

# Crowlas Sewer Replacement

## the South West Water Alliance team (H<sub>2</sub>O) 'Innovate to Renovate' a failing strategic sewer in the heart of Cornwall

by Geoff Willcocks and Les Metcalfe

The Crowlas gravity sewer transports foul flows from the West Cornwall catchments of Penzance, Crowlas and Marazion to the treatment works at Hayle, servicing a population of 22,000 people. Constructed in 1995 as part of South West Water's Clean Sweep programme, the pipeline has suffered from prolonged degradation through hydrogen sulphide (H<sub>2</sub>S) attack, mainly due to high saline content within the catchments. The pipeline passes through premium agricultural land, with crops and valuable daffodil fields along its length. Experimental daffodil fields were particularly affected, and substantial compensation costs were expended during the construction of the original pipeline.



800mm GRP socket and spigot joint being pulled home - Courtesy of BBU SL

### The problem

CCTV surveys had identified sections of missing soffit, hanging gaskets from pipe joints and reinforcement exposed in both manhole soffits and pipework walls. The consequences of a pipeline collapse were eventually realised during the scheme delivery when a section remote from the works area failed overnight. Two craters were formed and the resultant spill flooded an adjacent pig enclosure and farm courtyard.

An emergency open cut operation was carried out by the site team to restore flows using the lining pipes intended for the slip lining.

### Design options

As part of the K5 programme, the line was programmed for replacement in year 2 (2011) with a client target cost (CTC) of £1.7m estimated for an off-line open cut replacement and £1.45m for a close fit liner option.

The H<sub>2</sub>O delivery team identified a number of problems relating to each scoped solution.

- **Open cut:** Compensation costs for an open cut solution were substantial. The fragility of the existing concrete pipe limited the proximity in which construction plant could operate, resulting in additional wayleave costs and deeper excavation on the new parallel pipeline adjacent to the original optimum route.

Grouting of the abandoned line would cost over £100k.

- **Close fit lining:** Close fit lining works relied on repeated cessation of flows for a fixed time period, although offering benefits by eliminating grouting and reducing wayleaves. The estimated available working window was dependent on storage in the Penzance tunnels, Crowlas and Marazion





Launch cradle in position with prepared pipe for launch  
Courtesy of BBUSL

pump stations. During heavy rainfall or increased flows, the short storage period would inevitably result in spills into Mounts Bay.

The high dry weather flow rate of 475l/s rendered overpumping impractical.

Delays in curing or failure of a lining installation would result in a pollution event at either one or all of the three contributory pump stations.

### The proposed solution

Drawing on a method previously used to sleeve a collapsing stone culvert under a canal in Wales, a GRP slip lining solution was considered as an alternative option with a versatile installation method to maximise shutdown availability. Numerous innovations were introduced during the execution of the works.

This proposal limited excavations to seven alternate manholes to create a launch pit for upstream and downstream pipelines. In order to expedite set-up and installation times, the launch pits were standardised with a concrete base poured to a pre-determined level below the host pipe invert.

To immediately reinstate flows in an emergency event, the installation process could be suspended, the pipe locked into position and a flume placed across the launch pit in lightweight rigi-drain pipework.

A series of precast concrete pipe supports were available to configure the pipe arrangement across the pit base.

HsO, in partnership with a local steelwork fabrication company, Minear Engineering, produced a series of bespoke designs to execute the pipe lining process:

- **The launch cradle:** To accommodate the 5.85m long pipe with integral rollers and adjustable legs to match the required gradient.
- **The anchor clamp:** Serving two purposes; (i) providing an anchor to pull home pipes with ratchet straps and; (ii) to anchor the pipe against the host pipe if flows were restored prior to completion of the pipe pull.
- **The chamfered nose cone:** Attached to the lead pipe to avoid snagging on the host pipe joints.
- **The winch boot:** Fitted with a tested eye for winch rope attachment.
- **The pulley frame:** Inserted into the 'downstream' manhole to guide the winch rope to the centreline of the pipe for the pull. This was specifically designed to avoid man entry into the reception pit and could be rotated 180° to allow the reverse pull.
- **The lifting beam:** A certificated lifting accessory for unloading the shipping containers using a telehandler and transporting pipework on site.

All specialist fabrications were conceived by the site team and manufactured locally in conjunction with the fabricator's design team from Minear Engineering at Roche, Cornwall.

### Hydrogen sulphide resistant pipeline

HsO collaborated with Plymouth-based Pipex Limited to source a GRP pipe to provide an H<sub>2</sub>S-resistant product with a minimum 50-year design life. Protesa, based in Spain, put forward their Alphacor FW55 GRP composite pipe meeting the requisite specification.

The 800mm (internal diameter) pipe utilised a socket and spigot system with a unique locking device to anchor each joint. Pipex Limited confirmed the anchors would cope with winching forces and abrasion wear tests confirmed the dragging process would not adversely affect the collars. Cost savings were also generated using containerised deliveries.

Pell Frischmann consultancy confirmed the suitability of the pipework for the design flows.

The submitted target cost of £950,000 reflected savings to the CTC gained primarily through time-related and potential estates costs. Savings on manhole refurbishments added to the overall reduction.

### Public & business liaison

Early liaison with landowners commenced in 2011 with site staff and South West Water Estates involvement. Current crop use and harvesting issues were discussed with farmers and the programme of works adjusted accordingly to minimise disruption to working practices.

Local resident consultation continued through all stages of the project with most interaction relating to maintaining accesses during transportation of pipework and plant in the locality. The coverage was reinforced with local press and radio reports at the commencement of the works.

### Environmental issues

Flow shutdowns were managed by site staff in conjunction with South West Water Operations. Continuous level monitoring at each pump station, along with limited tankering from the smaller Marazion Pumping Station, maximised the shutdown duration, and ensured flows never reached pre-determined critical levels. An emergency procedure set out the timeline and communication routine in the event of flows requiring restoration.

Short-term planning measures were created to utilise the workforce on secondary tasks when shut downs were impossible on 'wet weather' days, and weather forecasts were monitored regularly for changes in conditions.



The slip lining method minimised waste generation with little excavated material removed from site. Leaving the H<sub>2</sub>S contaminated concrete exposed to the atmosphere, the material underwent a chemical reaction and converted to an inert material. The arisings were then taken to a local recycling centre for crushing for reuse as aggregate.

### Construction & programme

Work commenced on 12 September 2011 with a 15-week programme to complete the full 1,750m of slip lining.

Familiarity with the installation routine resulted in time efficiencies and increased production rates. The initial output of fifteen lengths per shift reached a peak of thirty-three lengths by the end of the scheme. Incremental modifications in working methods and establishment of each team member's role streamlined the procedure across all aspects of the operation.

The last of the 1,750m GRP pipes were grouted up on 22 December, although final reinstatement was deferred until ground conditions improved.

### Safety

With historical knowledge of the pipe mode of failure, the avoidance of H<sub>2</sub>S exposure to the workforce was paramount. Additional gas detectors were located at key locations where personnel were potentially exposed to sewer odours.

Entry into reception pits was avoided with the use of the winch frame (see right-middle photograph) lowered in following removal of the cover slab. Launch pits were battered rather than sheet-piled and air blowers were available in the event of gas detection.

With much of the method using bespoke designs, all fabricated equipment received certification in accordance to current Lifting Operations and Lifting Equipment Regulations (LOLER) legislation.

Despite the unorthodox equipment, methodology and terrain, there were no accidents recorded throughout the duration of the contract.

### Summary

The project demonstrated that in a potentially contentious location a well-planned and coordinated approach by the H<sub>2</sub>O delivery team working in collaboration with local sub-contractors and suppliers can deliver a successful scheme with minimal impact on either the environment or the local community.

With focused innovation and strategic programming, the scheme was completed under the original client target cost and fully operational by the programmed target date. In addition, the combination of innovative design and construction methods has provided a template for a similar scheme across Newquay Golf Course.

The scheme testifies that all stakeholders' best interests can be singularly embraced and provide a successful overall outcome for both the environment and the community.

### National recognition

The site team subsequently received national recognition in March 2012, as the scheme was awarded the United Kingdom Society for Trenchless Technology's Large Project Renovation Scheme Award at the annual awards ceremony in Birmingham. The award was presented by TV presenter Chris Packham.

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Excavated collapse section. The wall thickness had eroded to 12mm  
Courtesy of BBUSL



Lead pipe and nose cone entering reception pit with winch frame in position - Courtesy of BBUSL



UKSTT Large Renovation Scheme Award presented by Chris Packham  
Courtesy of UKSTT

### About H5O

H5O comprises South West Water, Hyder Consulting, Pell Frischmann, Balfour Beatty and Interserve and was established in September 2009. Its challenge is to deliver approximately £80m of engineering schemes per annum (the vast majority of South West Water's engineering programme) against pre-determined Client Target Costs for each scheme in the most cost-effective way possible.

Extensive use is made of the wider supply chain capabilities on a 'best person for the job' principle. To ensure across-the-board performance, a wide range of Key Performance Indicators (KPIs) have been established to focus the Alliance on achieving not just commercial but also programme, quality, customer feedback and health and safety targets. The initial framework will run for 4 years with the possibility of extending it to 10 years.