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2024 TECHNICAL AWARDS ENTRY FORM

Entry Deadline: Friday 19th April 2024

Please tick which categories you are entering (entries may be submitted in multiple categories using the same entry form)

Large Diameter Pipeline Project Award	x
Large Diameter Pipeline Technology Award	x
Utility Pipeline Project Award	x
Utility Pipeline Technology Award	x
Subsea Pipeline Award	
iICE Award	
Health & Safety Award	
Net Zero Carbon Award	

1. **Brief title of entry:** Vyrnwy Aqueduct Modernisation Programme – Air Pig Technology
2. **Company name:** United Utilities & Avove Utilities
3. **Signed:** Max Harwood / Jonathan Craggs
4. **Date:** 26/03/2024
5. **Company contact name:** United Utilities
6. **Telephone:** 07557173512
7. **Email:** maxwell.harwood@uuplc.co.uk

8. **Precis of your entry (50 words):**

Air Pigging is an innovative approach for cleaning large diameter pipelines and is an alternative to conventional pressure jet cleaning. It was proposed on this project by facilitating a collaborative approach between United Utilities and Avove and provided substantial benefits including reduced carbon production, water use savings and programme reduction.

9. **Summary of entry:**

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The Vyrnwy Aqueducts, first installed in the 1890's, are currently undergoing major refurbishment works to ensure United Utilities continue to provide wholesome drinking water to our customers. The aqueducts transport water from its source in Lake Vyrnwy, Wales, to Prescot Service Reservoir in Liverpool, supplying much of Merseyside and parts of Cheshire with water. They comprise of 3 no. 42" aqueducts, 2 of which are constructed of Cast Iron and the other is bitumen lined Steel. This submission revolves around the works to refurbish through cleaning the steel main in Siphon 1 of the scheme between Malpas and Cotebrook which is approximately 17.5km in length.

Traditionally, cleaning works on steel aqueducts would comprise of pressure jetting to remove the manganese film that forms on the lining. Pressure jetting uses potable water, typically extracted from network supply, to clean the aqueduct which is then removed from the pipeline and taken to be treated as wastewater due to the contaminants. During optioneering, several challenges were raised regarding this traditional solution, specifically around concerns regarding the impact on the environment and the amount of clean water to be used. With the need to protect our water sources and environment becoming a growing priority, alternatives methods needed to be sought. The answer to this question lay in a collaborative approach. Regular sessions were held before start on site with disciplines from construction and design to customer and operations. The appointed Principal Contractor on Siphon 1, Avove, proactively came to the table with alternatives and through collaboration, developed one of these alternatives into a single preferred proposal. This proposal was to Air Pig the steel main to clean it.

Air pigging is a technique that has been used in many industries including water but has had limited previous use on the size and scale of the Vyrnwy Aqueducts (1066mm diameter and 17.5km length). The technique involves inserting two foam pigs into the main, 2% larger than the aqueduct diameter, separated by the insertion of a volume of water. See Figures 1,2 and 3 for cleaning swabs. This 'train' is then transported through the aqueduct via pressurised air, compressed and inserted into the main through air valves in launcher and receiver manifolds. The initial foam swab disturbs and dislodges the existing manganese film on the internal wall of the main, with the volume of water between the two swabs picking up these deposits and effectively cleaning the pipeline as it is transported from launch to reception points. Once received, the pressure is reduced through opening a vent valve on the receiver manifold and the initial pig is removed, with the slug of wastewater being pumped out and taken to waste. See Figure 7 for typical details of the launch and reception points temporarily installed onto the aqueduct. The detail included fabricated long radius duck foot bend with a taper and 2 no.1200x2000mm fabricated pig launch pipework. Nominal average pressure to start moving the pig train was recorded at 2 bar, with pressures slightly increased to overcome some obstacles within the pipeline such as settled water at sluice points. Health and safety processes were always followed with thorough risk assessments and method statements created for the works. Additional benefits of this solution include the flexibility to be able to change the type of pig inserted into the main. For example, the pigging process was also used to CCTV the main after the cleaning of the aqueduct had taken place. This involved a specialist foam swab that included a HD camera within the nozzle, see Figure 4. Tracking technology was also included in the foam swabs meaning the live location could be monitored to ensure operational teams were ready to receive the swabs.

The 17.5km of pipeline to be cleaned was split into crossover sections; break points in the pipeline where water can be crossed between all 3 lines. These sections are approximately 2-3km in length and could be cleaned in one run, much more efficient than a typical 500m length for equivalent cleaning techniques such as pressure jetting. A duration estimate in the accepted programme from Avove prior to pigging was that these 2-3km section would take approximately 7 days to clean using air pig technology. This included for mobilisation and site set up, 3 days of pigging runs and dismantling of equipment with an allowance for Time Risk Allowance (TRA). A similar length section using conventional cleaning methods could potentially take up to 6 weeks to complete. As the performance of the air pigging was largely unknown at 1m diameter, it was agreed between UU and Avove to set a contractual number of passes, and any further cleaning required based on inspection after these passes would be deemed as a Compensation Event.

So how did it perform? See Figures 5 and 6 for images taken before and after the cleaning had taken place. The air pigging was deemed as a success by both contractor and client alike. Post cleaning inspections presented a very clean pipe, with much of the manganese film removed over the full 3km sections. The internal lining condition after pigging was one of the main concerns with using this technology. The bitumen, although worn in sections due to age, was found to have been hardly impacted by the foam swabs. Invert flushing in the aqueduct removed any excess debris which was limited in volume and mostly present towards the ends of runs once the pigs had become saturated. The duration of invert flushing was 1 day per section for air pigging compared to conventional pressure jetting which usually last at least a week. Operational colleagues noted how quickly pipeline sections were being commissioned due to speed at which the sampling passed based on the cleanliness of the pipe.

Not only was the air pigging beneficial based on programme when compared with a conventional cleaning method such as pressure jetting, but as mentioned previously, a positive impact on environment and sustainability was at the heart of the decision to adopt an alternative approach. Benefits include but not limited to; 118 tonnes of CO2 saved, 1104 estimated tanker journeys saved,15million litres of water saved and over 2200 journeys saved using the innovative solution. In addition, by reducing working areas through longer cleaning lengths, a reduction on the impact of ecology and customers could be realised.

Will Eyre, United Utilities Regional Delivery Manager for the VAMP project:

"As a client we often talk about innovation, but rarely do we receive breakthrough technologies such as this. As a traditionally more conservative organisation, the approach the team took to ensure buy in for Air Pigging has been amazing. I understand the technology has been used in other industries, but for the water industry this is a big first and carried significant risk if it failed. Due to the diligence of the team however, this was never in doubt. We now have a new technique that can be used elsewhere, and with the carbon, cost and programme savings that can be realised, it will revolutionise the way we approach refurbishment of large diameter trunk mains".

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Figure 1 - Various PIG swabs can be used on air pigging.

Figure 2 - Cleaning PIG condition after the first run & launcher manifold.

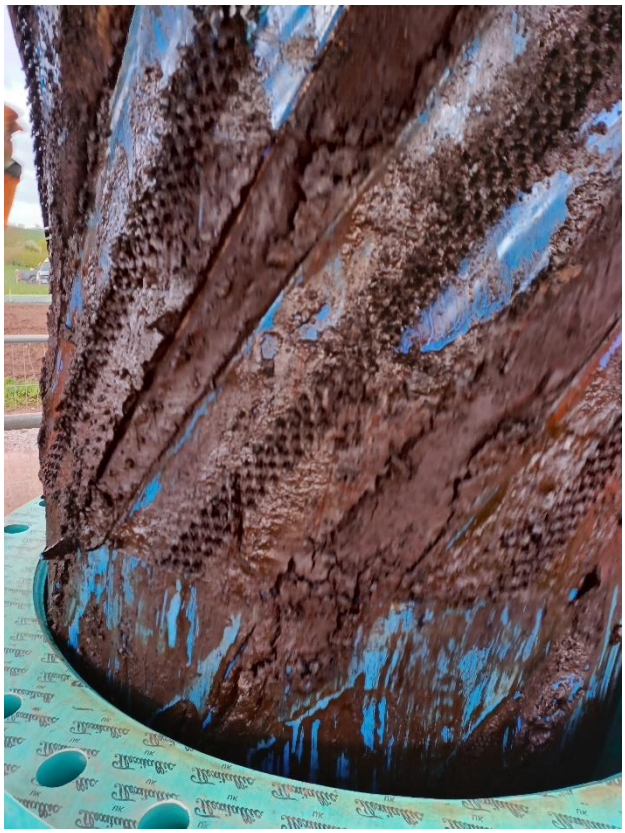

Figure 3 - The initial cleaning PIG would remove a considerable amount of manganese.

Figure 4 - A camera PIG was used to CCTV the main post cleaning.

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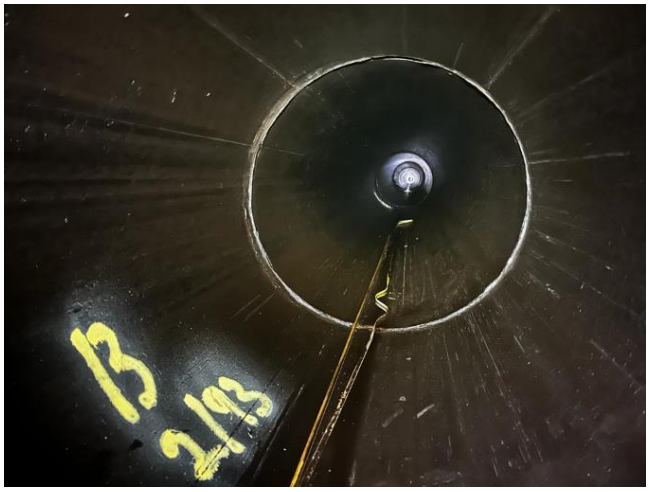
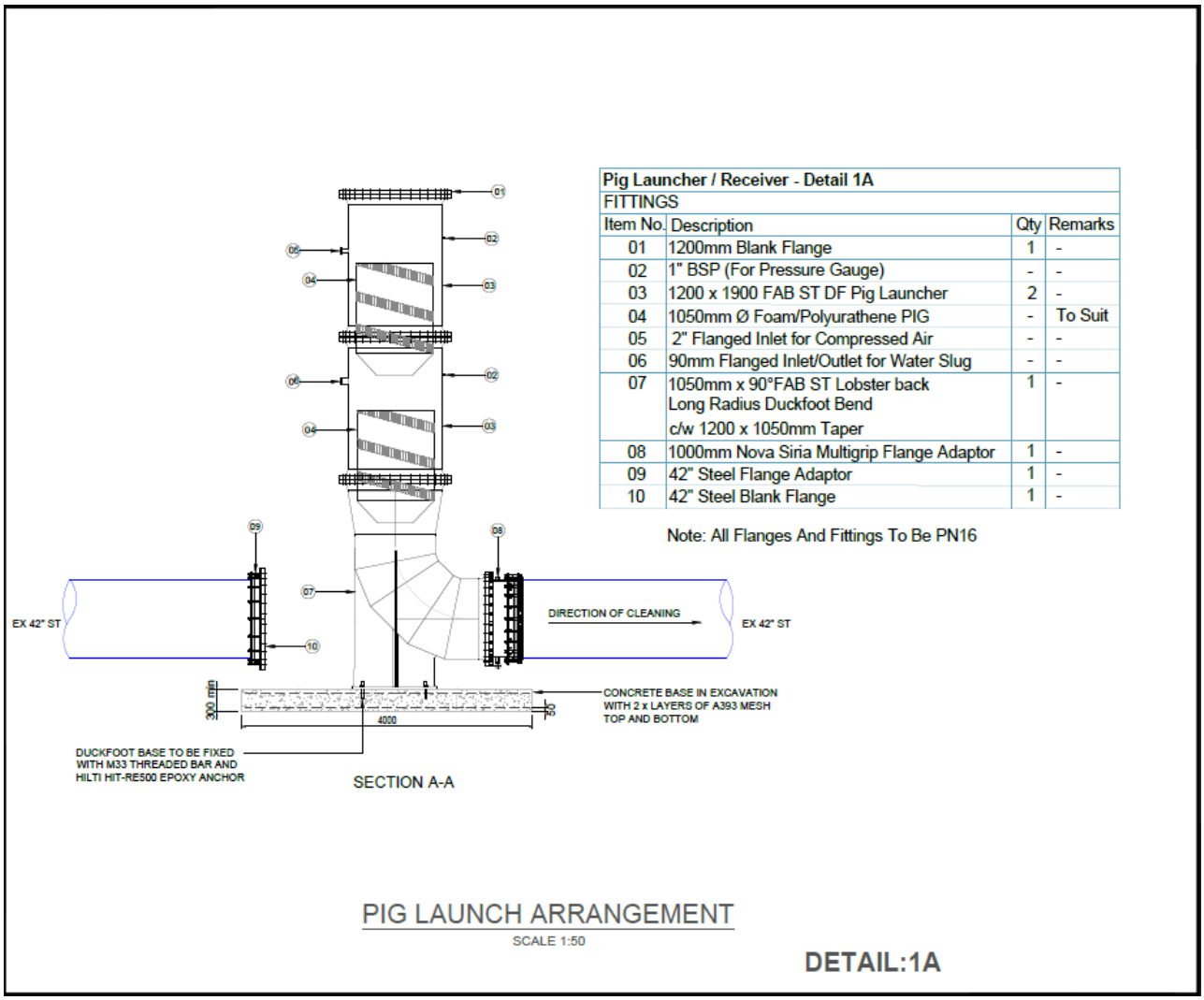


Figure 5 -Post cleaning condition after 4 runs of Air Pigging

Figure 6 - Pre cleaning of the aqueducts with significant manganese build up.



Pig Launcher / Receiver - Detail 1A			
FITTINGS			
Item No.	Description	Qty	Remarks
01	1200mm Blank Flange	1	-
02	1" BSP (For Pressure Gauge)	-	-
03	1200 x 1900 FAB ST DF Pig Launcher	2	-
04	1050mm Ø Foam/Polyurathene PIG	-	To Suit
05	2" Flanged Inlet for Compressed Air	-	-
06	90mm Flanged Inlet/Outlet for Water Slug	-	-
07	1050mm x 90°FAB ST Lobster back Long Radius Duckfoot Bend c/w 1200 x 1050mm Taper	1	-
08	1000mm Nova Siria Multigrip Flange Adaptor	1	-
09	42" Steel Flange Adaptor	1	-
10	42" Steel Blank Flange	1	-

Note: All Flanges And Fittings To Be PN16

Figure 7 - Pipework detail of PIG Launcher manifold. This includes valves for compressed air inlet and tapping for the water slug.

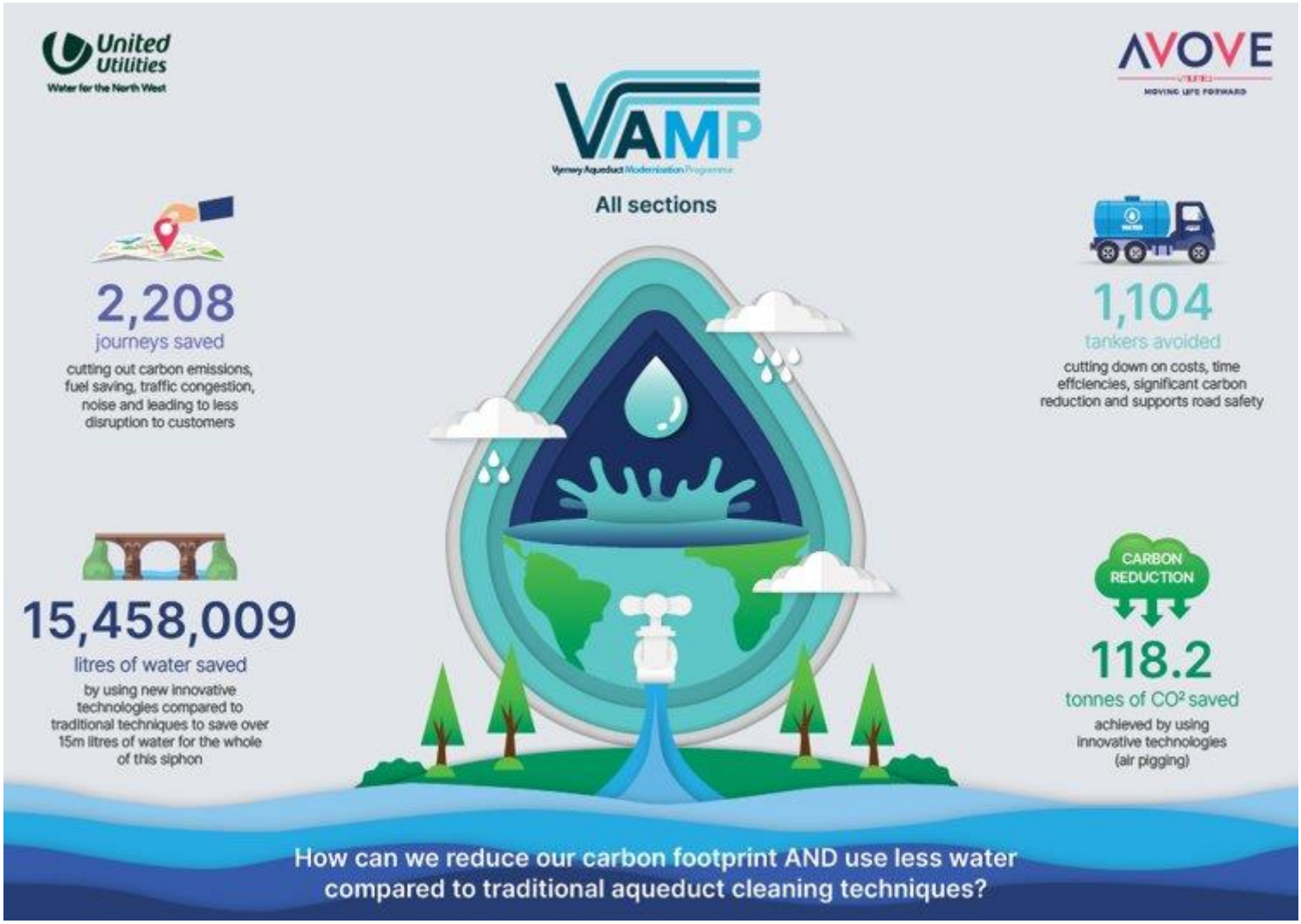


Figure 8 - Sustainability and environmental benefits from using air pigging on Siphon 1 of the Vyrnwy Aqueducts scheme.