Bristol STW

additional screening

£2.5m upgrade of major sewage treatment works

by Stuart Lewis BEng Hons & Sarah Frusher BEng Hons CEng MIMechE

Bristol STW, in Avonmouth, is the largest sewage treatment facility in the Wessex Water region, covering an area of 140 acres. Originally built in the 1960s, it serves the city of Bristol and surrounding areas. It is one of the largest treatment works in the UK, treating the domestic and industrial sewage from a population equivalent of approximately 1,000,000. More than £50m has been spent at the site over the past 20 years, but one significant problem still had to be addressed – a proportion of the flows arriving at the site could bypass the existing coarse screens and a new coarse screening structure has been constructed in order to alleviate significant operational problems.

Longwood ER Screens - Courtesy of Wessex Water

Project need

Under a previous scheme at Bristol STW, a new pumping station was provided to lift flows from the Frome Valley low level sewer into the STW. Prior to 2003 consented flow was pumped into the STW by the Inlet Screw Pumping Station (PS), which had two screws operating as duty/assist. Operation of the screw pumps changed so they ran on a duty/standby basis and when the inflow exceeds the capacity of one screw pump, Frome Valley PS (FVPS) comes into operation. A further pumping station, Saltmarsh, historically pumped flows into the STW (now retained for emergency use).

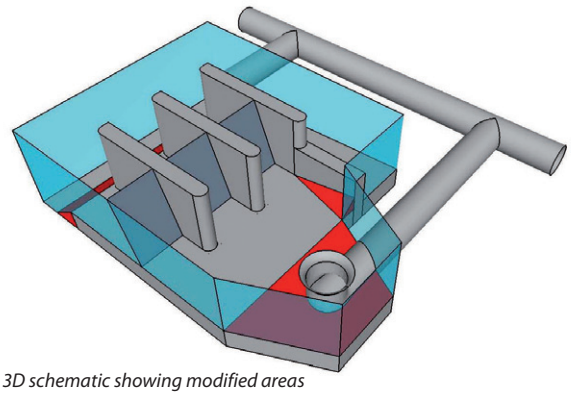
The total maximum inflow to Bristol STW is 657ML/d (7,600l/s), and all flows historically received coarse screening - 4 (No.) screens are located at the top of the Inlet Screw PS and 2 (No.) screens on the inlet to Saltmarsh PS. Flow from the latter discharges into the inlet works immediately downstream of the inlet works coarse screens. Further downstream, the inlet works included 6 (No.) grit channels each with a 5mm 2D fine screen at the end of the channel. There were also two unused grit channels.

FVPS was designed to discharge flows at the same location as Saltmarsh PS, i.e. downstream of the Inlet Screw PS coarse screens, and the scheme was progressed without coarse screening being provided on this flow. The two unused grit channels were brought into operation and 2 (No.) additional fine screens provided. The capacity of each of the fine screens is 1.4m^3/s (120ML/d). 6 (No.) screens operating will provide the required capacity (720ML/d) under full flow conditions.

Washpactors overwhelmed - Courtesy of Wessex Water

Existing screens overwhelmed - Courtesy of Wessex Water

Bellmouth on inlet pipe to screen structure - Courtesy of Wessex Water



3D schematic showing modified areas
Courtesy of Hydrotec Consultants

In practice, following commissioning of the FVPS, there were severe problems during storm periods due to first flush screenings being received at the fine screens. They were overwhelmed by significant volumes of screenings when the FVPS operated.

Blocked screens

The screens can usually remove significant volumes of screenings but the quantities experienced overwhelmed various pieces of equipment. 'Screenings balls' were often so large that they had to be removed by mechanical lifting equipment. The downstream screenings handling plant - 2 (No.) dual stream Washpactors - were also overwhelmed by the volume of screenings.

This exacerbated the problem with the fine screens, and during storm events continuous manning was required to unblock screens and Washpactors. Staff turnover as a result of these issues was higher than normal. It was not possible to prevent large volumes of screenings from bypassing, causing problems downstream with rags etc. in the primary settlement tanks, which in turn resulted in problems with the sludge stream, in particular with the Strainpresses and the digesters.

Blockage of the storm pumps downstream of the fine screens also occurred. Rag problems could take up to 4 weeks to resolve because of the problems arising from screenings bypassing the fine screens. Frequent failure of the grit pumps used to remove solids from the grit channels was also an ongoing problem because of the large volume of rags pumped, which the pumps were not designed to cope with.

Scope of works

The final approved scheme involved the construction of a coarse screening facility between the FVPS and the existing inlet works, intercepting the flows that pass through the FVPS discharge and coarse screening everything up to 437ML/d (5,060l/s), which is the current maximum flow through the FVPS rising main.

The screening chamber (which is 15m x 20m x 6m high) is an above ground piled reinforced concrete chamber, alongside the existing 1,800mm diameter rising main from FVPS to allow the flows to be intercepted with minimal impact on site hydraulics. Screened flows now discharge through the existing rising main upstream of the grit channels.

The screening facility comprises 3 (No.) Longwood multi-raked escalator type screens (ER), each screening to 19mm and capable of passing 150ML/d. Flows in excess of the combined total, and up to a maximum of 600Ml/d will discharge over a bypass weir.

Screenings will be transferred by conveyor and vertical chute to a compactor unit. The chute includes an automatic bypass to divert screenings to an open skip in the event that the compactor fails. A drainage pump station has also been incorporated to return screenings filtrate to the process for treatment.

The works were constructed on land owned by Wessex Water, but outside the existing operational site boundaries. However, the planning authority decided that an EIA was not required and as a result planning approval was only required for the MCC kiosk.

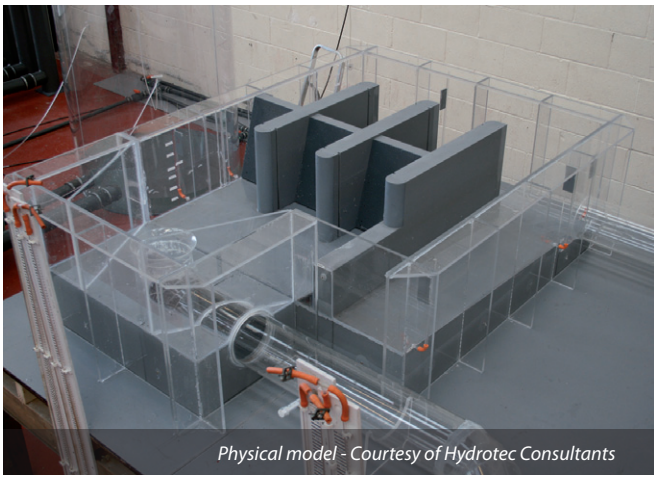
All flow is to be coarse screened to 19mm prior to downstream grit removal and fine screening. The location of the works created many restrictions and limitations.

Not only did the works need to fit within the confines of a working sewage works, but pipelines also had to cross a GPSS Oil Pipeline and a public footpath. Construction was over strategic drainage channels and also within the flood plain of the River Severn, so approval has had to be sought from Internal Drainage Board as well as the EA.

A physical model of the screening chamber was built by Hydrotec Consultants Ltd to determine the performance of the screen chamber, under its designed operating conditions, to ensure that satisfactory performance was achieved over the full range of anticipated flows (580 to 5,000l/s). The model was constructed to a scale of 1/10th full size and operated on the basis of Froude law of similarity.

The model was modified following unsuccessful runs to ensure that the chamber was capable of dissipating energy and promoting even distribution of flows to the three screens without the aid of baffles, weirs or trippers. Benching was added downstream of the screens to ensure that full clearance of solids was achieved.

The final test run confirmed that the chamber, with minor modifications, was able to operate within the specified parameters of velocity, depth, distribution and solid clearance over the entire flow range. Flow was demonstrated to be relatively equally distributed between the three screens and self-cleansing characteristics achieved.



Physical model - Courtesy of Hydrotec Consultants

Implementation

Wessex Water has adopted a 'workstream' approach for the delivery of schemes in AMP5, and the overall roles of the Partners for this scheme are as follows:

- CH2M HILL (who acquired Halcrow Group): Responsible for outline and detailed design.
- Balfour Beatty Regional Civil Engineering (previously Dean & Dyball Construction): Responsible for civil engineering construction services. Also principal contractor for the scheme.
- Nomenca: Responsible for M&E procurement and installation.
- Wessex Engineering and Construction Services (WECS): Responsible for automation, commissioning and environmental services.

Longwood escalator screens and launder channel Courtesy of Wessex Water

The scheme presented a number of challenges. Most of the surrounding land is industrial, and the site is within the flood plain of the River Severn Estuary, which is a main river. The estuary is also a designated Special Protection Area (SPA), Special Area of Conservation (SAC), Site of Special Scientific Interest (SSSI) and a County Wildlife Site (CWS).

Work commenced on site in October 2012 and completion was achieved in September 2013. The interfacing with existing operational assets and the constrained nature of the site influenced the construction programme. The following gives some idea of the scale of the scheme:

- 42,500 man hours on site.
- 1,000m of driven precast concrete piles.
- 4,000 tonne of imported aggregate.
- 1,000m^3 of structural concrete.
- 1,000m of ducts and pipes.
- 300 tonnes of steel reinforcement.

New Coarse Screening facility at Bristol STW - Courtesy of Wessex Water

The main structure was substantially completed by March 2013 and M&E installation commenced the following month; Balfour Beatty and Nomenca have been working closely together in order to coordinate their on site activities.

The scheme has proved to be complex and all parties involved with it have worked well together in order to deliver the scheme by the deadline of March 2014.

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Screening structure - Courtesy of Wessex Water