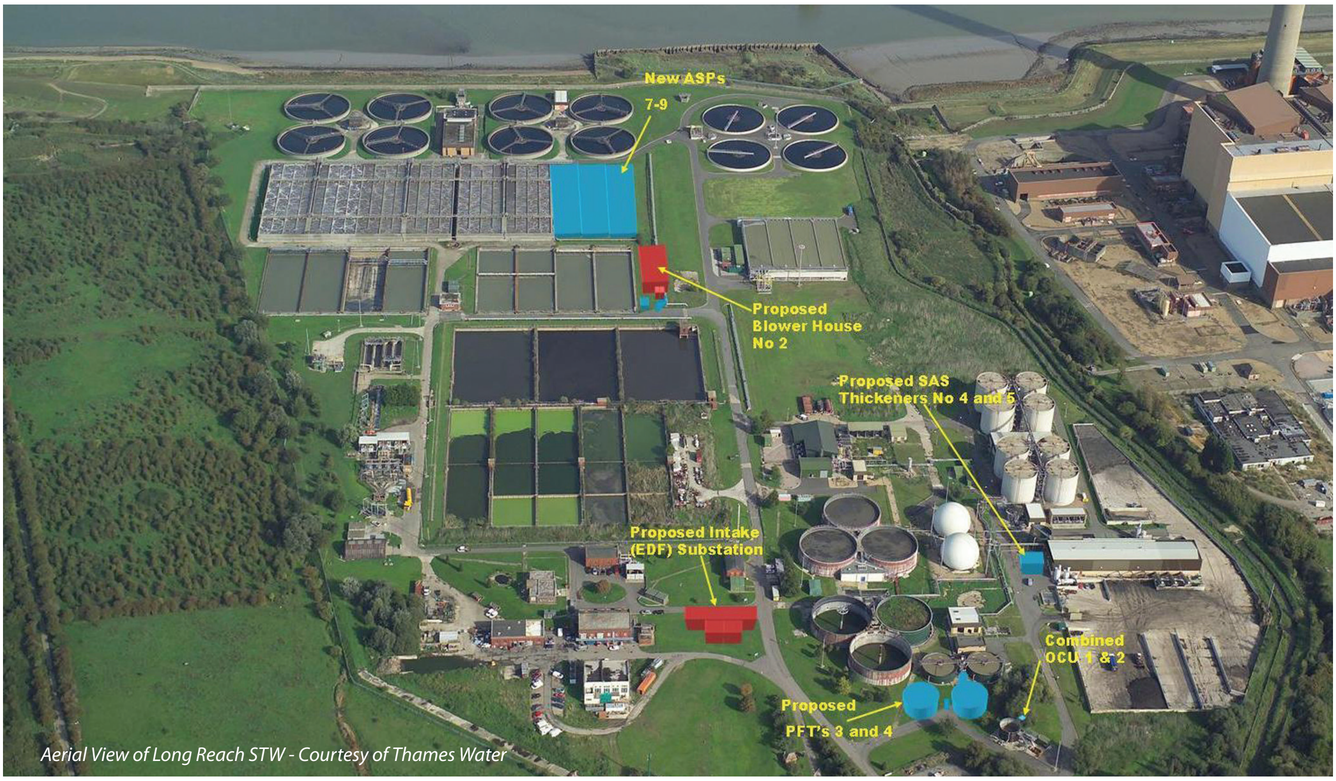
Long Reach STW

£40m works extension project for Thames Water as part of the London Tideway Improvements

by Ben Shin MA(Cantab), MEng

Long Reach STW is located in Dartford, Kent. The existing works is capable of treating flows up to 311MLD serving a catchment area of 518km^2 with a population equivalent of 836,593. The works receives flows from parts of Bexley, Bromley, Croydon, Dartford, Sevenoaks, Tandridge and Tonbridge & Malling. The catchment extends to the boundary with Southern Water and includes part of the Thames Gateway development area. As part of the London Tideway Improvements scheme, five major STWs serving the Greater London area are being upgraded with the aims of increasing the treatment capacity and improving effluent quality. These works are at Beckton, Crossness, Long Reach, Mogden and Riverside. This paper focuses on the £40m extension project at Long Reach STW.



Aerial View of Long Reach STW - Courtesy of Thames Water

Background

The existing works is a conventional activated sludge plant, which uses diffused air aeration. The treatment works comprise 6mm two-dimensional fine screens, constant velocity grit channels, screenings conditioning and grit washing facilities, primary sedimentation tanks, aeration lanes using diffused air aeration, final settlement tanks, return activated sludge (RAS)/surplus activated sludge (SAS) pumping stations, sludge treatment, storm tank, storm pumping station, washwater pumping stations and distribution systems, with an outfall of treated effluent to the River Thames.

Consent standards

The upgrade of Long Reach Sewage Treatment Works will enable an increase in treatment capacity to 346MLD coupled with increased quality standards.

The increased capacity, achieved by the construction of new aeration tanks and additional sludge treatment units, will, when completed, enable the works to handle additional incoming sewage flows from an almost 10% increase in population and achieve the consent standards in the table below:

Consent	Suspended Solids (mg/L)	BOD (mg/L)	Ammonicacal Nitrogen (Nmg/L)
Average	25	n/a	n/a
95%ile > 15 deg C	50	22	4.5
95%ile > 13 – 15 deg C	50	22	6.0
95%ile <13 deg C	50	22	9.0
Upper Tier > 15 deg C	125	58	18.5
Upper Tier 13 – 15 deg C	125	58	23
Upper Tier < 13 deg C	125	58	33

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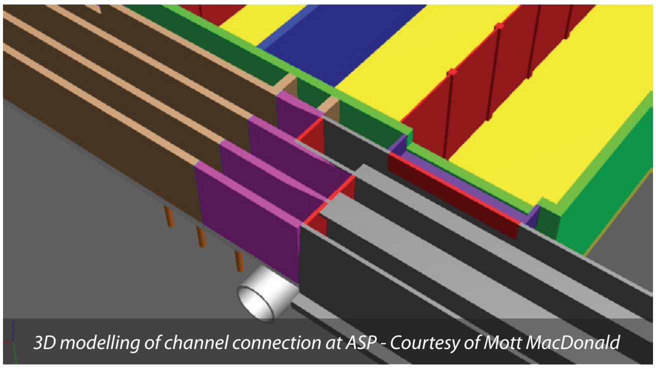
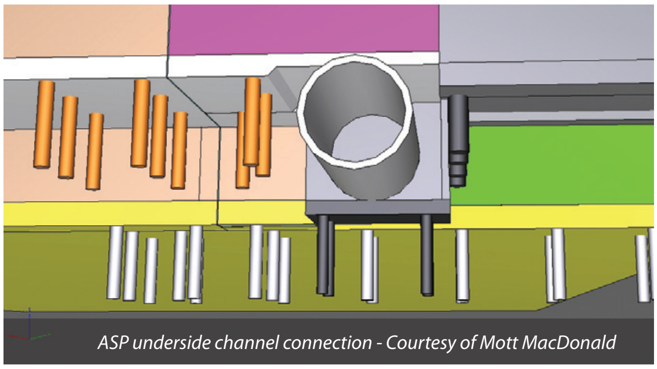

3D modelling of channel connection at ASP - Courtesy of Mott MacDonald


ASP underside channel connection - Courtesy of Mott MacDonald

Project team

For the detailed design and subsequent construction, Thames Water engaged GBJV, who were assisted by Mott MacDonald. GBJV is a joint venture between Galliford Try Infrastructure and MWH Treatment (formerly Biwater Treatment). MWH and Mot MacDonald are responsible for all design including process, mechanical, electrical and civil engineering as well as environmental advice such as contaminated ground assessment and landscaping.

The upgrade

The extended treatment being constructed under this project comprises 3 (No.) aeration lanes, a new blower house, refurbishment and upgrade of the existing blower house, 2 (No.) additional picket fence thickeners, 2 (No.) additional belt thickeners, additional standby power generation and fuel tank, upgrading the existing 12 (No.) FST scrapper bridges, a new substation, and a new SCADA system.

Aeration lanes

The new aeration lanes are designed to work in parallel with the existing 6 (No.) shallower aeration lanes. Each new lane is 8.3m wide, 80m long and 6m deep and comprises a two pass system with upstream anoxic zone, and is equipped with two point dissolved oxygen control. A pumped mixing system is being installed within the existing return activated sludge (RAS) channels to ensure even loading of RAS solids back to the new and existing aeration lanes. Connection of the existing lanes to the new lanes is complex and involves extending the existing channels, namely RAS, settled sewage and return liquors.

In the past, the existing base slab of Tank 6 protruded further than the existing wall, which was intended to simplify future extension with the protrusion forming part of the new floor. The liquor channels also extend further than the existing tank with a part-masonry vertical section intended to form a future weir and connection. However, for modern efficient aeration, the new lanes are designed to be 2m deeper than the original ones which render the mentioned arrangement a hindrance rather than convenience. Because of this, the 3 (No.) new aeration lanes were sited slightly further away from the existing structure and designed as a stand-alone structure.

The critical challenge involved the extension of the channels. The new ones were constructed off line as future extensions of the existing channels, while the actual connection would only be made during a brief shut-down period when the existing channels could


Aeration tank under construction
Courtesy of Mott MacDonald


New Aeration Tank undergoing water test
Courtesy of Mott MacDonald

be drained down. It was a significant structural challenge because a multidirectional movement joint was required to accommodate for any future differential movement whilst maintaining water tightness. This was further complicated by a large diameter pipe (2.5m ID) right underneath the connection which made piling impossible. The required connecting piece was therefore designed as a cantilever. The existing channel walls also feature a tapered section while linear sections were specified in the new channels in order to ease construction. The transition from the tapered section to the linear section was geometrically complex. Extensive 3-dimensional modelling was carried out to aid visualisation and structural analysis.

The ground investigation confirmed that the groundwater table is closely related to the tide level to the adjacent River Thames. The ground was made up mainly of alluvium below made ground and 830 (No.) Driven Cast In-situ (DCIS) piles of 340mm diameter, found on the River Terrace Deposit below the alluvium, were specified to support the structure. These piles were also designed to take tension to help resist flotation in the event of flooding from the River Darrent nearby or from catastrophic failure of any works process. Due to the high groundwater table, local dewatering and a sheet piled cofferdam were also required during the formation of the base slabs.

Blowers

4 (No.) blowers, arranged on a two duty/two standby basis, were required to provide the design maximum duty air demand of 28,000m^3/hr to the new aeration lanes. These blowers were housed in a structural steel portal frame structure. The original tender design of this building specified a basement of the same footprint to house the large diameter air header main towards the aeration lanes. Significant savings were realised when this feature was designed out, and the air main was housed in a separate concrete trough outside the building footprint. Due to the poor ground, the structure is also found on DCIS piles. However, there are numerous existing underground services in the area including washwater and surplus activated sludge pipelines. A concrete encased brick lined sewer and concrete sludge drying bed – not shown on any record drawings, stretching back to the Victorian times – were also discovered in subsequent ground investigation. An irregular pile grid was introduced in order to avoid all these underground obstructions. The need for deep trenches within the base slab of the blower house posed a particular structural design challenge of the base slab. Extensive three dimensional finite element structural analyses were carried out in order to optimise the pile location and reinforcement density. The proliferation of existing services below the new blower house vindicated the early decision to delete the basement construction.

As part of the scheme, the blowers in the existing blower house building were also replaced by 5 (No.) new Howden blowers arranged on a duty/duty/assist/assist/standby basis to cater for the increased demand of a design maximum of 88,700m^3/hr. Substantial modification of the existing building was necessary to accommodate the bigger and heavier blowers. Major modification of existing plinths was required where existing penetrations in the floor were filled in and new ones formed to accommodate the air pipe connection into the air main header in the basement area. Structural assessment was carried out and structural steel frames were installed to strengthen the floor following detailed analysis by MM structural engineers. An increase in air intake requirements meant that new openings were required on the external wall. The brick work behind the existing louvres was removed to increase volume of air intake while conserving the architectural features of the building.

Sludge treatment

The sludge treatment capacity was also increased as part of the upgrade. 2 (No.) 15m diameter picket fence thickeners were installed to supplement the 2 (No.) existing thickeners. The River Terrace Deposit below ground in this area is relatively thinner and it was feared that DCIS piles would be driven through this layer. Hence continuous flight auger (CFA) piles were specified for a more accurate depth control. It was identified that there were pockets of contaminated material in the ground. The Mott MacDonald environmental team carried out ground assessments to ensure that the proposed piles did not introduce new paths for the contaminants to reach the aquifer and developed the waste disposal strategy to ensure that any contaminated material found was segregated and identified for removal or storage on site.

Odour control units were also installed to deal with the odours emanating from the existing and additional sludge storage and treatment. Significant savings were achieved by providing one larger capacity OCU system treating all tanks and distribution chamber compared to the original design where separate OCU system was to be provided. The odour control system is arranged in two stages comprising a biofilter first stage with a dry carbon polishing second stage.

For increased dewatering capacity, 2 (No.) 1.5m wide Ashbrook Simon-Hartley aquabelt thickeners were provided. Only one additional thickener was specified at the tender stage and it would be housed in a kiosk on the hardstanding outside the existing thickener building next to the entrance. However, the number of thickeners required was later increased to two after a review by Thames Water. This was particularly challenging because of the lack of space.

There are also existing concrete encased telecommunication cables present close to the ground in the area and a 2-level base slab was developed to avoid this. Extensive tracking modelling was carried out by the civil engineering designers ensuring that the new kiosk does not obstruct the maintenance vehicles accessing the thickener building. Turning circles of different vehicles including 29T articulated-lorries and 7.5T lorries were accounted for in the analysis.

Power supply

A new 11kV intake substation was also required, mainly to cater for the increased air blower load, and would be connected to 2 (No.) 7.5MVA transformers, which in turn, would be connected to a 3kV intake switchboard. The existing ground levels in the new substation area vary and there is a 1 in 10 slope towards an access road. The level of the building was carefully chosen so that the existing ground level can be built up above the 1 in 100 year flood level by recycling the piling mat material at the aeration tanks. The higher level at the substation area also enables roof runoff to positively drain to the existing drains returning to the head of works.

Minimising the environmental impact

In order to minimise environmental impacts, all excavated materials are retained on site. They include excavated materials at the aeration tanks and the service corridor, piling mat and CFA pile spoils at the thickener areas and amount to over 37,000m^3. This was challenging as there is limited available space in the works and the heights of bunds are intended to be no more than 2m high stipulated by the planning authorities. A 3D ground model was developed by Mott MacDonald to investigate the suitable areas for landscape bunding. A new tree belt of native species including hornbeam, birch, oak and ash was introduced on the bunds along the site boundary, by landscape architects from Mott MacDonald, to help screen the site.

It is expected that the project shall be completed by the end of 2012.

The Editor and Publishers thank Ben Shin, Graduate Engineer with Mott MacDonald, for preparing this paper for publication.