Thornton Steward WTW

increased capacity and Process Stability

by
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Located in North Yorkshire, approximately 4 miles to the west of Bedale, Thornton Steward water treatment works (WTW) is a Yorkshire Water Services (YWS) asset that supplies a number of Production Management Zones in North Yorkshire, comprising: Upper & Central Wensleydale; Lower Wensleydale; Catterick/Richmond and Northallerton/Thirsk. Constructed during 1976 and commissioned in 1977, the plant has had two major refurbishments since then. The first refurbishment in the mid 1990s replaced the majority of the existing M & E equipment and included reconstruction of the rapid gravity filter floors. The second, between 2002 and 2003 included construction of new manganese contactors, construction of the clean water contact tank and upgrades to the sludge handling system.

Thornton Steward Works nearing completion *photo courtesy Peter Smith Photography*

Scheme drivers

Although there were no statutory drivers, quality or otherwise, directly associated with Thornton Steward WTW both Langthwaite WTW and Osmotherly WTW had water quality DWI compliance dates that required their closure by the 1st August 2006 and 31st December 2006 respectively.

In order to facilitate this AMP4 Rationalisation scheme, YWS would place increased reliance on Thornton Steward and it was recognised that the works output would need to increase to 33MLD in order to meet the demand at the design horizon of 2029.

Water Quality Issues

In addition to the rationalisation driver the performance of Thornton Steward WTW frequently fluctuated and was unable to meet the design output of 22.7MLD. Typically the secure output from the works was around 17MLD and this could further reduce to 13MLD during periods when raw water conditions were unfavourable.

The existing process deficiencies at Thornton Steward resulted for the most part from the inability of the existing upflow clarifiers to treat the design flow. This was predominantly caused by the periodic occurrence of algal blooms in the raw water reservoir, the development of filamentous algae in the clarifiers and the adverse impacts of wind turbulence and light on the clarifiers.

After consideration of the above rationalisation and water quality drivers the project proceeded on the basis of upgrading the works to 33MLD and implementing a number of measures to stabilise the treatment process.

Existing process

The main elements of the existing process comprised:

* raw water reservoir;
* inlet works with flash mixing and the facility to dose alum, sulphuric acid and lime;
* upflow clarifiers;
* rapid gravity filters (RGFs);
* interstage pumping station;
* manganese contactors;
* contact tank;
* clean water tank.

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Inside the new DAF building *courtesy Earth-Tech Morrison (ETM)*

The existing sludge handling system comprises:

* washwater holding tanks (which settle & decant on time basis);
* Sludge blending tank (blending washwater sludge with clarifier sludge);
* WRc type sludge thickeners;
* thickened sludge tank;
* filter press house.

Proposed solution

During a detailed feasibility study undertaken by *Arup* a number of options were considered for improving the performance of the existing plant whilst also providing increased throughput. Options considered included improvements to the existing clarifiers, a new dissolved air flotation (DAF) plant, the provision of additional RGF units and changes to the operational regime.

Initially the proposed scheme for the clarification stage considered the extension of the existing upflow clarifiers. Due to the poor performance of the existing works and the potential problems with algae in the raw water the preferred design incorporated the construction of a new DAF plant. The other key elements of the *Arup* notional scheme included:

* modifications to existing RGFs including construction of a building to cover them;
* Provision of an additional 2 units of RGF capacity (with a maximum loading rate of 4.5 m/hr with all filters in operation):
* increase to existing interstage pumping capacity to meet the 33MLD design output;
* provision of a single additional manganese contactor;
* upgrade of chemical dosing to accommodate increased works output;
* upgrade of the sludge handling system including the provision of a new plate filter press.

Procurement

Under the YWS AMP4 Large Scheme Programme the ethos of partnering under the NEC Option C was both encouraged and demonstrated via a number of Early Contractor Involvement meetings focussed on scheme risks and the development of the notional design.

Early meetings allowed *Arup* to present the notional scheme to Contractors prior to the issue of the tender and gain valuable feedback on potential construction issues and risks which could then be incorporated into the tender documents.

The *Arup* notional scheme was issued for tender on a design and build basis in November 2005. In addition to the contractor meetings prior to tender issue, mid tender reviews were arranged to allow the Contractors bidding for the works to meet in confidence with both YWS and Arup, in order to discuss specific design issues or proposals and to ensure a fully compliant bid was prepared.

Following the tender period and a preferred bidder design development stage, Earth Tech-Morrison (ETM) was awarded the contract in May 2006.

Design Development & Capital Efficiencies

The ETM design was based on the Arup notional design and incorporated the DAF clarification stage, two additional RGFs and an additional manganese contactor. ETM also contributed proposals for further innovations and capital efficiencies in a number of areas including:

* utilisation four of the eight soon to be redundant upflow clarifiers for revised duties including DAF run to waste, DAF sludge storage, rinse return and the extension to the dirty wash water sump. This negated the need to construct 4 new tanks to meet these duties;
* rationalisation of the existing washwater settling regime to minimise the volume of sludge passing forward to the sludge thickeners and thereby removing the need for additional sludge balancing capacity;
* conversion of part of an existing little used office space into a pump room, negating the need for an extension to the existing interstage pump sump;
* the re-commissioning and re-use (after testing for soundness) of a disused pipeline to return flows back to the raw water reservoir;
* disposal of excavated material on site by incorporation into a well realised landscaping scheme.

These efficiencies were agreed and implemented successfully through the early involvement of the wider team and the effective management of the project timetable that was used to identify dates

for key meetings during the initial detailed design phase. As a result during this period there were a number of well attended design development meetings. Particularly useful was the design walk through meeting. At this meeting the ETM project engineer presented designs to the project stakeholders to ensure a common understanding of the design concepts. This allowed the stakeholders an involvement in the design optimisation process.

Construction & Programme

A key consideration during detailed design was to minimise both the risk of the impact of construction on the existing treatment process and the number of shutdowns required to interface the new extensions to the existing process. This requirement resulted in an essentially off-line construction arrangement that minimised the risk of any loss of supply incidents.

Construction work began on site in July 2006 with excavation for the new DAF plant, the first major activity. In order to drive efficiencies in the construction process ETM adopted a LEAN approach in the programming design and delivery of the works, whilst utilising a 'buffered' programme whereby activities for all parties were programmed on the basis of minimum durations. The aim of this approach was to offer the best possible opportunity to achieve the prescribed contract completion date with the additional prospect of achieving an early completion with a significant element of the buffer intact (typically 0 to 20%). By adopting this approach the original contract stage 1 completion date, for increased throughput capability by June 2007 (stage 1) and final completion by September 2007, were met. To accommodate YWS operational requirements the refurbishment works to the existing RGF's were reprogrammed with final completion in November 2007.

Conclusions

The project is considered to be a successful part of the YWS AMP4 Large Scheme Programme and has been achieved both on programme and within the authorised scheme budget. The scheme has been undertaken in a positive and collaborative manner with the client, the contractor and the YWS framework consultants all contributing to an effective core team. 'Buy-in' from YWS operational staff has also been extremely positive and has significantly aided the interface between the new scheme and the existing works.

Key project participants

Client: Yorkshire Water Services.
Principal Contractor/Designers: Earth Tech Morrison (ETM).
Technical Consultant: Arup.
Commercial Consultants: Turner & Townsend.

Note: ***The Editor & Publishers wish to thank Ian Farmery, Arup Project Manager from feasibility through to completion and Mark Hayton, Project Manager with Earth-Tech Morrison (ETM) for producing the above article for publication.***■