Testwood Water Supply Works

capital maintenance scheme and large scale refurbishment of the rapid gravity filters in Southampton

by Charles Tinsley IEng MICE

Testwood Water Supply Works (WSW) is a critical surface water supply works within the Southern Water region, supplying 91 Ml/d to around 200,000 customers in Hampshire and the Isle of Wight. The site was designed and built in the 1960s, and consists of the following principal process stages; clarification (flat bottomed and Accentrifloc), filtration (rapid gravity sand filters) and disinfection (super and de-chlorination). The primary driver for this scheme is capital maintenance with a focus on ensuring resilience of supply whilst minimising operator intervention. Many of the assets are currently beyond their expected design lives and no longer meet industry best practice, representing a risk to water quality.

Testwood WSW - Courtesy of Stantec

Scope of works

Deadlines for completion have been agreed between Southern Water and the Drinking Water Inspectorate (DWI), and design began in early 2017. Optioneering and design is being undertaken by Southern Water Engineering and Technical Solutions (ETS) comprising Southern Water and their strategic solutions partnership; which is led by Stantec UK. Trant Engineering Ltd was contracted to deliver the scope; with work starting in Autumn 2017. The scope of works includes:

- Rapid gravity filters (RGF) 1-12 upgrade:
  - Building refurbishment, including repairs to roof (concrete repair to soffits and replacement of external membrane), provision of new ventilation system and additional access walkways around filters.
  - Media replacement, including new Leopold underdrain system.
  - Extensive modifications to filter outlet pipework manifolds within the existing pipe galleries.
  - New clean backwash system, including new backwash tank, pumps and air scour blowers.
  - Run-to-waste system, including new holding tanks and return pumps.
- Replacement of the washwater supernatant system, with provision to recycle.
- Refurbishment of RGF's 13 and 14 (Enelco travelling bridge sand filters):
  - Media replacement, including repair/replacement of lateral underdrains where required.
  - Manual run-to-waste facility.
  - New steel-frame building over filters.
- Chemical dosing systems:
  - Ferric chloride, including new liquid chemical delivery area.
  - Modular building housing ferric chloride dosing pumps, polyelectrolyte powder batching and polyelectrolyte dosing pumps (collaborative design with Ross-shire Engineering Ltd.).

- Powdered activated carbon (PAC): Upgrade of existing plant to enable increased dose to mitigate taste and odour risk.

Successful construction works on RGFs 13-14 was completed in early 2019, which has allowed works to progress onto RGFs 1-12.

Existing RGFs 1-12

RGFs 1-12 were constructed in two banks, filters 1-8 were built in 1963 and filters 9-12 were built in 1971 and are 12.95m x 5.56m (including side weir) featuring a header and lateral underdrain system, enabling separate air and water backwashing. The media consisted of 550mm gravel support to the underdrains, and a 300mm layer of 14/25 sand and 200mm of grade 2 anthracite. This gave a poor L/d ratio (ratio of depth of filter to average sand diameter) of 800, less than the 1200 that would currently be considered best practice for a modern filter. The performance of the filters did not achieve consistent removal of cryptosporidium that would be expected by modern standards, and there is currently no run-to-waste provision.

The existing clean backwash tank is under RGFs 5-8 and is fed directly off the filtered water from filters RGF 5-8 and a separate feed from RGF 9-10. Access to the tank is difficult and represents a health and safety challenge for maintenance and cleaning activities. The existing backwash pumps are dry well mounted in an enclosed area with no standby facility or lifting provisions, which presents further maintenance challenges. The blowers are internally mounted and have no acoustic attenuation, resulting in operatives requiring ear protection when in use.

RGF refurbishment

The design team had previously undertaken an optioneering exercise, comparing programme, costs and benefits of new build against refurbishment options. The outcome of this, due to the relatively good condition of the existing structure, was that a full refurbishment could be carried out that would see benefits in the shortest timescale, whilst still delivering the best value solution to customers.

Since work started in late 2018, RGFs 1 and 2 have been refurbished and brought back to service, and works on RGFs 3, 4, 9 and 10 are currently well underway. New air scour blowers have been installed and commissioned, and the new clean backwash pumping station and tank have been built. These will be brought online during commissioning of RGFs 9 and 10.

Building refurbishment

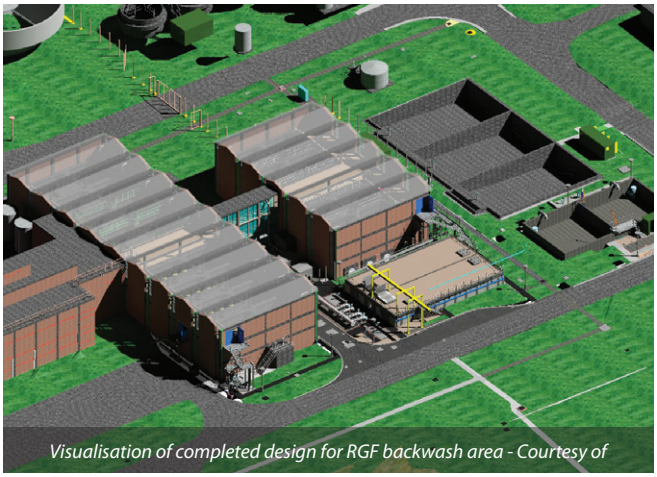
An intrusive structural survey was carried out within the RGF building in March 2018, which determined it to be in reasonable condition for its age. Significant defects however were identified with the reinforced concrete roof soffits, due to a combination of low cover to steel reinforcement, and the cyclic wet/dry environment caused by poor ventilation through the building. Spalling had occurred in many locations, and reinforcement was exposed. Based on the results of the survey, the scope was defined as; (i) replacement of the external roof membrane, (ii) concrete repairs to the soffits and (iii) a new forced ventilation system.

There is a low risk of chloride attack, but to provide an additional means of mitigation against this, a migratory corrosion inhibitor was specified as opposed to a significantly more expensive and maintenance-intensive cathodic protection option. These works were subcontracted to Concrete Repairs Ltd by Trant in early 2019.

Media replacement, including new Leopold underdrain system

'Crash decks' were installed under the roof soffits, allowing works to progress on the filter cells underneath simultaneously. However, upon removal of media it was determined that most of the existing lateral underdrains were asbestos cement, therefore the area

RGF backwash area prior to construction - Courtesy of Stantec UK and Site Eye (time lapse photography)



Visualisation of completed design for RGF backwash area - Courtesy of

Existing RGFs - lateral underdrain system - Courtesy of

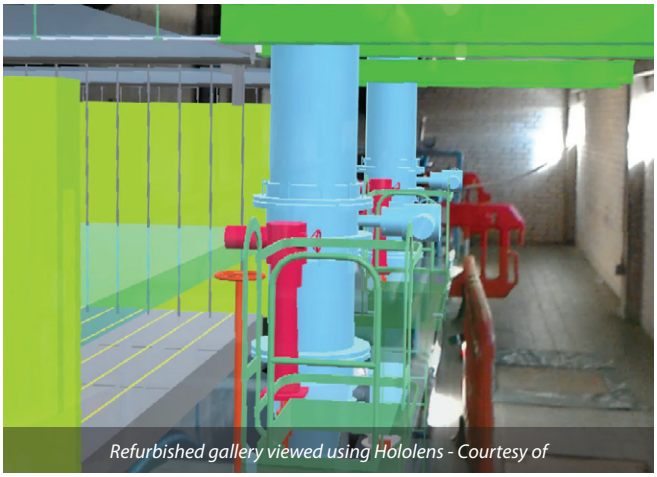
Refurbished filter cell - Courtesy of

had to be isolated and sealed, to allow a specialist contractor to remove them. Once civil demolition works were complete, work progressed on; increasing the height of the existing backwash weir, replacement of the existing penstocks, installation of the Leopold XA underdrain system and modifications to the access metalwork.

Making these changes has provided an increased depth of media and an increase in L/d ratio, to meet Southern Water specifications. The increased weir height will enable a combined air and water wash, once the new clean backwash pumping station is commissioned, further improving process efficiency.

Modifications to filter outlet pipework manifolds

The existing filter outlet pipework manifolds were located in a gallery, and critical valve actuators were only accessible via a ladder into an enclosed area. As modifications were required to the manifold to allow a new, larger backwash inlet main, improvements were also made to these existing valves by bringing the actuators up to the higher platform level significantly improving operational safety for Southern Water staff.



Refurbished gallery viewed using Hololens - Courtesy of

Reconfigured filter galleries - Courtesy of

Precast tanks completed by FLI Carlow Ltd (l-r) clean backwash tank, run-to-waste tank - Courtesy of

As part of the pipework modifications, a run-to-waste facility was incorporated by using the existing backwash main. The existing main can continue to be used for backwashing until the new backwash tank is commissioned. Careful consideration was made to the phasing of the refurbishment works, which required close collaboration between the designer, contractor and operational staff. Extensive use of Microsoft Hololens technology was utilised to allow visualisation of solutions in situ and to identify clashes. Identifying these issues at an early stage significantly reduced risk to programme during construction, and enabled the team to stay on track for completion prior to regulatory output date.

New clean backwash system

New air scour blowers were procured and subsequently installed and commissioned in October 2019.

Construction of the new backwash tank began in late 2019, and comprises a dual cell precast concrete tank, which provides 600m^3 working volume with an overall footprint of 20.0m x 12.6m. This provides sufficient partially treated water for two consecutive backwashes plus an additional 10% volume in accordance with Southern Water specifications. The pumps are submersible with all control equipment above ground adjacent to the tank to minimise the need for below ground access. The new feed to the tank is taken from the existing filtered water outlet main which combines filtered water from RGF's 1-8. On the feed to the backwash tank there is a control valve to manage a maximum take-off of 10% of forward flow to prevent issues with the disinfection process downstream.

A key Southern Water driver for AMP6 has been Design for Manufacture and Assembly (DfMA), therefore the design looked at options available at an early stage. To optimize the volume available within the given footprint on site, a rectangular shape was preferable, and was therefore a good candidate for modular precast concrete wall sections. FLI Carlow Ltd were engaged via Trant, and design progressed collaboratively. Keeping pipework penetrations to a minimum, and making them simple and linear minimised the amount of work required on site.

Space for the backwash tank was constrained and needed to fit logically into the overall plant process stream, there was a challenge to arrange the pipework in a way to maintain good access to all maintainable parts. The final design brought all major pipework above ground thus reducing the need for large ancillary chambers. The above ground design simplified the lifting plan for the area, as all major valving could be reached via Hiab from the access road, or in some cases, A-frames and trolleys. An overhead gantry was provided for the backwash pumps to reduce the need of contract lifts.
Along with the backwash tank, a run-to-waste tank has been included within the design to reduce the impact from post-backwash turbidity spikes. The design of this tank was again delivered with precast in mind collaboratively with FLI Carlow.

The return pump arrangement was designed with a similar arrangement to the backwash tank to standardise the design of the pumping stations on the project making maintenance easier for the operational staff.

Progress

Work on RGFs 1-12 is on schedule to meet the regulatory output date of March 2022.

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