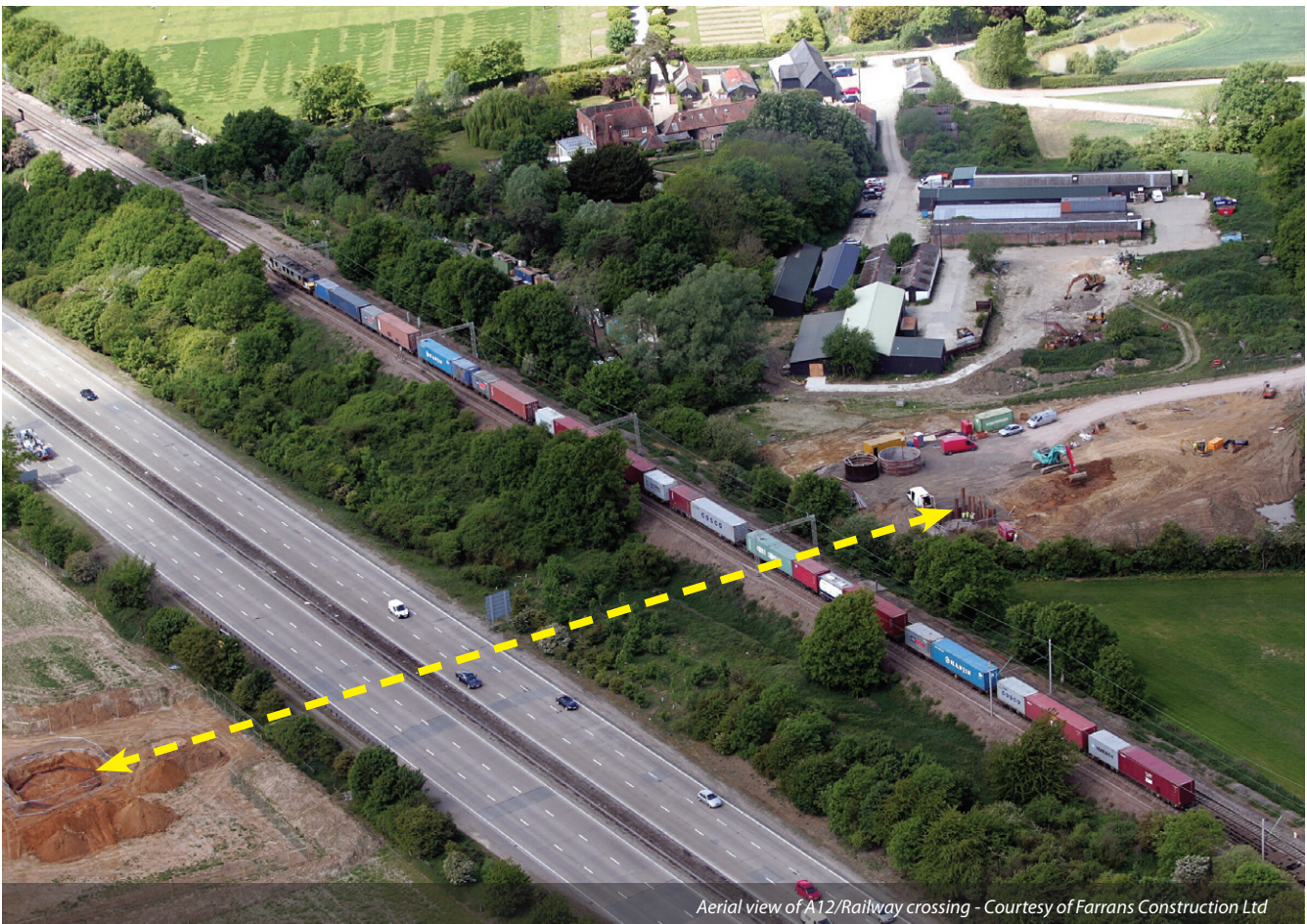


Abberton Pipelines Project

installation of 32km of pipeline to support the Abberton Scheme

by Jim Jenkins MSc BA (Hons) CEng FCIWEM FIW MIET

Northumbrian Water Limited (NWL) is the statutory water undertaker for a large part of south Essex including the towns of Chelmsford, Brentwood, Witham and Southend-on-Sea, and the London Boroughs of Redbridge, Barking and Havering. Trading as Essex & Suffolk Water (ESW), the company needs to take steps to cover the existing and predicted future shortfall in water supply to its 1.5 million customers in the Essex supply area. To meet the shortfall the company is constructing the 'Abberton Scheme' which comprises: (i) the provision of increased water storage capacity at Abberton Reservoir from 26,000ML to 41,000ML, (ii) increased abstraction from the River Ely-Ouse near Denver and (iii) increased conveyance of water from Denver to Abberton Reservoir via enhancements to the capacity of the existing ESW 'Essex System', and the Environment Agency's (EA) 'Ely-Ouse to Essex Transfer Scheme' (EOETS). This paper deals with the pipelines element of the scheme.



Aerial view of A12/Railway crossing - Courtesy of Farrans Construction Ltd

Overview of pipelines

Abberton Reservoir is located to the south of Colchester, Essex. Two new pipelines (32km in length) have been installed to increase the transfer capacity of the EOETS and support the enlarged reservoir.

The Kirtling Green to Wixoe pipeline: This pipeline comprises:

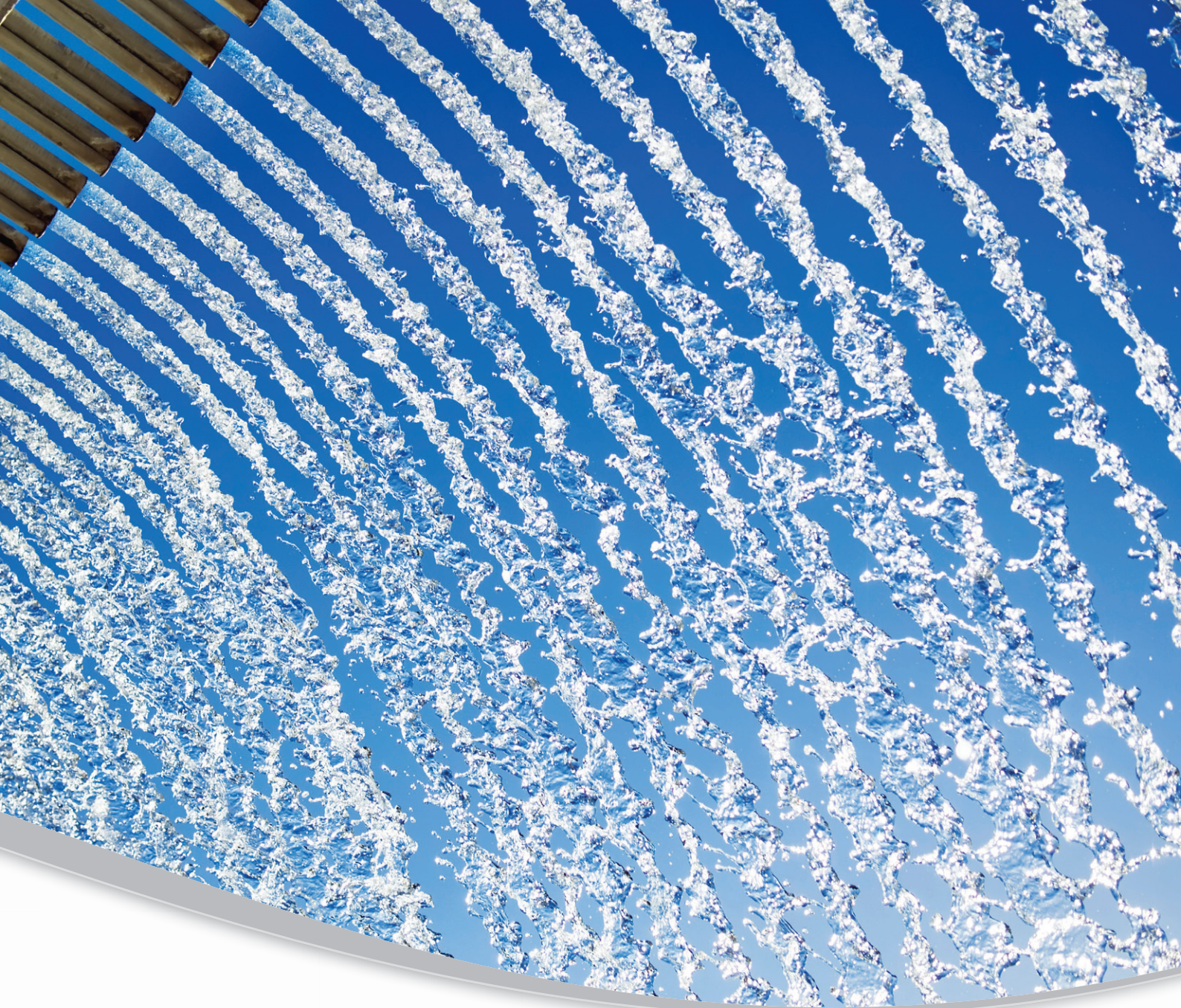
- **Pipeline intake at Kirtling Green:** Pipeline intake structure at the existing EOETS outfall structure at Kirtling Green, with a building housing facilities for periodic chlorine dosing for the control of zebra mussels.
- **Kirtling Green to Wixoe Pipeline:** A 15.5km long gravity pipeline from the existing outfall structure at Kirtling Green, to discharge at a new outfall at Wixoe on the River

Stour. The pipeline diameter is 1,200mm for the first 12.2km reducing to 1,000 mm for the final 3.3km.

- **Pipeline outfall at Wixoe:** Outfall structure to the River Stour within the EA compound at Wixoe, with flow control valve and aeration weir structure.

The Wormingford to Abberton Pipeline: This pipeline comprises:

- **Wormingford Pumping Main:** 2.1km long pumping main from Wormingford PS to Wormingford Break Pressure Tank (BPT). The pipeline diameter is 1,200mm.
- **Wormingford BPT:** Rectangular part-buried reinforced concrete tank of capacity 2,000m³ situated on high ground to the south of Wormingford.



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Pipeline working strip - Courtesy of Farrans Construction Ltd



Pipe Laying - Courtesy of Farrans Construction Ltd

- **Wormingford BPT to Abberton Pipeline:** A 14.5km long gravity pipeline from Wormingford BPT to Abberton Reservoir west of Colchester. The pipeline diameter is 1,200mm.
- **Pipeline outfall at Abberton:** Outfall structure at Abberton Reservoir with a flow control valve.

Pipeline route

The pipeline routes were developed from initial feasibility studies. The initially proposed routes were developed after further studies and walkovers to minimise environmental impact and avoid environmentally sensitive areas. A number of modifications to the initially proposed routes were made, aimed at minimising the environmental and social effects of the pipelines during and after construction, and minimising interference with existing services such as gas mains, water mains and sewers.

Prior to pipe installation extensive environment studies were undertaken and Great Crested Newt trapping was carried out to clear the working area. On the northern section of the pipeline extensive archaeological work was carried out and a large number of finds were recovered and catalogued. During installation there was an archaeological, environmental and tree specialist in attendance.

The pipeline was laid with a minimum of 1,200 mm of cover to the crown of the pipe and was installed by open cut except for five road and one river crossings which were auger bored.

The pipeline crossed under the East Coast railway and A12 trunk road to the west of Colchester at Stanway. At this point the railway and road ran close together and a single 150m long tunnel was constructed under both. This crossing was achieved by sinking concrete lined vertical shafts about 7m in diameter and up to about 20m deep at each side of the crossing, on farmland adjacent to the railway and the A12. A tunnel was then excavated between the shafts by an earth pressure balance machine with concrete pipes pushed in behind the excavator to form a tunnel of internal diameter 1,500mm. The main steel pipeline was then installed within the tunnel and the annulus was grouted to complete the crossing. The design and construction of this tunnel was carried out to the approval of Network Rail and the Highways Agency, in accordance with their procedures, and strict limits on permissible ground movements.

Pipe material and corrosion control

Based on previous experience of the performance of various pipe materials and an analysis of cost, the preferred pipe material for the pipeline was steel with welded joints. The pipeline has an epoxy coating and lining with an impressed current cathodic protection system for corrosion control.

Pipeline design

The design capacity of this pipeline is 145Ml/d for the northern section and 120Ml/d for the southern section. Flow is to be by gravity for the greater part, with a short section of 2.1km pumped from a river abstraction pumping station, and controlled by an actuated flow control valve installed at the southern (downstream) end of each section of the pipeline. Hydraulic calculations were carried out to determine the required pipeline diameter and limitations on the pipeline profile such that the required flow can be achieved by gravity.

The hydraulic gradient is shallow enough to maintain positive pipeline pressure at the critical high point. In order for the hydraulic gradient to remain above this high point, the required diameter of the pipeline is 1,200 mm nominal.

A steeper hydraulic gradient is possible for the last 3.3km of northern section of the pipeline after the critical point, and the

pipeline is reduced in size to 1,000 mm nominal over this section. This reduced the cost of the pipeline without affecting the flow capacity.

Air release valves are installed at all high points and significant changes in pipe gradient. Washouts are installed at significant low points to allow the pipeline to be drained down.

Isolation valves are not considered necessary along the pipeline route. Therefore, to allow for the backfilling of the excavation before a full hydraulic test could be carried out, the jointing method was spigot and socket with a double weld, one at each end of the socket. This allowed each joint to be air tested prior to backfilling. A full hydraulic test was then carried out on completion of the full pipeline length.

Pipes were welded in pairs on the surface and then lowered into the trench. Weld joints were cleaned and coated internally with brush applied 'Copon' and externally wrapped with 'Canusa Wrap'. Inspection hatches are provided at regular intervals along the pipeline and an impressed current cathodic protection system is installed providing corrosion protection for the pipeline.

Pipeline flow control system

Except during filling or drain-down, the pipeline will always operate with pipe-full flow throughout its length, with flow control at the downstream end. If the flow control was to be at the upstream end, then for flows less than the pipeline capacity sections of the pipeline would flow part full, and due to the number of peaks and troughs along the pipeline profile, sections would change from part full flow to full flow as the flow varied, with air being expelled or drawn in from air valves.

Past experience of such pipelines running part full has shown that there is a risk of choking and cyclic flow conditions which could cause excessive vibration, leading to pipeline damage. Fluctuations in flow could also occur, and reductions in pipeline capacity if air gets trapped between air valves during flow changes. For these reasons, the flow control system is designed to maintain pipe-full flow throughout the full range of flows from zero to pipeline capacity.

The control system for the pipeline flow is based on the following:

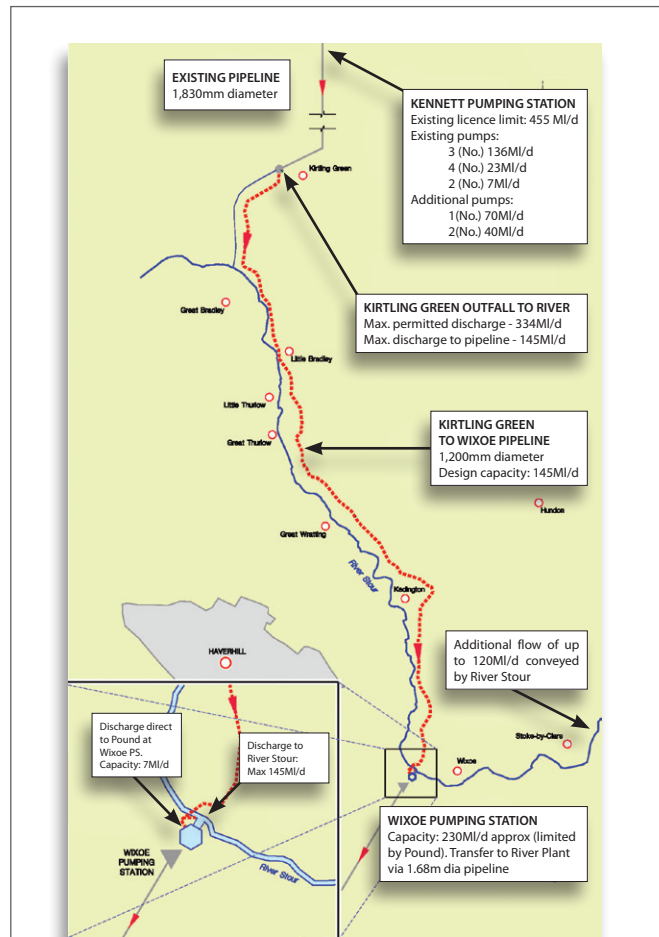
- Flow will be controlled automatically by a flow control valve and flowmeter.
- The required flow will be entered manually into the control system from the control room.
- In order to maintain full flow conditions throughout the pipeline, the control system will only allow a pipeline flow to be entered that is less than the water available. This could be overridden in exceptional circumstances, but will be the normal method of operation.

Undertakings

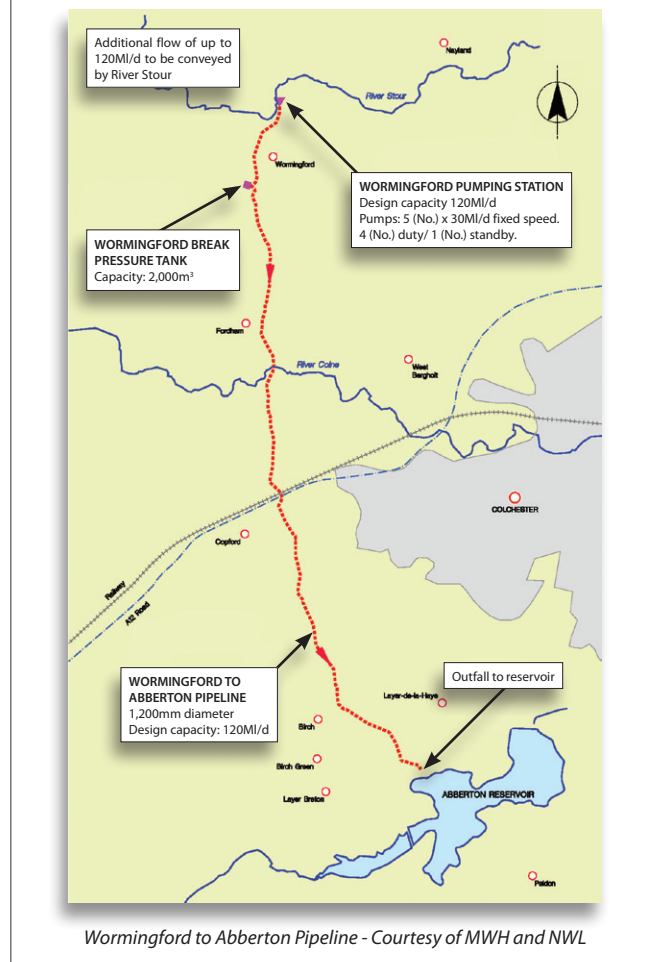
The project commenced in January 2011 and was completed in May 2012. The engineering consultants were MWH and the contractor was Farrans Construction Ltd. Pre-entry site surveys, traffic management plans and public liaison were key contributing factors in the success of the project which was delivered on time and under budget.

The Editor & Publishers would like to thank Jim Jenkins, Abberton Programme Manager with Northumbrian Water for providing the above article for publication.

Note: The Abberton Reservoir Enhancement project was featured in UK Water Projects 2012. The Woringford Pumping Station project is featured in the UK Water Projects 2013-14 Virtual Edition. All three Abberton case studies are available at www.WaterProjectsOnline.com



Kirtling Green to Wixoe Pipeline - Courtesy of MWH and NWL



Woringford to Abberton Pipeline - Courtesy of MWH and NWL