Using hydraulic models and real time monitoring to provide resilience for Birmingham

Colin Rimmer
Atkins / Severn Trent Water Chadwick House, Birchwood Park,
Warrington, WA3 6AE.
colin.rimmer@atkinsglobal.com

ABSTRACT

The Birmingham Resilience Project aims to deliver a new water supply for customers in Birmingham. The new water source will allow the Elan Valley Aqueduct to be shut down for extended periods so that maintenance on the 100-year-old asset can be completed. The new source will also provide backup during an emergency event. In addition to the new water supply the existing Severn Trent Strategic Grid is required to transfer at least 55 Ml/d into the Birmingham distribution network.

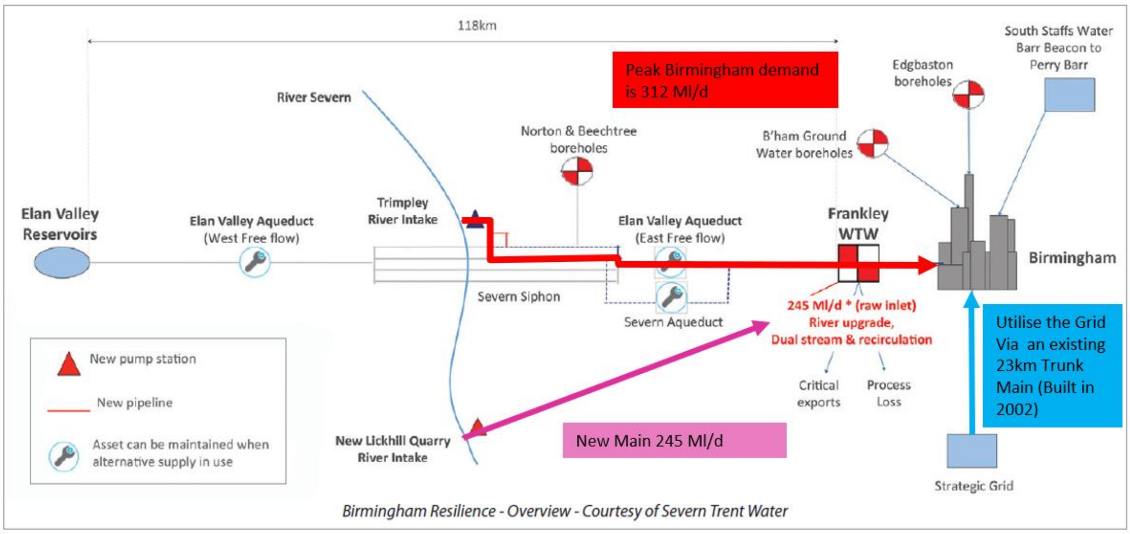

Figure 1. Birmingham Supply Schematic & Resilience Overview

Keywords: Systems Modelling, Real Time Monitoring, Decision Support, Discolouration Risk.

1 BACKGROUND

This paper describes the modelling techniques used to successfully increase the flow on key sections of Severn Trent's Strategic Grid System. The monitoring installed at key locations ensured that there was no disruption of supply for customers and any potential discolouration events were avoided. The Meriden to Highters Heath trunk main links the Birmingham distribution network to the Severn Trent Strategic Grid. The main was installed to provide resilience to Birmingham in the event of a failure of Frankley WTW or the Elan Valley Aqueduct, which are the sole supply for customers in Birmingham. The trunk main is located between Meriden Reservoir in Warwickshire and Highters Heath Reservoir in Birmingham and prior to the increase the main was operating between 10 - 25 Ml/d in the direction of Meriden. The main requires conditioning to ensure it can eventually transfer up to 80 Ml/d from Meriden Reservoir into the Birmingham distribution network.

The Severn Trent Strategic Grid consists of an approximate length of 1,300km of aqueducts and trunk mains. Streching from Ladybower Reservoir in the north near to Sheffield all the way south down to Strensham WTW and Mythe WTW near to Cheltenham. The map within figure 2 below shows the extent of the Strategic Grid network.

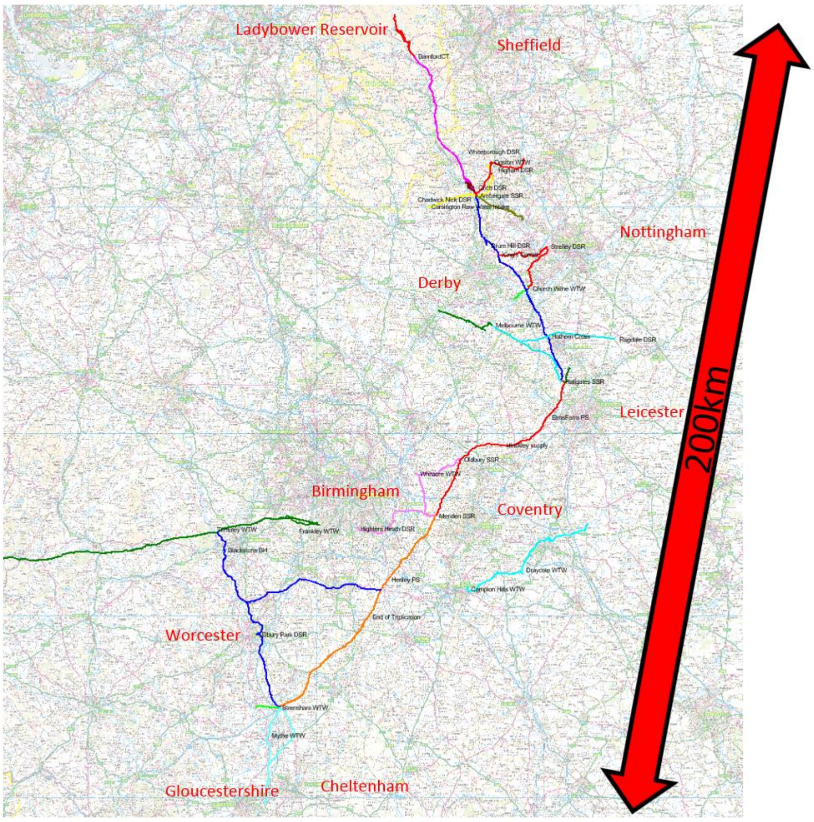

Figure 2. The Strategic Grid

Phase 1 of the project aimed to increase the flow to 40 Ml/d in the direction of Meriden Reservoir. Clean water modelling proved to be key and vital during Phase 1 of the project. Initial modelled scenarios allowed the key business stakeholders to plan and evaluate the requirements for the proposed flow increase. This continued during the increase period as data from hydraulic and water quality models (PODDS) guided the whole project team on a day to day basis, this ensured that the required network changes were completed without causing any customer complaints.

2 METHODS

2.1 Model Calibration

The asset data for the strategic grid was extracted from Severn Trent Waters GIS data then the hydraulic model was built within the software Synergi Water. The model consisted of 1,300km of pipes, more than 25,000 nodes and 68 tanks. To calibrate and verify the hydraulic model a total number of 250 pressure monitors were installed across the system. The plot in figure 3 below shows the locations of the pressure monitors on the network. The flow across the grid varied from day to day therefore to ensure that the model captured all the different flow scenarios the model was calibrated for seven different days. The data in the chart in figure 4 shows how the hydraulics can vary from day to day.

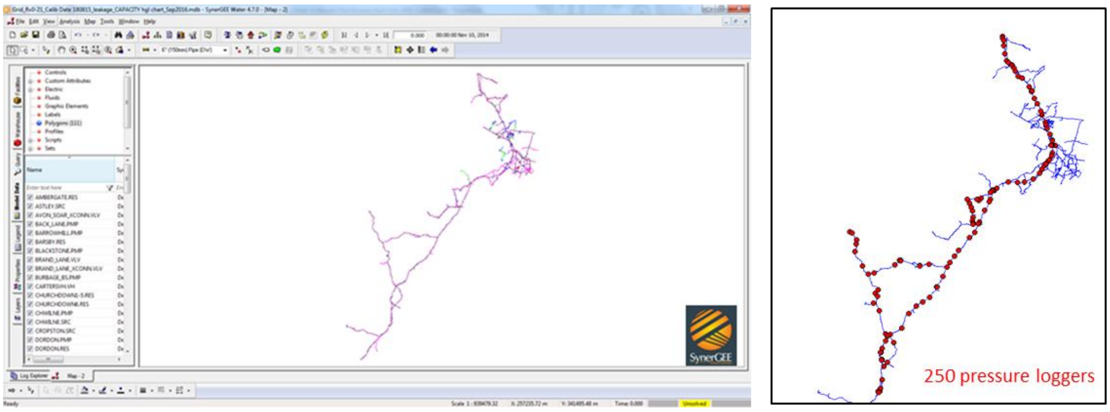

Figure 3 - Synergi Model & Pressure Monitoring Points

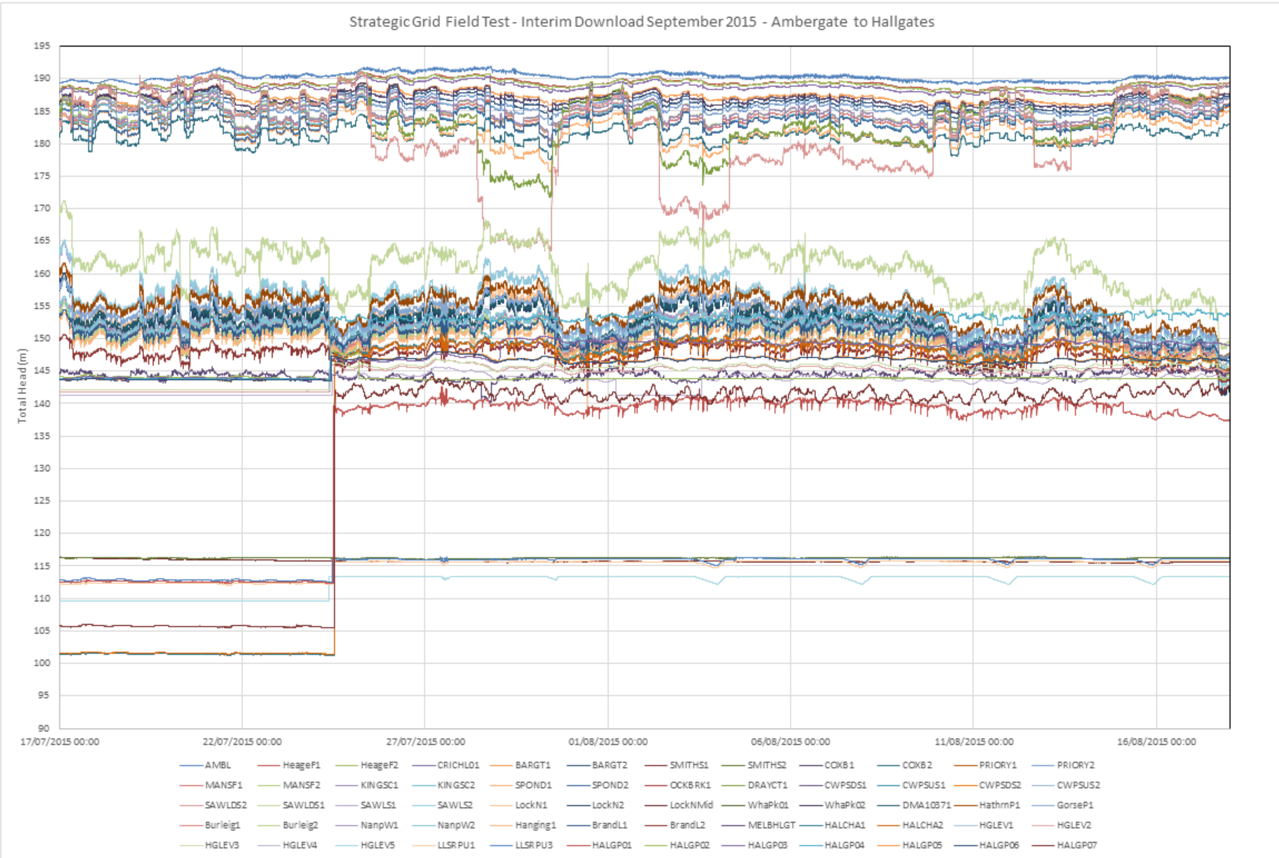

Figure 4 - Recorded Pressure Data

2.2 Model confidence rate and system capacity

For each of the key sections of the Strategic Grid the hydraulic information from the calibrated model was inputted into an assessment dashboard. The calibration accuracy was then assessed and a model confidence rating was then generated. The tables within figure 5 below show the data.

During Operational Readiness Mode when the supply from the Elan Valley is reduced the Strategic Grid will be required to increase the output from each of the Water Treatment Works. Therefore, it was important to understand the full capacity of the existing grid system and where the extra volume of water could potentially come from to maintain acceptable levels of service for customers.

The lower part of the table below in figure 5 shows the resulting full capacity for each key sections of the grid.

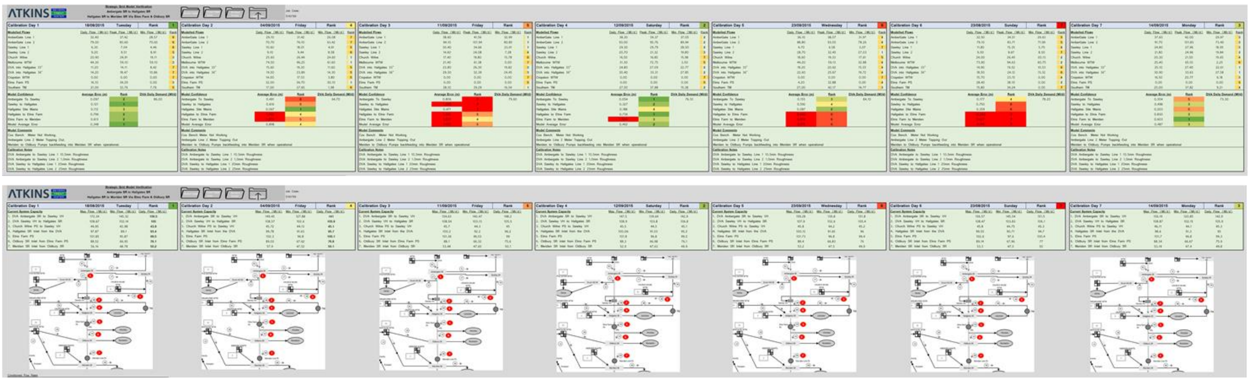

Figure 5 - Model confidence rating & System Capacity

2.3 Discolouration Risks

The extra volume of water required during Operational Readiness Mode will come from Bamford WTW via Ambergate Service Reservoir along the Derwent Valley Aqueduct, through to Hallgates Service Reservoir. Extra water will then be pushed to Meriden Service Reservoir via Elms Farm Pump Station. This extra water will then supply Birmingham via the Meriden to Highters Heath Trunk Main. The schematic in figure 6 below highlights the key sections of the Strategic Grid where there is a potential for discolouration risk during Operational Readiness Mode. They are as follows; the Derwent Valley Aqueduct, the Avon-Soar Link west of Leicester and the Meriden to Highters Heath trunk main supplying Birmingham.

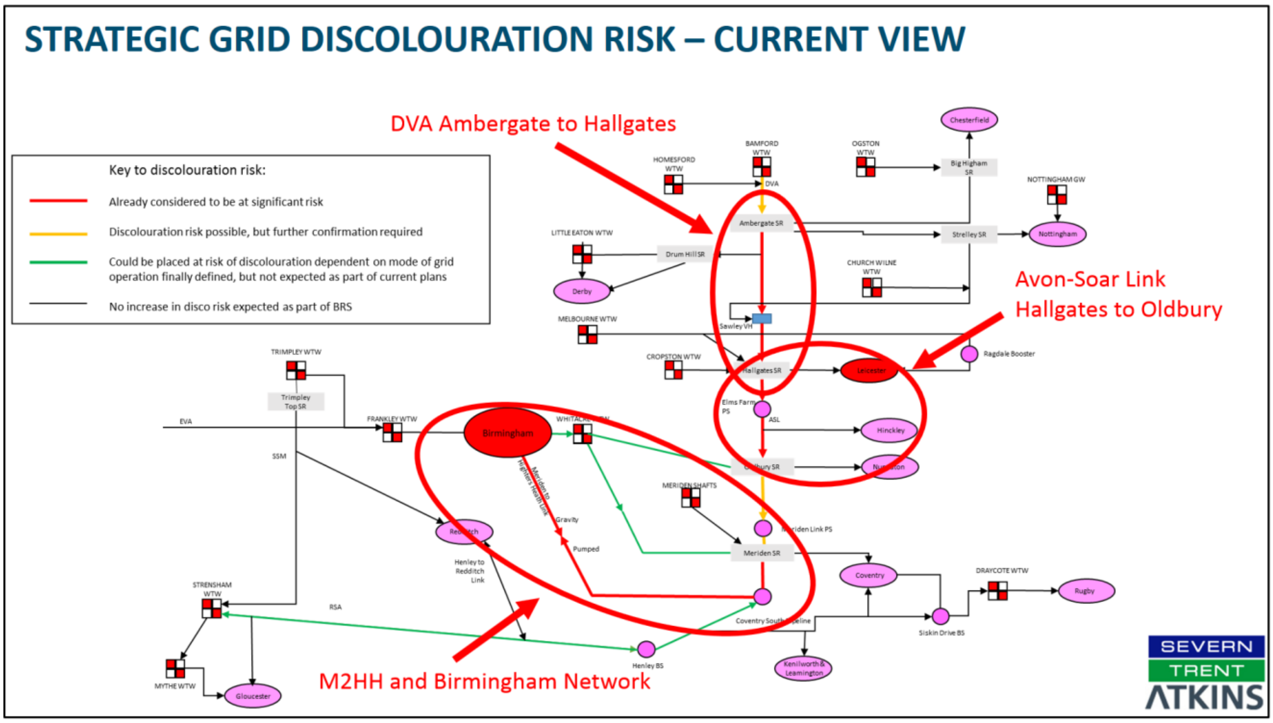

Figure 6 - Strategic Grid Potential Discolouration Risk

2.4 Conditioning Storyboards and Operational Processes

The sections of the Strategic grid that have been highlighted as having a potential discolouration risk were assessed within a PODDS model. The conditioned peak flow rates were simulated against the proposed peak flow rates during Operational Readiness Mode. Initial PODDS predictions were used as a guide to understand the how the flow rate can be increased without causing a discolouration event on the network. The peak flow times and pipe shear stress were also assessed to ensure that the optimum locations for turbidity monitoring was established. Time of travel modelling was also completed to allow the key stakeholders to be proactive if a discolouration event were to occur.

During the proposed operational changes, key documentation was given to all the key project stakeholders; this included a Crib Sheet and an Operational Storyboard. The Crib Sheet contained a schematic showing the key monitoring points, peak flow / demand periods, Key Stakeholder contacts and a turbidity response matrix. The Operational Storyboard detailed the proposed flow increases / rezones in a step by step way to ensure that operational staff fully understood what is likely to happen on the network as they make the changes.

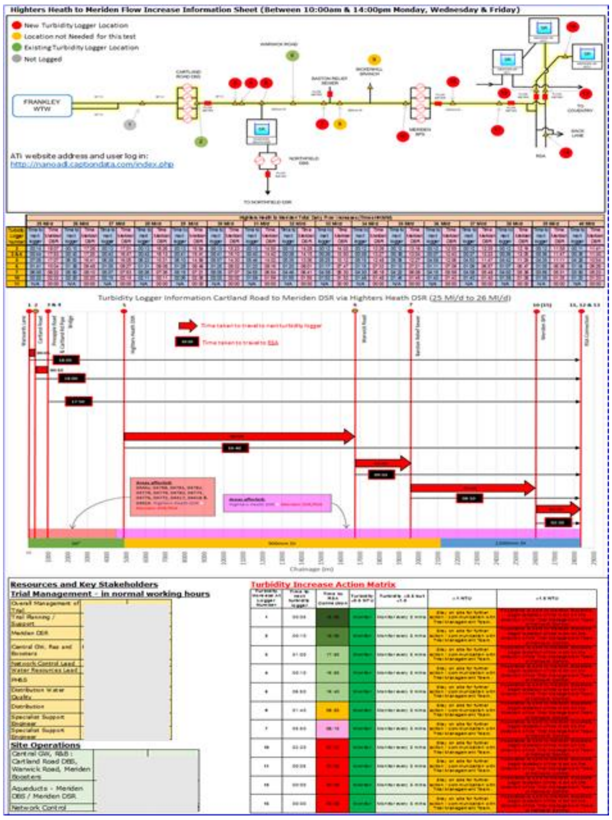

Figure 7 – Operational Crib Sheet

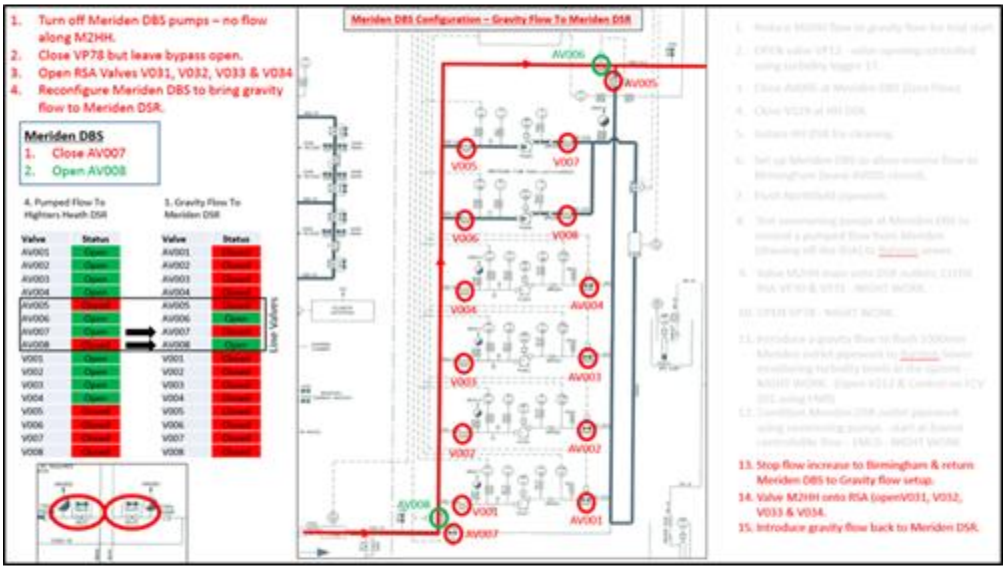

Figure 8 - Operational Storyboard Example

3 CONCLUSIONS

The trunk main in Phase 1 was successfully conditioned up to 40 Ml/d over a 6-week period, during this period Severn Trent Water did not receive a single customer complaint. Once the conditioning work was completed the flow along the trunk main was reduced back down to 25 Ml/d. After letting the network settle down for a week the flow was increased back up to 40 Ml/d over a 2-day period. Turbidity levels remained low during the increase and again STW did not receive any customer contacts relating to the operational changes.

To ensure that the water supply for customers remains acceptable the processes and documentation produced during phase 1 is currently being used on all the flow increases on the Birmingham network and also the Strategic Grid. Documentation produced helped operational staff manage the turbidity levels across the whole network.

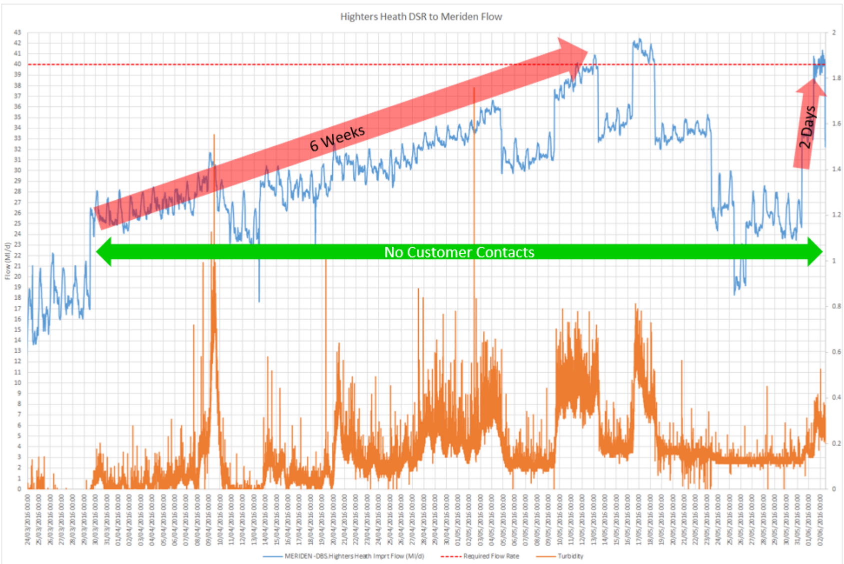

Figure 9 - Meriden to Highters Heath Flow Increase against Turbidity

Post conditioning; The chart in figure 10 below shows that the flow along the Meriden to Highters Heath Trunk Main was not increased again above 30 Ml/d for approximately 4 months. Once the flow peaked up at 36 Ml/d there was a turbidity response of 0.3 NTU. This shows that there is material regeneration on the inside of the pipe wall.

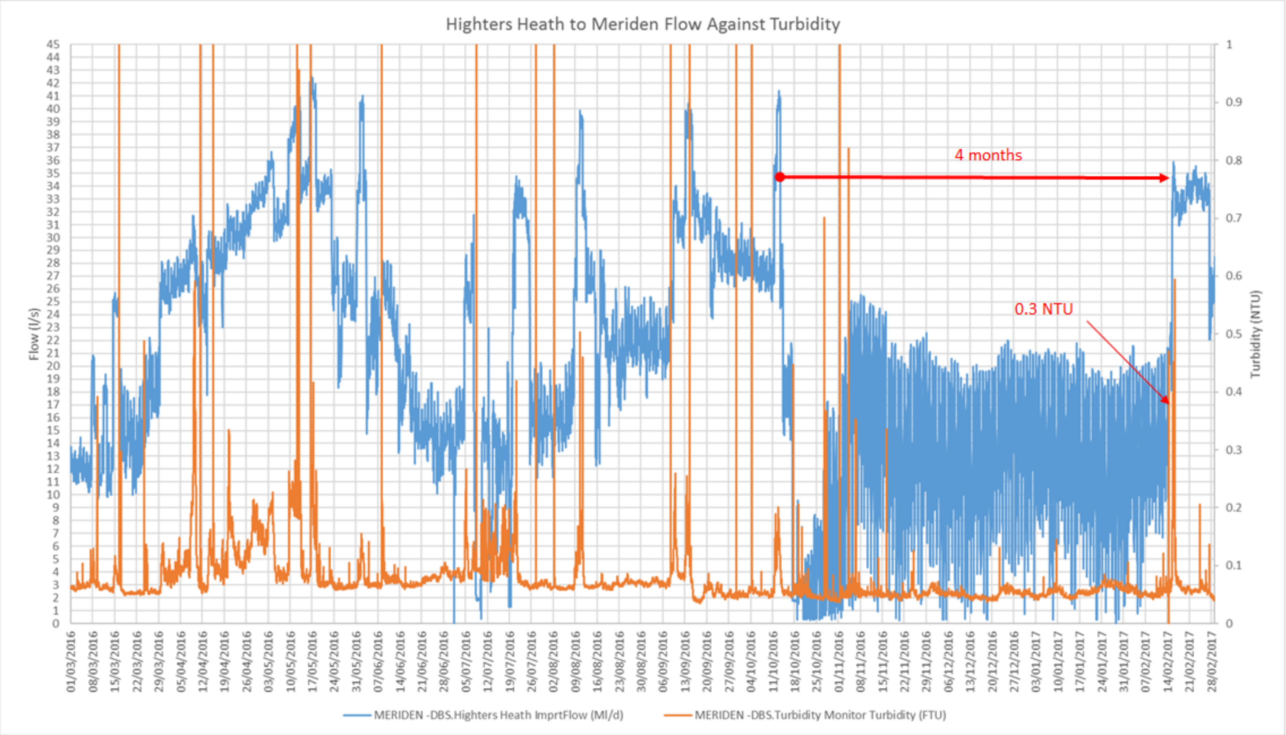

Figure 10 - Regeneration of pipe material

Colin Rimmer

Senior Project Engineer

ATKINS

Chadwick House, Birchwood Park, Warrington, WA3 6AE

TEL: 01925 238354 | **MOB:** 07714 223 533