

Colebrook Flood Alleviation Scheme

South West Water, the Environment Agency and Plymouth CC join forces to solve a long-term flooding problem in a busy suburb of Devon's largest city

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The village of Colebrook in Plympton, Devon, has historically suffered from flooding for over 20 years due to overloaded combined sewers and surface water drainage systems. The once isolated village on the eastern outskirts of Plymouth city is now surrounded by residential and industrial developments and the sewage and surface water loading has increased over the years. In severe storm conditions up to 47 properties were affected by the flooding, resulting in damage to buildings and property, loss of trade and significant clean-up costs.



Outfall cofferdam during construction - Courtesy of H5O

Scheme drivers

Schemes to address the flooding had previously been considered by individual statutory authorities; however these had either been unaffordable or resulted in minor works with marginal benefits. In 2013 local residents set up the Colebrook Flood Action Group and, with the support of their MP and councillors, began campaigning for improvements. Additional legislative pressures under the Environmental Protection Act 1990 also generated momentum for the delivery of a scheme. South West Water promoted an Integrated Urban Drainage Management Study for Plympton in 2011, which was completed by Hyder Consulting by 2014.

As part of this work, Hyder facilitated the formation of a partnership of the local statutory flooding stakeholders. The study resulted in an improved understanding of the problems in Colebrook, which were shown to be a complex mix of underlying causes resting within the responsibilities of all the partners. The study also identified the scheme that was ultimately promoted to alleviate the flooding.

In 2014 South West Water, the Environment Agency and Plymouth City Council announced their intention to collaborate on a £2.6m flood alleviation project, with the South West Water AMP5 H5O Alliance and its appointed partner Balfour Beatty constructing the scheme over a 12 month period.

Summary of options considered

Modelling predicted that out-of-sewer flooding mainly occurred at Golden Square Green and along Colebrook Road. The flooding is exacerbated by highway water run-off from Boringdon Hill and Lucas Lane and fluvial flow from the Boringdon Stream that discharges to the Tory Brook. An unsatisfactory and inefficient combined sewer overflow in Newnham Road was also a factor.

A range of solutions were considered including surface water separation, strategic sewer network improvements and local attenuation. In isolation, none of these were considered to be suitable due to uncertain levels of service that could be achieved,



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the impracticality of constructing large structures in narrow streets and the high cost of extensive downstream network upgrades.

The promoted scheme minimised disruption to the local community while being more economically viable. The scheme included the relocation and improvement of the existing CSO, the bifurcation of Boringdon Stream with a new outfall to Tory Brook, the rerouting of the combined sewer to avoid Colebrook Road, the addition of new surface water collection systems and provisions for managing highway run-off. The completed scheme provides 1:30 year protection against out-of-sewer flooding and 1:100 year protection against fluvial flooding.

Consultation

The key to the successful delivery of the scheme was the proactive liaison by the tripartite collaboration with local residents, businesses and landowners. Regular meetings were held with key stakeholders, the Parish Council and the Colebrook Flood Action group throughout the design and construction of the project. H2O appointed a dedicated customer liaison officer as a direct interface for residents and businesses. This ensured that the local residents and business had regular updates and feedback on the progress of the construction, along with any potential disruptive periods. The South West Water Communications team publicised the scheme via traditional print and broadcast media and used social media for regular progress updates.

New sewer

A new 300m long 450mm diameter foul sewer was laid through commercial land to the east of Colebrook Road. This route was chosen because it offered a better working area and reduced the impact on residents. However, the site had been identified for residential development. The team worked closely with the developer to determine a route for the new sewer that was sympathetic to the development proposals.

A link between Golden Square, the new sewer and Tory Brook was required for a 450mm diameter combined sewer diversion and a 1,050mm diameter bifurcation for the Boringdon Stream. The only route was along a single-track lane running between 19th century residential properties and a 3m high random rubble stone retaining wall.

Utility records indicated that services were congested under the lane, including fibre optic cabling, which was confirmed using ground penetrating radar.

An open-cut solution was rejected because it would require excavations to depths of 5m across the full width of the lane, extensive utility diversions and be in close proximity to the retaining wall. Therefore, no-dig technology was adopted. The route had a varying geological profile from cleaved slate to loose gravels and sands and Active Tunnelling Limited assisted in the consideration of various trenchless techniques.

The use of an auger-bore and slurry system was rejected due to the ground conditions and critical invert and soffit levels meant that a single larger diameter bore could not be pursued. Ultimately twin 1,200mm diameter micro-tunnels were chosen for the two parallel pipes because of difficulties in mobilising different tunnel rigs.

The potential complications of varying ground conditions precluded smaller diameter bores but the larger diameter brought the benefit of additional capacity.

CSO improvements

The unsatisfactory Newnham Road CSO in Colebrook discharged to the culverted Boringdon Stream. However, during high flows the outlet became submerged and its operation as a network relief point deteriorated. Relocation of the CSO, together with bifurcation of the Boringdon Stream, allowed the overflow to discharge freely



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to the Tory Brook for up to 1:100 year events. The new CSO structure included a 6mm two-directional Hydrok D-Screen mechanical screen that improved the discharge aesthetic quality.

The new CSO structure is 4m by 6m and 5m deep. A traditional reinforced concrete structure was considered however, following a buildability review the team decided that a prefabricated structure offered significant programme efficiencies and reduced costs. Pipex PX provided a prefabricated glass reinforced plastic (GRP) chamber with an integral former for a cast in situ cover slab and walls. The CSO chamber sits on a cast in situ base slab and came complete with weirs, pipe stubs and benching.

New outfall

To bifurcate the Boringdon Stream to relieve the existing culverted watercourse, a new outfall was required 500m upstream of the existing outfall. Surface water flows predominately enter the brook via the new outfall. The existing culverted section remains to provide relief during more severe storm events.

The in situ concrete outfall is 4m wide by 5m long, with a depth of 3.5m to the stream bed. Tory Brook has a large upstream catchment, including outflows from a mine workings, and is notorious for its quick response to rainfall events. This presented a challenge to the contractor, Balfour Beatty, particularly as the project programme dictated that the works be undertaken during the winter of 2014.

Working alongside MGF Excavation Support Systems the contractor employed a traditional propped cantilever cofferdam for the excavation with steel sheet piles driven to the rock head.

A full height cofferdam to resist the maximum hydrostatic head from an extreme rainfall event was considered uneconomic, so Balfour Beatty managed the work using a risk assessed flood relief and monitoring system. This consisted of three shorter sheet piles that would allow the excavation to flood during an extreme event, together with constant water level monitoring and a warning system for withdrawal of personnel from the cofferdam.

Monitoring of the Tory Brook indicated the presence of brown trout, bullhead eels and sea trout. The EA Fisheries Authority were keen to ensure that the passage of these fish and eels were not hampered by the new outfall, particularly as the new Boringdon Stream bifurcation would normally be flowing to approximately 3/4 depth of the 1,050mm pipe and had the potential to encourage spawning. The EA wished to avoid the use of a bar screen to prevent public entry to the new pipe due to potential problems with blockages.

As a solution to both an innovative 'cut-off' GRP flap valve was proposed. With assistance from Waterfront Fluid Controls Limited, the valve was fabricated with a 200mm gap between the invert of the pipe and the base of the flap, allowing sufficient space for the passage of fish with the flap in the vertical position. The valve was counterbalanced so as to not restrict discharge with the available upstream hydraulic head, but with sufficient weight so that members of the public could not easily lift the flap to gain access to the pipe.

Surface water management

As part of the scheme the Environment Agency was keen to address a known hydraulic pinch-point at the head of the culverted Boringdon Stream, a short distance north of Golden Square Green. The Environment Agency did not have funding for this so the H5O team worked closely with them to mitigate the problem.

The solution provided graded overland routes for exceedance flows to be able to enter the new pipe via high capacity PAM Saint Gobain Torrent gratings. Although this did not address the pinch-point directly it does manage the exceedance flow and prevent the flooding affecting Colebrook Road.



Prefabricated CSO in position - Courtesy of H5O



Completed outfall - Courtesy of H5O



New torrent gratings on Boringdon Hill in operation - Courtesy of H5O



Exceedance flow route over footway - Courtesy of H5O



Lifting of prefabricated CSO - Courtesy of H5O



Micro-tunnel in operation - Courtesy of H5O

Safety & the environment

No accidents or incidents occurred throughout the duration of the contract and careful traffic management by Balfour Beatty ensured that vehicles and pedestrians were guided through the work areas with minimal disruption.

The adoption of trenchless techniques and sound level monitoring throughout the contract substantially reduced the overall noise nuisance for residents. Despite major construction taking place only a short distance from residences no complaints were received. The trenchless method also reduced the amount of excavated material and vehicle movements. The volume of spoil removed from site was further reduced by using crushed rock arisings as Class 6 backfill.

The preliminary design identified that the southernmost length of foul sewer bypass ran through a storage yard that was heavily contaminated with Japanese knotweed. An alternative route for the sewer was not available so the H5O team employed an environmental management plan for works in the contaminated area that was overseen by Ebsford Environmental.

A geotextile and 300mm thick clean aggregate capping was placed in the knotweed area to prevent machinery or labour being contaminated with any fragmented rhizome. Excavation was undertaken through the new material, with the arisings monitored for signs of rhizome.

If encountered, they were loaded directly to lorries for transport to landfill and disposal as contaminated material. Clean pipe bedding and backfill was used for the reinstatement and upon completion the capping was disposed of as contaminated material.

Third party permissions & procurement

The Environment Agency granted an amended CSO Discharge Permit for the discharge location at the new outfall on Tory Brook. Flood Defence Consents were also granted for the Boringdon Stream bifurcation and construction of the new outfall. A planning application for the new CSO control cabinet was approved by Plymouth City Council and Wales & West assisted with the diversion of an existing gas main at the bottom of Boringdon Hill.

The team liaised with Western Power Distribution and British Telecom for new connections. Five road closures were approved by Plymouth City Highways Authority, all of which finished early due to efficient management by Balfour Beatty.

The main works were procured under the South West Water AMP5 NEC Option C framework contract, with percentage funding contributions from the Environment Agency and Plymouth City Council for their elements of the scheme.

Summary

The scheme has been an exceptional example of collaborative working between three statutory stakeholders who had a shared objective to alleviate often severe flooding in the parish of Colebrook.

Through close liaison with all parties concerned, the H5O team has delivered a sustainable and innovative, multiple-asset solution to a flooding problem that will provide protection to local residents and businesses for many years to come.

Client: South West Water Limited

Contractor: Balfour Beatty Utility Solutions Limited

Consultant: Hyder Consulting UK Limited

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