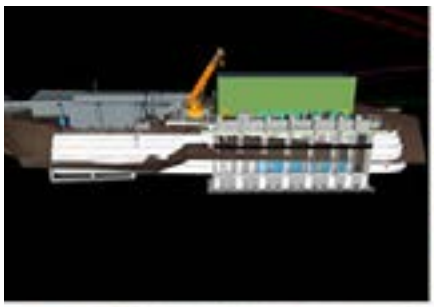
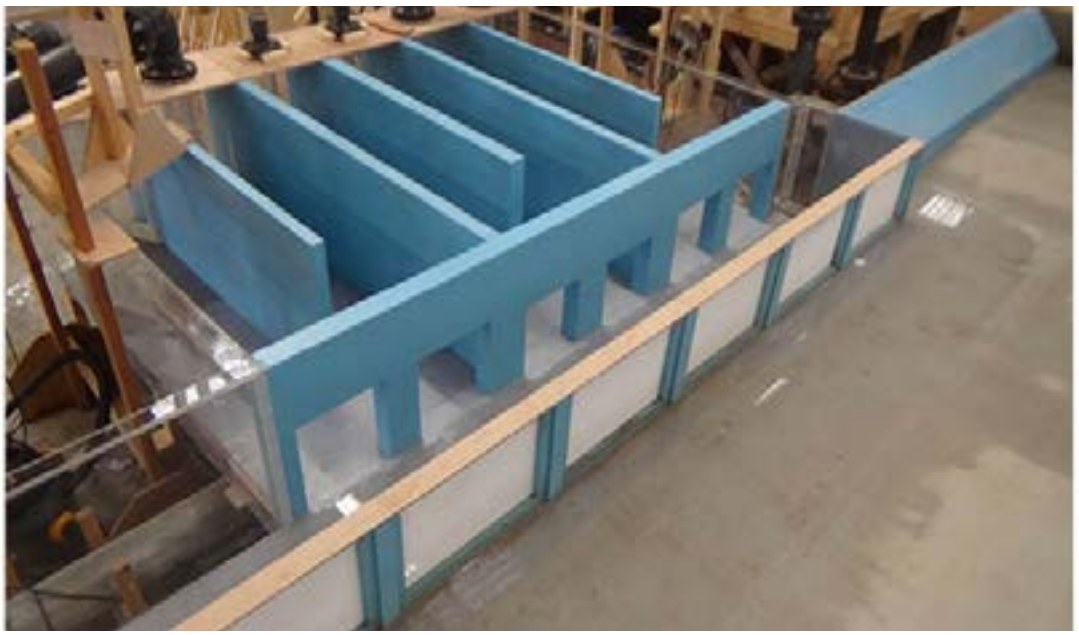
framatome BHR

# Prioress Mill Raw Water Pumping Station

## ARCADIS, MONMOUTHSHIRE





Prioress Mill Raw Water Pumping Station, is located approximately 2km North West of Usk in Monmouthshire, and pumps water from the River Usk approximately 4.5km to Llandegfedd reservoir.

The reservoir supplies Sluvad Water Treatment Works which in turn supplies a large proportion of Cardiff.

The existing station is aged and has poor reliability. It is also incapable of catering for upcoming changes in abstraction, which require delivery over a wider range of flows, and increased intake screening. The proposed solution was to construct a new intake and pumping station.

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For such a critical water supply, the most effective solution to the current problems whilst maintaining supplies is to construct a new intake and pumping station. Six pumps were to be installed, four high flow and two low flow, to cover the large range of flowrates from summer abstraction of 253 l/s from a river flowing at 2.535 m3/s to winter abstraction of 4416 l/s from a 17.361 m3/s river flow. Flow passes through screens into a common forebay area before dividing through penstock openings into three wet wells, each containing two pump bays.

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"The work conducted by BHR was essential to the optimisation of the sumps hydraulic and construction efficiency, which has been widely appreciated within DCWW. "

James Buckingham
DESIGN LEAD

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BHR was appointed to input into the design of the station, utilising their considerable experience to ensure optimal performance and efficiency over the range of flow conditions. A 1:7 scale model of the pumping station was built and used to carry out a hydraulic testing programme that:

- Assessed the hydraulic conditions generated in the suction wells in terms of inlet conditions and turbulence in the wet wells.
- Determined the degree of swirl at the pump inlets, vortex activity in the wet wells, air entrainment and solids deposition

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The original sump design was largely based on published sump intake guidance but with a challenge on depth for construction benefit purposes. Initial testing identified adverse flow conditions would arise with this original design. These included significant head losses through the penstock openings, air entrainment from turbulent approach flows through the penstock openings, surface and sub-surface vorticity with air and dye cores entering the pumps, and high levels of pump pre-swirl.

BHR engineers identified significant improvements that could be achieved through modifications of the original design. These included increasing the number of penstock gates, lowering the forebay floor and adding benching, walls and a splitter within the various pump bays. A rounded river wall was also added to the riverbank upstream of the screens.

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"This project was a great opportunity to utilise our extensive knowledge of working with river intakes. Using this experience, I'm pleased to say that we were able to make valuable recommendations that made a measurable difference. "

Sarah Fairhurst
PROJECT MANAGER

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Key recommendations included:

### MODIFICATIONS TO THE ORIGINAL DESIGN

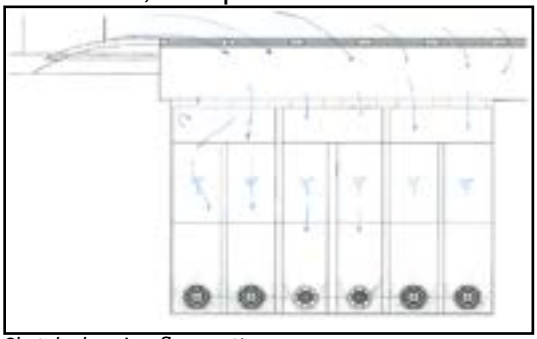
- Forebay to be lowered and the slope down towards the pump bay floors reduced accordingly.
- Benching, a splitter and walls to be placed within the pump bays, with walls extending to the full height of the pump bay.
- The three penstock openings should be increased to six (one for each pump bay) and increased in size.

### REVISIONS TO THE CONTROL STRATEGY OF THE STATION

- Implementation of a cleaning routine of regularly closing penstocks leading to inactive pumps.
- Periodic partial lowering of active penstock gates.
- The pump manufacturer is consulted to confirm minimum acceptable water level for the large pumps at high flow rate.

These modifications had a dramatic impact on the flow conditions, reducing pump pre-swirl and vortices to acceptable levels. Air entrainment was completely eliminated due to substantial reduction in surface turbulence.

A curtain wall proved effective at eliminating solid settlement, but due to the difficulty of installation and maintenance an operational solution was preferred by the client. A partial closure of one penstock per bay was subsequently modelled, and proved successful. This could then easily be implemented into the stations control philosophy as part of a "cleaning cycle".



*Sketch showing flow patterns*

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