Lostock WTW

process optimisation by the addition of prefabricated stainless steel rapid gravity filters

by Roger Essex CEng FICE MCIWEM MAPM

United Utilities' Lostock WTW located in the Bolton Demand Monitoring Zone (DMZ) is of strategic importance, supplying in excess of 700,000 customers in Bolton and Manchester. It was constructed and commissioned during AMP3 in 2004 and is a direct filtration plant with an original maximum design capacity of 180MLD . The works is sited at the end of the 84 mile long Thirlmere Aqueduct (TA), which was constructed 120 years ago and carries 220ML of water every day from Thirlmere reservoir, near Keswick, using gravity as the only source of power. To meet the challenging 12 month schedule required to increase capacity of the WTW to support an outage of the Haweswater Aqueduct (HA) the project has delivered an innovative and timely solution. This comprised the supply and installation of off-site fabricated packaged filter units aligning with UU's '*Future Concept for Design and Assembly*' approach. In addition, in-situ concrete backwash tanks, and associated pumping and control equipment enabled the project to provide an additional 60MLD filtration area while reducing the loading rate on the existing filters.

42m concrete pump installing concrete benching to the backwash tank (underground tank size 40m x 14m x 9.5m) - Courtesy of KMI

Haweswater Aqueduct planned outage

In October 2013 United Utilities has a planned two week outage of the Haweswater Aqueduct to undertake routine cleaning and maintenance. The Haweswater Aqueduct is a crucial part of UU's network, transporting 500ML of water down from the Lakes every day to customers in and around Greater Manchester. This means that water supplies from Thirlmere via Lostock WTW will be critical during that time and is why the upgrade to the works was deemed crucial.

The original treatment process

The treatment process facilitates the raw water to be dosed with sulphuric acid or lime for pH correction, aluminium sulphate and/or polyDADMAC for coagulation followed by microflocculation and polymer as a filter aid. There are 8 (No.) rapid gravity dual media filters and the filtrate is dosed with chlorine prior to entering a baffled contact tank. The water is then dosed with lime and phosphoric acid and under normal operation is pumped to the on-site treated water reservoir for supply to the Manchester ring main.

The process backwash water is treated on site using lamellas, with the supernatant being returned to the head of the works and the sludge being sent to sewer.

Issues with the treatment process

Since United Utilities commissioned the plant in 2004 it has become apparent that there are several issues with the treatment process. Most of these can be attributed to its reliance on polyDADMAC as

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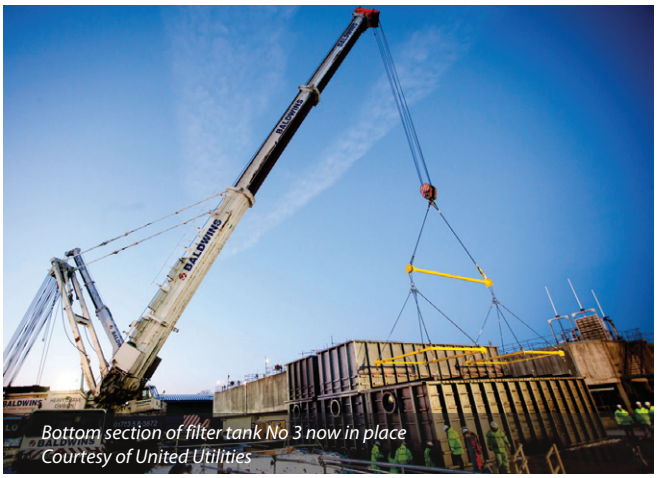
Backwash tank before roof beams/slabs have been installed
Courtesy of KMI


42m concrete pump installing concrete benching to the back wash tank - Courtesy of KMI


1,200T mobile crane installing the bottom section (approx. 40T) of filter tank No 3 - Courtesy of United Utilities



Bottom section of filter tank No 3 now in place
Courtesy of United Utilities

a surrogate for metal coagulant which prompted the plant to be designed to have a filtration rate over twice that of any other UU water treatment works. Due to issues with mud-balling and short circuiting this coagulant is no longer used.

The plant had to revert to more traditional aluminium sulphate which required the throughput of the plant to be significantly reduced. In addition, concrete degradation in the filter cells has partially blocked the filter nozzles, further reducing the capacity of the plant and increasing the potential for aluminium breakthrough.

Engineering review

An end to end engineering review in 2011 produced a report that recommended remedial actions:

- ***Short term***:
  To alleviate any threat of enforcement action.
- ***Medium term***:
  To return the plant to its maximum capacity of 180MLD during the Haweswater Aqueduct (HA) outage.
- ***Long term***:
  To have a stable treatment process maximising the use of the 'cheap' water fed from the Thirlmere aqueduct.

Short term action

Through innovative working with our supply chain the short term action was to inspect and refurbish the 8 (No.) filter cells, replace all the filter nozzles, carry out concrete repairs as required, and replace the media with 800mm of 14/25 filter sand covered by 400mm of No. 2 grade anthracite.

This work was successfully completed in March 2013 by Western Carbons acting as a sub-contractor to UU's process partner KMI+.

Medium/long term action

In parallel, the medium/long term action was to provide an additional filter area to:

- Make process loading rates and backwash development acceptable during poor water quality periods.
- Provide additional capacity so that the plant can cope with filter outages caused by equipment failure.

The area required to achieve this is the equivalent to three of the existing filters, thereby reducing the peak loading rate from 15m/hr to 10.5m/hr, or 11.7m/hr with one filter out of service for washing and one unavailable due to maintenance. In addition the dirty washwater system would be upgraded by 50% to remove the bottleneck in treating filter washwater.

To meet the medium term requirement of having the plant in operation before the HA outage in October 2013, whilst fully supporting UU's commitment to improving safety *("nothing we do is worth getting hurt for")* and aligning with the company's '*Future Concept for Design and Assembly*' approach, required some innovative thinking.

Solution

The solution called for increasing the filtration capacity by maximising the use of the available site with the largest prefabricated units that can be transported to site by road. This entailed the provision of 6 (No.) stainless steel 316L filters each with filtration surface dimensions of 4m x 14m.

This was to be provided and installed as a package plant with its own autonomous backwash system including clean and dirty backwash tanks and filter to recycle tank. The new plant will draw chemically dosed and microflocculated water from the existing inlet structure and discharge filtered water into the existing filter outlet channel.

Undertakings

The project was given the go ahead in July 2012 with the target of having water into supply by 30 June to support the scheduled HA outage. To facilitate this a high level design brief document was produced that provided sufficient information for an integrated team to rapidly progress an innovative design.

The design and implementation stage commenced in early August 2012 work being undertaken in parallel by a team comprising representatives of UU Engineering, UU Operations, KMI+ and their designers, and the packaged plant supplier, AMT Systems Ltd. Regular design review meetings, involving the whole team, were held every Friday morning during this first six months to resolve issues and make decisions to facilitate the rapid progression of the design demanded by the challenging schedule.

Third party challenges

At the access point to the treatment works off Chorley New Road there is a pre-school nursery catering for 50 children. The nursery shares the entrance with United Utilities, a tennis club and private housing.

In order to ensure the safety of all, an early public exhibition was held and agreements reached with all parties; the tennis club very kindly allowed their two courts to be converted into a temporary car park. This was undertaken whilst the site was being set up. Porous tarmac was laid flat so that two clay all weather courts could be laid on top of the tarmac at the end of the contract.

Site set up

Construction on site commenced on 24 September 2012. The establishment of the site set up consisted of several elements which were all undertaken concurrently. Due to the challenging schedule this was to remain a feature of the contract throughout the construction phase.

Whilst the site cabins were being set up site surveys and service location work was undertaken to confirm precisely the locations of existing live services. Where these services clashed with the new works they were diverted. At the same time an alternative access into the treatment works was constructed. This allowed the establishment of a temporary one way system to be made which formed part of the site traffic management plan.

Tank foundations

As soon as the service diversions had been completed, the filter tanks foundation was excavated and a temporary piling mat installed. This enabled the installation of 134 (No.) continuous flight auger concrete piles to be installed.

These had to be located and installed precisely to avoid the existing live water service pipe which could not be diverted due to the existing site layout. Reinforced concrete foundation slabs were cast over these piles in time for Christmas ready for the delivery of the first three prefabricated tanks in the New Year.

Meanwhile a temporary haul road was being constructed along the south boundary of the works to allow the removal of an existing earth bund in the south east corner. This material was excavated to create the room needed to construct the backwash tanks.

This excavated material was transported approximately 0.5 miles to the north end of United Utilities land.

A temporary slab foundation was installed in the backwash tanks location. This was to act initially as a platform for the piling and later for the crawler crane. Just before Christmas the installation of 112 (No.) secant piles commenced. These were 1,200mm diameter and 15m long. They were designed to act as the temporary works to support the ground during construction and to be part of the permanent works of the completed backwash tanks.

Whilst the secant piles were being installed work continued on the construction of the north pipe gallery slab and underground ductile iron pipe installation commenced.

Prefabricated filter tanks

At the same time the first three stainless steel prefabricated filter tanks were delivered to site and installed. This required careful planning and coordinating with the on-site activities to prevent any clashes.

A temporary crane platform was installed to cater for a 1,000T mobile crane. Due to the size of the tanks and the limitations imposed due to delivery by road, each tank was fabricated and delivered in two halves.

Work now progressed on four fronts at the same time. Construction of the north and south pipe gallery slabs continued; underground pipework was installed, construction of the backwash continued with the excavation of material inside the secant pile cofferdam down to a depth of 10.5m. Much of this work was done on nightshifts to allow other work to progress during the day.

Existing filter upgrade

Simultaneously, Western Carbons were refurbishing the existing 8 (No.) filters, replacing the nozzles and media and undertaking any necessary concrete repairs. This work was continuous from October until the end of March and had to be coordinated to maintain water production and to allow optimum working for the new construction.

Mechanical above-ground installations

As soon as the north and south pipe gallery slabs neared completion, the mechanical above-ground installation commenced. Work progressed on the construction of the backwash tanks running concurrently with the construction of the MCC kiosk base.

The construction of the backwash tank base was also undertaken at this point involving the placing of 1,000m^3 of concrete. This was followed with the construction of the walls of the tanks that were poured in sections to the full height of 8m.

During the construction of the backwash walls, the remaining three prefabricated filter tanks were delivered and installed. The mechanical pipework installation continued and the electrical installation work commenced.

The completion of the backwash tank roof involved bringing in precast beams and panels as an innovative form of construction again aligning with UU's '*Future Concept for Design and Assembly*'.

Work on the external work and testing and commissioning started in March 2013 with Water into Supply (WIS) being successfully achieved ahead of schedule on 27 June 2013.

Conclusion

There were many challenges to meet on this scheme but teamwork undertaken could not be outrivaled and ultimately led to the £14m Lostock WTW project being delivered in just ten months, against a normal timescale of 24-30 months.

The integration of UU Engineering, UU Operations, KMI, their designers and suppliers, working seamlessly with the construction team has led to the successful and safe delivery of the Lostock WTW Process Optimisation project to United Utilities and will provide a reliable supply of low TOTEX treated water for years to come.

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