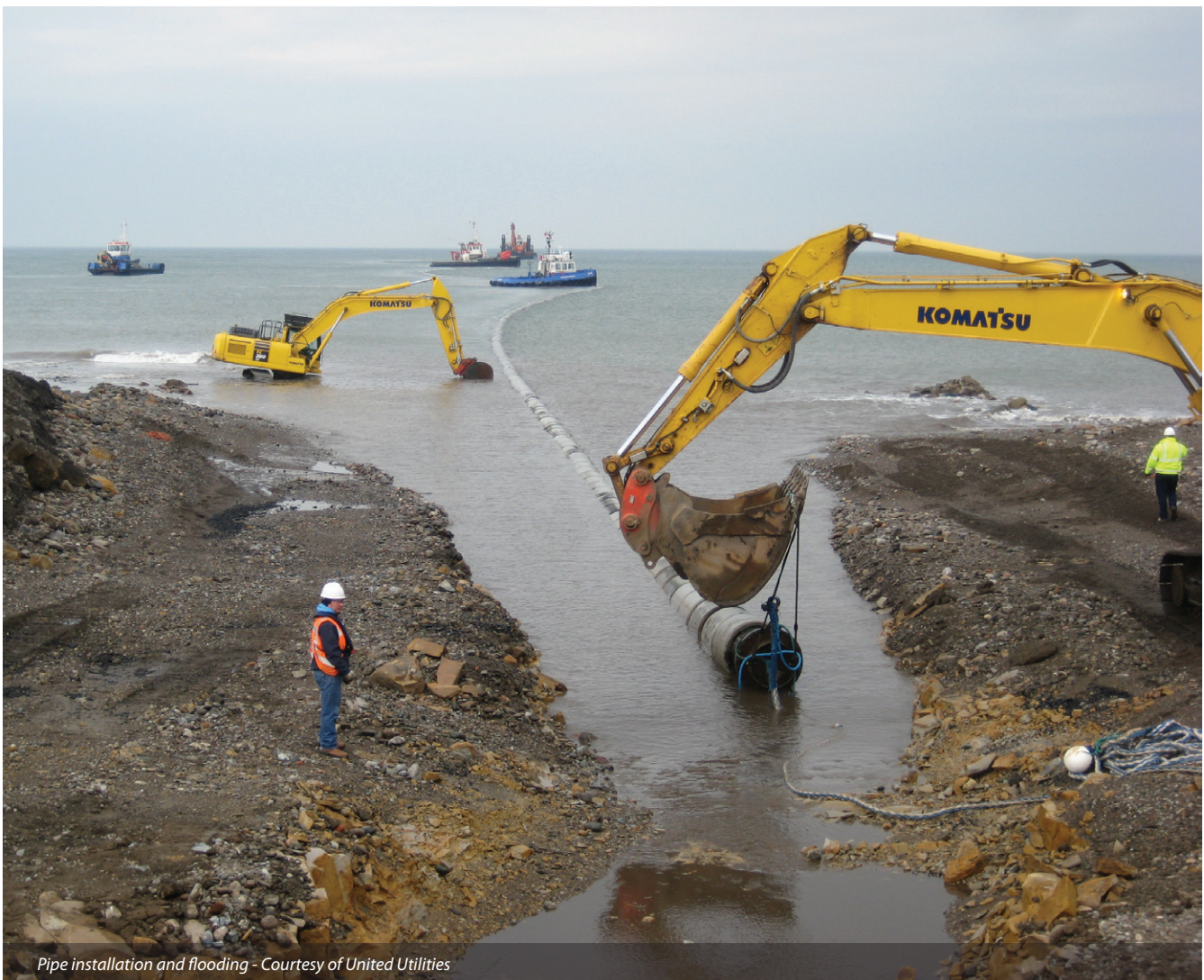


Whitehaven (Parton) Long Sea Outfall

designing and installing the next generation of submarine outfall pipelines in the North West

by Martin Berry CEng BEng MICE & Jonathan Starling CEng MEng MCIWEM

Whitehaven is a coastal town with a large and historic port, located south of Workington in Cumbria with a population of around 25,000. The town and surrounding area is served by Whitehaven (Parton) Wastewater Treatment Works (WwTW) which treats and discharges both storm and final effluent to below low tide level via a long sea outfall pipeline. An outfall was first constructed in 1976 as part of Water Quality improvements along the Cumbrian coast and was originally used as a sludge discharge pipeline to the Irish Sea with an extensive diffuser arrangement to provide a high level of dispersion. Since then, significant improvements in quality standards led to the addition of secondary treatment at the treatment works in 2000 and conversion of the outfall to a final effluent outfall. The paper details the £8m installation of a new long sea outfall pipe to replace an aging cast iron pipe.



Pipe installation and flooding - Courtesy of United Utilities

Background

As part of their AMP4 delivery programme, United Utilities undertook extensive marine surveys and inspection of its sea outfall pipelines. At Whitehaven, this included detailed bathymetric survey, diver inspections and land inspections of the existing pipeline and associated pumping facilities. Assessment of the survey data indicated that the existing outfall pipeline had reached the end of its serviceable asset life. Construction of a replacement outfall was hence submitted as part of the Price Review (PR09) for implementation during AMP5.

Wastewater treatment

Whitehaven (Parton) WwTW is situated adjacent to an environmentally designated watercourse, Lowca Beck, and inland of the main coastal railway line. The treatment works receives flows from both the Whitehaven and Maryport catchments.

Full treatment flows of up to 365 l/s are lifted via pumps to the inlet works where they are screened, settled and treated through batch reactors and returned to an outlet well for discharge. During storm events, flows spill directly from the inlet works to the outfall outlet

well. Due to the relatively low elevation of the works, the discharge of final effluent from the well to the sea is tidally constrained. Under mid to low tidal conditions, flows are discharged by gravity. However, pumps are required to provide additional head at high tides.

Existing outfall

The original outfall pipeline, constructed in 1976, was 1.4km long and discharged via multiple port diffuser. As it had been originally designed to discharge higher volumes of sludge with a total of 23 (No.) outlet ports, the outfall was adapted through closure of 16 (No.) ports to suit the change in effluent type and flow volumes in 2000. Although adequate, the revised arrangement meant that the outfall was not operating as effectively or efficiently as desired. This was confirmed by survey inspections in 2006 which identified that the diffusers were suffering from debris build up and marine growth caused by low flow velocities and saline intrusion.

The original pipe was known to be steel with an outside diameter of 750mm. However, due to its age, very little information existed on the exact construction, material specification and existence of protective coatings. Additionally, the outfall pipeline had been re-laid under the railway line at the time of the treatment works upgrades and further pipe failures downstream on the beach and along the marine sections had also necessitated a number of sectional repairs. The steel pipe was considered to be in poor condition and ongoing deterioration with increasing failures was considered likely. The pipe was hence considered at the end of its operational asset life and identified for complete replacement.

Solution

The outline design phase was undertaken in 2011 and considered and technically assessed a number of options including patch repairs, internal lining and full offline replacement. The marine outfall was surveyed again in September 2010 to further understand its condition and assess seabed stability and the risk of bed movement.

The process identified a preferred solution to construct a replacement outfall parallel to the existing, comprising circa 1,000m length of 710mm polyethylene pipe terminating in an 8 (No.) port diffuser. The outfall was elected to be constructed off-line to allow existing discharges to continue prior to final connection above high water.

The outfall would utilise marine design and construction techniques. To combat floatation, the design proposed that the polyethylene pipe would be stabilised using a combination of continuous concrete weight collars to reduce buoyancy and enable controlled installation by sinking, as well as rock armour backfill to the trench to provide additional stability from storm loadings.

Site investigation

Further bathymetric surveys were undertaken in 2010 to enable the design to be completed. Site investigations were carried out by Fugro Seacore consisting of 5 (No.) marine and 3 (No.) beach boreholes which enabled the stratigraphy and material properties along the proposed outfall route to be assessed. These were found to comprise sands and gravels thickening away from the shore, overlying stiff to very stiff glacial clays and coal measures rock.

Constraints

Due to the location of the railway line between the treatment works and the beach, the only existing access to the beach was via a narrow underpass with a height restriction of 1.8m. Due to its designation, access through Lowca Beck was also prohibited and hence a constraint was imposed requiring all plant, machinery and materials required for the beach works to be transported via marine access. In addition, the works were undertaken with consent from the Marine Management Organisation.



Pipe delivery leaving Norway - Courtesy of Pipelife Norge AS



Pipe delivery storage at Workington - Courtesy of United Utilities



Pipe string jointing in River Derwent - Courtesy of United Utilities



Restricted access to foreshore - Courtesy of United Utilities



Pipe string tow inshore - Courtesy of United Utilities



Pipe installed, diffuser installation offshore - Courtesy of United Utilities



Installation of land connection pipe - Courtesy of United Utilities



Connection to existing pipe - Courtesy of United Utilities

Design progression

Following completion of the outline design by United Utilities Engineering, Van Oord Dredging & Marine Contractors successfully bid and were appointed as Principal Contractor by United Utilities to undertake the marine works in 2012. Mouchel were subsequently appointed by Van Oord to provide detailed design services.

The parties worked in close co-operation to produce a final design which removed the need for large quantities of imported rock armour and provided a high standard of stability and protection to the pipeline through the use of continuous concrete weight collars (1m long, 550kg each) supplemented by 3.5t concrete 'kennels' placed directly over the collars at 7.5m intervals along the main pipeline.

The use of concrete 'kennels' enabled the final pipe weight to be increased to meet the minimum specific gravity requirement of 1.3 and design wave and current conditions without having to combat excessive weight through the use of buoyancy aids during installation.

The use of continuous collars also meant that the PE pipe was fully protected externally from damage, meaning lower requirements on backfill material were acceptable. This enabled the existing excavated seabed material to be re-used, avoiding the need to import granular fill and dispose of excavated spoil.

The use of split weight collars on the beach section enabled the pipe to be installed and quickly and stabilised within the trench using traditional land-based techniques working over tidal windows.

Marine works

A total length of 1,025m of polyethylene pipe (710mm OD SDR 17) was manufactured by Pipelife Norge AS at their production facility in Stathelle, Norway. The 855m offshore section of pipe was split into 3 (No.) 285m lengths prior to stringing on site to ensure that the pipe could be stored and protected within Workington Port.

Due to the natural buoyancy of the air-filled pipes, it was possible to tow all the pipes across the sea without additional support. Pipe end caps were securely installed to ensure the pipes remained filled with air throughout. The tug *Thor Goliath* commenced its tow from Norway on 5 July and arrived seven days later at Workington Port where the pipe was stored in the water alongside the quayside. The diffuser pipework was fabricated in polyethylene and welded separately in the UK.

The excavation of the marine trench was undertaken by backhoe dredger without the need for additional breaking or rock tooling. The excavated trench material was side cast adjacent to the trench for later re-use as backfill material.

The use of a GPS system with 3D dig software on the dredger backhoe, combined with monitoring bathymetric surveys, allowed the trench to be excavated to the required tolerances.

The concrete collars and kennels were fabricated off site by Cornish Concrete Products and delivered to the port for storage. The pipe preparation works prior to installation required the concrete collars to be 'threaded' onto each pipe string within the port. The pipe remained full of air and sealed at both ends throughout, to assist with the installation and positioning of the collars onto the pipe.

Once all 750 (No.) collars were fitted on to the pipe strings, Viking Johnson couplings were installed to allow for the final single pipe string (3 (No.) strings totalling 855m) to be jointed.

The Port of Workington has only a 300m long berth and is tidally locked, therefore the final pipe string could not be jointed within the port.

The port approaches and the adjacent River Derwent were utilised over two consecutive high tides to complete the final single string. This was a critical activity as there was limited working area available due to the depth of the channel and river and access to the port could not be restricted at any time due to other shipping movements. Once the single string was completed, the pipe was towed 5 nautical miles to Whitehaven to enable the pipe installation to commence on the following high tide.

Installation

The dredger *Dinopotes* was positioned at the seaward end of the excavated trench with excavators on the foreshore to receive the pipe. The single pipe string was attached to the *Dinopotes* before being gradually towed inshore and pulled onto the beach and positioned in the leading trench.

The pipe was installed in a controlled manner using the 'float and flood' technique. Seawater was pumped into the pipe via a bulkhead at the offshore end as the pipe was lowered into the trench using an excavator. By controlling the fill rate, a smooth S-shaped bend is formed in the pipe as it floods and slowly sinks.

The process is aided by a number of smaller tugs and multi-cat vessels which assist in the final alignment. Final positioning of the pipe was undertaken on the following high water prior to a detailed multibeam survey of the pipe to confirm its position in the trench.

With the pipe now located and sheltered within the trench, the *Dinopotes* and a support barge were fitted out with a dive team from Northern Divers who undertook the installation of the diffuser section. The diffuser consisted of 4 (No.) multi port risers, concrete diffuser domes and rock armour scour blanket. Following the completion of the diffuser construction, 110 (No.) concrete kennels were located over the pipe at approximately 8m centres before the trench was backfilled with as-dug material.

The section of pipe from low water to the existing pipe adjacent to the railway line was excavated by land plant landed on the beach from a marine barge. Being below high water level, the single 170m length of PE pipe was fitted with 44 (No.) split concrete weight collars to provide stability within the trench.

An access flange on the pipe for future inspections was installed above high water level on the beach and protected with a buried manhole. The final connection to the existing outfall pipe was undertaken on a planned works shutdown at the beginning of May 2013.

Conclusions

The successful completion of this project and the investment undertaken by United Utilities will continue to provide water quality benefits to Whitehaven Parton and the west coast of Cumbria.

The installation required meticulous planning by a team of marine experts to continue United Utilities' vital work cleaning up the seas and beaches of the North West.

The outfall project was part of a £3.6bn fund being invested by United Utilities to improve water quality and the environment by 2015. The Whitehaven Parton outfall pipe is the first to be completed during AMP5 and further articles will appear in future editions of UK Water Projects.

The Editor & Publishers would like to thank Martin Berry, Design Manager with United Utilities Engineering, and Jonathan Starling, Engineer with United Utilities Engineering (CH2M Hill), for providing the above article for publication.

The authors thank United Utilities, Van Oord and Pipelife Norge AS for their assistance with this paper.



Concrete collar insertion - Courtesy of Van Oord