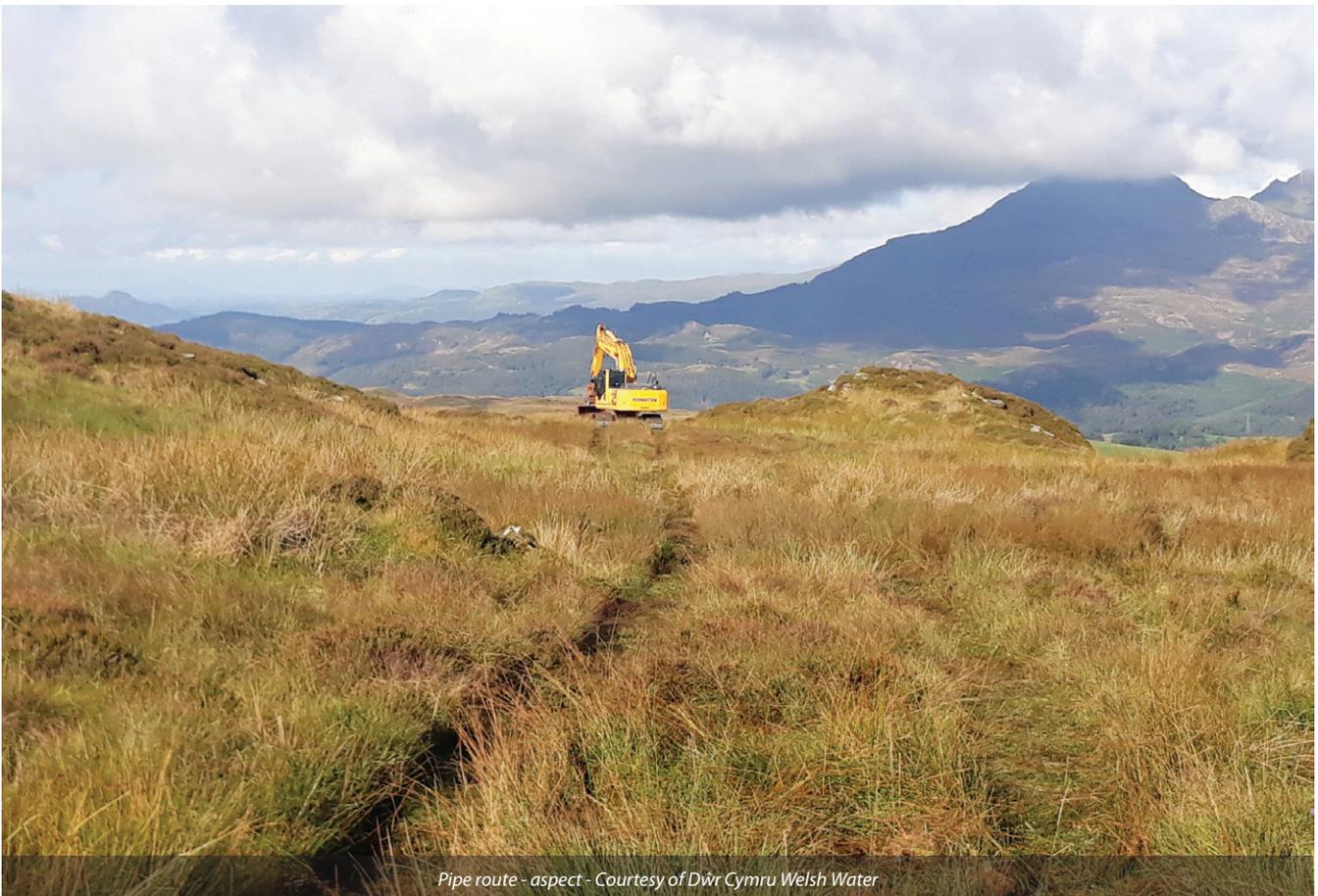


Garreglwyd Raw Water Supply Main

ensuring Welsh Water customers an uninterrupted supply during harsh weather extremes in challenging terrain

Dŵr Cymru Welsh Water has an extensive network of rural water supply assets in North Wales, with numerous service reservoirs and many kilometers of pipeline. Emergency repairs or mitigation measures have arisen from both freeze-thaw conditions and dry weather over the past few years. During 2018 there were both extremes of cold weather and one of the driest summers for many years. Welsh Water successfully mitigated these by working collaboratively on a framework call off with Waterco, a specialist design consultancy based in North Wales, O'Connor Utilities (OCU) and UTS, a national pipeline contractor specialising in directional drilling and specialist fabricators. Throughout 2018, the Welsh Water/Waterco/OCU/UTS team dealt with over eighty reactive projects, ranging from minor to major repairs of trunk mains, distribution mains, sewers, rising mains, pumping stations and service reservoir valves - many directly related to the weather events.



Pipe route - aspect - Courtesy of Dŵr Cymru Welsh Water

Storm Emma

One example of this collaborative working was during the Storm Emma weather event, dubbed *'The Beast from The East'*, in early 2018. Welsh Water's Engineering Delivery Team (EDT) were allocated a *'Mini-IB (intervention brief)'* by their colleagues working in Water Services.

Freezing conditions had caused numerous bursts in the town of Blaenau Ffestiniog and resulted in the service reservoir at Garreglwyd Water Treatment Works (WTW) being drained down. Flow restrictions in the raw water main meant that the unusually high flow requirement at the works (40 l/s) was not being met with only 22 l/s being delivered via the 1.2km of raw water pipeline from Llyn Morwynion Reservoir. The pipeline consisted of 800m of 8" cast iron (laid in 1975) and 400m of 250mm MDPE pipe (laid in

1988). The WTW was in danger of failing to maintain supply and as the situation was deteriorating rapidly, the EDT were required to respond quickly to deliver security of supply to customers.

Emergency response

The immediate emergency response was to install a temporary overland supply pipe from the reservoir raw water supply to the WTW. Waterco were engaged at the onset and undertook hydraulic calculations to size the proposed temporary pipe for the required supplementary flow and check that pressures remained within the safe working limits of the temporary lay-flat pipe that was available.

The route of the proposed overland supply was partly through private land consisting of a disused quarry, Crown land, a designated Special Area of Conservation (SAC) and a Site of Special Scientific



Llyn Morwynion intake - winter - Courtesy of Dŵr Cymru Welsh Water



Llyn Morwynion intake - summer - Courtesy of Dŵr Cymru Welsh Water



Access bog matting to enable heavy machinery
Courtesy of Dŵr Cymru Welsh Water



Pipe strings - Courtesy of Dŵr Cymru Welsh Water

Interest (SSSI). Extreme weather conditions were encountered due to the prevailing storm conditions, which included thick fog and snow; this further hindered access to the remote location.

It was determined that special fabricated fittings would be required to connect at the WTW and downstream of the dam wall. UTS fabricated these fittings and flew them directly to the site from Newcastle by helicopter in order to accelerate the works.

OCU worked in very hostile weather conditions in an isolated and challenging location, with limited time for planning to install the temporary overland pipeline. The EDT managed the project, dynamically monitoring the emerging situation - the whole team showed commitment to the urgent need to maintain supply, such that the temporary supply was commissioned within 36 hours and loss of supply to customers was avoided.

Permanent solution - planning

Following the completion of the reactive solution, Welsh Water quickly progressed a scheme for delivery within the summer/autumn 2018, to ensure a permanent solution that would allow the overland pipe to be removed. Waterco were commissioned to carry out the detailed design for the replacement section of raw water main and deal with all third party issues.

Divers were used initially to confirm the intake within the reservoir was clear. Incremental testing was then carried out to locate the flow restriction. It was concluded that this was attributable to severe tuberculation in some 450m of the 8" cast iron raw water main. Records showed this had been the reason for the earlier replacement section of 250mm MDPE. Inspection of the MDPE pipeline showed it to be in good condition; the material being less susceptible to tuberculation.

Pipeline planning and optioneering

The route of the existing raw water main crossed rough mountainside open fields, passed through a disused quarry and crossed several dry-stone walls and stock proof fence field boundaries, as well as watercourses. A site walkover was carried out to view the existing route and determine potential issues with the route being partially through Crown property together with a SAC and SSSI.

Alternative routes and various installation methods were considered to try and overcome these issues at an early stage.

- **Pipe bursting:** Pipe bursting the existing cast iron pipe was investigated as the first option, but the remoteness and lack of access for the required equipment ruled this out.
- **Directional drilling:** Directional drilling was also considered in conjunction with OCU as they specialise in this installation method and the distances were well within their capability. However, this did not prove to be a viable option, partly due to access to the remote location, but also because some of the route was through a steep sided quarry. Another section was through peaty marshland where directional drilling does not work well so substantial diversions would be necessary.
- **Open cut:** It was concluded that the most practical option would be open cut installation following, for the most part, the route of the existing main as a proven route.

Topographical survey

To aid the design and enable the correct positioning of air valves, topographical details of the route were required. Waterco investigated the option of utilising Ordnance Survey mapping coupled with LiDAR (levels) data to provide the level information but found that the level data was not available in this remote area. Surveying by conventional methods would be both time consuming and expensive and would also require legal notice of entry onto private land.

In order to obtain the required data quickly, a survey was commissioned using an unmanned aerial vehicle (UAV) thereby negating the requirement to serve notice, although all affected landowners and tenants were notified out of courtesy. A day of fine weather conditions was selected and the UAV survey was completed in half a day; with the results back within a couple of days later. Based on the UAV topographical survey, the route was selected to avoid Crown Estates Land because Statutory Notices are not valid, the applications process is lengthy, and this would have delayed the programme into the winter period. The route was also deviated from the original to minimise the impact to the SAC and SSSI. The alternative route added a further 100m to the length of pipe to be replaced.

Archaeology

Whilst carrying out third party enquiries, the local archaeologist was consulted and whilst there were no archaeological artifacts known to be in the area, attention was drawn to the fact that the old quarry had the potential for hidden adits due to the way it had been worked. Although this ultimately proved not to be an issue, it was always a risk for the contractor whilst working in the area.

Pipeline sizing requirements

Waterco undertook the calculations and modelling and confirmed the hydraulic adequacy of 250mm MDPE for future supply requirements on the proposed extended route. The agreed solution was therefore to replace 550m of 8" cast iron with 250mm PE100 SDR11. Waterco prepared legal notices of entry for Welsh Water to issue to private landowners and to submit applications for the works to Natural Resources Wales (NRW) and Gwynedd County Council.

With all necessary assents obtained, OCU was able to commence works in early September 2018. An additional 6" overland pipe was also laid to facilitate replacement of the existing section of pipeline online.

Construction/commissioning

The OCU site team dealt with some extremely challenging terrain by open cut methods and worked long hours to deliver the scheme two weeks ahead of programme, with the new pipeline section replaced and commissioned by Welsh Water in October 2018.

This scheme, including both the reactive and planned elements, has delivered long term security of supply to customers, ensuring Welsh Water's good reputation is maintained. The team effort was recognised by Welsh Water in early 2019, with the scheme being awarded an internal Alliance Excellence Award for Best Customer Outcome.

Proactive management of water resources

Waterco and OCU were active during the dry summer of 2018, when Welsh Water made the decision not to impose any water restrictions on its customers. Welsh Water began proactive management of water resources; whilst some catchments had ample capacity, certain areas had low water levels and were a cause of concern.

Welsh Water called upon Waterco to assist with the proactive management and to explore different methods to maintain supply. These were designed/detailed 'on the fly' together with feasibility studies produced for the potential of long-term event emergency measures. In close collaboration with Welsh Water and OCU, Waterco provided dedicated teams to respond to the challenge which included site and office based activities.

A considerable number of options were examined. Some remained on the shelf as feasibility studies such as reservoir dead water recovery and reactivation of abandoned raw water intakes (only to be used as last resort), however rainfall returned water levels to acceptable levels before it became necessary to implement them.

Others were implemented as they became apparent, including:

- Cross connections between separate catchment potable water systems.
- Reversal of flows in strategic mains.
- Improved access to service reservoirs with extended tanker off points to facilitate a fleet of tankers which were spread over the North West area.
- Dedicated tanker draw-off points from large diameter high pressure mains that, with pressure relief valves (PRV) in place, allowed three articulated tankers to be filled simultaneously. These tanker draw-off points were manned for active management and were running 24/7 over a number of weeks servicing multiples of three tankers.
- Installation of additional in-line pump booster stations.
- Increased reactive leak/run to waste/lost flow management.

To deliver the solutions required to keep the water running for Welsh Water's customers, OCU ramped up their resource to deliver what was required as it was required on a 24/7 arrangement; supported by their supply chains.

Welsh Water did not need to implement a hosepipe ban. The actions taken during this dry weather event provided them with additional resilience in their network. Many of the installed features have become permanent, whilst others were removed with enhanced knowledge of what can be achieved in response to challenging weather conditions. The dry weather event of 2018 was a useful 'stress test' for Welsh Water's system, their own teams and of their supply chain.

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Steep section access - Courtesy of Dŵr Cymru Welsh Water



Pipe string before burial - Courtesy of Dŵr Cymru Welsh Water