Sudbourne Road Flood Relief Scheme

investment in Brixton to remove properties from the Sewer Flooding History Database

by Khem Limbu

Five properties on Sudbourne Road, Brixton, are listed on the Thames Water Sewer Flooding History Database (SFHD) as suffering from foul water flooding. It was believed that the flooding mechanism was a lack of sewer capacity within the catchment, and customer questionnaire surveys were carried out over four separate days in August and September 2010 to try to confirm that this was the case. A number of the properties that replied to the survey reported flooding due to ingress of water through the walls and floors of their basements. A solution to the flooding problem had to be found to remove the 5 (No.) properties from the Thames Water SFHD, which ensured that the properties did not flood during a 1:30 year rainfall event.

Pipe-jack machine ready to be launched from the drive shaft *Courtesy of MGJV*

Undertakings

Thames Water is working with its delivery partner MGJV (Morrison Galliford Joint Venture) to deliver capital improvements to the wastewater network in South London. The contractor's team worked closely with its designers, Mott MacDonald, to develop the solution to flooding problems in Sudbourne Road.

Hydraulic modelling

Thames Water had previously assessed overall foul and combined flooding in the Lambeth & Southwark catchment, which includes Sudbourne Road, under a separate project. The Lambeth & Southwark (L&S) Infoworks model was made available to Mott MacDonald. The model provided by Thames Water had been verified along trunk / main sewers in the Lambeth & Southwark catchment but not locally around the Sudbourne Road area.

The L&S model verification was reviewed and was considered reasonable for the Lambeth & Southwark catchment, but not suitable for assessing the flooding on Sudbourne Road, as the model had been simplified in the area surrounding the driver properties. Therefore a new flow survey was undertaken to verify the model locally to understand the flooding mechanism. A localised manhole survey was also undertaken. The model was then updated with the manhole survey data, and verified with the flow survey data. The updated verified model suggested that the flooding mechanism was 'basement flooding' caused by high surcharge levels in the surrounding network, generated by general lack of capacity in the surrounding network. The updated model predicted flooding for a 1:10 year design event.

The preferred option was added to the updated L&S model to ensure that the properties would be protected during 1:30 year rainfall events. The surcharge levels would also be maintained at least 0.5m below the basement connections along Sudbourne Road.

Developing the preferred option

Sudbourne Road is a typical residential London street affected by the normal urban constraints that would be expected in any such environment. The main constraints identified were the heavy

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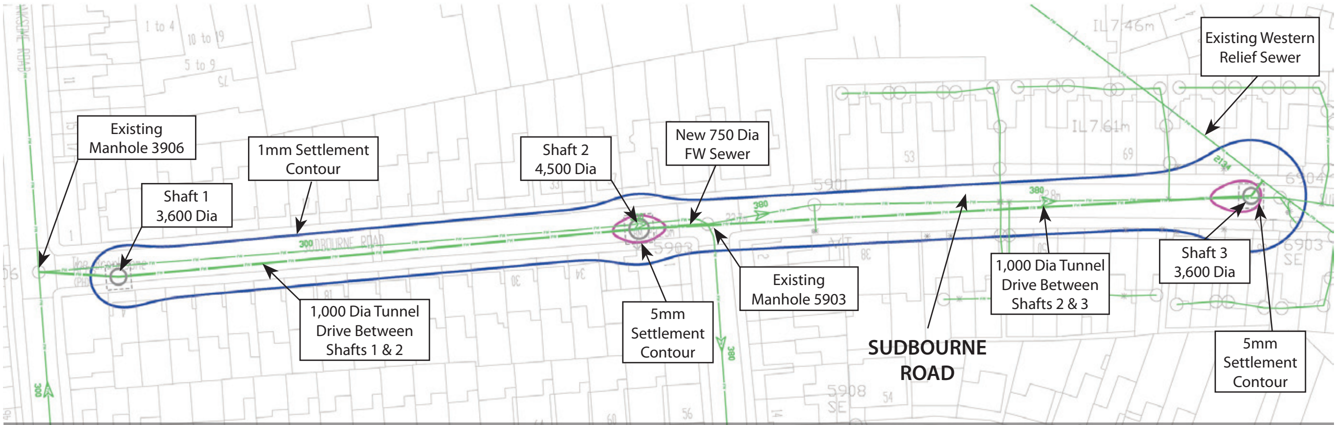


Settlement contours plan showing the locations of all the shafts. Drive shaft 2 is in the centre and the reception shafts are on either side of it. The new foul sewers are shown in bold green and the connection into the Western Relief Sewer from Shaft 3 is shown - Courtesy of Mott MacDonald

density of buried services, the need to maintain vehicle access for both residents and local buses, and an existing width restriction on part of Sudbourne Road.

Four options were considered at the optioneering stage. The preferred option chosen was a rider sewer to the existing sewer in Sudbourne Road spilling to the Western Relief Sewer. The Western Relief Sewer is an existing brick sewer which crosses Sudbourne Road at an approximate depth of 15m below ground level.

The existing sewer in Sudbourne Road has an invert level of approximately 4-5m below ground level. A parallel sewer installation at a similar depth using an open cut methodology would have required difficult excavation around many services and existing lateral connections. Trenchless construction techniques were therefore selected for this scheme. By tunnelling beneath the depth of the existing sewer the risk of clashing with other services could be minimised. The preferred solution was then developed into a tunnelled solution beneath Sudbourne Road at detailed design.

As detailed ground information was fundamental to design the underground works, a ground investigation was initiated early on to confirm the geology and suitability of the proposed shaft locations. To understand the potential risk of unexploded ordnance, a specialist desktop assessment was also carried out. The settlement analysis undertaken to assess the level of risk to adjacent properties and existing services confirmed the suitability of the preferred option.

Tunnel Design

Following a review of site constraints, three shaft locations were selected along Sudbourne Road. Two reception shafts would be located to the east and west of the drive shaft which would be used to drive the pipe jack towards the reception shafts. Hydraulic calculations were carried out, which showed that the new tunnelled sewer would need to be at least 600mm diameter between shaft 1 and 2, followed by at least 900mm diameter between shaft 2 and 3. However, the size of the drive and reception shafts for pipe jacking and the achievable drive lengths are a function of tunnel diameter. The distances between the three shafts gave a preferred tunnel diameter of 1,000mm. The Thames Water specification and tunnelling requirements gave a preferred size of the reception and drive shafts of 3,660mm and 4,500mm respectively. At detailed design, installation of the three shafts was designed to be installed using an underpinning method to suit the contractor's preferred method of working.

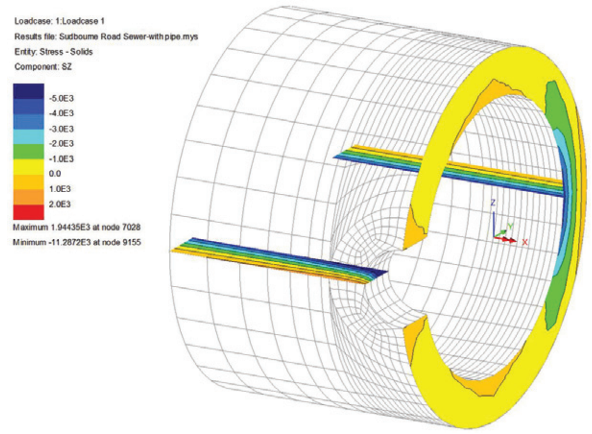
Flow from existing manholes 3906 and 5903 would be diverted to shaft 1 and 2 respectively. The connection sewers sizes would be 600mm between manhole 3906 to Shaft 1, and 700mm between manhole 5903 and Shaft 2. These sewers would be installed using open cut method approximately 3.5m below ground level. Internal backdrops in both shafts would then divert the flow to invert level of the shafts which would be approximately 8m below ground level. The invert levels of the two diversion sewers above, would be set above the invert levels of the existing sewers at the manholes so that they would come online only when the existing network surcharged. Flows entering the new sewer would then gravitate to the existing Western Relief Sewer. The 5m connection from Shaft 3 to the Western Relief Sewer would be made using stitch drill to install a 600mm diameter sewer.

To summarise, the preferred option required the design of the following:

- One drive shaft (4,500mm diameter) and two reception shafts (3,660mm dia) to be installed using underpinning method. The deepest shaft would be about 17m deep.
- Installation of 270m of 1,000mm concrete sewers using pipe jacking at a depths of about 8-9m below ground level.
- Installation of 40m total length of ductile iron overflow sewers (600mm diameter from MH3906 to Shaft 1 and 700mm diameter from MH5903 to Shaft 2) using open-cut method at depths of about 3.5m below ground level.
- Installation of 5m connection sewer from Shaft 3 to the Western Relief Sewer using stitch drilling technique to connect the outfall pipe into the circular brick storm relief sewer with minimal confined space working at a depth of about 15m below ground level.

Challenges

The biggest challenge of breaking into the existing sewer was that it was a 1924 built live storm relief sewer (normally empty), which needed to continue to operate even when adjacent excavation was



Stress patterns as assessed by in-house Mott MacDonald specialists to confirm that breakout into the existing brick lined sewer would be possible - Courtesy of Mott MacDonald undertaken. It thus needed to cope with the impact of stress relief from both the adjacent shaft excavation and subsequent break in works. The design approach needed to simulate this effect and satisfactorily develop a method which would cause least impact to its stability and operation.

The final solution involved the construction of deep shafts within a busy urban environment, uncharted underground services, a narrow working area, and undertaking major construction outside residential property including the risk of tunnel induced settlement.

The construction team undertaking the project have previous experience of similar micro-tunnelling in the Brixton area, and were confident that the Herrenkenecht AVN machine proposed would handle the ground conditions (stiff London Clay). After initial problems, the cutting head was modified and the programmed 10m per day was achieved.

Added value

The preferred solution, including micro-tunnelling, and the number of, and location of construction shafts, was designed to minimise the impact and disruption on local residents.

MGJV's construction background, together with Mott MacDonald's experience and expertise in tunnelling design and ground behaviour assessments, meant the chosen options were feasible against the various technical, programme and environmental constraints imposed on the project. Shaft locations, sizes and tunnel sizes selected were all specific to local constraints, which also addressed CDM requirements. Past experience in similar projects meant the team were able to foresee potential risks, and address them from the onset with considerations for managing the risks.

In the case of connecting to the existing brick lined sewer, in-house specialists assessed stress patterns for the sewer with 600mm diameter breakout, to confirm the contractor's methodology for connecting into the sewer. Unwanted tension stresses were restricted locally to the breakout causing no structural problems.

Designing of shafts in close collaboration with the contractor's method of working, allowed the designers to understand every step of the process, and provide a design appropriate for short or long term needs. An example is designing the deep shaft, which if designed for permanent situation would have required thicker special segments. Understanding the whole process meant the design could consider short term loads only as appropriate for the situation, thus leading to savings for the contractor by not procuring thicker segments. In the longer term, the lower 7m of the shaft will be backfilled with concrete, after the connection works to the existing sewer and the vertical pipe is in place, hence it was no longer a shaft but rather a solid mass of concrete with pipe within.

Conclusion

Thames Water customers benefitted as the five properties affected by flooding were removed from the Thames Water SFHD. During the design and construction process, the methods chosen were considerate of the surrounding environment, thus leading to minimal impact on residents. The early involvement of the construction team in the design process and adapting the design to suite the preferred tunnelling method has enabled significant cost savings.

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