Chamberlayne Road Flood Alleviation Scheme

upgrading an ageing combined sewer network and increasing capacity to protect against basement and overland flooding

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Chamberlayne Road and the surrounding area is a well-developed and busy part of north-west London. There are several major road, bus and rail networks in an area where open space is at a premium. The existing sewer network is a combined system that drains to Beckton STW. As London has grown, the vast majority of any remaining permeable ground has been built upon. Subsequently, there is now a significant lack of hydraulic capacity in the network, particularly during summer-time flash floods caused by high intensity rainfall inundating the sewer system. This has resulted in many local businesses, residents, schools and churches, experiencing internal flooding from the combined sewer.

Tunnelling rigs setup in main shaft - Courtesy of Optimise

Thames Water flooding programme

Optimise is Thames Water's AMP5 delivery partner for networks in North London and Thames Valley and is a joint venture of Murphy, Barhale, Clancy Docwra and MWH. Midway through AMP5, Thames Water briefed Optimise to remove 280 properties from their sewer flooding register, through a design and construct programme that would meet strict regulatory requirements and be cost affordable. It was a significant programme of work to undertake and required completion before the end of AMP5.

Understanding the flooding problem

The Chamberlayne Road Flood Alleviation Scheme was identified in July 2013 and, as with all projects in the flooding programme, it had to first pass through a significant screening process and needs assessment in order to clearly understand the flooding mechanism.

Numerous asset surveys were necessary in order to update and run the hydraulic model, to establish root cause and define possible solutions. Ongoing communication with customers played a key part in determining the flooding mechanism and revealed a joint issue of overland flooding occurring, along with basement flooding from direct connections to the sewer. The results of the investigations were fed continuously into the MWH flood risk tool and hydraulic model. A detailed 2D mesh was created using topographical surveys and LiDAR ground level data. The flood volumes from the 2D hydraulic model were transposed onto the ground level mesh to replicate the overland flooding and predict the impact on neighbouring properties, see Figure 1 (next page).

The needs assessment was subject to stringent controls put in place by Thames Water and, therefore, it ran concurrently with outline and detailed design, during which time phased design freezes were implemented to gradually refine the solution.

Solution development

By the time site investigations and hydraulic modelling assessments had been sufficiently progressed to begin outline design, there was little over 12 months to achieve project takeover on a £6m

Flooding in Chamberlayne Road - Courtesy of Optimise

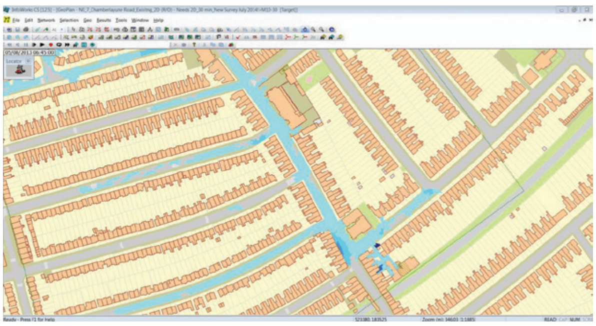


Figure 1: 2D hydraulic modelling - overland flooding for a 1:10 Year event

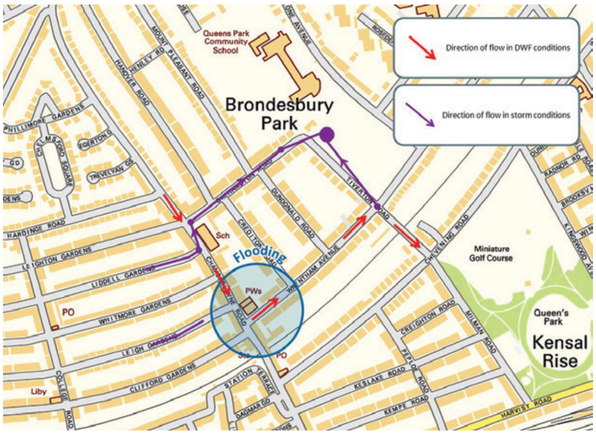
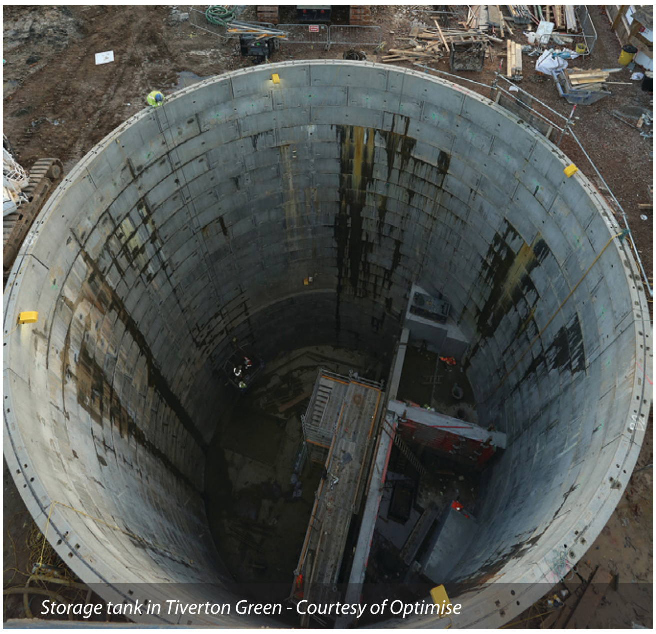


Figure 2: Site Layout - Courtesy of Optimise



Storage tank in Tiverton Green - Courtesy of Optimise

scheme. The scale of the hydraulic incapacity ensured that offline attenuation would be necessary in order to provide the 1 in 30 year flood protection standard. A substantial underground storage tank and associated above ground structures, including a control kiosk, a 6 m high pressure relief column and large access covers, would be required. Crucially, for the project to be a success, early and regular collaboration was established between design, construction, planning and third party communication teams. This took full advantage of the joint-venture approach to design and construction and ensuring each discipline would have a real opportunity to shape the final solution.

Various design options that delivered the required hydraulic performance were considered alongside cost, constructability, carbon footprint and impact on the local community. The construction partner for this scheme, Barhale, was consulted during the option development phase which enabled a more robust solution at an earlier stage in the project.

A solution which favoured a considerable proportion of trenchless construction techniques was selected over open-cut excavation, offering significant reductions in noise and road closures affecting residents and schools, despite putting greater pressure on the construction programme. The final solution comprised a 15m diameter underground offline storage tank, approximately 650m length of 1.2 m diameter microtunneling, to convey storm flows from the combined network to storage, and a further four intermediate shafts to enable tunnelling works and allow operational access to the sewer (see Figure 2).

To build a solution capable of protecting properties from a 1 in 30 year event, a storage volume of 1,700m^3 was required. In a developed area there were few locations suitable to construct such a large underground structure that could work within the existing hydraulics. Tiverton Green (approximately 400m from the flooding properties) was selected as the optimal location; however it is a popular place for families and locals to enjoy the playground and outdoor gym facilities, as well as providing open space for dog walkers. The Friends of Tiverton Green were consulted on the plans and the design of the finished park layout to build support for the solution. Early collaboration and a pre-application consultation with the Local Authority, Brent Council, enabled a straight-forward transition from design and planning consent to construction. The design team and landscape architect created a solution that lived up to the expectations of residents for the finished park and the requirements for safe operational access to the storage tank.

In dry weather flow conditions, the existing sewer network continues to pass flow forward, as it did before the solution was implemented. During surcharge events, a float-operated penstock and level monitors, installed upstream of the low-lying properties, control the pass-forward flows and protect downstream properties from flooding. A system of weirs, upstream of the penstock, diverts storm flows into the 1.2m diameter sewer towards the Tiverton Green storage tank. With the tank located 400m away from Chamberlayne Road, a key design feature was to capitalise on the additional online storage provided by the 1.2m diameter sewer.

The local topography and limitations in site selection of the storage tank meant that the 1.2m diameter inlet and outlet are at approximately half the full depth of the shaft. Within the storage tank, storm flows are conveyed through the shaft within a channel in the slab that is suspended at the mid-depth of the structure. The high and low level weirs are partitioned to ensure that the first spill protects the most vulnerable properties from flooding and a delayed second spill occurs only after the full upstream online storage has been utilised. Regular discussions were set up with Thames Water Operations and other local schemes to establish consistency in the design approach across the flooding programme and to assist future operation and maintenance.

Construction

The construction of the shaft was divided into two phases; the first phase excavated to the mid-depth at which point a temporary concrete base was constructed with RSJs cast in, to enable two tunnelling rigs to be set up, each driving to a different point in the sewer system. A 1.2m diameter Iseki tunnel boring machine was used to carry out the microtunneling and a mud separation plant was set up at two locations to dry the slurry and recycle the water throughout the tunnelling process.

This reduced disruption by minimising the frequency of muck wagons to site. A specialist tunnelling surveyor was employed to construct a curved microtunnel, with a radius of 350m, along part of the 1.2m diameter sewer to avoid intersecting property boundaries and reduce any potential impact of settlement on buildings.

Following completion of the tunnelling, the second phase of the shaft construction was carried out; the temporary base was broken out and the shaft was excavated to formation level at approximately 28m below ground level. This resulted in large hoop compressive forces in the shaft wall where the cuttings had been made for tunnelling. In the temporary case, steel gland plates were bolted around the openings, however, for the permanent design, concrete headwalls were constructed into the shaft wall with additional support provided by the weir wall and slab.

The weir slab was constructed off-site by the precast concrete supplier, FP McCann, and called to site when required. It was lifted into place and supported on steel beams, columns and a corbel ring. Steel was preferred over concrete to ease assembly and provide greater strength. A concrete lining was cast around the steelwork prior to installation using a simple shuttering system and the joints were finished using small quantities of sprayed concrete, once in place. The remaining weir wall and partition was constructed in situ using a PERI wall formwork system to reduce the complexity of the temporary works for this aspect of the construction. The loading on the weir slab was minimised by using Cordek Filcor 190 structural polystyrene blocks to reduce the volume of concrete.

The ground conditions, being London Clay, lent themselves favourably to a variety of construction techniques, enabling efficient progress. The main 15m diameter shaft was constructed by underpinning, typically seeing one ring constructed per day including grouting of the annulus behind the shaft segments. Other intermediary shafts used a combination of jacked caisson rings and smaller underpinned segmental shafts, depending on the site-specific conditions.

Summary

Given the programme constraints imposed on this project and the complexity of the solution, the design was undertaken concurrently with the start of construction. A design engineer was permanently based on site to coordinate the remaining design activities with the procurement and construction stages, as with other key schemes on the flooding programme. This provided huge benefits in rapidly getting the construction teams up to speed with design and stakeholder concerns.

The construction was completed ahead of schedule and reinstatement of the park is in its final stages, with a community orchard due to be planted in the autumn of 2015. The project received praise from local residents, who had particularly appreciated the weekly public drop in sessions based on site throughout construction.

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Mid level weir slab and wall - Courtesy of Optimise