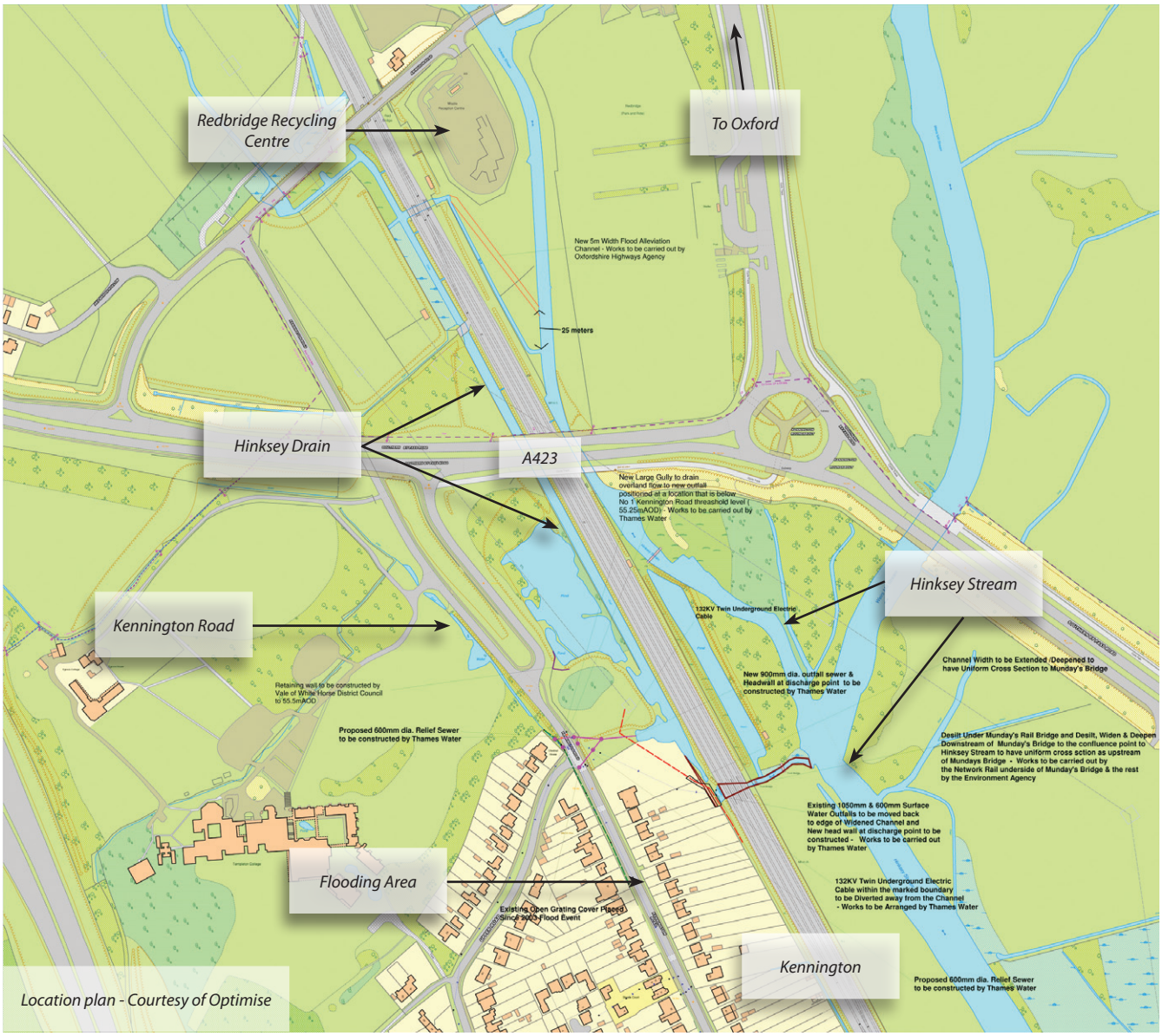
Kennington Road Flood Alleviation Scheme

under the umbrella organisation of the Oxford Area Flood Partnership, private companies and local authorities work together to resolve Kennington flooding

by Peter Quinn BSc MCIWEM CEng

The northern end of Kennington, a village to the southwest of Oxford City and the A423, had suffered regular internal and external flooding over a number of years. Some 2,400 people in the area are served by the surface water network that discharges to the Hinksey Drain between property gardens and the railway line to the south of Oxford City. The DN1050 outfall and a DN600 railway drain opposite Mundays Railway Bridge shared the same outfall structure. The overall capacity of the surface water network and receiving watercourse was insufficient resulting in properties being flooded approximately once every 3 years.



Location plan - Courtesy of Optimise

Background

During storm events the surface water network could not discharge against the raised top water level in the watercourse. This resulted in backing up into the Templeton Ditch which overflowed onto the Kennington Road flooding properties. The lack of capacity in the Hinksey Drain resulted in overtopping of the banks from a side ditch and a pond area onto the road causing further flooding from the Templeton Ditch and surface water network. The railway line also flooded regularly.

Project drivers for multiple organisations

The Thames Water driver for the project was to remove the flooding properties from the DG5 flooding database. Network Rail contributed to the scheme to help reduce flooding to the railway line. The Environment Agency is responsible for protection against river flooding and the three local councils (Oxford City, Oxford County and Vale of White Horse) contributed to reduce highway flooding, maintain the bus service during high river events and to help their constituents.

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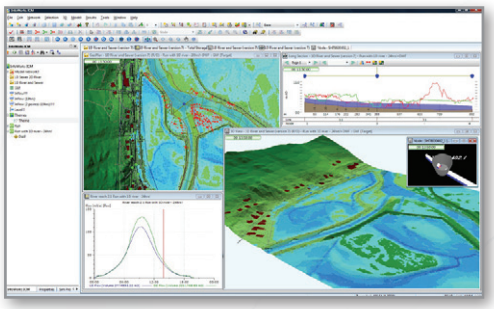

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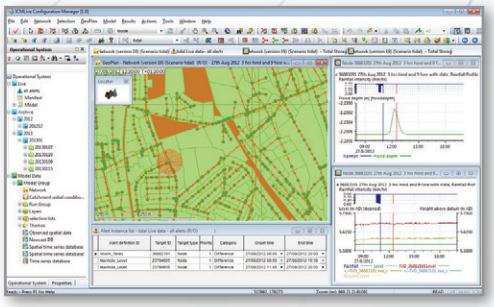

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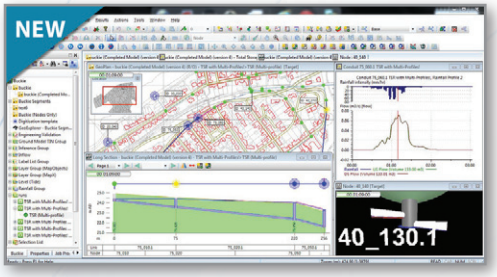

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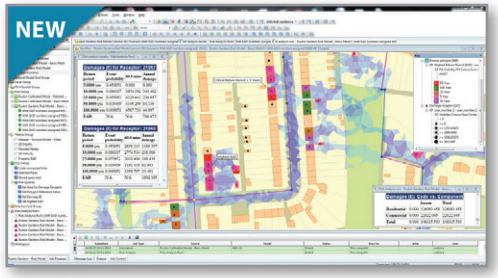

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Flooding in Kennington Road - Courtesy of Optimise

Hinksey Drain close to Mundays Railway Bridge prior to construction Courtesy of Optimise

The piling looking towards Mundays Bridge - Courtesy of Optimise

The new swale to the side of the recycling centre looking upstream Courtesy of Optimise

Two watercourses contribute to the network from Bagley Wood and from the Templeton Ditch. To resolve the flooding problems it was necessary to analyse the surface water network and the River Thames with its subsidiary channels and how they all interacted.

Hydraulic modeling of the watercourse

To provide greater understanding of the flood mechanism, and to test potential flood alleviation options, the most up to date hydraulic model of the River Thames system for the area was requested from the Environment Agency. The most recent complete model available was the 2007 Section 105 1D model constructed using ISIS software.

This model was obtained and updated with a more detailed representation in the area of interest using new cross-sectional surveys obtained by the project team. The existing hydrology for the modelled events of 5, 10, 25, 50, 100 and 200 year recurrence intervals was reviewed and updated to include a 30 year recurrence interval which is the relevant design standard for Thames Water's urban drainage networks.

To represent the changes made to important channel structures over the years, individual models of the channel status during the 2003 and 2007 flood events were set up along with an existing case (2010) model. The model was then calibrated to levels recorded during the 2007 flood event and used to identify flood alleviation options by identifying low points and areas of hydraulic inefficiency.

Through an iterative process, a proposed case model was developed to demonstrate the reduction in flood levels that could be achieved. Results were presented showing improved conveyance, a reduced maximum water level longitudinal profile and flood protection potentially up to the 100 year recurrence interval. Sensitivity tests were carried out on important model coefficients including downstream boundary conditions, inflows, channel roughness and structure losses to provide greater confidence in the model results.

Hydraulic modeling of the network

A new type 3 hydraulic model of the surface water network was built and run using Infoworks. The two watercourses contributing to the catchment were modelled using inputs derived from the Flood Estimation Handbook. Options were modelled to obtain a solution whereby a 1 in 30 year storm could be discharged against a high water level in the watercourse.

The presence and alignment of the oil filled 132kV electric cables was a problem. This led to the development of options using a discharge point upstream at the location of the pond, just to the north of the properties. It was also noted that for any rainfall event the watercourse takes days to respond whereas the surface water catchment responds immediately.

Option development

A review of the model and its outputs was carried out by the Environment Agency and an independent consultant. The model was accepted as a good representation of the flooding mechanisms in the area. The model was then made available to the Environment Agency enabling it to be used to update the flood maps for this area. The modelling process and results were documented and used to demonstrate that the scheme would provide the required flood protection for Kennington Road residents but not increase water levels at neighbouring locations, and as such the scheme achieved agreement from the Environment Agency's Development and Flood Risk team.

Site constraints

Most of the complex construction work on the project was located close to the railway line. The main electricity supply to Oxford runs through a series of 132kV oil filled EHV cables buried in the rear gardens of the properties north of Mundays Bridge and in

a ground level duct between the railway and the gardens to the south of the bridge. The existing outfall structure for the DN1050 surface water sewer and a DN600 railway drain intruded into the Hinksey Drain reducing the capacity. Kennington Road has a lot of utility apparatus running along it and the fall between the shallow Templeton Ditch and the Hinksey Drain is minimal.

Ground conditions

The ground conditions across the site are consistent for this area. They comprise an initial superficial layer of made ground 1-2m thick above a thin layer of soft to firm silty clay; below this is a 4m thick layer of flood plain gravels which overlies a thick layer of firm to stiff Oxford clay.

The Oxford clay was previously used to facilitate the Kennington Road to Littlemore foul sewer tunnel. This DN1200 pipe takes the sewage from Botley and Kennington below this project and 500m across the River Thames flood plain to Littlemore Pumping Station.

Designed scheme

The scheme was designed to lower the top water level in both the watercourse and the surface water sewer network protecting the properties from flooding in up to a 1 in 30 year event. The hydraulic design of the whole scheme was carried out by Optimise on behalf of Thames Water. The scheme comprised increasing the capacity of the surface water network and the Hinksey Drain. The main watercourse improvements extended from the first pond area, past the rear of the properties in Kennington Road, beneath Mundays Bridge and 60m further downstream to the Hinksey Stream.

In addition a bund was required to prevent flooding onto the road from the second pond area of the Hinksey Drain; and at the rear of Redbridge Recycling Centre the flood plain was cleared and a new swale cut. The swale is 5m wide has an average depth of 0.5m, a maximum of 1.2m, it is 130m long.

The capacity of the Hinksey Drain upstream of the bridge was increased by sheet piling both banks with 8m long AZ-12-770 to protect the railway and the electric cables whilst increasing the width and lowering the bed level. A secondary channel was also provided above the 132KV cables which were protected by a mesh reinforced concrete slab and a brick faced retaining wall was constructed at the rear of the slab to retain the adjacent gardens. The other capacity improvements were achieved by excavation.

Improvements to the surface water network included a new DN900 outfall and sewers connecting 130m away on the far side of Kennington Road. The existing DN1050 outfall was moved back 5m retaining the bottom part of the pipe as a discharge channel to protect the cables. Natural slopes were restricted to a maximum gradient of 1 in 2.5m to maintain stability.

The improvement to the Hinksey Drain at the rear of the properties was close to the railway line and on Network Rail land. This meant that these works had to meet Network Rail requirements for long term stability of the railway embankment, and that all works had to be carried out with pre-agreed working methods to avoid construction risks to the railway such as plant or materials falling on the track or subsidence of the embankment.

Construction

Delivery of the scheme was split between the duty holders. Thames Water provided the improvements to the surface water network and the Hinksey Drain upstream of Mundays Bridge. Network Rail increased the capacity of the watercourse beneath Mundays Bridge and The Environment Agency increased the capacity of the watercourse downstream of Mundays Bridge.

The Vale of White Horse District Council provided the bund. Oxford City Council and Oxfordshire County Council provided the new swale.

Aerial view of construction near Mundays Bridge - Courtesy of Optimise

The contractor for Thames water was J Murphy and Sons, part of the Optimise joint venture. Dyer and Butler were employed by Network Rail and The Environment Agency. They removed spoil through the Optimise site making use of the lowered bed level and drained down channel during the Thames Water work.

The construction was completed safely on time and on budget. The major disruption was the laying of the surface water sewers across Kennington Road and a complete road closure and bus route diversion was required during half-term. Sheet piling had to be completed using overnight and weekend track possessions of the main line since the fall radius of the piles was so close to the track.

The work was planned to be completed with five overnight possessions but thanks to the hard work of the teams, the noisy piling was completed in two nights and due to extensive communication with local residents, no complaints were received.

A Movac SPH-75 Side Grip Vibratory Pile Hammer was used to minimise the noise as the 8m long AZ-12-770 sheet piles were sunk through the gravels down into the firm clay that also forms the formation layer the for abutments of Mundays Bridge. The pile caps and other waterside finishing works were completed from a light weight cellular pontoon.

During the majority of the works on the channel the water was drained down and piped through the site. Removal of the outfall structure and existing DN1050 and DN600 pipework with their concrete surrounds was achieved using low powered equipment to avoid damage to the sensitive oil filled 132KV cables which were directly beneath the DN1050 outfall pipes concrete surround.

During construction further protection was given to the cables by the extensive use of bog mats to disperse the load generated by site plant.

Key construction information

- Zero incidents or accidents.
- Road crossings completed under road closure during autumn half term 2012.
- Main work started in April 2013 and completed two months ahead of schedule in August 2013.
- No customer complaints during construction and customer commendations from residents whose homes had previously flooded.
- Surplus excavated material from the construction of the new surface water sewers was used to construct the bund.
- The increased capacity in the Hinksey Drain will help protect the habitat of a very rare form of glutinous snail in the nearby ponds that requires clear still water.
- Property owners donated land at the end of their gardens to facilitate widening the Hinksey Drain.

Under the umbrella organisation of the Oxford Area Flood Partnership, Thames Water, Network Rail, The Environment Agency, Oxford City Council, Oxford County Council and Vale of White Horse District Council have completed this £1m project which has reduced the risk of flooding over a wide area - and created a great model for future complex schemes.

January 2014 Flood Event

The completed works were given a real test during January 2014. A severe prolonged flood event occurred on the River Thames, but the properties in Kennington Road were protected from flooding by the completed scheme.

The Editor & Publishers would like to thank Peter Quinn, Principal Engineer and Lead Designer with MWH (part of Optimise working on behalf of Thames Water), for providing the above article for publication.

Looking towards Mundays Bridge – January 2014 - Courtesy of Optimise

Looking upstream from opposite Mundays Bridge – January 2014 - Courtesy of Optimise

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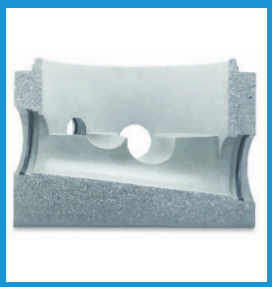

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