Deephams WwTW

Thames Water's £40m project to improve storm storage and treatment facilities and the water quality of the River Lea in Edmonton, north London

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Thames Water is investing in significant improvements to its wastewater treatment facility at Deephams in Edmonton, a large plant serving an area of north London with a population of nearly 900,000. A £40m programme of works will radically increase the ability of the plant to deal with storm events and its effectiveness in day-to-day sewage treatment. Working on an existing operational site, the programme's innovative design, and a strong partnership between client, designers and contractors, have been vital in generating a flexible solution that surpasses initial expectations in terms of delivering value for investment. This has been made possible through a civil engineering solution that maximises use of the site area, and design and construction methods that have delivered savings in time and cost.

Columns cast in storm tank for elevated fine screens structure *Courtesy of AECOM Ltd*

Background

Deephams WwTW needed additional storm storage and additional screening to deal with future storm flows. This forms part of Thames Water's wider investment programme in a related series of improvements to wastewater treatment facilities in London, including West Ham Strategic Flood Alleviation Scheme, completed in 2010, and the ongoing construction of the Lea Valley and Tideway Tunnels.

Built in the early 20th century for a catchment area that, at that time, was far less populous and built-up than it is today, Deephams deals with up to 14,000 litres per second of sewage during a storm event. This project involves separating one of the three incoming sewers from the works and pumping it through a new system of treatment and storage. Once operational, the upgraded works will have the capacity to store more than 63 million litres of sewage for treatment post-storm.

Deephams lies in the Lea Valley, upstream from the 2012 Olympic Games site; hence it will have a direct impact on the quality of river water flowing through the Olympic site and the reduction of sewer discharges to watercourses during major storm events. The main works are due to be commissioned by the end of March 2012, with other elements of the project scheduled for completion by the end of December 2012.

Proposed Works

In exploring ways to enhance the Deephams facility, Thames Water actively sought an innovative solution that would deliver operational effectiveness, environmental protection and value for money.

The winning tender bid was supplied by J Murphy & Sons Ltd, with civil designer AECOM Ltd, and M&E supply chain partner, Nomenca Ltd. The proposed works includes:

Tottenham Low Level Pumping Station shaft view from the base *Courtesy of J Murphy & Sons Ltd*

Intermediate shaft between sewer connection/TLLPS. This will ultimately include a baffle wall, developed by Hydrotec Ltd to prevent formation of a standing wave in the tunnel downstream - Courtesy of AECOM Ltd

Detritor concrete structures nearing completion with installed detritor rake mechanism Courtesy of AECOM Ltd

- A new sewage pumping station to lift dry weather flow (DWF) and storm flow from the Tottenham Low Level Sewer up to ground level and onwards to treatment and storage respectively.
- 2 (No.) new storm storage tanks each of 5.6Ml capacity, increasing the total storm storage to more than 63Ml.
- Integration and balancing of all incoming sewer storm flows to make best use of storage and screening.
- 5 (No.) replacement and additional 6mm storm screens to remove the bulk of rags and solids stored in the tanks.
- Modifications to 2 (No.) on-site pumping stations, including the replacement of coarse screens to improve efficiency.
- Modifications to 8 (No.) existing storage tanks to fill sequentially and thus reduce the likelihood of overflow.
- Provision of additional 6mm fine screens and grit removal products to improve existing flow to treatment.
- Improved screenings-handling facilities.

A summary of the key elements of the project are as follows.

Tottenham Low Level Pumping Station (TLLPS)

The pumping station shaft contains a 20 metre deep wet well and separate dry wells for the 4 (No.) DWF Hidrostal Prerostal pumps (max. 1,800l/s) and 6 (No.) KSB storm pumps (max. 3,600l/s). The Dry Weather Flow pumps will lift up to 3DWF above ground level into a gravity system to full treatment. The storm pumps will lift sewer flows in excess of the 3DWF treatment capacity into the storm screening and storage system.

The commissioning of a 1:9 scale physical model of the main pumping station helped to establish viability during the detailed design stage. The model was built and tested by Hydrotec Ltd. The results of the testing included a reduction of the pumping station size, as a result of satisfactory testing to determine that the wet well was self cleansing. Solutions were developed to eliminate the creation of vortices in the storm pump suction pipes, which could otherwise draw in air and cause pump vibration. The Hidrostal Prerostal DWF pump system, by design, induces swirl into the suction intake to match the impeller rotation and improve efficiency.

The new pumping station has been constructed using 29m long, 1.2m diameter, secant piles by Murphy International, to form a watertight shaft 18.75m internal diameter. Compared to the use of diaphragm walling, this has reduced the cost of temporary works by around 20%, and reduced the construction programme.

Flow to Full Treatment

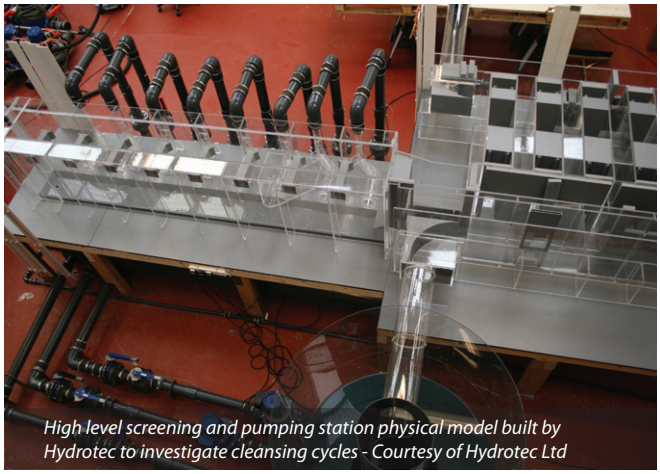
Dry weather flow lifted in the TLLPS will discharge in an above ground chamber, and flow in an elevated channel to a fine screens structure, perched on columns above the storm tanks.

Five elevator screens will remove rags and solids larger than 6mm, before the sewage gravitates to the second elevated structure, the detritors, where rotating rakes will remove grit from the flow. The effluent will then flow over the existing tanks in an elevated channel before dropping back into the main works flow, to undergo the full treatment process.

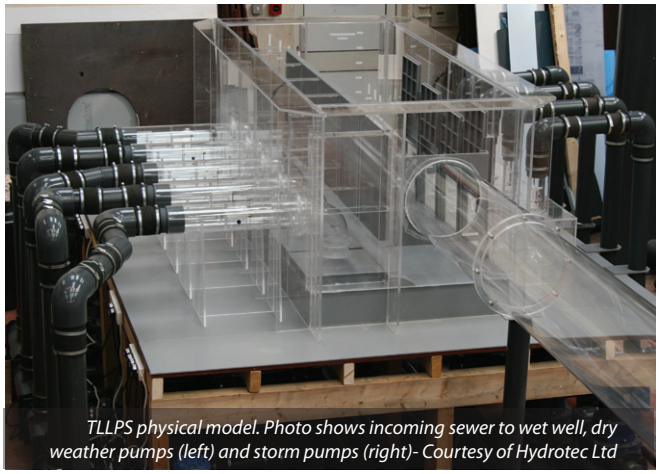
Screening of the existing flow to the treatment process is supplemented with additional fine screens, to reduce the volume of solids flowing forward to the primary settlement tanks.

Storm screening and storage

Improvements to storm water treatment will be provided through new and improved screening equipment. Historically, raw storm sewage would be stored in the tanks and returned to treatment when capacity became available. Five escalator screens will remove rags and other solids larger than 6mm before reaching the tanks, thus reducing the volume of solids to be passed back through the treatment stream once capacity is available.



High level screening and pumping station physical model built by Hydrotec to investigate cleansing cycles - Courtesy of Hydrotec Ltd



TLLPS physical model. Photo shows incoming sewer to wet well, dry weather pumps (left) and storm pumps (right)- Courtesy of Hydrotec Ltd

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Temporary works excavation for connection to Tottenham Low Level Sewer - Courtesy of J Murphy & Sons Ltd

Detritor concrete structures nearing completion Courtesy of AECOM Ltd

Two new tanks have been constructed with in-situ reinforced concrete to act as blind tanks. AECOM developed the filling sequence to ensure that the works retained the most concentrated of the sewer flows, during the first flush of a storm.

Only once these tanks are nearly full will the flow start to fill the other eight tanks, in sequence. A weir is being cut into each tank to implement this sequential filling regime. This reduces the opportunity for a tank to overflow until every bit of available capacity has been utilised. In charge of designing, installing and commissioning the mechanical and electrical equipment will be Nomenca Ltd.

Innovative design

The civil and structural design of all reinforced concrete structures was provided by AECOM, along with expertise in tunnelling and shaft design. The hydraulic design process was carried out by specialist AECOM hydraulic engineers.

For the storm tanks, a grid of around 250 (No.) piles was sunk into the ground by Murphy subsidiary JM Piling Ltd, anchoring the tank base to resist flotation when empty. Concrete columns rise from the pile grid, which in turn support the fine screens and detritor structures above the top water level of the new tanks. As a result, space that would otherwise have been lost, was utilised for the fine screening and grit removal plant, thus freeing up space on site for other structures. In-situ reinforced concrete was carried out by specialist subcontractor J Carney Construction Ltd.

Return of the DWF flow back into the treatment stream using an elevated culvert across 4 (No.) of the existing 8 (No.) storm tanks saved space on an already congested site. This includes a flume for measurement of the flow and control of the upstream water level, added value provided by AECOM.

A major design challenge was balancing the various storm flows converging in the works. Storm flows from the three sewer

Murphy International secant piling rig in action on the TLLPS Courtesy of AECOM Ltd

Elevated detritor structure base slab formation, on columns over new storm tank - Courtesy of AECOM Ltd

catchment areas may arrive at Deephams WwTW at different times. The works has a set capacity that can be treated, but above this, flows have to be diverted to the storm storage tanks. The hydraulic design allows for balancing of these flows to ensure efficient use of storage and screening on site. Furthermore, the improved sequence of tank filling ensures that the most concentrated of sewer flows is held back in the new tanks with no means of overflow to watercourse.

AECOM faced a secondary challenge of designing an additional fine screening structure on the existing flow to primary treatment, working with marginal hydraulic levels and a very constrained site. This work had to be built without taking that part of the treatment stream out of use, and required extensive overpumping arrangements to deal with the flow. The design solution included an innovative solution of a fixed weir with an additional actuated weir penstock to avoid surcharging of upstream measurement flumes, which would otherwise have compromised flow measurement.

Conclusions

The project will bring the capability of the Deephams Wastewater Treatment Works up to the required capacity to deal with predicted demand for the future, whilst improving the quality of sewage treatment. The new works will be commissioned in time for the 2012 Olympics, and so will directly have an impact on the quality of river water and environment of the Lea Valley.

The designers faced some challenging problems fitting the additional treatment into an existing site and working with available hydraulic levels. Murphy has had to build the new pumping station and treatment structures in an operational site and live sewers, which are challenges in their own right.

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