# Barrow in Furness WwTW Outfall

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

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Spring 2015 saw the successful completion of a new 2.4 kilometre-long sea outfall across Roosecote Sands in Barrow in Furness. This outfall extension improves dispersion of the final effluent in the Walney Channel, provides protection to the European Designated Sites and ensures compliance with the Habitats Directive. The installation required meticulous planning by the project team working for United Utilities on an £8m scheme to continue the company's vital work cleaning up the seas and beaches of the North West. The outfall project was part of a £3.6bn five year investment programme to improve water quality, the environment and services to customers.

*Installation in Walney Channel - Courtesy of United Utilities*

### Background

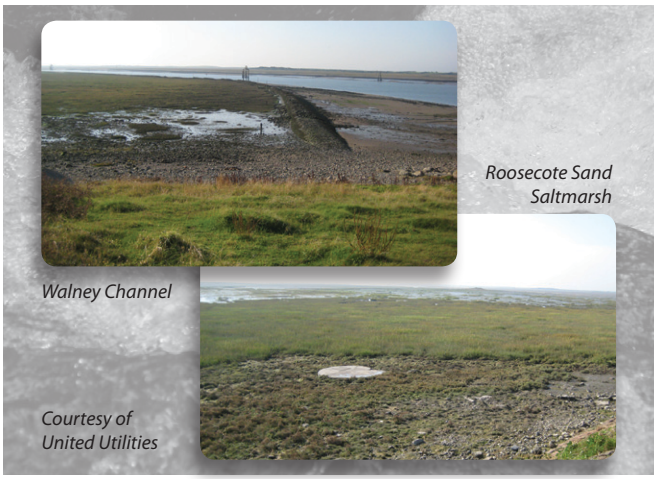
Barrow in Furness is located on the South-West coast of Cumbria and is one of the larger industrial towns in the area with a history of ship building. The town and surrounding area is served by Barrow WwTW which treats and discharges final UV treated effluent via an existing 1.1km long sea outfall pipeline discharging within the tidal reaches of the Barrow Estuary.

The existing outfall was first constructed in 1913 as the town of Barrow grew and the population increased. The current WwTW was built and commissioned in 1996 to provide biological treatment. Since then, significant improvements in quality standards led to the addition of tertiary treatment and UV treatment facility. The existing outfall discharges within Roosecote Sands into the head of a brick-lined open drainage channel which subsequently drains to the Walney Channel.

The location of the existing and proposed outfalls from Barrow WwTW is within European designated sites including the Morecambe Bay Ramsar, Special Area of Conservation (SAC), Special Protected Area (SPA), and three sites of Site of Special Scientific Interest (SSSI). These sites have both regional and national importance for wildlife including wintering birds and wildfowl.

Eelgrass beds are present on the saltmarsh and are rare nationally and represent the only eelgrass population in the North West of England. Protected under the Habitats Directive, the eelgrass beds are also important as they aid the stabilisation of sediment and provide a food source for migratory wildfowl.

As part of their AMP4 delivery programme, United Utilities undertook extensive ecological surveys of the area and eelgrass beds. The requirement proposed by Natural England and endorsed





Construction of access road - Courtesy of United Utilities


Installation of dewatering - Courtesy of United Utilities


Installation of pipe through training wall - Courtesy of United Utilities

by the Environmental Agency (EA) was to extend the final effluent outfall in order to ensure that the effluent is discharged away from the eelgrass habitat. From an early initial assessment during PR09 (Price Review 2009) the preferred option was to replace the existing outfall with a new, longer 2.4km outfall which would cross the training wall and discharge into the Walney Channel.

### Wastewater treatment

Barrow in Furness WwTW is situated to the east of the Barrow dock system adjacent to Cavendish Dock and receives flows from the Barrow, Dalton, Lindal and Walney Island catchments. The works is bordered by a site of Special Biological Interest (SBI) and the Cumbrian Way footpath.

Full treatment flows of up to 689l/s are lifted via screw pumps to the inlet works where they are screened, settled and biologically treated with UV before gravitating to the tidal pumping station. Flows are discharged by gravity when tidal conditions allow; otherwise pumps are required to provide additional head at high tides. During storm events, flows spill to a combination of storm tanks and 33,000m$^3$ UID storage tanks constructed as part of a separate project during AMP5. Only once all these tanks are full will the existing outfall discharge combined flows up to 1,500l/s.

### Existing outfall

The existing outfall pipeline, constructed in 1913, is believed to have been an untreated discharge from the upstream catchments. The current wastewater treatment works was built and commissioned in 1996 to provide biological treatment to the discharge. The treated flows are connected to the existing 1.1km section of 48" cast iron pipe at the foot of the coastal defences at approximately MHWS. The outfall discharges via a brick headwall into a straight engineering brick U-channel which transfers the flow to the main Walney Channel. Inshore of the sea defences the outfall was replaced in 1994 with a 340m long 1,200mm diameter GRP pipe to the tidal pumping station.

There have been no reported operational problems with the existing outfall pipeline. Maintenance inspections were undertaken during AMP4 and at the start of AMP5 and the cast iron pipe was in good condition with no internal sediment. The GRP pipe also had no operational problems or historical bursts but access restrictions limited the ability to undertake further investigations.

### Solution

The outline design undertaken for PR09, with technical support from a marine contractor, was based on a 2.4km steel pipeline across Roosecote sands to the channel. Three route options had been considered but limited investigation work had been undertaken at the time these options were considered. Marine surveys were undertaken in 2011 which including bathymetric, topographic, sub-bottom profile geophysics and magnetometer of the saltmarsh and Walney Channel. These surveys indicated that the saltmarsh was predominantly flat with the presence of large drainage channels.

The three proposed outfall route options were assessed against the latest survey data and ecological constraints. Two of the routes followed the alignment of the existing outfall, or extended from the existing outfall and were discounted due to the complexities of the drainage channels. The preferred route was to follow the profile of the existing flood defences before crossing under the training wall to the channel. The hydraulic analysis indicated that due to the flat nature of the saltmarsh the longitudinal profile of the outfall would introduce high and low points with air valves and wash outs respectively.

Preliminary dispersion analysis had been undertaken prior to PR09 to assess the discharge location for the outfall. This analysis included initial dilution predictions and Cormix modelling of a

discharge location within the Walney channel. Due to the relatively shallow depth of the channel achieving initial dilution targets was not practical, however achieving a bacterial log kill target for the UV treated effluent was agreed with the Environment Agency. A single open ended pipe with no diffuser structure below MLWS was agreed as the preferred solution.

The outfall project scope had included for replacement of the existing tidal pumps within the pumping station as these were deemed to be unreliable and close to the end of their asset life. The increased length of the outfall significantly increased the hydraulic head required by the pumps. The hydraulic analysis of the pumping station indicated that the wet well volume was insufficient for the flows thus affecting the pump start/stop regime. Due to the limited space available, and the need to maintain pumping capability at all high tides, the preferred solution was to construct a new tidal pumping station offline.

The GRP section of the outfall from the tidal pumping station to the saltmarsh was not to be replaced. There were no historical bursts or failures to support its replacement as this would have required construction work through the protected reed beds of the SBI and through the coastal defences.

The outfall would be constructed off-line to allow existing discharges to continue prior to final connection at the high water level. The outfall would be 2.4km long 1,000mm diameter pipe with the outer section in the channel being constructed on piled supports above seabed level. The selection of pipe material would be the contractor's responsibility but this would require a pressure pipe to cater for the pumped surge pressures.

## Site investigation

The bathymetric surveys undertaken in 2011 by Aspect Surveys had included both geophysics and magnetometer surveys of the outfall route. There had been concerns regarding the potential for UXO within the estuarine deposits in proximity to the port as a legacy from the Barrow blitz during WWII. The potential for radioactivity associated with local construction of nuclear fuelled submarines and contamination associated with historic in-filling to reclaim the land below the treatment works were additional concerns that needed to be addressed before and during the intrusive investigations.

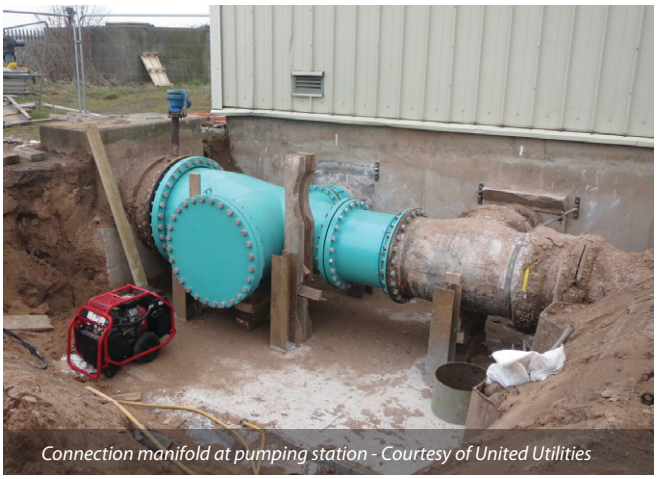
Geotechnics Limited undertook intrusive investigation comprising of 32 boreholes and cone tests which enabled the stratigraphy and material properties along the proposed outfall route to be assessed. The investigations on the saltmarsh required tidal working in an environmentally sensitive area with low strength surface soils. Specialist Hagglund vehicles were developed for the investigations work and these proved to be effective with the works completed ahead of schedule.

The investigations essentially proved the anticipated geology encountered along the outfall route comprising tidal flat deposits mainly of clay and silt. The wider geology of the area suggests that the tidal flat deposits are underlain by glacio fluvial deposits comprising of marine alluvium sand and gravel, glacial fluvial deposits and till. As the outfall site is below high water level, the soils along the route are fully saturated at all times and inundated during high tides. At the tidal pumping station a mixture of made ground, glacial deposits and till were encountered with groundwater within a metre of the surface.

## Constraints

The construction of the outfall pipeline, in particular the access route to the saltmarsh, was agreed with Associated British Ports Barrow (ABP Barrow) as it is within the jurisdiction of the operational port. There are no existing access ramps from road level onto the salt marsh so the location of temporary stone ramps had to be


*Pipe supported on piles in channel - Courtesy of United Utilities*



*Connection manifold at pumping station - Courtesy of United Utilities*

*Connection to existing outfall station - Courtesy of United Utilities*

*Outfall with duckbill check valve operating*
*Courtesy of United Utilities*

consented. Due to the presence of other contractors at Barrow WwTW, restrictions on working areas, storage and parking around the tidal pumping resulted in personnel access via Cavendish dock. The main site compound also had to be located remotely from the working area due to the lack of available land within the port.

ABP Barrow is a key stakeholder for this project and was consulted throughout the project and design development. The discharge location for the outfall within the Walney Channel had been agreed with the EA to improve dispersion; however the presence of this pipe within the channel posed a navigational issue for submarine transits.

A revised outfall design was produced which minimised the pipe's protrusion into the channel whilst still achieving the dispersion requirements. In addition the outer sections of the outfall had to be designed to be removable, hence reducing the outfall length, as this may be required if the Walney Channel was to be deepened to cater for larger vessel or submarine classes in the future.

The proposed outfall is within a number of European designated sites necessitating relocation of existing areas of eel grass and the protection of an area of vegetated shingle in proximity to the existing training wall. The top layers of materials on the salt marsh had to be stored and reinstated to ensure the natural habitat could re-establish naturally. The length of trenched excavation that could be open at any one time was also limited and the existing drainage channels and overflow spill from Cavendish Dock had to be maintained. The works were undertaken with consent from the Marine Management Organisation.

## Design progression

Following completion of the outline design by United Utilities Engineering, Farrans successfully tendered and were appointed as principal contractor by United Utilities to undertake the construction works in 2014. Mouchel and TES were subsequently appointed by Farrans to provide detailed design services.

The pipe material selected for the outfall was Saint Gobain TT PUX ductile iron pipe 1000mm diameter with a cement mortar lining satisfying the hydraulic and pressure requirements. The Saint Gobain TT PUX external protection system is deemed suitable for use in any ground conditions. However, unlike the smaller diameter ductile iron pipes, there are no galvanic layers beneath the polyurethane to protect the pipe should the coatings become physically damaged.

A sacrificial anode cathodic protection system was installed to provide additional external corrosion protection in the event that the primary coatings are damaged.

The sections of the outfall pipe within the Walney Channel were supported on concrete piles and precast pile caps with rock armour to provide scour and pipe protection as far as the existing training wall. The profile of the outfall was re-designed to minimise excavated depth in the saturated ground conditions.

## Outfall works

The construction phase commenced with the installation of the access ramps onto the salt marsh and the haul road to provide access along the outfall route. Installation of the outfall pipe commenced with the crossing through the training wall at the boundary of the main channel.

Following a number of trial excavations a dewatering system using pre-installed well points with pumping system was developed, these were installed in advance of the main pipe trench.

The pipe laying team then progressed back upstream towards the connection point with the existing outfall. The cathodic protection

system was installed at the same time as the pipe using pre-fixed lugs and connecting wires run from the temporary works.

The outfall construction within the Walney Channel was undertaken using a jack-up supplied by ABCO Marine to install the concrete piles and supports. The outfall was terminated with a duckbill check valve and concrete mattresses were installed to prevent scouring of the existing channel bed material.

The installation of the outfall pipe across the Roosecote saltmarsh was particularly challenging for the pipe laying team. Access onto the marsh was restricted to tidal periods and required careful planning. The setting up of the temporary works and dewatering system would use up valuable time leaving only a reduced duration for pipe installation per shift. Typically four pipes could be installed during a low tide window but this reduced as the winter months were encountered.

The re-profiling and raising of the outfall level was designed to improve the ground conditions encountered during the trenching. However, the nature of the soft glacial materials and their variability, combined with the tidal water table saturating the area, resulted in some particularly challenging conditions.

Establishing a safe and stable trench for pipe installation was a constant battle across the marsh. Farrans utilised a combination of battered excavations, trench boxes, base stabilisation using geomembrane and stone and a short section of restraining piles to install the pipeline.

### Pumping station

The design of the tidal pumping station was undertaken in conjunction with Xylem and the orientation was rotated to facilitate access requirements around the existing pumping station. A new area adjacent to the existing tidal pumps was designed to allow the new control panels to be installed off line. This reduced the complexities of the control transition between the new and old stations during commissioning.

The pumping station wet well was constructed using concrete shaft segments 8m in diameter sunk to 6m below ground level. The concrete valve chamber and weir diversion chamber were constructed within limited space around the existing pumping station. The installation and commissioning of the new tidal pumping station was phased around maintaining operation of the existing site.

The final connection to the existing outfall and commissioning of the new pumping station was completed in March 2015.

### Conclusions

The successful completion of this project and the investment undertaken by United Utilities will continue to provide water quality benefits to Barrow in Furness and the protected eelgrass habitat.

The eventual installation programme coincided with the winter season and Farrans selected installation techniques involving a mixture of both land based and marine plant, which was sufficiently robust to ensure the project was completed within the specified timeframe.

This outfall project bears testament to the collaborative working ethos of the entire project team and suppliers. The Barrow WwTW outfall pipe was the final outfall project completed during AMP5.

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