Winlaton Mill Flood Alleviation Scheme

sewer upgrades with surface water separation reduces flood risk to residential properties

by John Johnson IEng MICE ACIWEM RMaPS

As part of their AMP5 undertaking, Northumbrian Water (NW) committed to reducing the risk of flooding to all known flooding properties by March 2015. Following the severe weather of 2012, the 2014 Flooding Programme was challenged with reducing the risk of flooding to 1,135 AMP5 outputs in addition to 140 newly emerging properties per annum for an estimated cost of £57m. NW raised a Request for Assistance in February 2013 to investigate reports of internal and external flooding at properties in Winlaton Mill, Blaydon-on-Tyne, which lie within Drainage Area 05-D09 Derwenthaugh. The report concluded the cause of the internal flooding and external flooding reported at a number of properties was due to hydraulic incapacity within the public combined sewer network and the overtopping of a nearby culverted watercourse.

Installation of the dual trench - Courtesy of Grontmij

Background

Grontmij was appointed by NW to complete a Stage 2 feasibility study to consider acceptable solutions to reduce the risk of the reported flooding. This then followed with further commission to complete designed design and provide design support during construction.

Objectives

In accordance with the recommendations in the NW *"Guidance Notes for the Preparation of Feasibility Studies",* the objectives of the study where set out in terms of primary and secondary objectives. Primary objectives are those which are essential to satisfy NWL's target levels of service to customers while secondary objectives are associated with the opportunity of realising other associated benefits.

Primary objective

- To prevent combined flows discharging from the public sewer network and causing internal and external flooding during a 1 in 40 year return period storm.

Secondary objectives

- Minimise disruption to the local residents.
- Minimise the construction period of any proposed works.
- Expedite the removal of the properties from the DG5 register as quickly as possible to provide the best possible service to NW's customers.

Success Criteria

- The primary objective is the minimum criteria each option should achieve.
- Construction and whole life costs where appropriate, should be compared.

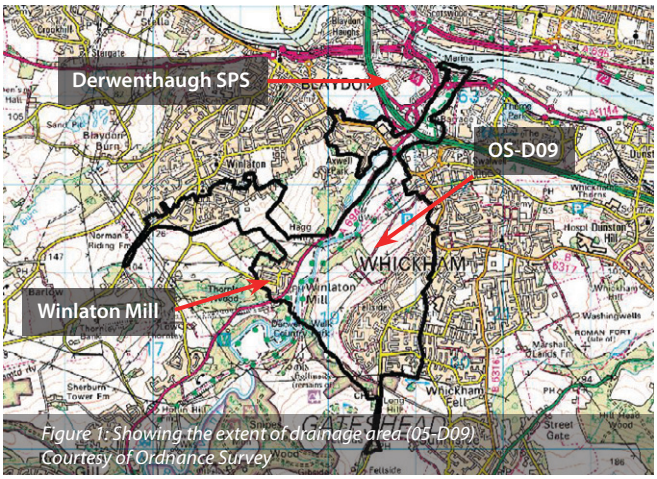

Figure 1: Showing the extent of drainage area (05-D09) Courtesy of Ordnance Survey

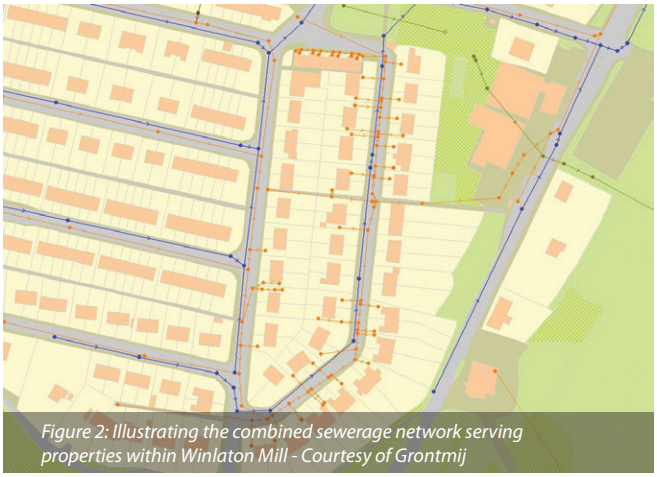
Figure 2: Illustrating the combined sewerage network serving properties within Winlaton Mill - Courtesy of Grontmij

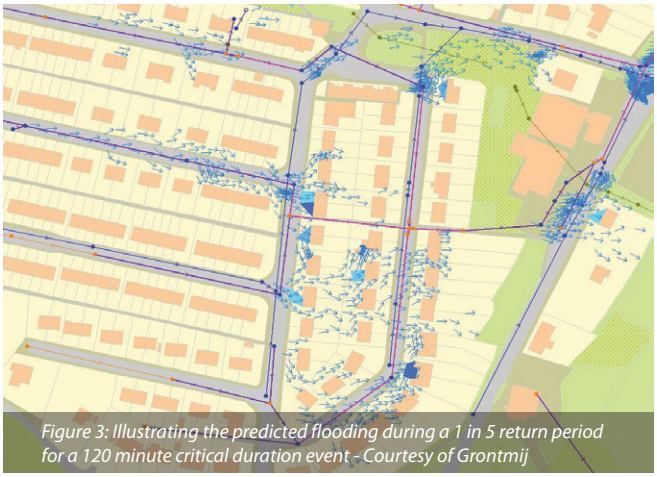
Figure 3: Illustrating the predicted flooding during a 1 in 5 return period for a 120 minute critical duration event - Courtesy of Grontmij

The feasibility study

The feasibility study highlighted the requirement for a significant volume of storage. A traditional approach to the project would have been to provide storage tanks to offset the water escaping the sewer network; however this would have made the project none cost beneficial.

An initial option appraisal highlighted the following options:

- Construction of a new CSO within Winlaton Mill with an overflow to the River Derwent. *This would not have been accepted by the Environment Agency given the potential for alternatives.*
- Gravity storage: The volume required would have been significant and would be required adjacent to the properties where there was insufficient space available to accommodate the sewers required. An initial assessment required the installation of 2,100mm diameter sewers throughout the village where other sewers and services restricted the available room for construction.
- Storage with pumped return: Increased storage requirement of circa 300m^3 which would have to have been constructed within Derwenthaugh Country Park. This would have required planning, excavation and disposal of significant volumes of contaminated material as well as long term OPEX costs for NWG.
- Separation of highway drainage and associated impermeable contributing areas.

To provide a solution that could be completed within the project budget, separation of the highway drainage and associated impermeable contributing areas from the sewer network was taken forward.

Hydraulic analysis

Winlaton Mill in Blaydon-on-Tyne is situated within the NWL Derwenthaugh Drainage Area (05-D09). Flows from this drainage area drain to Derwenthaugh Sewage Pumping Station (SPS). Figure 1 *(right top)* shows the extent of drainage area (05-D09).

Combined flows from Winlaton Mill drain via 150mm and 300mm diameter sewers drain to Riverside Way CSO approximately 2km to the north. Flows subsequently drain to Derwenthaugh SPS, via a 1,830mm diameter interceptor sewer before flows are pumped to the Tyneside Interceptor Sewer. Flows from the drainage area ultimately drain to Howden STW.

Surface water flows from Winlaton Mill drain via 450mm diameter and 675mm diameter sewers to a 750mm diameter culverted watercourse before discharging into the River Derwent. Figure 2 *(right middle)* illustrates the combined sewerage network serving properties within Winlaton Mill.

There was no existing hydraulic model for drainage area (05-D09) available within the NW hydraulic model library; therefore a hydraulic model was built in accordance with the NW modelling specification at Stage 1.

The 'base' hydraulic model was created using data held within NW's InfoNet database (baseline March 2013).

To enhance the hydraulic model during Stage 2, further manhole surveys and connectivity surveys were completed for 16 (No.) NW manholes and 69 (No.) private manholes. In addition an impermeable area survey was undertaken.

2D modelling

A 2D overland flow assessment was undertaken to verify the flooding mechanism reported by the customers. Figure 3 *(right bottom)* illustrates the predicted flooding during a 1 in 5 return period for a 120 minute critical duration event. A number of manholes located within the public highway surcharge lead to flooding to a number of properties via overland flow. Customers reported sewer flooding to properties from manholes located within the public highway which was also exacerbated by surface water run-off.

Additional property memoranda (APMs)

APMs were issued by NW as they had received reports of additional flooding to other properties. An analysis of the hydraulic model confirmed the cause of flooding to be due to hydraulic incapacity and that all the properties should be included on the Internal or External DG5 Risk Register depending on the flooding type.

DREAM2D

DREAM2D outputs were used to categorise each property within the drainage area and colour coded a mapping layer using a traffic

Figure 4: An indicative DREAM2D output for the area
Courtesy of Grontmij

Figure 5: Showing the overall scheme proposal
Courtesy of Grontmij

light system. On a plan, the results were used to quickly identify where other potential problems existed and cross reference all areas against historical records and anecdotal evidence. Figure 4 *(above)* shows an indicative DREAM2D output for the area.

The solution: surface water separation & combined sewer upsize

The implemented solution consisted of three elements:

- Upsizing the existing combined sewer network in addition to constructing new combined sewers within the public highways in Winlaton Mill.
- Construction of a new highway drainage system including new road gullies.
- Construction of new surface water sewer within the playing fields at Derwent Walk Country Park.

The combined sewers were upsized to mobilise flow to new storage tank sewers installed within the public highway. The storage sewers were constructed from reinforced HDPE pipework to ease installation. Given their location within residential streets the sewers were installed beneath numerous service crossings. To improve flow characteristics at low flows, the sewers were installed with prefabricated dry weather flow channels.

The existing highway drainage system was reviewed with the Local Authority and additional highway gullies installed to improve the drainage collection of surface water run-off.

An existing surface water culvert ran through the village and through the adjacent Derwenthaugh Country Park before discharging surface water flows into the River Derwent. This existing system was upsized with online storage to provide a discharge for the additional flows from the new highway drainage network. Figure 5 *(top right)* shows the overall scheme proposal.

Property level protection

During the progression of the detail design and prior to the construction phase, all properties affected by flooding were provided with interim flooding protection measures to reduce the risk of internal property flooding. This included the installation of flood proof external doors and guards and modification to air bricks.

Scheme benefits

The proposed scheme provides a number of benefits; these included, reduced spill to a downstream CSOs and thus improving river quality, reduced storage requirement, reduced ultimate treatment and therefore reduced capital and operations expenditure and also gives additional headroom within the network for new development.

Collaboration

Optimising the volume of storage required was completed innovatively by partnering with Gateshead Council and developing a separation solution. Full separation would have been cost prohibitive, but separation of highway runoff and associated impermeable areas was not. This optimised the volume of water to be removed from the sewer network.

Throughout the design phase the project team worked closely with the nominated partner contractor, Seymour Civil Engineering Contractors Ltd. They provided invaluable information on sequencing of the construction to coordinate the road closures and traffic management proposals, as well as suggesting dual trenching of the surface water and combined sewers, overcoming specific construction difficulties and efficiencies on specifications for the design of the scheme.

Community engagement

Consideration was given during the design phase to minimise the disruption to the local residents. In doing so, discussions were held with the local bus company to minimise the impact to the residents. A shuttle bus was provided by NW during the construction phase where there was no access for the normal bus service.

Health and safety

During the design phase of the project an innovative solution using lightweight, reinforced plastic pipe was proposed instead of traditional concrete pipes. This required less manpower, smaller plant and was quicker to install.

Conclusion

NW's target of 1,135 AMP5 outputs was a huge undertaking. The Winlaton FAS, along with the rest of the flooding programme, was successfully installed ahead of the March 2015 deadline.

Separation of the highway drainage and associated impermeable contributing areas from the sewer network provided a robust cost effective solution to minimise the risk of flooding in Winlaton Mill, with other added benefits of reduced capital and operations expenditure.

A collaborative approach between all parties ensured that the scheme was delivered efficiently and safely with minimal disruption to the residents, ensuring that Northumbrian Water's reputation remained intact.

The editor and publishers would like to thank John Johnson, Principal Engineer with Grontmij UK Ltd, for providing the above article for publication. The author would like to thank Loren Jennings, Project Manager with Northumbrian Water Ltd.