Aquarius 3 – Mourne Water Treatment Works

£20m 3rd phase of major Northern Ireland project

by Norman Johnson, BSc, MICE

This third and final stage of the massive 'AQUARIUS Mourne' water project involves the construction of Northern Ireland's biggest greefield water treatment works - a £20 million facility designed to treat up to 155 million litres of water a day. The new water treatment plant is the culmination of a project which has encompassed replacement of the Mourne Conduit, which supplied water to more than 280,000 consumers in North Down and the Greater Belfast area for more than 100 years.

Aerial view of water treatment works *(courtesy Water Service NI).*

Phase one of the Aquarius Project, which is now fully complete, involved the replacement of 20km of conduit and siphon pipework; the construction of a 140Ml/d pumping station and a 4M/l break pressure tank. **Phase two** involved further conduit replacement works along with the construction of an 18Ml/d pumping station. A new chlorination plant was also built and other ancillary works carried out including major refurbishment of four 45 million litre tanks which make up the Water Service's eight acre reservoir at Purdysburn in South Belfast. To promote sustainability, two energy recovery turbines were also installed as part of phase two works.

Phase three

Third phase of the project, known as Aquarius 3 - is the design and build of the water treatment works. At present the water receives chlorination and pH correction. However, to meet stringent new

EU Drinking Water Directives and protect against cryptosporidium a new treatment facility is required.

The works is located near the village of Drumaroad in County Down and lies adjacent to the Aquarius phase one pumping station.

The contract

In July 2001, Water Service invited tenders from their Water Quality and Treatment Framework select list. Each tenderer submitted detailed technical proposals and costs for the scheme. Proposals were evaluated in terms of quality and whole life costs and in December 2001 *Earth Tech Farrans* were named as the 'preferred bidder'.

In January 2002, the scheme entered what is referred to as the design development stage. Lasting for a period of six months and involving all parties this period of consultation was used to hone and develop the design and buildability aspects of the project. This period was seen, by all team members, as being beneficial for the project. The end user and maintenance personnel were able to get involved in the detail of the scheme and have a valued input. It also allowed time to appoint preferred sub contractors and suppliers, who could then work on solutions as part of the overall team. Agreements were put in place, such that if Earth Tech Farrans received the construction award, sub-contractors and suppliers would in turn receive an order. In summary, it allowed the civil, construction to hit the ground running.

Work on site commenced in June 2002 following award of the construction phase to *Earth Tech Farrans.*

Process design

The following process has been used to achieve the final drinking water quality requirements:

* chemical conditioning of the water with lime, alum and carbon dioxide;
* flocculation followed by DAF;
* dual media filtration;
* chemical dosing on final water;
* clarification of process washwater; sludge being pressed for removal from site and clarified water receiving filtration prior to return to the head of the works.

Raw water is first dosed with carbon dioxide, followed by alum and lime for coagulation at the optimum pH. The carbon dioxide reacts with the lime to increase the alkilinity of the water and stabilises its pH for distribution.

Once conditioned the water is flocculated for twenty minutes before passing to ten floatation units, where it receives air saturated water before passing to the flotation zone sized at a maximum hydraulic loading 10 $m^3/m^2/h$.

The sludge float is removed intermittently by hydraulic desludging.

The floated water then passes to 12 dual media filters. The filters consist of 500mm of anthracite over 500mm of 16/30 sand. The anthracite will enable the filters to effectively retain solids within the bed without excessive head loss.

Filtered water is chemically treated before being pumped off site. Lime is used for final pH correction to achieve a value of 8.3 to 8.7 suitable for distribution. Phosphoric acid is also dosed for plumbo solvency (to protect against lead leaching off into the water from old domestic lead piping. Finally, it is chlorinated for final residual in the distribution system. The offsite main and receiving tank are used for contact to achieve the required C_t value.

Clarification of the process washwater sludge is achieved by lamella separators. A sludge recycle has been added to improve the concentration of the settled sludge. The sludge produced is then pumped to presses. Pressed sludge is removed from site for disposal. The supernatant from the separators is treated by rapid gravity filters to meet a stringent solids specification before returning to the head of the works.

Treated water leaving the works is split between the existing pump well, from where it is pumped to Belfast and North Down, and on site variable speed pumps delivering water to a new service reservoir at nearby Ballywillwill. Water from this service reservoir feeds the town of Newcastle.

The works has been carefully designed to fit into the existing system's hydraulic gradient to avoid the need for interstage pumping.

The plant will have full PLC control with intelligent motor starter units and inverters and Profibus for the connection of intelligent motor starter units, sealed devices and remote I/O to the PLCs. An Ethernet fibre optic ring will be provided around the site for the connection of Human Machine Interfaces (HMIs) and the Water Service SCADA system to PLCs for control, data acquisition and data display. Control of the Silent Valley outlet valves will be possible from the new WTW as well as monitoring the status of the receiving service reservoirs in distribution.

Chemical area including lime plant *(courtesy Water Service NI).*

Progress to date:
Key dates in the project are as follow:

Start of construction phase (Civil) .. .. June 2002.
Start of main M & E installation .. .. Aug 2003
Commence commissioning .. ..April 2004
Commence performance tests .. .. Aug 2004
Take over/start operational year.. .. .. Nov 2004

Civil works on the project commenced in June 2002. Raw water mains crossing the site have been diverted and the DAF building reinforced concrete substructure and steel frame are already complete. The filter cells are also about half complete and the sludge building and ancillary tank commenced. Overall the Civil works are about 40 per cent complete.

The only problem encountered to date has been ground conditions under the chemical area, where what appeared to be an old stream cutting in the rock head was discovered. This was not picked up by the ground investigation and resulted in the ground slab being redesigned to accommodate potential differential settlement.

On the mechanical and electrical front, the design is substantially complete and items of plant are being procured to support construction. It is anticipated that some 80 orders will be placed to cover the full range of equipment and services required for the works. Approximately 60% of these have been placed to date. At site the lime silos and chemical tanks have been installed in advance of the building frame being erected. The main mechanical installation is programmed to commence in August 2003.

A demonstration project
The Aquarius 3 contract is being monitored by the Movement for Innovation and the new *Rethinking Construction Centre at the University of Ulster, Jordanstown.*

As a demonstration project for the Movement for Innovation, it is hoped that lessons learned on this particular contract can be applied to others - and not just water related projects, but construction works in general. Coming under the microscope is the concept of partnering, the design development phase of contracts, risk assessment, sustainability and 'Value Stream Analysis', which translates as minimising waste in the construction process.

Aquarius 3 is one of the first UK based construction projects to employ Value Stream Analysis, a term borrowed from the automotive industry, it involves measuring performance and looking at ways of minimising waste.

Mourne WTW like many other construction projects is unique. There are areas however, which are repetitive and which offered opportunities for adding value both in terms of time efficiency and cost savings. Areas that were looked at on the project were RC concrete works for the DAF cells and miscellaneous steelwork.

Value Stream Analysis is not about measuring the performance of individuals but about looking at processes and making them more efficient. This involves sitting down with the site workforce to analyse each operation and investigating the teams ideas for improvements.

Partnership approach
An *Extranet* system has been installed which allows updated drawings and other information to be accessed both on and off the site. This has proved to be instrumental in keeping all team members at different locations up to date with design information and supplier equipment, drawings and specifications. The free flow of information has greatly assisted the partnering ethos instilled in the scheme.

Adoption of the team approach and involvement of the end user from the start has encouraged a greater exchange of ideas and focuses on a complete integration of project management techniques, design and construction processes.

Close team involvement has allowed early decision making and greatly assisted the design process.

At present the scheme is on programme and costs are currently within target provision. The partnering approach adopted is considered a significant factor in the success of the project to date.■

Note: *The author of this article, Norman Johnson, is Earth Tech's Manager for Aquarius 3.*