Beckton STW

primary sedimentation tank odour project

by Phil Muir CEng MIMechE and John Mulrooney

Beckton STW, Europe's largest, is located in the London Borough of Newham. Formally called the Northern Outfall Works, it was constructed in 1864 by the Metropolitan Board of Works following the construction of three horseshoe shaped outfall sewers and four large storage reservoirs, which enabled sewage to be discharged on the ebb tide of the River Thames. The works now treats sewage from a population equivalent of 3.7m within a catchment of 300km^2. Over the years Beckton STW has seen many significant changes. In 1889, covered sedimentation tanks, pumping plant and elevated storage tanks were constructed, which enabled the sludge to be deposited at sea. The 1950s saw the construction of detritus pits, a screen house, pre- aeration channels, mechanically scraped sedimentation tanks and a new main outfall. And in 1998, one of the first sludge powered generators to be constructed in the UK provided an environmentally friendly solution for the disposal of sludge by utilising waste heat from the incineration process to drive an 11.4MW generating set, which provides power for the site.

New covers at Beckton STW - Courtesy of GBM JV

Modern day Beckton – how it works

Beckton STW receives its sewage from a large collection of sewers and pumping stations within a north and east London catchment. These all connect to leave one incoming sewer onto site, the Northern Outfall Sewer. Beckton itself contains no storm tank facility and relies mainly on Abbey Mills and Western SPS pumping to the river in times of high flow.

Main flows at Beckton are gravity fed around the various treatment process areas. The inlet works consists of 6 (No.) coarse screens, which serve the adjacent 6 (No.) detritus channels. The incoming flow then reaches the fine screens, of which there are 8 (No.) units available; 6 (No.) are fixed and 2 (No.) have the capability to lift out of service so that the flow can be bypassed from the fine screens onto the primary sedimentation tanks in cases of high flows and emergency asset failure.

The sewage flow is then distributed between 16 (No.) primary sedimentation tanks (PSTs). Each tank originally consists of a Meider scraper, which runs along the tank, and Flygt scrapers, which run at the end of the tank and collect all the sludge from the tank and pushes into an outlet hopper chamber.

Tanks 1-8 were built in the 1950s and split in half leading to 2 (No.) Meider scraper bridges per tank. Tanks 9-16 were built approximately 10 years later and have 1 (No.) bridge for the whole tank.

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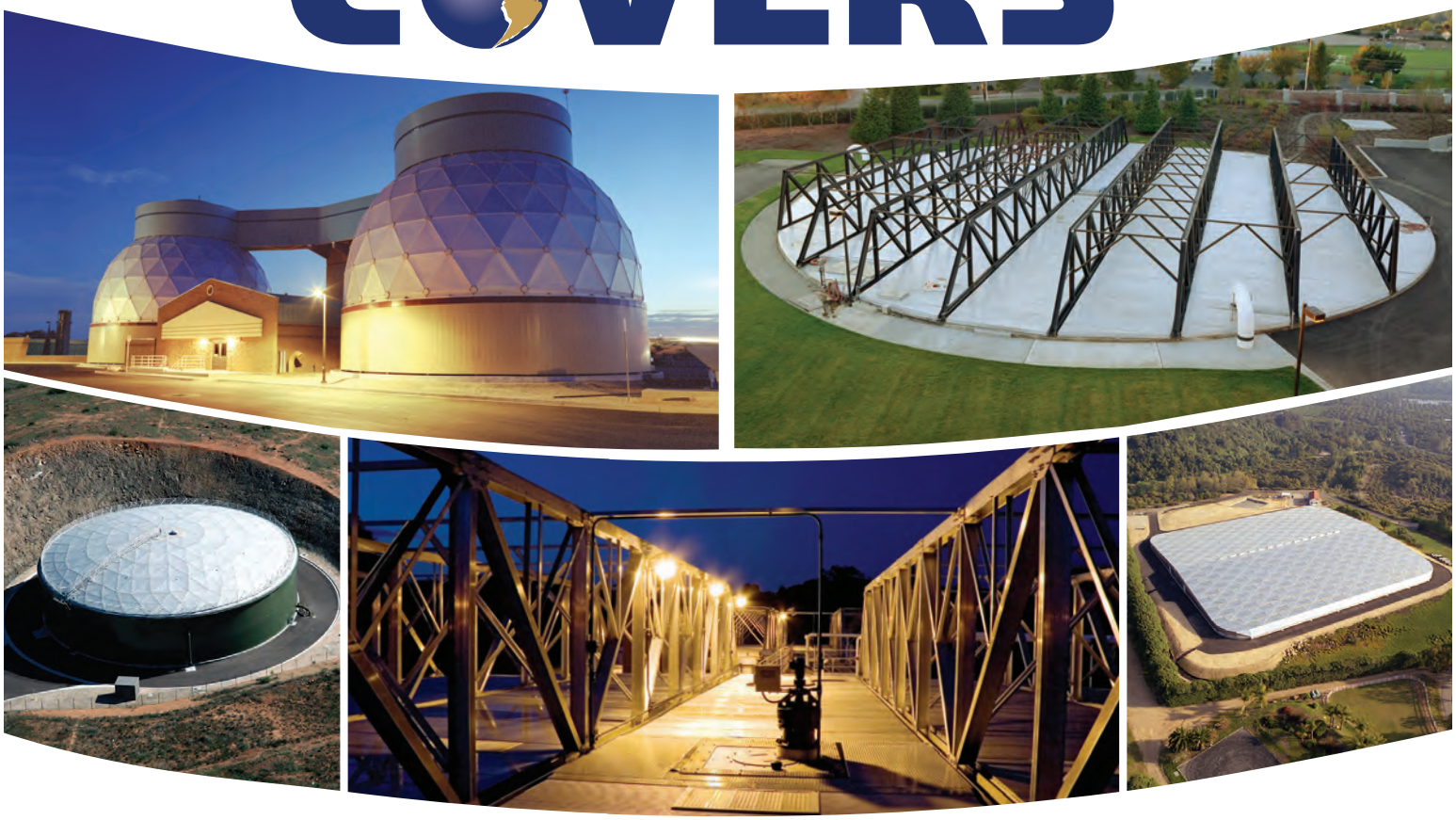

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Aerial view of the odour control project at Beckton - Courtesy of GBM JV


Formation of 11m deep new raw sludge pumping station at Beckton STW - Courtesy of GBM JV


Zickert scraper system installed in primary settlement tank 9 Courtesy of GBM JV


Odour containment covers on PST 7 & 8 - Courtesy of GBM JV

The activated sludge plant is split into two areas. The settled sewage will flow to either ASP2 or ASP3. ASP2 has 6 (No.) tanks each comprising of 8 (No.) lanes. ASP3 consists of a further 8 (No.) aeration tanks.

There are a total of 72 (No.) final sedimentation tanks (FSTs). The plant is operated to maximise the removal of all solids from the effluent before it weirs into the outlet channel of each FST and from there into the River Thames.

The final effluent flows from the FSTs into the effluent outlet channel, where there are a series of effluent battery air lifts that ensure adequate removal of effluent in times of high tide which hinder the exit from the works.

The sludge from the outlet hopper of the PSTs is drawn out through a bypass valve at the bottom of the tank, the system is controlled via the SCADA system in the control room with each tank getting an allocated time for de-sludging before the valve automatically closes and the next tank started.

The raw sludge is collected in the sump where 4 (No.) pumps transfer the sludge up 1 of 2 mains to the picket fence thickener distribution chamber. The raw sludge is then thickened in the 4 (No.) PFTs and then pumped into sludge blending tanks. The separated liquor from the thickening process weirs over the top of the tank into a drain and is then fed back to the head of the works via the intercepting sewer.

7 (No.) Aquabelts are employed to remove 100% of the surplus activated sludge (SAS) from the works to prevent the surplus returning back to the head of the works.

No.1 blending tank mixes the thickened sludge from the PFTs with the thickened SAS from No. 2 blending tank, which is in turn fed from the Aquabelts. The blended sludge is continually mixed and re-circulated to create a blend of thickened SAS and thickened raw sludge suitable for pressing and incinerating in the sludge powered generator (SPG).

Key process facts

Current Population Equivalent	3,700,000
Average Flow to Treatment	1,175,249m^3/d or (13,600l/s)
Crude Sewage BOD Load	180,000kg/d
Crude Sewage Ammonia Load	30,500kg/d
Final Effluent BOD Load	9,400kg/d
Final Effluent Ammonia Load	940kg
% Removal BOD	95% (22mg/l) in winter
% Removal Ammonia	97% (6mg/l) in winter
Consented Maximum Flow	2,730,000m^3/day

Beckton – the odour control project

To comply with the requirements of the Section 106 agreement associated with the Beckton STW Extension Project, and meet a specific OFWAT AMP5 output to reduce odour nuisance from the works, Thames Water engaged GBM, the Galliford Try, Biwater (now MWH) Treatment and Mott Macdonald Joint Venture, to carry out a £63m project to upgrade the existing primary sedimentation tanks, install both odour containment covers and odour removal plant.

The project scope involves the following:

- Provide replacement reciprocating bottom sludge scrapers and top scum skimmers in 12 (No.) PSTs.
- Modifications in a further 4 (No.) PSTs which have already had the new scraper system installed.

- Refurbishment of all valves and penstocks associated with the afore mentioned PSTs.
- Provision of odour containment covers to all 16 (No.) PSTs, associated chambers and settled sewage channels prior to flows entering the aeration tanks.
- Upgrading the wash water facilities serving the PSTs.
- Provision of a new raw sludge pumping station to include diversion of sludge flows from the PSTs.
- Refurbishment of the existing raw sludge pumping station.
- Provision of processing plant for the treatment of odour under containment on the PSTs, settled sewage channels and new raw sludge pumping station wet well.
- Provision of a scum removal system in the settled sewage channels.
- Provision of electrical and ICA installations for all of the above plant to be controlled and monitored via SCADA.

Project challenges

A project of this scale has many challenges including:

Package interfaces: The initial project challenge involved integrating the PST reciprocating scraper system with a suitable odour containment cover system. The surface scraper system requires supports to enable it to operate across the full 80m of the PST. The solution was to source a cover system with the ability to support the scraper system from its structure.

Process interface: Further challenges included tying into the existing raw sludge lines serving the PSTs with the newly constructed pumping station and renovating or replacing raw sludge valves and outlet penstocks whilst maintaining the minimum disruption to the live sewage treatment.

Programme restrictions: Beckton STW is also affected by restrictions placed on it under an agreement known as Tideway. Thames Water and the Environment Agency monitor final effluent more stringently during the summer months and as such it is not possible for GBM to work on more than 2 (No.) PSTs at a time during this period.

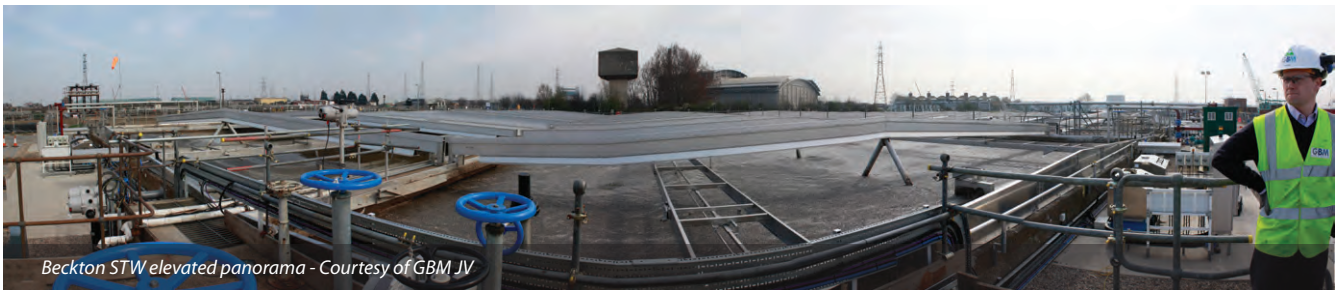
Construction interface: Concurrently with the odour control scheme, Beckton STW is also extending its treatment capacity to enable it to treat an increased volume of incoming flow, via the Northern Outfall Sewers (NOS), and pumped out from the Lee Tunnel (under construction) to a higher quality standard.

To achieve this new quality consent, another contractor is in process of constructing a separate new secondary treatment stream (ASP4), which will operate in parallel with the existing works. This is combined with the construction of the Lee Tunnel project which includes the construction of a large storage tunnel running from Abbey Mills Pumping Station to the connection shaft at Beckton STW, and then further to an overflow shaft near the Thames river.

These three major projects and a fully operational sewage works makes project liaison a key factor to success at Beckton.

Solutions

Reciprocating scraper systems: The scraper systems have been sourced from Hydro International, the UK agent for Zickert scrapers. The system comprises 3 (No.) sets of bottom scraper blades on the main floor of each half tank and a set of bottom cross collector scrapers on the floor of the former scraper area at the front of each half tank.


Beckton STW elevated panorama - Courtesy of GBM JV

The surface scum skimmers comprise 2 (No.) sets of blades per half tank which deposit the scum into a trough spanning the width of each half tank at the front end of the PST. The scum is extracted from the trough and pumped to the existing sludge line via a chamber on the side of each tank. The scraper systems are made entirely from 316 stainless steel.

Odour containment covers: The odour containment covers were provided by Temcor Conservatek, one of the world's leading aluminium cover suppliers. Combining this walk-on aluminium cover with a serious of hatches enabled us to remove the requirement to enter the cover/tank for frequent maintenance. The non-entry cover solution enabled GBM to reduce the required air changes (AC) from three AC/hr to one. The lower profile design of Zickert surface scraper enabled us to reduce the cover height to no more the 1m, therefore reducing the volume of air requiring treatment further reducing the running costs for the end user.

Odour control plant: In collaboration with the supply chain GBM entered into discussion with the TW technical engineering specialist on odour control sizing and modelling to show the odour treatment system operating with a single air change per hour would provide the requirement to reduce the odour nuisance from Beckton STW. GBM employed an independent consultant odour control specialist from MWH to assist with the detail, design and proving of the single air change. Reducing the required volume of treatable air enabled the utilisation of bio-trickling filters instead of the original proposed chemical scrubbers that present a larger whole life cost to the end user.

Progress to date

GBM JV are currently 94 weeks into a 210 week programme of work. Thus far 5 (No.) PST have been renovated and are in operation with new scraper systems, 2 (No.) of these PSTs have odour containment covers installed. The PST refurbishment is on target to be completed by September 2014.

The new sludge pumping station is structurally complete with a 12m deep shaft, 15m in diameter being sunk in the ground, next to the existing pumping station and 1950s inlet channel. The sludge main tie-ins have now also been completed. The pumping station will be accepting sludge flow by the summer of 2013.

The final objective is to turn on the odour control plants, which are scheduled to be fully operational by December 2014.

The editor & publishers would like to thank Phil Muir, Project Manager with the GBM JV, and John Mulrooney, Construction Engineer with the GBM JV, for providing the above article for publication.


Aerial view of Beckton STW - Courtesy of GBM JV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