West Ham Strategic Flood Alleviation Scheme

£65m project improves environment for residents

by
Steve Lousley

West Ham in East London was once described as the "factory centre of the south of England", an industrial hub for chemicals, textiles, food and drink and tobacco manufacturers. Today the area is better known as the site for the London 2012 Olympic Park. However, ground contamination from the area's industrial heritage, together with densely packed Victorian streets, pose challenges for Thames Water's biggest flood alleviation scheme, which will reduce combined sewage flooding affecting more than 600 properties and businesses.

Photograph looking into the shaft down on to TBM *Courtesy of Thames Water*

Scheme drivers

Existing sewers in West Ham and Stratford were constructed largely in the late 19th Century as a combined storm and foul water system. Over the years additional development has taken place, Victorian town houses have been subdivided into flats and areas once covered by permeable surfaces have been concreted over.

As a result both foul flow and surface water run-off have increased. Sewers frequently surcharge during storms, leading to sewer flooding in basements or cellars. The mechanisms for internal sewer flooding are via direct drain connections or migration of sewage through cracked pipes running close to cellar walls or floors.

Thames Water's AMP4 target under Ofwat performance standard DG5 is to alleviate sewer flooding at 5,561 properties for a one-in-10-year return period. West Ham Strategic FAS is the group's major DG5 project, delivering approximately 13% of this target.

Project scope

The £65m main scheme comprises of the following elements:

- A 3.3km long, 2.8m internal diameter bored tunnel, with average depth to invert approximately 20m, to transfer flows from mid-levels sewers to Abbey Mills pumping station.
- 2.8km of 1.2m and 900mm diameter sewers constructed by micro-tunnelling running at a depth to invert of 6-12m.
- 2.5km of cut and cover sewer upgrades, ranging in diameter from 350mm to 1.3m.
- 24 pre-cast concrete caisson shafts acting as collector points for storm flows from the mid and high level sewers and drive and reception shafts for the tunnels. These vary in diameter from 4.2m to 7.5m and include 22 overflows carrying between 100l/s and 3,000l/s.
- A terminal pumping station at Thames Water's existing Abbey Mills Pumping Station site. This is to be constructed as a wet-well/dry-well arrangement with two duty-standby

500l/s fixed speed main pumps, with a static head of 20m and a friction head of 10m, supplied by Hidrostal. Two 44l/s wet well drain pumps, supplied by Flygt, will also be provided.

An additional £9m package connecting into the West Ham FAS tunnel is being constructed concurrently under the separate Clova Road FAS contract. This comprises of 1.1km of 600mm to 1.2m diameter micro-tunnels, eight caisson shafts and approximately 230m of online sewer upgrades.

Two further inter-linked schemes are planned for construction during AMP5 - the £9m Broadway FAS in Stratford and the £2m Neville Road FAS to the south east of the project area. These will alleviate flooding at a further 100 properties to bring the combined total for the four schemes to 840.

Project development

Thames Water developed the scheme through the combination of several small-scale sewer flooding projects and flooding studies undertaken in 2005 and 2006. The original solution was to build two geographically separate storage tanks in the order of 2 x 20/25m diameter, with some 15m depth of storage. Discussions with the landowners, established that negotiations to gain acceptance for these structures would be prolonged and difficult and could delay the scheme.

A number of alternative options were considered, with the most cost effective long-term solution being to construct a new deep-level strategic sewer, which would also provide capacity for future extensions. This will act as an overflow facility during storms for a sewer catchment area initially serving approximately 44,000 people.

Procurement

The reference design for the West Ham FAS main scheme, including hydraulic modelling and the design of the main tunnel and micro-tunnel alignments, was carried out by AECOM, formerly known as Faber Maunsell. Detailed design and the construction of the project is being procured under an ECC Option C target cost contract let to Costain Group. Costain's designers for the scheme are Halcrow Group. The Clova Road scheme was fully designed by AECOM and the construction contract was let to Barhale Construction under an ECC3 Option C target cost contract. The works for both schemes are due to be complete by the end of March 2010.

Hydraulic modelling

AECOM carried out solutions development for the project using a verified Infoworks CS hydraulic model built by Thames Water's in-house modellers. A particular feature of the area is that many of the existing sewers surcharge above ground level during storms. In view of this AECOM carried out 2D hydraulic modelling in addition to the conventional 1D modelling. This uses topographical data to map out where water escaping from the sewerage system would flow. This information was used to indicate where properties were at risk of overland flooding so that targeted flooding investigations could be carried out using customer questionnaire surveys and physical inspections.

In addition to computer-modelling, a number of physical models were built both at the reference design stage and detailed design stage. Hydrotec constructed models to optimise the design of a number of drop pipes within shafts as well as the discharge point for a 3,000l/s gravity overflow from the pumping station. BHR Group produced a physical model to optimise the layout of the 12.5m diameter wet well/dry well sump.

Third party liaison

Due to the scheme's congested urban location, good public relations and third party liaison have been a key requirement of the scheme. A number of stakeholder approvals have been required including London Borough of Newham, Transport for London, Network Rail (NR), High Speed 1 (HS1), the Metropolitan Police, other emergency services, local businesses and residents.

The main 2.8m diameter tunnel passes above the recently constructed National Grid and EDF cable tunnels, which carry power lines beneath the Olympic Park. It also passes beneath London Underground's Jubilee Line and above High Speed 1's twin tunnels between St Pancras and Ashford. Due to the high running speeds of the HS1 services, Costain and Halcrow carried out a 3D finite element analysis of the effect of the West Ham tunnel on HS1's infrastructure using the FLAC numerical modelling package. Costain is also carrying out real-time electro-level monitoring of the track bed, through subcontractor Datum, during the transit of the main tunnel above HS1 and the construction of three micro-tunnelling shafts close to the HS1 down line.

Tunnelling challenges

Ground conditions in the area are variable, consisting for most of the route of mixed cohesive and granular deposits of the Lambeth Group and underlying Thanet Sand Formation. Groundwater conditions are complex with an upper aquifer comprising the River Terrace Deposits, an intermediate aquifer zone comprising the Harwich Formation and Lambeth Group and a deep aquifer comprising the Chalk and Basal Sands. Groundwater bearing strata and associated groundwater levels are expected to vary across the scheme. Levels up to 10m-14m above the invert of the main tunnel have been identified during investigation works.

General view of the entry shaft at Abbey Mills *Courtesy of Thames Water*

Costain is using a newly-purchased Lovat earth pressure balance machine to drive the main tunnel. This has a maximum torque of 1,830kN, rotation speed of 4.8 rpm and is fitted with chromium carbide-coated rippers and scrapers. The drive is hydraulic with two electric motors and variable displacement pumps.

Organic compounds including both light and heavy fractions have been identified in the ground and groundwater at the main tunnel launch shaft at Abbey Mills, these may be related to past land usage in the surrounding area. As a result a number of precautions to prevent contamination of the deep level aquifer have been implemented. These include constructing a secant-piled wall to act as a cut-off for contaminated groundwater around the top two thirds of the shaft and a programme of groundwater monitoring. To deal with hydrocarbon vapours associated with the organic contamination Costain has implemented a specialised working regime after liaising closely with the Health and Safety Executive before the start of work. This includes health monitoring for workers and a "red zone" access system, within which full face mask and suit protection is required.

As the area was heavily bombed during the Second World War a

number of intrusive unexploded ordnance surveys have been carried out at shaft locations prior to the start of excavation.

Sustainability and environment

The environmental impact of the scheme has been minimised through a number of initiatives including the re-use or recycling of 74% of all spoil to date and the use of a Trenchmod recycling plant on-site for open cut sections of work. Waste streams such as timber, metal, concrete and plastics are also being segregated on site for recycling.

Costain is carrying out vibration, noise and dust monitoring where work is being carried out close to businesses and residential property. In addition, lorry movements for the removal of spoil from the main tunnel are being strictly controlled to minimise the impact on local traffic.

Operational and maintenance considerations

Pre-cast concrete shaft and tunnel segments, supplied by Charcon and Buchan, have been designed to last 150 years to minimise the need for future maintenance. A safe system of entry into the main tunnel for inspection purposes has been developed by Costain, including the provision of penstocks in a number of shafts to isolate storm flows from the mid-level collector sewers. These will be operated using portable pneumatic actuators to minimise opening and closing times while also removing the maintenance requirements of electrical actuators.

A forced ventilation system is being provided to enable safe entry for Thames Water operatives into the dry well. The fan capacity has been designed to provide up to four changes of air per hour.

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