Enhanced Water Treatment Project

Severn Trent develop arsenic removal technology for boreholes

by

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In order to comply with forthcoming EU legislation which requires that potable water shall have less than 10µg/l arsenic, Severn Trent Water Ltd developed a programme to provide additional treatment to water produced from several borehole sites throughout the region. This programme is known as 'Enhanced Water Treatment (EWT) Project. With compliance scheduled for the end of 2003, the company began feasibility work in 1997. A prototype plant was constructed at Burton Joyce, Nottinghamshire in 1998 – the first UK arsenic treatment plant. Severn Trent then set to work on an additional 15 sites requiring the construction of EWT plant.

EWT adsorber vessels *(courtesy Severn Trent Water Ltd)*

The project involves civil, mechanical and electrical works to be carried out at each of the sites with major items being the provision of:

* replacement/additional borehole pumps;
* adsorber vessels together with associated process pipework and equipment;
* reinforced concrete inlet, outlet and washwater balance tanks;
* building to house control panels, pumps and chlorination equipment;
* control panels and associated electrical works;
* new chlorination equipment.

Process

Enhanced Water Treatment utilises the SORB 33™ arsenic removal process as developed by Severn Trent Water in the UK over a five year period. Numerous treatment options were evaluated at laboratory scale including coagulation with ferric salts, ion exchange resin, reverse osmosis and adsorption onto activated alumina, catalytic media and granular ferric media. Exhaustive pilot trials in a 60m^3/day pilot plant concentrated on treatment by adsorption, primarily with activated alumina and granular ferric media.

Parameters studied included grain size, empty bed contact time, pH, pre-oxidation, disinfection and hydraulic properties. Selected granular ferric medias were tested at full scale in the 20Ml/d prototype plant where the process was optimised and the design value engineered prior to construction of further EWT plant.

SORB 33™ treatment process consists of fixed bed adsorption of the arsenic onto Bayoxide® E33 ferric oxide, developed by *Bayer AG* for the treatment of potable water sources. This adsorption technology allows the arsenic to be fixed onto the media without the need for regeneration. Media life is dependent on the borehole water chemistry, but is anticipated to be up to two years prior to replacement, whilst the spent media may be disposed of to landfill.

Raw water is pumped from the boreholes, through the adsorber vessels and is then disinfected with chlorine before passing into an outlet balance tank prior to distribution. Waste water from the media handling and backwashing processes is collected in a wash water effluent tank and settled prior to discharge to a local watercourse.

EWT adsorber vessels as delivered to site
(courtesy Severn Trent Water Ltd)

Reinforced concrete washwater effluent tank construction
(courtesy Severn Trent Water Ltd)

Contractor selection

Construction work for the main EWT project was split into two phases to enable work to be managed efficiently and to reduce the impact on the affected operational areas. Eight sites were included in Phase 1 with the remaining seven forming Phase 2. Severn Trent had to develop a contract strategy that would ensure that the project benefits were achieved whilst retaining control of the treatment process developed from the valuable experience gained when engineering the prototype EWT Plant.

In accordance with EU Procurement requirements, the company placed advertisements for suitably qualified contractors to form a tender list for a design and build contract. A tender list of three contractors was formulated and in October 1999 a Project Scoping Document was issued to enable a contractor to be selected to move forward into the Design Development Stage (DDS) and eventually to be awarded a contract for construction of the works. Tenderers were invited to submit rates and prices for elements of design, project management and construction of the works.

In December 1999, following analysis of returned tenders, *Tilbury Douglas Construction Ltd (now Interserve Project Services Ltd)* was selected to proceed to the DDS.

Design development stage

A teamwork approach was essential from all parties if this stage of the project was to be successful. To facilitate this, fortnightly design development meetings were held with Interserve. In addition, to improve communications between Severn Trent and *Interserve,* staff from both parties shared offices and so worked closer together. As outline designs were developed, a design freeze was implemented at key milestones so that certainty of the work to be included in the final tender price was assured.

The contract was awarded on a cost reimbursable basis with a target price and a pain/gain share arrangement. This incentiivised both contractor and client engineer to work efficiently and generate cost savings as the project proceeded, so yielding a share of the savings made on the initial target price.

EWT plant showing adsorber vessels & reinforced concrete tanks *(courtesy Severn Trent Water Ltd)*

By the end of the DDS the target price was formulated using the rates and prices submitted during the competition stage against the final quantities determined from the designs.

Fundamental to evaluation of the initial target price was a risk management approach that was adopted using the following principles:

* shared risks were identified and included in the Target Price;
* client risks were identified and included on a risk register for future reference during the construction stage. These were not included in the target price;
* risk mitigation/elimination was key to the risk management philosophy.

In May 2000 a design and build contract was awarded to *Interserve* for Phase 1 of the EWT Project.

Design & construction.
The contract programme allowed for staggered site starts, with the first site commencing in August 2000. In the initial period following contract award, designs were finalised to enable construction activities to commence. Final Take Over was targeted for April 2002. Following on from the DDS, regular design meetings were held for both civil engineering and MEICA disciplines. This ensured that all final design solutions were developed jointly for the benefit of the project. This approach guaranteed that all key dates were achieved and targets met. Risk continued to be proactively managed throughout the implementation stage of the project.

A teamworking approach has been maintained throughout the life of the project with any problems encountered during design and construction stage being regarded as "the teams" with a quick resolution being achieved. This approach has also been extended to involve all of the supply chain. Key subcontractors have been involved since the contract was awarded and Interserve have introduced the "EWT Bonus Scheme" to enable them to share in the benefits of any efficiencies achieved. Close liaison has developed with Severn Trent Operational Managers, with all key activities requiring plant shutdowns agreed as work progresses. This has helped to ensure that commissioning of the plants has run smoothly.

At present (April 2002) four out of the eight sites in Phase 1 have been completed with the remainder due for completion imminently. The contract for Phase 2 of the project has been awarded to Interserve with works commencing on the initial sites and the whole project on programme for completion in April 2003.

Summary
Following a series of trials at a small scale plant Severn Trent have developed world beating arsenic removal technology to ensure that compliance with forthcoming EU legislation is achieved on programme. In addition, this project has pioneered the company's contract strategy for AMP3 and has achieved the following benefits at an early stage:

* collaborative working with main contractors;
* all problems regarded as "the team's"
* a detailed and proactive approach to risk management;
* incentivisation of contractors;
* effective management of all parties in the supply chain. ■

Note: *The authors of this article, Frank Thompson and Joanne Barnes, are assistant engineers with Severn Trent Water Ltd.*