources attending a site visit on Sept 3rd 2009 gave an opinion that the restoration of some boards at the crest of the weir would to constitute maintenance within the ordinary activities of the riparian owner, and would not of itself require an application for an Impoundment Licence. This has been accepted within the abstraction licence which was granted.

Consents for the works-in-river (Flood Defence Consent) to agree the timing window for the works will be sought in due course once planning consent is obtained.

Flood risk analysis

It has been identified that the new structures will be at risk of flooding, and that a Flood Risk Assessment is required with the Planning Application. The aim of the Flood Risk Assessment is to identify flood risk and propose measures to mitigate that risk, with reference to PPS 25 ("Planning Policy Statement 25: Development and Flood Risk", DCLG, December 2006).

The EA's Flood Map for Bullhouse Mill was consulted via their website www.environment-agency.gov.uk. This shows the River Don, the former intake and the field across which the mill lade runs to lie within the dark blue floodplain, defined as an "area that could be affected by flooding, either from rivers or the sea, if there were no flood defences. This area could be [affected] by a flood that has a 1% (1 in 100) or greater chance of happening each year."

According to the EA's revised Standing Advice on Development and Flood Risk, electricity-generating is classed as essential infrastructure, permitted in Flood Zone 3 on passing an Exception Test. The commonsense argument typically accepted is that hydropower is in fact "water-compatible development", if not explicitly listed under that heading in PPS25.

Local knowledge confirms that the intended location of the screw is set into the reverse slope of an embankment which lies above the worst remembered flood levels. Accordingly this does in fact appear in the whitespace outside the flood zone in the flood map (below).



Flood Risk Assessment consists in answering the following questions.

1. Will the proposed scheme reduce the flood flow capacity of the river, either by reducing the cross section or by slowing flows?

No. At one point the cross-section will be reduced by the profile of the above-ground structures (generator shroud and control cabinet), but only by <4m^2 per vertical metre of overland flood depth. However this will not be impermeable and will be allowed to flood, therefore not displacing any potential flood water. At the same time, the cross section at other points will be increased by a greater area by the excavated channels – so there may in fact be a slight increase in flow within the immediate locality (10m radius). On balance, there is no net reduction in capacity.

2. Does the scheme propose any alterations to structures or construction of new structures in the river (such as weirs, dams, culverts or outfalls) or alterations to existing flood defences (such as embankments or walls)?

Yes. The weir will be repaired to a uniform crest height by replacing some boards which have become dislodged. At the historic intake, silt build-up will be removed, allowing the abstracted water to leave the river. The tail of the screw will descend into the river, and be mounted on a small (<2m^2) concrete pad at or below normal water level, posing negligible effect to flood flows. All other structures are not within the river.

3. Does the scheme propose to create new channels or change the flow path in any way?

Yes. The licensed abstracted flow will leave the river above the weir via an existing intake sluice into an existing (though currently heavily silted) mill lade. After <20-30m, a new channel will be excavated to deviate from this, diverting the flow towards the turbine site where the water falls back to the river. This new channel, cutting through an isolated and apparently natural embankment, constitutes a third way for flood waters which at present continue to the right (over the weir) or spill to the left (over the floodplain). In all three cases, the flood waters must converge within some 30m downstream. Hence the localised impact of the proposed modification is negated long before the river reaches any buildings or property boundary. Therefore the new channel provides neutral or even positive impact on flood capacity.

The reinstated length of lade and the new channel deviating from it will be flush with the existing ground level for most of their length, thus causing no change to the current situation. With its sluice gate closed, the proposed channel presents no reduction in flow over the present situation: water follows the existing routes for any such high flood flows. With the sluice open, the proposed channel provides some new capacity to allow flood flows to pass through. The channel is not constrained by culverting, and therefore does not impede flood waters rising evenly within the existing flood plain. Under all flow conditions, water would return to the same pool downstream.

4. Does the scheme propose to deepen any existing channels?

No, except insofar as maintenance is concerned. The intake and the initial part of the lade will be excavated to their intended depth. The surface level above the weir will be slightly raised from present levels, being returned to a level 200mm higher by restoration of the crest boards. The effect of the raised level will not extend beyond the property boundary which is continuous floodplain. Reinstatement of the weir boards to restore the water level was considered uncontentious by the EA Flood Defence representative who visited the site on Sept 3rd 2009, who considered it to constitute repair work within the activities of the riparian owner.

5. Is the scheme in the floodplain as shown on the Environment Agency's flood map? Does the scheme reduce the available floodplain area or block potential overland flow?

Yes, the scheme is - and can only be - in the floodplain. (See PPS25 on water-compatible development and electricity generating installations.)
No, on balance there is no net reduction in flood flow or floodplain area.

6. Will the scheme change the available access to the river or adjacent flood defences for maintenance, including by construction of fences or walls around new structures, or of overhead cables?

No. Cables will be buried. The location is private and the structure requires no fencing.

7. Could the cumulative impact of the current proposal along with others increase flood risk or adversely affect land drainage?

No. Existing flood events already cause localised overland flow within the floodplain (as per flood map). The same will continue to happen unmodified by the proposed scheme. There are no other buildings or property that could be affected in this area. Therefore this application does not add either individual or cumulative adverse effects to flood impacts on any party or property. The necessary Land Drainage Consents must be and will be formally applied for and are subject to appropriate consideration by the EA.

In summary, the client's acknowledgement of the potential flooding risk to this hydropower scheme, and the works to be carried out as per the construction method statement, meet the EA's minimum requirements for a development in this location.

Fluvial geomorphology

Rivers act as a conduit not only for water, but also for sediment. The point at which the Don passes Bullhouse Mill is dynamic, and has evolved in response to a combination of natural and anthropogenous processes. The Archimedean screw turbine will improve the continuity of silt transport, allowing an increased volume of sediment of all sizes to pass through the site, and reducing the build-up behind the weir in the existing channel. An improved flow and consistent water level in this channel will improve the existing habitat. The outflow is angled to direct the flow downstream and back into the natural river channel, thus preventing erosion on the opposite bank.

Flow Regime

The maximum flow to be abstracted will be 600 litres per second, but this will only be taken when there is sufficient water available to maintain the water level flowing over the weir crest. The agreed minimum residual flow is 130 l/s, which will be left to flow down the weir to provide a route for fish at all times of abstraction. In addition, the minimum flow required to operate the hydropower system is 90 l/s, so for all flows below 220 l/s the flow regime remains as today. The inlet sluice gate will be controlled automatically to comply with these requirements, by using a level sensor to monitor the upstream water level.

Effect on the depleted reach

Under the conditions of the abstraction licence a minimum flow of at least 130 litres per second will always be maintained down the weir to form a dedicated route for fish at any time abstraction is taking place. No other part of the river will suffer from reduced flows, as the scheme proposes only to move a portion of the flow which currently passes over the weir to another outflow immediately downstream of the weir.

Fisheries

Screening

The design of the turbine permits the safe passage of fish in a downstream direction. The chambers formed by the blades have a semi-circular diameter of 0.7m and a depth of 0.35m, with no pressure change, and rotate at only 42 rpm Therefore it is not necessary to physically stop all fish from entering into the turbine. However, for safety reasons a coarse screen is required, consisting of vertical bars with a spacing of 100mm apart, to be fitted across the intake structure.

Upstream fish passage

The ability of fish to pass obstacles is site-specific and depends on several factors. These include the flow rate, depth of the water at the foot of any obstacle, as well as the nature and dimensions of the obstacles.

Upstream passage of fish via the weir at present is believed to be seasonally limited. The turbine itself would also represent an impassable upstream barrier to fish. The reduction in flows in the river at certain times of the year may make it more difficult for fish to migrate upstream. The present proposal also involves repairing damage to the weir crest which at present may be assisting fish moving over the weir.

The EA has therefore agreed to the installation of a fish pass at this site as appropriate mitigation for the reduction in flow peaks down the weir. The EA has expressed a preference for a hybrid pass, making use of low-cost baffles affixed to the face of the weir, with an initial section of Larinier pass at the steeper gradient at the toe of the weir, fed by the residual flow from a notch in the weir crest. This will allow more fish species to pass the weir over a wider range of flows. Detailed finalisation of this design is ongoing with the EA, and must be approved by the EA's National Fish Pass Panel as per conditions in the abstraction licence before operation may commence.

It is possible that some fish will initially be attracted to the outflow of the screw, but when they fail to ascend, will soon fall back and locate the main river channel. Fish studies carried out on other installations have not found this situation to cause any harm or significant delay to the fish.

Ecology

All species listed for which legal protection is currently afforded must be considered, which includes:

- Habitats Directive (92/43/EEC)
- Freshwater Fish Directive (EC/659/EEC)
- Salmon and Freshwater Fisheries Act (1975 as amended)
- EU Eel Protection Policy (1100/2007)
- The Water Framework Directive (2006/60/EC)
- Wildlife and Countryside Act (1981 as amended)
- Countryside and Rights of Way Act (2000)
- Protection of Badgers Act (1992)

The site is not covered by or close to any specific designations of environmental sensitivity. Due consideration must be taken of the potential of the development to impact on the following flora and fauna:

- All fish, and specifically eels and salmonids
- Breeding birds
- Bats
- Otters
- Badgers
- Water voles
- White-clawed crayfish
- Freshwater pearl mussel
- Bryophyte mosses

In this regard, a site-specific wildlife assessment (available with this study) has found no evidence of the presence of otters, badgers, water voles, burrowing birds or crayfish.

Major clearance of vegetation should not take place during the bird breeding season. In particular, dippers are reported to breed in the vicinity, and work should be postponed if investigation finds these to be nesting nearby.

Where appropriate habitats are present, the potential presence of these species is not only seasonally-determined but can change from year to year. The construction method statement for the scheme identifies the need to assess the impact of the development on the surrounding wildlife prior to commencing construction. Due consideration will be given to the protection of wildlife and to the appropriate eradication of any undesirable invasive flora and fauna discovered.

Trees

No trees will be removed during the proposed works. Care will be taken not to damage the roots of trees in the surrounding area, mostly self-seeded alder *betulaceae*.

Noise

Noise is generated in the turbine housing due to the rotation of the gearbox, drive and generator. This noise is similar to other rotating machinery such as motors or fans. The generator has a noise rating of 69dB. It is recommended that the gearbox and generator are covered with a sound-proofed structure, which dramatically reduces external noise. This is proposed in the design for the present site as depicted in the drawings.

Study of noise impacts in the vicinity of Archimedean screw turbine installations has previously been carried out on behalf of Mann Power Consulting Ltd at other installations. These studies have found that even within short distances the additional noise from the turbines was insignificant against the levels of ambient background noise from the weir and river itself. The most recent of these studies considered an installation immediately adjacent to a Grade-1 listed residential building, and found no unacceptable impact. Copies are available on request.

We submit that this will be the case at the present site also, in that the weir itself will always produce a background noise level against which the turbine's impact when in operation will be proportionate. Furthermore at Bullhouse Mill, the proposed location is both distant from and screened by topography from potential receptors; such that the risk of nuisance is highly unlikely. If noise is still considered to be a potential issue at the present site, we will be pleased to discuss this with the planning authority.

Potential environmental risks in construction

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

Record of relevant discussions

3rd Sept 2009	Site meeting	S Moore (MPCL)
Pre-app discussion on site with client, reps from 4 x EA functions, Barnsley MBC planner		

Dec 2009	Comments on 'An Initial Assessment of Fisheries Impacts' report	Jerome Masters (EA Fisheries Technical Officer)

"The FishTek report says that the upper River Don is not currently a high priority for improved fish passage. However, it is still a priority under the National Trout and Grayling Fisheries Strategy. Although the upper Don is not currently a priority for Environment Agency funded fish pass installation projects, it is necessary for us to consider fish passage when assessing any hydropower proposal, in order to meet the requirements of the Water Framework Directive (and the Trout & Grayling strategy)…

The Fishtek report notes that fish passage upstream over this weir is possible, if difficult. The migration window is noted as probably being 'very small and restricted to high flow events' although from observations of trout at weirs elsewhere in the Don system, trout might be able to ascend during flows of winter mean, or above. One of the main fish species living in the Don around Bullhouse is the brown trout. This species spawns in late autumn / winter and migrates upstream during elevated flows.

A reduction of flow over the weir will make fish passage more difficult, reducing the window of opportunity. As such a fish pass will be required as our guidelines (Environment Agency, 2009) state that a fish pass will be required on hydropower sites on rivers where there are migratory species, if the ability to migrate is compromised.

A fish pass would also be required under Section 9(a) of SAFFA as both hydropower installation and repair of the weir's crest would make fish passage more difficult. This is because under SAFFA a fish pass needs to be installed when an existing dam is 'raised or otherwise altered so as to create increased obstruction'.

The designs for any fish pass would need to be submitted to, and approved by, the Environment Agency via the National Fish Pass Group, prior to construction. Under SAFFA, the owner of a fish pass is legally responsible for proving the effectiveness of the fish pass and also legally obliged to maintain the fish pass (if constructed under Section 9) in working condition…

A bywash channel will be required at Bullhouse Mill weir, to ensure the safe passage of downstream migrating fish. Our guidelines state that 'a screen bywash is required wherever the intake screen of the hydropower scheme is not located in the normal course of the river'. Some types of fish pass can be used as the bywash where they can be suitably positioned. Larinier, vertical-slot, pool and traverse or nature-like fish passes are suitable for this purpose...

Details of the requirements [for a fish pass and bywash] were included in comments sent to MannPower earlier in the year…" *[MPCL: no detailed comments received]*