Stage 2 Report, Site 4: Abbeystead Reservoir

Introduction

This study follows on from a pre feasibility report produced by Inter Hydro Technology on behalf of the Forest of Bowland AONB, this is published at www.forestofbowland.com. This stage two study has focussed on the identification of flow and head available for a turbine at the foot of the reservoir dam, costs, proposed site layout, power and energy predictions and Environment Agency and planner feedback. Further research into the feasibility of this site is likely to be continued by the trustees of Abbeystead Estate.

Existing infrastructure

A plan of the site is included. The existing infrastructure and control systems at the site are described. There are five discharges from the reservoir:

- Two low-level scour pipes, controlled by manual valves, are opened during high flows to help maintain the reservoir level.
- One central scour pipe which discharges into an ornamental pond. This pipe is known to be below ground, even within the valve house, and will require further investigation.
- A salmon ladder which runs from reservoir level and curves down to the river
- A large spillway

All of these discharge into the River Wyre. These features will remain generally unaltered, with the exception of the central scour pipe. It is proposed that this will have a turbine installed on it at, or close to, its current outlet.

The management of the reservoir dictates the majority of water should discharge via the three scour pipes, rather than the spillway, as this manages the build-up of silt. There are two manual valves controlling flow to the two low-level scour pipes. These are opened during high flows to maintain the reservoir level and manage sediment build up in the reservoir. The pipes discharge either side of the valve house and ornamental pond. The third, central, pipe branches off the northern of the two low-level scour pipes, and discharges into the ornamental pond. This pipe is mainly used as a scour pipe to prevent excessive built up of silt at the bottom of the reservoir.

Black and Veatch (dam engineers) have advised that in the event of a hydro scheme being installed, flow from the reservoir should not be restricted. They agree in principal that if an existing pipe were to be utilised, then this should be the middle scour pipe. However, they recommend that a by-pass be provided in the event that water needs to be expelled from the reservoir.

There is an electricity supply just downstream of the site at the Thirlmere Aqueduct, downstream of the footbridge (Vale house, Abbeystead 11,000 Volts). It has been assumed that a connection will be made here.

Proposal

It is proposed that we use the mid-level central scour pipe for abstraction, install a turbine at the outlet of this pipe, and discharge the water back into the river. In order to accommodate a powerhouse, it will be necessary to remove the existing valve house from its current position. The ornamental pond would also require removal. It is proposed that the replacement powerhouse be designed in keeping with the period and style of the existing stone architecture.

The size of the scheme is dictated by the diameter of the existing scour pipe. This has yet to be established on site. Historic records suggest that the pipe has a 15 inch diameter (380mm). The pipe is unfortunately not shown in the

historic plans or survey reports, but is noted in the text of a paper by Mansergh (Mansergh on Lancaster Waterworks Extension [Selected Papers] 1881, page 266). At this stage of the design process it is assumed that this diameter is correct.

The scour pipe to be used in the hydro scheme branches off the north scour pipe (of the two main scour pipes). Using the existing pipe diameter and head, we estimate that approximately 1000 litres/second will be an achievable flow rate. The condition of the scour pipe is unknown and it is recommended that a survey of this pipe be commissioned. The condition of the scour pipe will affect the maximum flow rate possible.

An alternative to installing a turbine on the existing scour pipe, might be to install a new intake on the reservoir, at the southern end of the spillway, and bring the water down via a pipe through the woodland and return to the river via a turbine. This would avoid the potential problems of gravel and silt on the blades of a turbine and hence would prolong the life of the machinery. It may also enable more water to be used, as well as an additional metre or two of head, returning a greater power and energy. In order to investigate this further, it is recommended that a topographical survey is commissioned of the existing weir and potential pipe route around the southern end of the spillway. In this scenario, the same two turbine options (crossflow and Turbinator) would be recommended. This scenario is likely to require more environmental investigation as it does not use existing infrastructure to the same extent.

Power and energy predictions

Initial power and energy predictions in the Stage 1 study were made using the dam height and the mean flow of the river (1.86m³/s). Mean flow is a generally acceptable flow figure according the Environment Agency. For the stage 2 study, although the head value of 12 metres remains an estimate, we have made a more accurate estimate of the available flow according to the existing scour pipe diameter. In order to more accurately assess the head available, it is recommended that a topographic survey be commissioned.

Two turbine types have been investigated: a crossflow turbine and a Turbinator turbine. The estimates for power and energy are described below:

	Flow	Power	Energy
Crossflow	1 m³/s	85 kW	400 MWh
Turbinator	1 m³/s	78 kW	280 MWh

Ecowave Systems have advised us that a crossflow turbine for this site will cost in the region of £40,000 (for the technical package only). As shown above, the crossflow turbine would produce approximately 400 MWh a year, with predicted annual average revenue of approximately £88,800 (assuming 18.7 pence per kilowatt, plus a 3.5 pence export tariff).

Clean Energy Solutions have advised us that a Turbinator installation would cost in the region of €275,000. This turbine is likely to produce an average annual energy of approximately 280 MWh. This suggests predicted annual average revenue of £62,160 (assuming 18.7 pence per kilowatt, plus a 3.5 pence export tariff).

Planner and Environment Agency Feedback

Biodiversity

It is likely that trees will need to be removed in order to access the site with the construction plant. The extent of tree removal will be related to the size of the plant and the re-profiling that will be necessary on the embankments. It will be necessary to consult with the City Council's Tree Office in relation to this need for tree removal.

It is worth noting that tree removal will be required as part of on-going maintenance of the dam structure, separate to any requirements of the hydro development. This is because the tree roots risk the integrity of the dam structure. Some areas of habitat around the area likely to be required for access is designated and protected, however, it will be necessary to remove a proportion of them as part of the site maintenance. The Environment Agency have stated that ecologists should be consulted during the process of routine tree removal (aside from any hydro development), in order to minimise damage to species and habitat.

Woodland proximal to the site is designated as a Biological Heritage Site and as Ancient Woodland.

In order to comply with the ecological requirements, the Environment Agency has requested that the following is taken into account:

- An assessment is made of the impact on the Biological Heritage Site by the development.
- A full consultation with Lancashire County Council ecology service is undertaken to discuss method/ scope and mitigation for any damage.
- Any impact on ground flora should be discussed to identify any species of ecological concern e.g. ferns.
- Loss of trees to be kept to a minimum, particularly as the trees form part of the Biological Heritage Site
- Any loss of trees would require Bat and Nesting Bird Survey. Mitigation would also be required.
- Potential species surveys should include otters

The amount of environmental mitigation at this site will be dependent on the results of the surveys and the impact of the works. It is understood that, in general, mitigation should be at least on a like-for-like basis. If trees/structures containing bat roosts will be affected (or any other protected species), a licence from Natural England may be required.

No Special Areas of Conservation or Special Protection Areas will be affected by a scheme here so an Appropriate Assessment will not be necessary. The planning authority will determine whether a full Environmental Impact Assessment is required. Some form of ecological report will be needed and this continues to be investigated.

Under the Water Framework Directive the section of the River Wyre that includes Abbeystead Reservoir is classified as being at Good Ecological Status. Any scheme here must not result in the deterioration of this classification.

Heritage

The valve house and pond are classed as heritage assets, and as such will require a Heritage Statement for the proposed changes. It is recommended that in the event of this scheme being taken further, early dialogue with the planning authorities will be valuable.

Consents

The reservoir itself as an impoundment is listed under the reservoirs act and is regularly inspected by Dr Mike Prisk (recently retired of Black and Veatch).

There are no existing licences for this site. The scheme as currently planned is likely to require an impoundment licence and Flood Defence Consents for works to the weir. Further advice should be sought from the Environment Agency.

The Environment Agency has a levels gauging station on the reservoir which operates as an alarmed early warning system for nearby flood basins. The developer would need to look into how this would be affected by the hydro scheme.

Fish passage

The Environment Agency would like improvements to be made to the fish pass, and for the turbine to discharge adjacent to the fish pass entrance. Inter Hydro Technology have looked at the wider impact of positioning the outlet next to the fish pass. We suggest that despite the obvious ecological benefits, it would not be reasonably practical to move the discharge of the existing fish pass to the turbine outlet, or to move the discharge from a central position to a position proximal to the existing fish pass. It is suggested building a new fish pass would add significant, and probably prohibitive, costs to the scheme. However, the area adjacent to the salmon ladder entrance may be able to be modified to create an attractant flow, at a lower cost.

Next Steps

The next steps at Abbeystead Reservoir are to:

- Start work to comply with the Environment Agency's licensing and other requirements e.g. ecological assessments and consultation and consideration of the levels gauging station
- Commission a survey of the middle scour pipe
- Commission engineers to design the scheme such that applications can be made for planning permission and abstraction
- Commission a topographic survey of the site to confirm location of access track and plant
- Continue to keep Black & Veatch involved during the design stage