

# Eyton Nitrates Blending Scheme

## nitrates blending scheme to ensure Eyton boreholes remain a key part of the supply network

by James Colwell MEng CEng MICE

The Eyton Boreholes form a key element of Severn Trent Water's Shropshire Water Supply Network. Rising nitrates in the groundwater required action, leading to the water company's £4.1m investment in the Eyton Nitrates Blending Scheme. The boreholes at Eyton are a cost effective, sustainable supply of water, which would have been lost without a capital intervention. Without the boreholes the system would have been more reliant on river abstraction at Shelton, which would have substantially increased the cost of water production and reduced the overall deployable output in the area.



Eyton Pump Station – Courtesy of Mott MacDonald Bentley

### Optioneering

The optioneering for the scheme highlights the choices faced by engineers in the 21st century; straight forward, conservative design, with higher costs, more embedded carbon and a greater environmental impact, or; the innovative reuse of existing assets which has the potential to significantly reduce cost, the carbon footprint and environmental impact.

In collaboration with Severn Trent Water, Mott MacDonald Bentley (MMB) promote 'engineering sustainable outcomes'. The Eyton Nitrates Blending Scheme is an example of how water engineering projects can be fundamentally more sustainable whilst ensuring the water supply is 'always on and good to drink' through good engineering practice, stakeholder engagement and quality planning/execution.

No.	Option	CAPEX	OPEX	Embedded Carbon	Impact on existing network
1	Pump Eyton water back to Shelton to blend (requires 10km main).	£6.7m	High – (Pump back cost)	High	Low
2	In pipe blending by supplying Westbury with Shelton water and pumping the Eyton water west to blend in higher demand areas.	£4.1m	No Change	Low	High
3	Treat the water at Eyton through the introduction of an ion exchange plant (11km waste main).	£5.8m	High – Treatment	High	Low

### Background

Eyton Borehole Pumping Station is situated in rural Shropshire, 10 miles west of Shrewsbury and forms a key part of Severn Trent Water's supply network. The company monitors nitrate levels regularly and wanted to act before the network could be affected, potentially by the end of 2013.

The existing arrangement comprises a blend between the boreholes and the Shelton to Oswestry Link main, which passes through the site, (see figure 1 below). The existing blend feeds two small rural reservoirs. Due to the small demand and the ratio of Shelton to Eyton water required to achieve a suitable blend, the output from Eyton would need to be reduced to a point where it would not be viable to continue using the site.

One option considered was to abandon the Eyton site but without the boreholes at that location, additional demand would be placed on the river abstraction at Shelton WTW. The additional treatment required would substantially increase the cost of water production and more importantly reduce the overall deployable output.

Therefore a £4.1m capital intervention was promoted to prevent an issue with nitrates and to maximise the use of Eyton source and ensure the 'sustainability of supply'.

### The options

The Project Team undertook detailed analysis to determine the most efficient option for the Eyton scheme, taking into account Capital Expenditure (CAPEX); Operational Expenditure (OPEX); Embodied Carbon and the existing network impact. The options identified for consideration are in the table above.

The treatment option was ruled out due to the high CAPEX and OPEX and due to a lack of a straight forward waste route.

Given the two remaining options, the choice for the project team was clear:

- **Option 1:** A low risk, conservative design with higher costs, more embedded/operational carbon and a greater environmental impact.
- **Option 2:** A more complicated reuse of existing assets which had the potential to significantly reduce cost, the carbon footprint and the impact on the environment.

Option 2 was chosen by the Project Team and involved pumping the Eyton water into the link main to blend with larger quantities of water in areas of higher demand (see figure 2). In order to maximise the use of the Eyton source, two blend points were required, the first at the Eyton site and the second at Pentre Water Treatment Works.

In order to provide a robust blend, it was necessary to break the pressure at Pentre and re-boost the blended water into supply. This solution involved significant modifications to the existing network, but the reuse of existing distribution assets reduced project cost, the carbon footprint and the environmental impact.

The embedded carbon saving was commensurate with removing the need for a 10km/11km pressure main (required for option 1), and an operating carbon saving realised though avoiding additional pumping or treatment. The scope of works included:

- New pumping stations at Shelton and Eyton.
- New borehole pumps at Eyton.
- A new 250m<sup>3</sup> break pressure tank at Pentre Water Treatment Works.
- A number of modifications to the live network.
- New disinfection dosing at Shelton.

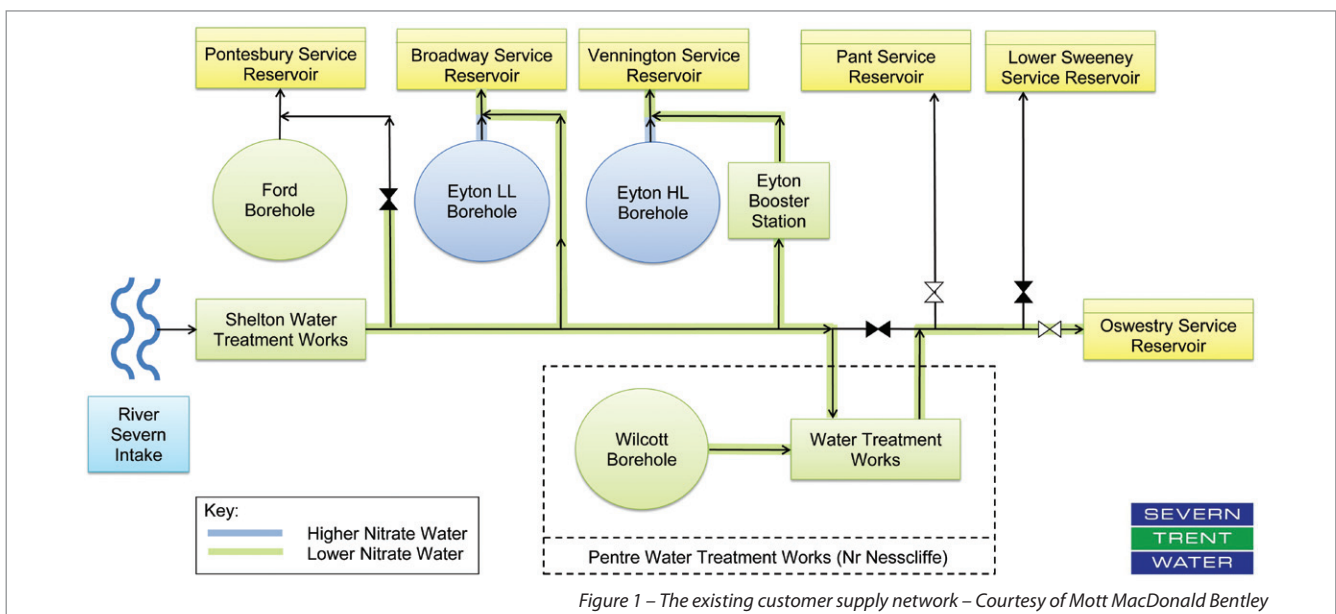


Figure 1 – The existing customer supply network – Courtesy of Mott MacDonald Bentley

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The solution aimed to maximise the use of existing water resources, whilst reducing the cost of water production and hence reducing the overall cost of water supply in the area. This is in line with Severn Trent's aim to provide the best service while minimising costs to the customer.

In addition, Severn Trent Water operates eight key strategic Intentions that drive the company ethos. Specifically relevant to the scheme are:

- KSI 1 – Providing a continuous supply of quality water.
- KSI 4 – Minimising our carbon footprint.

In making the decision between the options, the team aimed to meet KSI 4, whilst minimising the risk to KSI 1.

#### Design considerations

Careful modelling was undertaken to prove the feasibility of both the hydraulic solution and the nitrate blend. Both were rigorously reviewed by an independent design team, Severn Trent Water's Process Design group and Service Delivery Team.

The solution involves the modification and precise control of three water production sites to provide a dual stage blend of three water sources.

The control system uses fast loop monitors to vary the output of the boreholes to maximise the use of the source, whilst providing high quality water to meet a constantly varying demand profile.

In order to create a robust blend it was necessary to break the pressure at the final blend point and reduce the pressure in the trunk main. Reducing the pressure in the main required the installation of two new pumping stations:

- A gravity boost, low pressure pumping station pumping from Shelton to Pentre.
- A high lift station a Eyton boosting the Shelton water to the Vennington and Broadway service reservoirs.

To provide greater visibility of the system, the Eyton and Pentre sites were added to the Shelton Major Works SCADA so that the system could be viewed and optimised remotely.

In order to build resilience into the system it was decided that the existing high pressure booster pumps at Shelton should be maintained to be used in an emergency. This decision added significant complexity to the scheme as turning on the existing pumps raises the pressure in the main prior to Pentre by approximately 8bar. All dosing, surge suppression and blend points had to be designed to operate at both pressures.

Pump selection was critical, as pumping water between Shelton and Oswestry costs in excess of £250,000 per year and creates 432,000kg CO<sub>2</sub> equivalent per year. Even a small percentage efficiency gain can produce a hugely significant impact on the sustainability of the scheme. A 3% gain was achieved through active consultation with the pump suppliers and undertaking a cost benefit analysis to consider the whole life cost of the pumps.

#### Community and stakeholder engagement

The proposed solution involved controlling pump stations across three geographically separate sites. To ensure the existing system was fully understood and the proposals were robust, multiple control philosophy workshops were held with full engagement from the Severn Trent Water team.

Without the full support of all stakeholders and the local community, the solution could not have been realised.

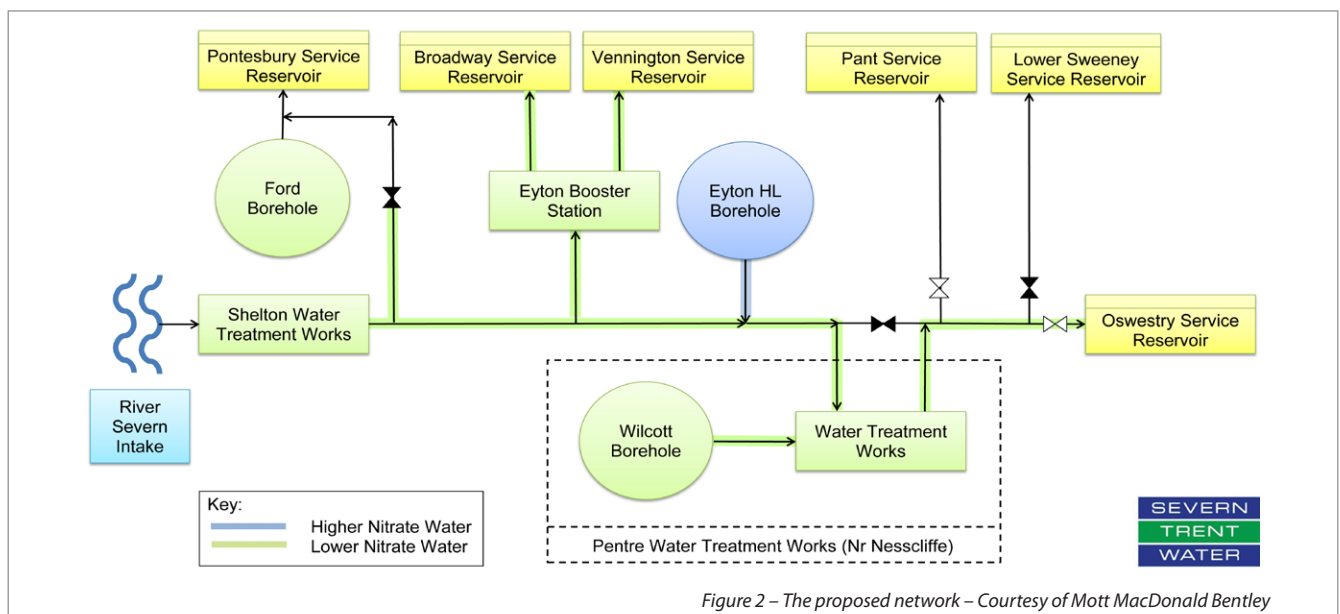


Figure 2 – The proposed network – Courtesy of Mott MacDonald Bentley



Eyton Pump Station – Courtesy of Mott MacDonald Bentley

In addition to Severn Trent Water's stakeholders it was crucial to engage with customers, so that the need for the scheme was understood and the potential changes to the water supply were explained in a customer focussed manner. Customer meetings were held in Westbury and Oswestry to enable the local community to ask questions and sample the modified blend. Positive feedback from the consultation was reported in the local press.

#### Quality planning & execution

The delivery programme was tight, so three separate construction teams were deployed so that the modifications to all three sites could proceed in parallel. It was a challenge to ensure that each team delivered their portion of the works and also understood the impact they were having on the scheme as a whole.

The option chosen was a significant challenge to implement, as it involved modification to the existing live network. Over three

night time shutdowns of the Shelton to Oswestry link main, 13 (No.) large diameter connections were made. The connections involved a dedicated planning team involving MMB, Severn Trent – Water Production, Reservoirs and Boosters, Asset Optimisation, District Valving and Public Health and Standards.

The link main affects supply to 7 (No.) reservoirs and a shutdown has the potential to cut off more than 40,000 customers, but though careful planning the connections were executed without any impact on customers whatsoever, which was a great success for all involved.

It was clear from the start that commissioning the new system would require detailed planning. A commissioning working group met on a monthly basis throughout the construction period to minimise the risk of problems. The group had representatives from all of the stakeholders within Severn Trent Water.

#### Conclusion

The challenge of the Eyton Nitrates Blending Scheme was great, but through excellent design, stakeholder engagement and quality planning and execution, a sustainable source of water supply for the Shropshire area was secured.

The £4.1m investment provides a cost-effective solution of utilising existing assets to negate the requirement for costly alternatives, ultimately reducing the overall cost of water supply in the area.

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Pentre break tank – Courtesy of Mott MacDonald Bentley