Wichling Pumping Station
turbidity removal scheme

by
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The Wichling pumping station is a key resource for the North Downs and Maidstone water supply zones of South East Water (SEW). Wichling supplies up to 14 million litres per day, mainly to Hollingbourne Reservoir, which is located on the top of the North Downs and serves a population of approximately 26,500. The site generally receives high quality raw water from five chalk boreholes and existing treatment comprised microfiltration with super and de-chlorination as the disinfection process. The station has single stage pumping with pumping pressures provided from the borehole pumps typically 15 bar at ground level.

Membrane plant racks *courtesy of South East Water*

The boreholes have increasingly suffered from intermittent high turbidity as a result of fine chalk particulates being drawn in from the aquifer. The turbidity occurs mainly after high rainfall and during periods of high pumping rates. If the treated water turbidity exceeds 1NTU the station is automatically shut down, to prevent compromising the disinfection process. The records show that raw water turbidity has on occasions exceeded 30NTU.

A microfiltration plant was installed in 1998 but this has proved to be ineffective and unreliable. The high maintenance cost, excessive demands on staff time and the increased risk to SEW are unacceptable.

The current project was developed by SEW for inclusion within their AMP4 programme of works. The project included a feasibility study, supported by pilot plant trials, to investigate options and provide a secure solution for turbidity removal.

Options Considered

The following options for turbidity removal were investigated:

1. **Slow sand filters** - this required a split pumping arrangement with new low pressure borehole pumps delivering to slow sand filters and the disinfection system. Treated water would be pumped to Hollinbourne Reservoir via a new high lift pumping station.

2. **Disposal cartridge filters** - This option considered the use of banks of disposal cartridge filters for filtration. The existing high pressure pumping arrangement would be maintained.

3. **Microfiltration membrane system (high pressure system)** This would retain the existing high pressure single stage pumping arrangement, pumping directly from boreholes through the microfiltration membrane plant.

4. **Microfiltration membrane system (low pressure system)** - This involves a two stage pumping arrangement with new borehole pumps delivering water through the microfiltration membrane plant. New high lift pumps would pump the treated water up to Hollingbourne Reservoir.

Feasibility Study & Pilot Trials

1. The pilot plant trials confirmed that slow sand filters were not appropriate as the raw water could not support an active 'Schmutzdecke' (the complex biological layer formed on the surface of the filter). It was also found that fouling of the slow sand filter units occurred after only 4 months, and this would result in high operational costs to maintain the hydraulic capacity of the slow sand filters.

2. Disposal cartridge filters were rejected due to their anticipated short life (3 months) resulting in an annual replacement cost of approximately £340K.

3. The high pressure single stage pumping arrangement, with the membrane plant operating under pressures up to 15 bar, was rejected due to the risks involved in operating the plant at such high pressures and concerns over how surge pressures could be effectively controlled.

4. The low pressure membrane system with two stage pumping was chosen as the best option. Whilst it did not represent the least capital cost solution, it was selected after careful consideration of the operational risks and costs.

Membrane Plant Selection

Three microfiltration membrane plants were tested during the pilot plant trials. A membrane plant from PALL Corporation was chosen as it provided the greatest flexibility for treating foulants, a small footprint, easy access to membrane modules, robust integrity test procedures and a low fibre failure rate. The plant is also compatible with another Pall membrane plant recently installed by SEW at another site.

Main elements of the new Pall membrane plant comprise:

* 4 racks of membrane modules, each with 40 modules, giving a total of 8,000m^2 of filtration area;
* 2 semi-automatic strainers;
* Air enhanced backwash system;
* Clean in place (CIP) facility with acid and hypochlorite;
* Waste tank and neutralisation tank;
* Fully automatic control system including motor control centre (MCC) and human machine interface (HMI).

The membrane fibres have a pore size of 0.1 micron and are designed to remove all particles greater than 0.1 micron. The membrane plant will be operated to maintain treated water turbidity below 0.1NTU. It is also capable of providing up to 6-log removal efficiency of cryptosporidium oocysts should this become a problem in the future.

Flux (filtration) rates will depend on the number of membrane racks in operation. This will be 75 l/m^2/h when all four racks are on-line at flows of 14 Ml/d and 100 l/m^2/h with one rack off line.

Development of the Design

Halcrow was commissioned by SEW to develop the design under a framework agreement for the provision of consultancy services. This included preparing an outline design, submitting the planning application, preparing the tender documents and administering the Contract under an IChemE Red Book form of Contract.

The main challenges were:

* The tight timescale for delivering the project to meet DWI deadline of 31 December '07;
* The compact site and treatment building with limited space available. The need to both re-use and extend the building and replace most of the existing plant to accommodate the new membrane plant and high lift pumping facilities;
* Replacement of the existing MCC in-situ with minimal interference to the control and operation of the existing plant. SEW could only allow short site shut-downs (8 hours maximum) due to the strategic importance of the site.

The requirement to keep the site operational during construction and commissioning, with only short plant shut downs, has meant that a complex and comprehensive commissioning programme had to be developed.

In addition to installation of the new membrane plant, new borehole and high lift pumps, a pump balance tank, new MCC's, new standby generator and surge protection vessels are being provided.

Delivery

Halcrow developed a fully scoped outline design which included the civil, building, MEICA, hydraulic, environmental and process design, from which associated contract documentation for the works was prepared.

After a competitive tendering process, a contract was placed with Biwater Treatment Limited and construction works commenced in January '07

A 3-dimensional 'virtual reality' scale model of the membrane plant was developed by PALL. This presented an accurate representation of the layout of the four membrane racks and associated pipework and enabled the designers to optimise the use of the limited space available within the building for the plant and for access for operation and maintenance.

The new membrane plant was successfully installed with water delivered into supply through the membrane plant in December 2007.

Note: ***The Editor & Publishers wish to thank the author Joseph Yip, a Principal Engineer with Halcrow, currently seconded to South East Water as Project Manager, for producing the Wichling Scheme article.***■