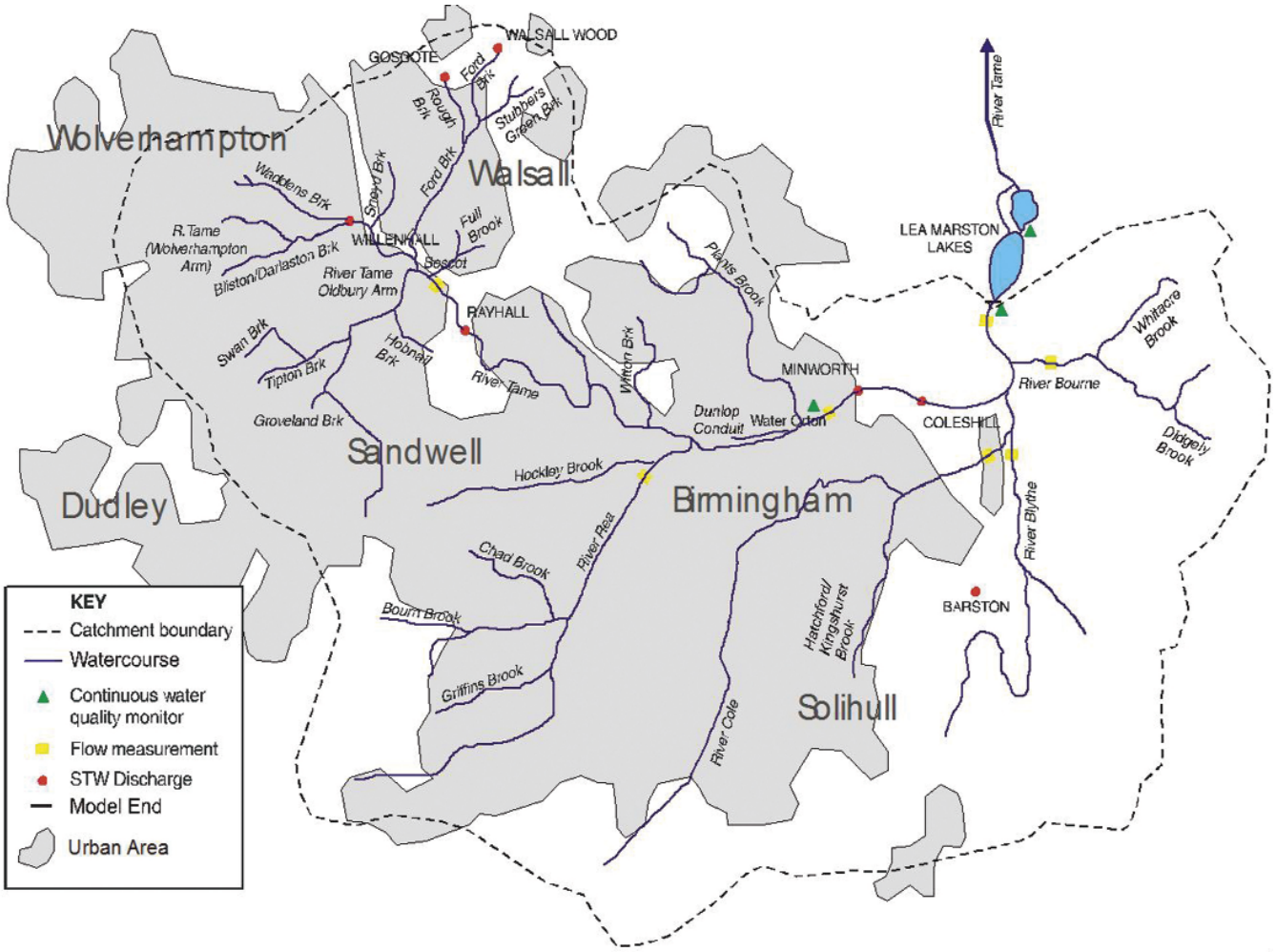
Tame Urban Pollution Management

Foxton Road & Sir Johns Road CSOs - collaborative working to deliver innovative solutions

Severn Trent Water Ltd has undergone a massive investment programme in the River Tame catchment over the AMP3 / AMP4 period (2000 to 2010) with the emphasis on improving the river quality of the River Tame and its many tributaries. Within the catchment there are 374 Combined Sewer Overflows (CSOs), providing hydraulic relief points for the sewerage system during periods of heavy rain, 92 of which were identified and categorised as Unsatisfactory Intermittent Discharges (UIDs) to be improved.



River Tame catchment *Courtesy Severn Trent Water*

WRc were commissioned to assist STW by carrying out a major Urban Pollution Management (UPM) study for the Tame catchment. The River Tame UPM catchment has an area of 1,067km^2 covering the whole of Birmingham, Solihull, Sandwell, Walsall and the majority of Wolverhampton and Dudley. The population is approximately 1.9 million and there are 6 significant sewage treatment works within the catchment.

To complete the UPM study, it was first necessary to upgrade and verify the individual sewer hydraulic models and integrate them by adding the major 'Black Country Trunk Sewer', which carries flows from Wolverhampton, Walsall, Sandwell and central Birmingham to Minworth Works to the east of Birmingham.

WRc used the integrated sewerage model to help conceptualise a SIMPOL3 water quality model of the complete system, including receiving watercourses. This model was calibrated against the sewer model and sampling data collected from the river reaches. The model was used to establish the base line performance and additional storage requirements to achieve water quality standards agreed with the Environment Agency.

Two major projects, both part of the southern area River Tame UPM programme, are described in this article.

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Proud to have been part of the team delivering the Foxton Road UID Project

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Foxton Road CSO
Washwood Heath, Birmingham

The CSO located in Foxton Road, Washwood Heath in Birmingham was identified as an UID as part of the Tame South UPM Study. The receiving watercourse, the Washwood Heath Brook, flows through a parkland of high amenity value and suffers from aesthetic pollution and a reduction in water quality due to excess spill flows. Three other UIDs were initially identified discharging to the Washwood Heath Brook; Ward End Park Road / Washwood Heath Road was shown to be satisfactory following detailed analysis and a joint scheme to address Harts Road and Nansen Road UIDs was completed in 2003. The improvements to the sewerage system were considered holistically with all of the storage to address the water quality problems provided at the Foxton Road site.

Foxton Road Site during piling works *courtesy of Forkers Ltd*

Restricted site

Many of the Tame UIDs have been located in heavily urbanised areas and for the Foxton Road scheme, Severn Trent Water commissioned Mott MacDonald Ltd (MM) to investigate the feasibility of constructing the scheme on such a restricted site. In addition to the technical and construction difficulties managing the customer interface was extremely important as several residents would have restricted access to their properties throughout the works in addition to concerns over the proximity of major works.

Restricted Access for Some Residents *courtesy of Forkers Ltd*

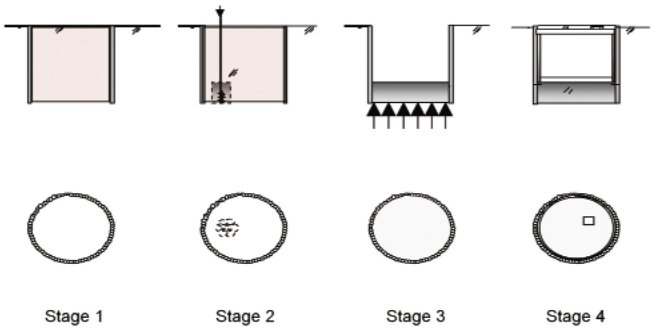
The scheme comprises of a new CSO chamber, incorporating a mechanical screen, and the provision of 1000m³ of shaft storage. The spill flows will be screened to 6mm, for rainfall events up to a 5 year return period, and the stored flows returned to the sewerage system after the rainfall event has finished.

Design

For the design and construction of the shaft (12.5m diameter by 12m deep), various options had been considered by Mott MacDonald. The main considerations were the high ground water table and the close proximity of the residential houses to the shaft location. As sand materials exist to a depth of approximately 30m below ground with the groundwater table close to the ground surface, if large scale pumping is required during construction, it will be bound to cause unacceptable settlement to the adjacent house structures. Constructing piles to 30m depth to form a complete cut off is neither technically attractive nor economically desirable.

Secant piling shaft

Taking into considerations all the constraints, MM recommended the option of adopting a “shallow” secant piling shaft with a jet grouted plug formed at the bottom of the shaft to support the excavation. The shaft was formed in circular shape with 72 No. secant piles of 880mm diameter. 76 No. single and double jet grouted columns ranging from 1.6m to 2.8m diameter were used to form the grout plug at a depth between 12.5m and 17.5m below ground.



Grout Plug Construction Sequence *Courtesy of Severn Trent Water*

Case Secant Piling Construction *Courtesy of Mott MacDonald*

While the design of the secant pile shaft was relatively standard, the design of the jet grouted plug required serious consideration. The plug was analysed as an arch to resist the water pressure below. The compressive strength of the soilcrete (cemented soil) was a key consideration in the design. The plug will also need to be bonded to the secant pile surface such that the two elements can act together against the full hydrostatic uplift load. Due to the potential high variation in the quality of the soilcrete and the consequence of failure to the adjacent households, an appropriate factor of safety was built in the design. Another key parameter to be considered for the soilcrete is its permeability. Substantial water drawdown outside the shaft would still occur if too much water entered into the shaft.

Construction

Forkers Ltd is the main contractor for the works and Bachy Soletanche (BS) was the subcontractor carrying out the secant piling and jet grouted column works. As the quality of the grout plug heavily depends on the grout mix design and jetting technique, BS also carried out the final design of the jet grouted columns. The cased CFA technique was adopted for the secant piling works and which was proven to be a much faster method of completing the 18m long secant piles. Site control was crucial to ensure the quality of the jet grouted columns works met with the design requirements.

During construction, a tight monitoring programme was implemented to monitor the ground and groundwater movement. The completed works have lived up to the design expectation. The permeability of the soilcrete was estimated only to be in the order of 1 x 10^{-9}m/s and most of the cored samples taken from the grout plug reached the design strength. Very minimal dewatering was required within the shaft during the excavation works and no tangible ground movement had occurred as a result.

Programme

Work started in September 2009 with beneficial use of the asset achieved in March 2010 meeting the regulatory delivery date. The complete project costs are £3.4m.

Severn Trent Water and Forkers Ltd have received praise from the local residents for the level of communication regarding the scheme and managing the disturbance during the construction phase.

Drilling of Jet Grouted Columns *Courtesy of Mott MacDonald*

Sir Johns Road CSO
Cannon Hill Park, Birmingham

Sir Johns Road CSO is in the Selly Oak area to the south of Birmingham city centre within Birmingham City Council's Cannon Hill Park and serves a population of approximately 149,000. The catchment served by the CSO is predominantly partially separate. The CSO is a high sided weir which spills via twin 525mm diameter pipes to the River Rea which in turn discharges to the River Tame. Continuation flows discharge via the Lower Rea main trunk sewer to the Black Country Trunk Sewer and onto Minworth STW.

Hydraulic & Water Quality Analysis

Hydraulic analysis of the catchment was completed using a macro model of verified Hydroworks & Infoworks drainage area models within the Tame catchment. WRc used this hydraulic model to build, conceptualise and calibrate a SIMPOL catchment model to identify water quality problems in receiving watercourses caused by poorly performing CSO's and additional storage requirements in the sewer network necessary to achieve the required improved river quality.

The Tame UPM study identified Sir Johns Road CSO as a large spiller with a predicted spill frequency of 58 spills per annum and an annual spill volume of approximately 233,000cu.m. The UPM study suggested 3,000cu.m of storage was required at the overflow to secure biochemical oxygen demand (BOD) compliance in the local watercourse (River Rea). An additional 7,000cu.m was also recommended to assist in reducing the dissolved oxygen (DO) non-compliance in the Lower Tame.

During AMP4, local re-verification of the hydraulic model was undertaken including flow monitoring and updated asset surveys. These changes as well as improvements completed in other catchments local to Sir Johns Road CSO were used by WRc to re-assess storage requirements. Analysis showed that the there were no local quality compliance issues in the River Rea. Various storage volumes were then assessed to determine the optimum storage required to address DO non-compliance in the Lower Tame. A solution incorporating 4,075cu.m of storage and an increased pass forward flow was approved by the Environment Agency as being acceptable to meet the overall spill reduction requirement of 5,000cu.m and deliver the improved river quality.

Solution Development

Following identification of the storage requirements at the CSO, a delivery team consisting of STW's In House Asset Delivery team with Barhale Construction appointed as main contractor worked collaboratively to develop the preferred solution procured using a Target Price Contract in accordance with STW's AMP4 Contract Strategy. STW's In House Service Delivery team responsible for future operation and maintenance of the new assets were an integral part of the delivery team in ensuring operational risk was considered at each stage of the solution development process.

The existing CSO is within a heavily wooded area of Cannon Hill Park where access for construction plant would be difficult. An area downstream of the CSO, still in the park, and known as the 'redgra' area offered the ideal location to relocate the CSO and storage tank to, both for construction and also future operation and maintenance.

The key features of the developed solution are:

- New bifurcation chamber on the Lower Rea Main trunk sewer to replace the existing CSO with a 1050mm continuation sewer connected to a new CSO;
- New CSO incorporating a Longwood Stormguard model 650 6mm mechanical screen with 825mm diameter continuation sewer connected to the existing trunk sewer and 1050mm diameter overflow pipe connected to a pumped return storage tank;
- 4,075m³ of screened storage incorporating pump return with a capacity of 256l/s operating on a duty/assist/standby basis;
- New 1050mm diameter overflow pipe from the storage tank to a new outfall structure discharging to the River Rea.

Aerial View of storage tank site *Courtesy of Commission Air*

First Weholite manifold placement *Courtesy of Barhale Construction*

This solution allows flows to spill via the new bifurcation chamber diverted through the new CSO with spill flows screened before discharging to the storage tank. Depending on the rainfall intensity and the consequential volume of spill to the tank, the total spill is either retained in the tank or if the spill volume exceeds the tank capacity, the additional screened spill volume discharges to the River Rea. Level control equipment located in the pumped return manhole on the trunk sewer inhibits emptying of the tank until the storm has abated and levels in the receiving trunk sewer return to normal.

In developing the preferred construction method for the storage tank, the delivery team considered a number of alternatives including:

- A reinforced concrete storage tank with separate pump return chamber;
- A series of linked shaft storage tanks with pump return;
- A series of Weholite HDPE pipes with integral pump return chamber.

The delivery team considered each alternative with respect to buildability, programme duration, health and safety, operation and maintenance, cost and carbon reduction and agreed to proceed with more innovative Weholite HDPE solution. The pipe supplier, Asset International, worked closely with the delivery team to develop the optimum solution which included approximately 500m of 3.5m diameter pipe laid in 47m long rows interconnected by nine manifold sections and includes a 3.5m diameter integral sewage pumping station.

Publicity

Cannon Hill Park is a popular public open space in the centre of Birmingham and is also used as a thoroughfare by cyclists making their way to and from the city centre. Before work commenced, STW hosted a 3 day publicity drop in centre in the park to inform STW's customers and park users of the impending works. This event was supported with a press release, publicity leaflets and a link on the

River Rea through Cannon Hill Park *Courtesy of Severn Trent Water*

Weholite tank construction *Courtesy of Severn Trent Water Ltd*

STW website. Members of the delivery team also supported park user groups at a number of public events in the park again to promote STW's work and to keep the community informed. The publicity campaign helped keep enquiries during construction to an absolute minimum bearing in mind the high profile location of the site.

Construction and Programme

This large CSO project has improved operational performance of the sewerage network in Cannon Hill Park through the construction of a new screened CSO and associated storage tank. The project has significantly reduced aesthetic pollution in the River Rea and has helped address water quality problems in the Lower Tame.

Work started in May 2009 and the new assets were commissioned in March 2010 meeting the regulatory delivery date for the project. Final reinstatement and soft landscaping is due for completion in June 2010. Delivery of the project was achieved for a total cost of £3.33M. During 11 months of construction there were no lost time incidents, no written customer complaints and no category 1, 2 or 3 pollution incidents.

Conclusion

Severn Trent Water Ltd has undergone a massive investment programme in the River Tame catchment, Foxton Road and Sir Johns Road are two examples of collaborative working to deliver innovative solutions to meet the required water quality standards. The collaborative approach adopted during the design and construction process of the projects clearly demonstrates the delivery team's capability of developing the best investment choice for STW and its customers. The projects also demonstrate how STW's investment is meeting the objectives set out under the company's Key Strategic Intentions of dealing effectively with waste water and minimising our carbon footprint.

Note: ***The Editor and Publishers thank Severn Trent Water Ltd for providing the above article.***■