

# Boughton Water Treatment Works refurbishment for Dee Valley Water

by  
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**T**he water treatment works at Boughton, on the outskirts of Chester has been treating water from the River Dee and providing drinking water for the people of Chester for the last 150 years. Throughout those years the works has periodically been updated and improved in order to meet increased demands for both quality and quantity. In 2003, Dee Valley Water carried out a review of the Company's assets to ensure capital works expenditure plans were justified and could be targeted at those locations which were critical to the continuity of supply. The asset review of the Boughton treatment works identified many parts of the plant coming to the end of their reliable life. The main processes included in the scope for the Works upgrade were - a new two stage filter building to replace all the existing filtration process and to refurbish the Dissolved Air flotation Plant.



Boughton WTW: Brick end wall to filter gallery

photo courtesy Enpure

The existing works had a nominal capacity of 36MLD although due to the diurnal effects of the distribution system upwards of 50MLD has been pumped from the reservoirs, if only for short periods. The new works does not increase the nominal plant capacity as the forecast demand for Chester area can be met by the existing plant capacity and the operational flexibility.

Dee Valley Water decided to procure this contract in a way that would require the true partnering and the formation of a team that included all parties with the single aim of refurbishing the works whilst continuing to supply over 90% of Chester with potable water. Selected contractors were invited to tender for the project with the award going to the *Enpure Morrison Construction Consortium* in May 2005.

Due to the constraints of the site and to provide an integrated design, a core design team was formed with representatives from DWV

Engineering and Operations as well as the consortium to carry out this work with *Halcrow* supporting the consortium with civil engineering design services.

The initial contract award was for a design and feasibility study where the combined team would investigate the issues associated with the existing works. Options would then be generated through a process of brainstorming, primary risk assessment and availability, reliability and maintainability analysis (ARM). Options were then compared using whole life costing and further risk analysis, analysing both primary and secondary risks, before recommendations were presented to the Dee Valley Water management for approval. The works was broken down into 9 areas for this study with an engineer allocated to each area to coordinate the efforts of all parties to meet the design programme, the whole process being orchestrated by a Design Manager dedicated to the project.



Water Tower and buildings in conservation area

photo courtesy Enpure

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**Main challenges for the team were how to build a new plant effectively on top of the existing works, whilst maintaining water supply to Chester and locating 150 years worth of buried services. A combination of both machine and hand dig proved to be the best solution for the various trial holes around the site.**

The existing treatment process used dissolved air flotation and rapid gravity filtration followed by slow sand filters and pressure filters, the combination of processes being a legacy of the site's development over the years. This process combination had proved to be very robust, in that it had not failed to provide potable water for the people of Chester. The ARM analysis dictated that the new plant should be as available as the existing works and hence flexibility was an integral aspect of the new design.

Concerns were also raised about the capacity of the existing works to cope with removing the largest slow sand filter from service during refurbishment, to create the site for the new filtration block. A study by *Enpure Morrison*, and installation of 2 extra flow meters, showed this could be achieved without needing temporary plant.

Early involvement of the *Enpure* commissioning team helped to formulate a commissioning protocol that was agreed prior to the target cost. This enabled the commissioning connections to be incorporated into the design constructed with the main works. **This proved to be successful in that the first phase of the project, the new 2 stage filtration plant produced water to supplement the existing works output and the second phase of the project then started in an adjacent slow sand filter.**

Pilot trials/treatability studies were carried out on the existing rapid gravity filters as part of the optioneering methodology. In total, 80 options were reviewed and over 50 were priced for the purpose of



Site view

photo courtesy Enpure

the whole life cost comparisons. As the solutions were agreed for each of the process areas, further costing was carried out so that a target cost for the whole project could be determined. Costs had to fit within the business plan budget that Dee Valley Water had agreed with OFWAT, this being at the heart of the approval process.

#### After detailed discussion and analysis Dee Valley Water board elected to:

- \* refurbish the existing dissolved air flotation plant;
- \* construct a 2 stage filtration block using GAC in the first stage followed by sand & manganese dioxide in the second stage;
- \* construct a new chlorine contact tank and update the existing chlorine dosing system;
- \* extend the existing lime dosing system & convert the ammonia gas dosing system to ammonium sulphate liquid;
- \* construct new DWW settlement tanks & a sludge thickening system.

#### The design comprises:

- \* refurbished DAF plant with updated recycle system using Enpure's DAF Rapide® nozzles and new flocculators, inlet static mixer and refurbished scraper bridges;
- \* new draw off tower with multiple offtakes built in the North and Mid raw water reservoir;
- \* new raw water inlet main 800mm diameter from the new offtake tower to the new filter block;
- \* new 2 stage filter block with the first stage filters using GAC as the filter media. The inlet channels and walls of the filters being at the same hydraulic level as the north and Mid reservoir, thus negating the need for an overflow from the first stage. The 2nd stage uses sand with a layer of poliorite (manganese dioxide) to assist in the removal of manganese. A common pipework gallery has been used with all flow meter & filter valves above the mezzanine floor for ease of maintenance. Backwash pumps and air scour bowers are housed at the north end of the building along with all of the MCC & control panels.
- \* chlorine contact tank based on 30 minutes retention;
- \* new filtered water outlet main 1000mm diameter with separate lime dosing chamber;
- \* 4 dirty washwater settlement tanks with floating arm supernatant draw off;
- \* settled washwater/DAF sludge blending and sludge thickening using a lamella thickener;
- \* three new treated water supply pumps in a new pumping station;
- \* two refurbished treated water pumps;
- \* forward rinse holding tank & return pumps.

Detailed design of the filter block was carried out to give a flying start for construction once planning was in place. With part of the existing works being within a conservation area the local planning authority and conservation officer also played an important part in

the process, particularly as a new pumping station was to be built in the conservation area and the existing engine house was to be modified to accommodate a new mains distribution panel. The water tower and engine house were subsequently listed as buildings of special interest, the water tower, for example, is a well known landmark on the Chester skyline.

In December 2005 approval was gained from Dee Valley Water to progress with the construction of the new works, subject to planning approval and on February 2nd 2006 planning permission was granted. On the 3rd of February 2006 excavators were removing sand from one of the old slow sand filters, the site for the new filter block. During 2006 progress was steady with the new filter block completed in early 2007. This then supplemented the existing works output with 8-12 MLD of filtered water, which allowed the second phase of the project, construction of the new chlorine contact tank and dirty washwater handling systems, to be built during 2007.

#### Construction

With the new filter block completed in early 2007, this then supplemented existing output with 8-12MLD of filtered water, which allowed the construction of the new chlorine contact tank and dirty washwater handling systems to be built during 2007.

Challenges that have occurred include building within the existing slow sand filter, an efficient temporary works design by *Morrison Construction*, saving both time and cost as well as protecting the adjacent slow sand filter which was still in operation. Installation of the new 1000mm diameter filtered water main and the 800mm diameter raw water mains in and around existing buried services - a test of the skills of the team, were successfully achieved.

#### Careful planning allowed an early start for M & E installation.

A new treated water pumping station was completed with commissioning of the new pumps being carried out alongside Dee Valley Water operations staff. Refurbishment of the existing DAF plant, built over 25 years ago inside the first raw water reservoir, commenced in May 2006, with *Enpure's* DAF Rapide® nozzles being used in the new recycle system. Although the DAF units are not operating at the loading rates normally associated with DAF Rapide® the nozzles are being used due to the efficiencies they bring to the DAF system. New chemical dosing systems are due to be built in September 2007 to coincide with the construction of the new chlorine contact tank and final connections to the pure water reservoirs. Dirty washwater handling and sludge thickening is also being constructed at the end of 2007.

**Current completion date for the works is February 2008. ■**

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