Blackburn Meadows WwTW

additional activated sludge treatment, replacement of PSTs and refurbishment works to existing assets to meet Freshwater Fish Directive consent

by David Hartshorne CEng, BEng (Hons), MICE, MCIWEM, RMaPS

Blackburn Meadows (BbM) WwTW is located north-east of Sheffield, adjacent to the Tinsley Viaduct on the M1 motorway, in close proximity to the Meadowhall Shopping complex. The Blackburn Meadows site has been developed and extended many times over the years. Historically the environs of the site have a rich industrial heritage and an iconic feature of the location was the twin cooling towers on an adjacent site which have now been demolished. Blackburn Meadows WwTW receives predominantly pumped flows from Sheffield, comprising flows from the Don Valley Interceptor Sewer (all of which is pumped into the works), Tinsley Pumping Station, Blackburn Valley Pumping Station, as well as a high level gravity sewer which picks up flows from the closer surrounding area. The design of the works is to allow for plant capacity to cater for forecast flows and loads up to the design horizon of 2025 for a population of 496,728. The current and future dry weather flow and flow to full treatment are 158,000m^3/day and 368,000m^3/day respectively.

Blackburn Meadows WwTW - Courtesy of Yorkshire Water

The existing facility

The current Blackburn Meadows WwTW comprises course bar screens followed by spiral flow grit separation. Screened flows pass forward to 8 (No.) rectangular settling tanks. From here the effluent is divided 1/3 to a Simplex surface aerated activated sludge plant (ASP) and the other 2/3 to a hybrid ASP (a mixture of surface and fine bubble aeration).

Effluent from the ASPs pass forward to 14 (No.) circular final settling tanks; 4 (No.) FSTs serve the Simplex ASP and 10 (No.) the hybrid ASP. The final effluent passes through an inverted siphon to the river Don. When river levels are high the final effluent screw pumping station is operated which raises the head to enable the works to discharge to river.

FFD consent

Under the Freshwater Fish Directive, BbM WwTW is required to achieve a 3mg/l ammonia (NH_3) consent. This condition of the consent will be effective from 31 March 2015 and the final effluent must comply by this date. To achieve these requirements, additional secondary treatment process capacity will be required and the existing secondary treatment plant will be modified and updated.

The problem

Failing assets and high maintenance costs have been identified on this site which has lead to various feasibility studies being carried out by Yorkshire Water. This has culminated in current scheme to replace of the existing preliminary and primary treatment processes.

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The existing storm tank cleaning system is manually intensive and inefficient and this leads to odour issues which are a source of complaint by the public. Yorkshire Water have identified a number of business risks associated with the existing operational plant and these affect the operational efficiency of the WwTW. These impact the treatment processes and present a source for failure which can lead to the works failing to meet the current consent.

The solution

Yorkshire Water commissioned a report to review the process systems in operation at BbM. As a result dynamic process modelling has determined the minimum process parameters for an additional activated sludge plant (ASP) to augment the existing hybrid and Simplex ASPs with an additional side stream ASP comprising an anoxic tank, 4 (No.) aeration lanes and 4 (No.) final settlement tanks (FSTs). ETM, a joint venture between AECOM Design Build and Galliford Try, won the large scheme contract to carry out the work. The project comprises additional new ASP and a number of existing assets refurbished. The works are more fully described below.

Pumping stations

Sewage flows enter the site via 2 (No.) high level gravity sewers and pass to Blackburn Valley Screw Pumping Station (PS). This PS is to be retained. The 3 (No.) screw pumps will be refurbished and the existing stop log isolation used to provide isolation to the pumps during refurbishment. The existing penstocks in the cross-over chamber and inlet sewer will also be refurbished. Cross connections from the existing gravity sewers and overflow connection to the Don Valley Pumping Station will be maintained.

The existing Tinsley PS structure will be retained with the pumps replaced to deliver the additional head required to discharge to the new inlet works. The sewage flows from the network enter the Tinsley PS via a gravity sewer. A new flow meter will be provided on the delivery main.

Inlet works

A new inlet works facility will comprise 3 (No.) coarse screens and coarse screens handling, 2 (No.) detritors and 4 (No.) fine screens with 3 (No.) fine screens handling units.

When flow into the works exceeds maximum FFT these will overflow at a pair of storm weir penstocks and pass to the storm tanks. 2 (No.) weir penstocks electrically controlled will respond to control signals from a pair of submerged flow meters measuring FFT at a location downstream of the storm overflow.

Primary sedimentation tanks

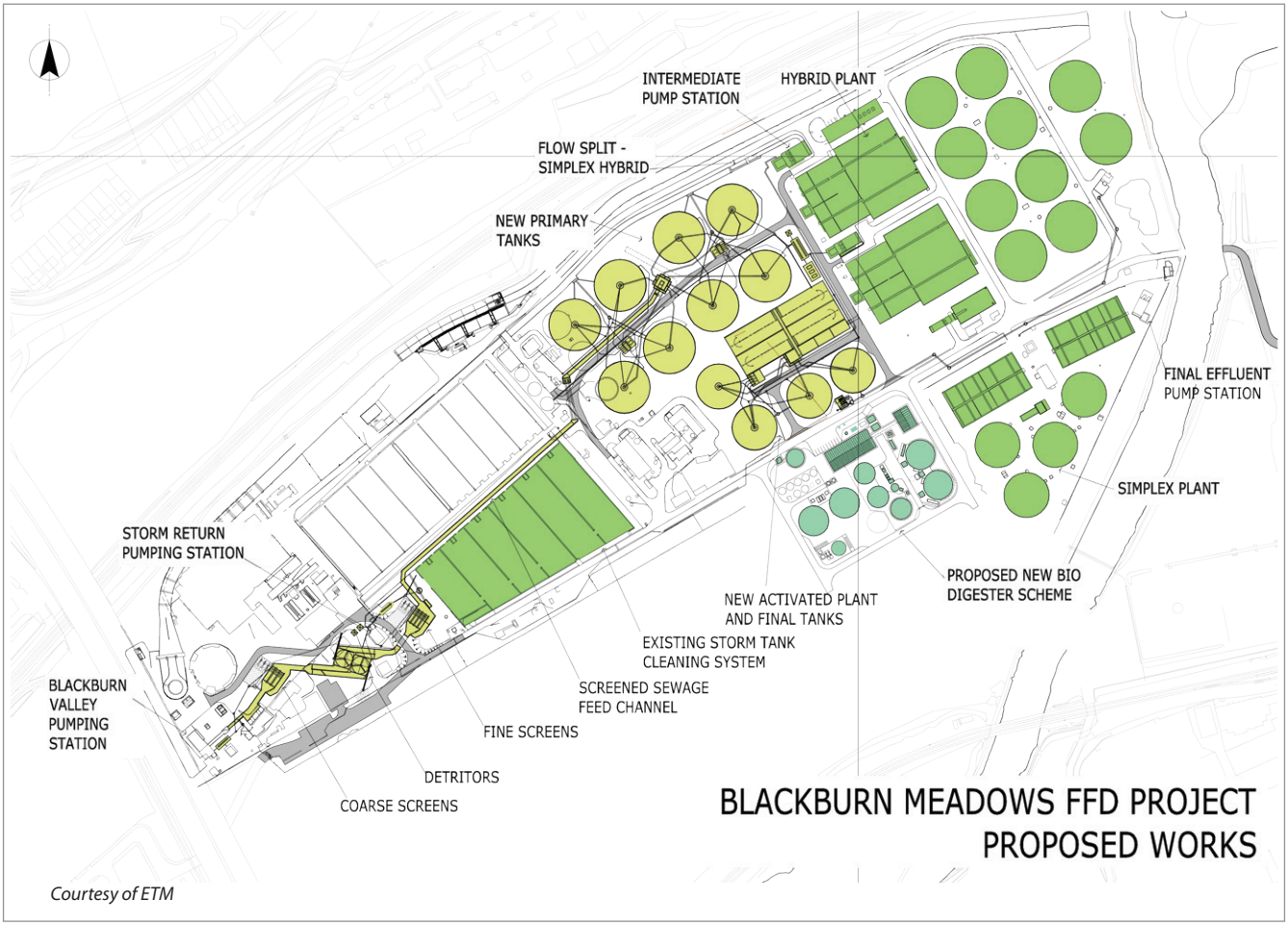
Screened flow from the inlet works will be split into 8 (No.) new 40.4m nominal diameter circular primary sedimentation tanks (PST). PST outlet will comprise 'V' notch weir plates.

The desludging arrangement is based on desludging in rotation for a set time per day via 2 (No.) pumping stations each serving a group of 4 (No.) PSTs. With dual pumping stations it is possible to desludge the tanks alternatively, providing a more even sludge flow throughout the day and providing the best operational flexibility. The PSTs will be equipped with ¾ bridge scrapers, new scum system and sludge draw off.

Flow splitting flumes

Settled sewage from the PSTs passes down the existing primary settled sewage channel to two existing flumes, which are designed to permit British Standard (BS) flow measurement. The flows will continue to separate between Simplex plant and to a modified hybrid intermediate screw PS.

The main flume will convey the flow for the two hybrid ASPs (30% each in normal conditions) and the new ASP (20% in normal conditions). The side flume will continue to serve the Simplex plant (20% in normal conditions).



Courtesy of ETM

The present flow proportion through the Simplex flume is 25%. Flow in the Simplex flume will be reduced by the installation of removable full-depth restriction plates near the entry cutwater of the flume. Full-depth plates will ensure the same split proportion at all depths of flow in the primary effluent channel. The effect of the reduction in the Simplex split proportion will be to increase normal flow into the main flume from 75% to 80% (60% hybrid ASPs + 20% New ASP).

Modifications will be carried out to the existing hybrid intermediate screw pumping station to provide sufficient capacity to deal with the new proportions of primary effluent flow to the hybrid and new ASP Plant.

Activated sludge plant

Distribution of settled sewage to the 2 (No.) existing hybrid ASPs takes place in the distribution chamber located at the outlet of the hybrid intermediate screw PS. This chamber will continue to be used. Downstream of the three lengths of weir, the collection channels will be modified to direct flow to three destinations in the future, rather than the present two destinations. The length of each weir will be adjustable using insertable side plates that can reduce the length of any chosen weir to achieve a required flow proportion.

A new ASP, which includes a 1,900m^3 anoxic zone, is to be built. This will utilise a fine bubble diffused air (FBDA) system. The ASP capacity will be 18,500m^3. The integrated design incorporates the anoxic zone and outlet flow split arrangement to the final settlement tanks (FST). 4 (No.) FST at a nominal 35m diameter provide the final settlement capacity. The return activated sludge (RAS) will be fed to a separate RAS pumping station. The FSTs will be fitted with ½ bridge scrapers and dipping scum removal system. The RAS return will be controlled by actuated bell mouths and flow meters.

The 4 (No.) pumps at the hybrid intermediate PS will be refurbished to their original design (1,149l/s per pump) providing an additional 5% capacity to the flow requirements of the new and hybrid ASP.

The existing hybrid ASP anoxic zone damaged baffle walls are to be replaced. The anoxic zone mixers and their associated equipment will be retained. The first two zones, currently aerated by surface aerators, will be converted to FBDA. Final settlement will be retained and the running gear and wearing components replaced. A new scum removal system will be installed. The associated RAS pumping station will be retained and the 3 (No.) screw pumps refurbished.

The existing Simplex feeder PS will be refurbished to provide their original design capacity (1,065l/s per pump). The Simplex anoxic zone mixers and their associated equipment shall be replaced. The Simplex surface aerators with their single speed drives will be retained. The outlet weirs will be levelled to the same level. The aerators will be set to design depth of immersion, internal baffles repaired and new aeration control system fitted. The FSTs will be refurbished and a new dipping box scum removal system will be installed. The existing scum boards, launders and 'V' notch weirs will also be replaced and levelled. New actuated sludge bell mouths are to be installed to the existing sludge draw off chambers. The 2 (No.) RAS screw pumps will be refurbished along with associated inlet isolation penstocks to provide bring them back to their original design (527l/s per pump). The SAS pumps will be replaced.

Storm tanks

The storm tanks and storm pumping are to be modified to automatically return the tank contents for treatment. A new automated storm tank cleaning system is to be provided to remove sludge from the storm tanks and leave the assets clean to reduce odour emissions. Venturi type pump mixers and pipework will be installed with proprietary nozzles to circulate tank contents. The storm return PS pumps will be replaced.

Existing final settlement tanks to be refurbished and bridges removed and replaced with new - Courtesy of Yorkshire Water

Existing storm tanks to be fitted with storm tank cleaning system Courtesy of Yorkshire Water

Retaining assets

Repair, refurbishment and modification to existing assets will be undertaken where possible. Examples include:

- The final effluent storm flap valve will be repaired and remounted onto the structure.
- The existing pumping station pumps will be refurbished along with their associated inlet isolation penstocks.
- The 2 (No.) screw pumps will be refurbished to provide the full flow of their original design (2,170l/s per pump).

Where existing assets are to be retained and utilised in the proposed works, these will be made good and safe including site lighting improvements. Structural remedial work will be carried where required.

Flood protection

There are a number of 'critical assets' identified across the site that require protection against flooding. During the 2007 floods the majority of the site was flooded. Protection works are to be provided to a number of new assets; new aeration blowers, MCC rooms, transformers and pump motors.

Demolition

A number of redundant structures will be demolished upon completion including the inlet screen house, grit channels, grit storage and distribution channels, redundant flow distribution structure/channel at side of administration building, the ICA building, 2 (No.) sludge tanks near the incinerator, sludge thickening tanks, centrate tank and the Kent meter house.

The 8 (No.) rectangular PSTs are to remain but made safe by the removal of macerator pumps and pipework. In order to drain rainwater from these tanks an automated system will be provided to transfer collected rainwater to the treatment process by utlising the existing centrifugal desludge pumps and pipework and transfer into the FFT channel.

Washwater pumping station

A new washwater pumping plant will be provided to supply the new ASP and the new inlet works. The supply will be drawn for the final effluent from the new FSTs.

Innovations

This project has embodied many innovative ideas. For example:

- The inlet works structure built on a raft reduces excavation and avoids disruption to existing sewers.
- New screened sewage channel built within existing storm channel negating excavation for large diameter pipework through areas of the site that bristle with existing pipes and cables.
- The reuse of existing intermediate screw pumps to negate new build.
- Retention of Blackburn Valley screw pump station omitting the need to build new.

These are a few concepts that have lead to significant capital savings on this project.

Schedule

The current project value is £31.5 million and work started in February 2012. At the time of writing (June 2012) excavation and the early start works is underway, with detailed design progressing well. The project has a target completion date of 30 September 2014.

The editor & publishers would like to thank David Hartshorne, Project Manager with Aecom Design Build, for providing the above article for publication.

The existing surface aerator to be decommissioned and replaced with fine bubble diffused air system - Courtesy of Yorkshire Water