NITRATE RESILIENCE PROJECT REVIEW

For Portsmouth Water

30236048 –ARC-ZZZ-TN-PE-00011 P01 S3

20/8/2024

[redacted]

[redacted]

Nitrate - Background

- Nitrate is found throughout the company (and UK) supplies based on historic / current land usage leading to aquifer contamination.
- Various Portsmouth Water sources exceed the PCV limit of 50mg/l. This is seasonal predominantly in the summer when demand is high and aquifer recharging is low. Duration of high Nitrate varies depending on source but is typically between 3 to 6 months.
- Historically, Portsmouth Water have manually blended these various sources when problems arise. This is inefficient and reduces network resilience during these event periods.
- Online Nitrate monitors assist with manual blending, but they rely on continual monitoring from operational staff within the network.
- Atkins completed a study to review the risk to the network and customers considering:
  - Predicted changes in nitrate levels over time
  - Normal usage of the network with blending of relevant production facilities
  - Interconnectivity of the network with other supply zones

  This was carried out to address nitrate levels in the network rather than all sources as this was seen as the most efficient way to address the problem and provide customers with the most economic solution. The alternative of treating all sources with nitrate levels >50mg/l would lead to higher capital expenditure and higher operational expenditure. Atkins report was produced to identify how to achieve the same resilience in an optimum solution.

Atkins report conclusions

As part of the Atkins report various areas were considered culminating with there being two discrete areas identified that require improvement of Nitrate levels. These are:

- **[redacted]h SR**

  Normal operation for[redacted] 4 treatment facilities that feed into the service reservoir for distribution. These are:

  – [redacted] WTW,

  – [redacted] WTW,

  – [redacted]n WTW,

  – [redacted]e WTW

  [redacted]e boreholes and [redacted]e boreholes exceed the Nitrate PCV limit of 50mg/l. The Nitrate level is expected to rise to a peak of 52mg/l in coming years

  For network resilience during high nitrate period there is a means of using a transfer main from Lavant SR which is c.8km away in a westerly direction from [redacted] Subsequently [redacted] be fed from [redacted]n via [redacted] booster pumps.

  The main from [redacted]t to [redacted]h is gravity.

- **[redacted]n SR**

  [redacted]n SR is predominantly fed from [redacted]n WTW

  [redacted]n boreholes exceed the Nitrate PCV limit of 50mg/l , The concentration is believed to have plateaued at existing levels.

  Direct links through supply zones with other local service reservoirs have limited impact to reduce nitrate risk

  During high Nitrate levels, manual blending of flow from[redacted]ll SR Transfer main and [redacted] WTW to the west [redacted] is instigated.

Nitrate Treatment options - discussion

[Chemical removal of contaminants - Drinking Water Inspectorate (dwi.gov.uk)]

Nitrate removal is usually achieved by ion-exchange. Water is passed through a column of synthetic resin beads that remove anions including nitrate and exchange them for equivalent amounts of chloride. When the capacity for exchange is exhausted, the resin is regenerated by backwashing with a concentrated solution of sodium chloride. This restores the resin to its initial chloride form. The bed is then rinsed with clean water and returned to service. The waste solution and rinse waters, containing high concentrations of sodium chloride, as well as nitrate, are collected for disposal.

Nitrate-selective resins preferentially remove nitrate and also add less chloride to the treated water because of the lower sulphate removal. This is desirable since high chloride concentrations and chloride to bicarbonate ratios are associated with increased corrosion of certain metals. A sodium bicarbonate rinse can be used after regeneration with sodium chloride to convert the resin in the lower part of the bed to the bicarbonate form and reduce the chloride to bicarbonate ratio during the early part of the run.

Nitrate can also be removed by some membrane processes and by biological denitrification.

Ion Exchange (IX)

Selective IX resins reduces the nitrate concentration to very low levels when operated correctly. With this in mind, it is possible to utilise a side stream option and only treat part of the flow; blending the low nitrate portion with the bypassed water reducing the size of the plant. This is applicable to the Portsmouth Water sites.

Membrane Processes

The only membrane process that are effective for the removal of Nitrate are reverse osmosis and nanofiltration. Both of these are non-selective and remove other anions as well. They can be operated in a side stream arrangement, blending the permeate from the membranes with the bypassed water. This is applicable to the Portsmouth Water sites.

Biological Denitrification

This revolves around utilising denitrification bacteria to reduce the nitrate to nitrogen gas and required a level of carbon and other elements in the water and a suitable environment for the bacteria to thrive. All of the flow would have to be treated. Although this is regularly used in continental Europe and the US, it is not regularly installed in the UK. This is because of the risk of the significant risk in producing ammonia which can cause DBP's if uncontrolled leading to tase and odour complaints from customers.

Blending

For this to be applicable an additional source without elevated Nitrate levels is blended with a source with elevated levels. This reduces the overall nitrate load being consumed. This is applicable to the Portsmouth Water sites

Area of interest

Atkins highlighted to distinct network blend sites at high risk : Lovedean SR and Littleheath SR

[redacted]

[redacted] *SR*

North of region feeding local zone and towards south and west.

Currently Nitrate levels approx. 55mg/l for c.10wks/yr.

[redacted] *SR*

East of region feeding down local zone and towards south and east. (includes [redacted] WTW)

Currently Nitrate levels approx. 55mg/l for c.10wks/yr

Nitrate Resilience at [redacted] SR

Flows & Nitrate Concentrations:

The water at [redacted] is primarily a blend of 4 borehole treatment sites. The water is generally good quality although experiencing up to 10 weeks each year of high nitrate concentrations from [redacted]e and [redacted]e facilities. These also provide the greatest fraction of the water to [redacted] SR and supply zones.

[redacted] SR can receive water from other areas in the network for resilience with up to 3Ml/d being provided from [redacted] SR as a supplemental supply. This is a gravity connection which [redacted]e BH's pumps in to

With [redacted] SR being in the far East of the region, connectivity to other service reservoirs is limited with the supply zone being predominantly south and east of the site.

[redacted]

Current Situation	Typical Flow *	Avg Nitrate conc'n
[redacted] WTW	6 Ml/d	58mg/l
[redacted] WTW	7 Ml/d	58mg/l
[redacted] WTW	2 Ml/d	Est 35mg/l
[redacted] WTW	6 Ml/d	Est 45mg/l
[redacted] SR Outlet	21 Ml/d	52mg/l

(Slindon does not operate at all times)*

These values are generic approximations of a dynamic system and not to be taken for design purposes.

Actual instantaneous flows for each site are determined by the operation of the borehole pumps, with pumps called in / out of service depending on the level in the relevant reservoir.

Operations currently manually control the utilisation of each site to manage abstraction licences and nitrate levels

[redacted] SR Option evaluation

The Atkins report highlights the primary two options of blend the water with a better supply or treat the water to remove the nitrate. Nitrate is particularly difficult to remove from water with the Nitrate anion being highly soluble and relatively inert in dilute chemistry of water treatment. As identified earlier, the three primary methods of treatment are:

a. Ion Exchange
b. Membrane (RO or NF)
c. Denitrification

The levels of Nitrate are not significantly higher than the PCV limit and the limit is only breached for approximately 10weeks of the year. Therefore, to minimise operating costs, the preferred treatment option should be easy to put on standby for the remainder of the time it is not needed. Similarly, the capital cost should be mimimised as the whole life cost will be made up of only 10week operation each year. The water that is treated should not impact the overall blend quality detrimentally such that the risk of customer contacts could increase. It should preferably be constructed within the confines of the existing boundaries for security and ease of operation. The technology should be robust and proven.

a. IX – With the high removal efficiency an IX plant can be constructed and operated as a side stream on only one treatment plant with the IX output, IX bypass and other sources still maintaining a limit below the 50mg/l PCV limit. As a side stream the Capex and Opex will be comparatively small.
b. Membrane – NF would be the preferred membrane and would also have a high removal efficiency such that it could be run as a side stream on one facility. There is more wasted water which would require disposal increasing complexity or cost if a new sewer of sufficient size was included.
c. Denitrification – this would lead to an expensive capital investment as well as significant land usage. Although running costs may be low, chemical dosing may be required to sustain the denitrification bacteria and there is a high risk of ammonia production leading to risk to disinfection byproduct formation and reduced disinfection efficacy.

Options for the blending without bringing in other water sources is limited. The obvious solution is to increase the [redacted] BH's as this water has naturally low Nitrate levels. However, existing abstraction limits and treatment equipment limit this from being a viable option. None of the other existing sources offer a sufficiently low Nitrate level to allow them to be used for blending. [redacted]n BH's are already a draught site and increasing the normal abstraction will not be allowed.

Currently, during times of high Nitrate, water is bought in from [redacted] and the other sources are turned down to ensure the correct blend. This is a complicated procedure as the water from [redacted] has to be supplemented by water [redacted] SR which naturally low in Nitrate and actually provides the water at 39mg/l Nitrate. To achieve this low Nitrate water at [redacted], the 8Ml/d [redacted] BH supply has to be turned off as this is consistently at 45mg/l leads [redacted] having a Nitrate level of 45mg/l preventing it from being used as a blending option. With the network in its current configuration, this is the only blend option and the one selected by Atkins.

[redacted] SR – Long list selection

Options Considered	Defined Solution	Resolves Problem	Technically Feasible	Able to Construct	Long term Operation Feasibility	KPI Risk Impact	Network Resilience Impact	Customer Impact	Enviro Impact	Carbon Impact	Biodiversity Impact	Total	Ranking
Do Nothing	3	1	1	5	1	0 (note 1)	1	0 (note 1)	3	3	3	21	6
Blend – Increase [redacted] BH Capacity	1	5	0 (note 2)	4	5	4	5	5	3	3	3	38	5
Blend – [redacted] Transfer Increase	3	5	2	3	1 (note 4)	2	1 (note 4)	5	3	3	3	31	3 (note 1)
Treatment – 33% Side Stream Ion Exchange at either [redacted] or [redacted]	4	5	5	4	3	4	4	5	2	2	2	42	1
Treatment – 33% Nanofiltration at either [redacted] or [redacted]	3	4	4	4	2	4	4	5	2	2	2	36	2 (note 3)
Treatment – 100% denitrification at [redacted] and [redacted]	2	4	2	2	2	1	1	2	2	1	2	21	4

Score based on 0 to 5 relative to overall impact with a higher score being more favourable. A score of 0 is only used when a solution is not possible.

Notes:

1. To ‘do nothing’ is not a viable option as there will be customers who experience high Nitrate levels which also impacts on KPI’s and overall company performance to deliver wholesome water. There is DWI support in solving the problem of high Nitrate levels at [redacted] SR
2. Increasing capacity at [redacted] is not technically feasible due to abstraction licenses and restrictions with the borehole operation, therefore this option has been terminated
3. The NF treatment option has a higher score than the [redacted] Blend option, but there is no reason to go into detail on more than one treatment option while IX is still a valid option
4. This option relies on [redacted] BH’s being stopped and water transferred from [redacted] SR. Although technically possible, this removes 8Ml/d of capacity from the network and significantly reduces the resilience on the west of the network

[redacted] SR Option evaluation

	Option 1 – [redacted] Transfer Optimisation	Option 2 – [redacted] IX treatment
Scope summary	Increase output at [redacted] SR, transfer to [redacted] SR and on to [redacted] SR. Required blend valves, increased telemetry and remote pump [redacted]	33% Sidestream IX plant based at Westergate SR to blend with bypassed water and other supplies.
Technical Risks	Significant : Blend has been used for short periods and manually controlled. Areas of concern are • Losing 8Ml/d of supply with [redacted] WTW being off • Sufficient water available at [redacted] SR to pump across and no other issues in network. • Hydraulic concerns over transfer flowrate and [redacted] pumps.	Minor : Proven technology with the only elements not determined being • Final location ([redacted] is favoured but not confirmed) • Wastewater disposal • Salt delivery infrastructure
Relative Capital Cost	Low capital costs – Utilising existing network pipework and gravity for part of the way. Increased pump capacity at [redacted]	Moderate : Due to new assets of IX plant, building and road infrastructure. Optimised to 33% treatment capacity at only 1 WTW.
Relative Operational Cost	Low : Shutting [redacted] will mean more expensive options in network have to be used.	Moderate : Operational costs for salt consumption and power but for only 10wks/yr minimises the impact
Carbon Assessment	Low : Increase in pump power will have slight increase in carbon footprint	Moderate : Increased lorry movements and power will increase carbon footprint.
Customer Impact	High Risk : Removal of significant portion of resilience from western region of network during summer period	Positive : New asset will produce water, retain resilience with no notable change to quality except removal of Nitrate
Environmental Impact	None : Existing infrastructure	Minimal : Two options for locations, both within existing site boundaries where no claimed biodiversity and both brown field sites
Resilience Impact	Significant : Reduction in resilience in western area as water from [redacted] SR diverted and [redacted] WTW not operated.	Improved : Removes the need for [redacted] SR transfer allowing more water to be used elsewhere in the network.
Performance Indicator Impact	Reduced : Risk of greater customer contacts due to lower resilience	Improved : less likelihood of water quality failures (Nitrate)
Overall Conclusion	Although initially attractive due to low expenditure, the risks associated with the reduction in resilience and the unknown hydraulic issues are too great for Portsmouth Water to accept in the long term. To date this option has been used in the short term where the resilience of the network has been established beforehand. Relying on it in the long term will create failures elsewhere in the network – Option **Not** taken forward.	Although this option has a higher capital and operational cost, the investment will improve the water quality to customers in the distribution zone and reduce the reliability on the [redacted] Transfer main so improving overall resilience in the network. There is sufficient space for construction and good access for operation. Being only a side stream, with the plant only required for c.10wks/yr, the operational impact is optimised – **Option Proposed**.

Ancillary work to maintain Nitrate compliance at [redacted] SR

Improving the [redacted] SR outlet Nitrate level is being looked at as a whole catchment approach with all the works feeding [redacted] SR being considered as a complete system. To optimise this system, ancillary works are identified and included. These are:

[redacted] WTW Draught Order Protection

Slindon feeds into [redacted] SR and was considered an option for increasing abstraction as the nitrate level is considerably lower than other in the region.

However, [redacted] boreholes suffer from high turbidity (>0.5NTU) when the level in the borehole is depressed from high flow. To keep the operating cost of the Nitrate plant at [redacted] WTW as low as possible, the [redacted] BH supply should be invested in to improve performance. Currently, the turbidity rises and the borehole shuts down when operating at high flows for an extended period due to exceeding Reg26 for disinfection.

The costs for ensuring the resilience of [redacted] WTW is included as part of the [redacted] SR Nitrate scheme.

In addition, [redacted] WTW has an obligation to achieve 11Ml/d to meet the dWRMP24 1-in-200 year draught condition. The turbidity issue is obviously amplified at the 11Ml/d output and therefore any solution needs to account for the higher flowrate.

It is proposed a simple cartridge filter system is employed. These are low capital cost to install, can be operated at the normal flowrate for extended periods without impact and can quickly be bought online at high flowrates without any detriment to the water quality. The costs for this system and the enabling infrastructure at [redacted] are included in the costings for the [redacted] scheme.

The cost for the UV needed for the disinfection under the dWRMP24 is excluded from the [redacted] SR scheme (and included in PRT101-03).

Included Cost : £1.55m

[redacted] Turbidity Concerns

Eastergate provides a significant portion of the flow to [redacted] (c.30%). During periods of rain, the treated water turbidity spikes. This leads to an unreliable water source and operations are making an increasing number of manual interventions to manage the risk of shutting down the site.

Although not directly related to the nitrate in the system, being without the water from [redacted] WTW into [redacted] SR, would create undue stress on the other supplies. The largest of which is [redacted] WTW, where the proposed Nitrate selective IX plant is proposed.

If this is considered a significant risk, then the Nitrate IX plant may have to be increased in size.

As these turbidity spikes are predictable (when it rains), it is proposed that investigating the cause of the turbidity spikes and rectifying the turbidity spikes will assist in the overall scheme.

Included Cost : £0.5m

Nitrate Resilience at [redacted] SR

[redacted] SR is in the north of the region and is fed almost exclusively from the [redacted] BH's. The water from [redacted] SR feeds two further SR's to the north and the main distribution zone is to the south.

Water can be transferred through the distribution zone to the South from [redacted] SR and [redacted] SR although the this is convoluted, and manual valves at [redacted] must be changed to enable the back feed of water to [redacted] SR.

[redacted]

Current Situation	Typical Flow *	Avg Nitrate conc'n
[redacted] BH's	6.8 Ml/d	62mg/l
[redacted] SR Outlet	13.5 Ml/d	62mg/l

([redacted] does not operate at all times)*

These values are generic approximations of a dynamic system and not to be taken for design purposes.

The two boreholes produce a fixed flowrate of 9.2Ml/d each with the water quality being comparable. The borehole water is combined and passes through an Ultrafiltration (UF) unit prior to disinfection and distribution.

During periods of high Nitrate, the Operations team will minimise [redacted] WTW production to only feed north using water from [redacted] via [redacted] SR. Due to the position of [redacted] on the network, water from [redacted] SR and [redacted] SR are used as much as possible. [redacted] SR can reach Nitrate levels of 47mg/l making blending with [redacted] SR water difficult at times to be below the limit of 50mg/l. This still leaves water to Clanfield SR and [redacted] SR's with high Nitrate water.

[redacted] SR Option evaluation

The Atkins report highlights the primary two options of blend the water with a better supply or treat the water to remove the nitrate. Nitrate is particularly difficult to remove from water with the Nitrate anion being highly soluble and relatively inert in dilute chemistry of water treatment. As identified earlier, the three primary methods of treatment are:

a. Ion Exchange
b. Membrane (RO or NF)
c. Denitrification

These are the same as for [redacted] SR Nitrate solution and the same discussion and conclusion apply.

There are no other feeds into the [redacted] SR apart from the [redacted] WTW and therefore blending can only be achieved by transferring water from other areas or creating a new borehole local to the site or north. This is included on the long list of alternatives, but there is no evidence that this can be achieved.

For blending with existing sources transferred across, there are three identified possibilities.

a. Automate the existing system of bringing water from [redacted] via [redacted] SR and building a blend chamber at [redacted] SR site and uprate the pumps feeding [redacted] SR and [redacted] SR. This is developing the same route they currently use to provide an alternative supply to the distribution zone south of [redacted] SR but due to hydraulic restriction an additional blend chamber is required at [redacted] SR with uprated pumps to achieve a blend with the water at [redacted] as the water will not flow directly from [redacted] SR to [redacted] SR directly. [redacted] water that feeds [redacted] SR has a nitrate concentration of 47mg/l and therefore the blend ratio will be high. A high degree of control would be required with control over the telemetry systems due to remote nature of the various sites.

b. Bring in a new main from [redacted] PS which has a lower nitrate level than [redacted] / [redacted] SR's. This would be a c.7km new 600mm dia pipeline fed from [redacted] WTW requiring pump modifications at [redacted] and could feed directly into the service reservoir at [redacted] The downstream distribution network would not require modification as no blend chamber would be required. Control of the blend would require remote control of the [redacted] PS but a direct control cable could be laid between the two sites while the new pipeline was being constructed.

c. Utilise the [redacted] supply feeding to [redacted] SR. There is a manual cross connection between the [redacted] to [redacted] main and the [redacted] to [redacted] main at [redacted] Automating these valves would allow [redacted] water to reach [redacted] SR. There are some particular challenges around the hydraulics of controlling the correct flow of water from [redacted] and [redacted] towards [redacted] to meet the demands of the distribution network and the a new blending chamber would be required at [redacted] SR site. With the new blending chamber comes the need to uprate the distribution feed pumps to [redacted] SR and [redacted] SR. The blend ratio required is less than alternative 'a.' as the nitrate levels from [redacted] SR are lower than just applying [redacted] SR water for the blend. A complex control system will be required over telemetry due to site locations and the valves requiring automation are remote from Portsmouth Water site boundaries with very limited access for construction etc.

[redacted] SR – Long list selection

Options Considered	Defined Solution	Resolves Problem	Technically Feasible	Able to Construct	Long term Operation Feasibility	KPI Risk Impact	Network Resilience Impact	Customer Impact	Enviro Impact	Carbon Impact	Biodiversity Impact	Total	Ranking
Do Nothing	3	1	1	5	1	0 (note 1)	1	0 (note 1)	3	3	3	21	6
Blend – Automate existing blend option from [redacted] SR / [redacted] SR with new blend chamber pumps at [redacted]	3	3	3	5	3	4	2	5	3	3	3	37	5
Blend – New Pipeline from [redacted] PS and uprated pumps at [redacted]	4	5	5	3 (note 2)	4	4	4	4	2	2	3	40	2
Blend – Automate [redacted] Valves to integrate [redacted] PS, new blend chamber and uprated pumps at [redacted] SR	4	5	4	4	4	4	4	4	3	3	3	42	1
Treatment – 33% Side Stream Ion Exchange at [redacted] WTW	5	5	5	4	3	4	4	4	2	2	3	40	2
Treatment – 33% Nanofiltration at [redacted] WTW	3	5	4	4	2	4	4	5	2	2	3	38	4
Treatment – 100% denitrification at [redacted] WTW	2	4	2	1	2	1	1	2	2	1	3	21	6

Score based on 0 to 5 relative to overall impact with a higher score being more favourable. A score of 0 is only used when a solution is not possible.

Notes:

1. To 'do nothing' is not an option as there will be customers who experience high Nitrate levels which also impacts on KPI's and overall company performance to deliver wholesome water. There is DWI support in solving the problem of high Nitrate levels at [redacted] SR
2. The route and construction of a new pipeline has not been defined. The cost of this is significantly higher and the environmental impact greater than the other blend options.

[redacted] SR Option evaluation

	Option 5 – Lyeheath valve automation	Option 4 – Lovedean IX treatment
Scope summary	Automation of [redacted] valves. Uprating of [redacted] PS and Lovedean pumps to [redacted] and [redacted] New blend chamber with associated controls and telemetry systems for remote actuation of valves and pumps.	33% Sidestream IX plant based at [redacted] WTW to blend with bypassed water.
Technical Risks	Significant : Several areas of technical challenge to be overcome including hydraulic and control concerns and remote automation of valves located in farmland.	Minor : Proven technology with the only elements not determined being • Final location (Westergate is favoured but not confirmed) • Wastewater disposal • Salt delivery infrastructure
Relative Capital Cost	Low : The majority of existing assets are being maintained including the pipelines through third party land. Construction limited to blend chamber and pipework arrangement at [redacted] WTW.	Moderate : Due to new assets of IX plant, building and road infrastructure. Optimised to 33% treatment capacity.
Relative Operational Cost	Low : Increase in operational costs from increase in motor power for revised pump duties during periods of high nitrate	Moderate : Operational costs for salt consumption and power but for only 10wks/yr minimises the impact
Carbon Assessment	Low : Increase in power consumption during periods of high nitrate	Moderate : Increased lorry movements and power will increase carbon footprint.
Customer Impact	Positive : No notable change or interaction with public with output being reduced nitrate concentrations	Positive : New asset will produce water, retain resilience with no notable change to quality except removal of Nitrate
Environmental Impact	Minimal : Majority of construction work will be within site boundary which has limited biodiversity etc. Remaining construction will be localised in farmland	Minimal : Within existing site boundaries where no claimed biodiversity and both brown field sites
Resilience Impact	Minor : [redacted] will have less resilience when feeding [redacted] SR when needed for blending with [redacted] SR. However, [redacted] SR can be fed from multiple sources to compensate.	Improved : Removes the need for [redacted] SR transfer allowing more water to be used elsewhere in the network.
Performance Indicator Impact	Improved : less likelihood of water quality failures (Nitrate)	Improved : less likelihood of water quality failures (Nitrate)
Overall Conclusion	Although this has technical challenges the value for money that this option offers customers is preferred. The technical challenges can be overcome at detail design with the contractor and the reduction in resilience during the high Nitrate period does not pose a significant threat to the network, particularly if the [redacted] IX plant is developed as [redacted] SR would then be able to divert water to the western half of the network. **Option Proposed** for [redacted] Nitrate	This is a viable option that may be required in the future if Nitrate levels increase higher than predicted in [redacted] WTW or other sources. However, this is not value for money at this time.

Summary of Options considered in Atkins report

[redacted] SR

To reduce the nitrate in [redacted] SR, the options revolve around reducing the reliance of untreated water from [redacted] BH's / [redacted] BH's.

Option 1 – [redacted] SR Transfer Optimisation

Transfer water from [redacted] SR to [redacted] SR and reduce output from [redacted] BH's and [redacted] BH's. This option formalises an existing temporary / emergency arrangement.

- The blend requires c. 33% of the water in [redacted] SR to be transferred from [redacted] SR.
- The additional demand from [redacted] is made up with water transferred from [redacted] SR.
- To maintain the low nitrate level required for the blending, [redacted] WTW has to be turned off as the 8Ml/d output from [redacted] contains 45mg/l and nitrate level would be breached

Option 2 – Nitrate treatment at [redacted] / [redacted] WTW's

By calculation, a 20% side-stream from either [redacted] or [redacted] needs to be treated to remove nitrate to low levels for final blend to be within limits.

- Ion Exchange is preferred treatment method
- Some blending control required to ensure nitrate treatment operational when demand called from either [redacted] or [redacted]
- [redacted] is preferred location due to land, power and services availability

[redacted] SR

Option 5– [redacted] valve actuation from [redacted] SR

[redacted] SR has a Nitrate concentration c.42mg/l

Actuation and control of [redacted] valve including remote telemetry and operation.

New blending chamber with control valves, and uprated booster pump sets to pump flow to [redacted] SR and [redacted] SR as additional headloss from location of blending chamber.

Option 4 – Nitrate treatment at [redacted] WTW

By calculation, a 33% side-stream at [redacted] WTW is required to remove sufficient nitrate to ensure the water leaving [redacted] SR is with the limits.

- Ion Exchange is the preferred treatment method after consideration of alternative methods

Options available for [redacted] SR are independent to options available for [redacted] SR : these sites are mutually exclusive and do not interact within the network so solutions for both sites need to be carried out to achieve the overall output of compliant Nitrate levels.

Final Proposal

[redacted] SR Nitrate Resilience

[redacted]

[redacted] SR Nitrate Resilience

[redacted]

Business Plan Cost Build-up - Nitrate

[redacted] SR IX Nitrate removal plant

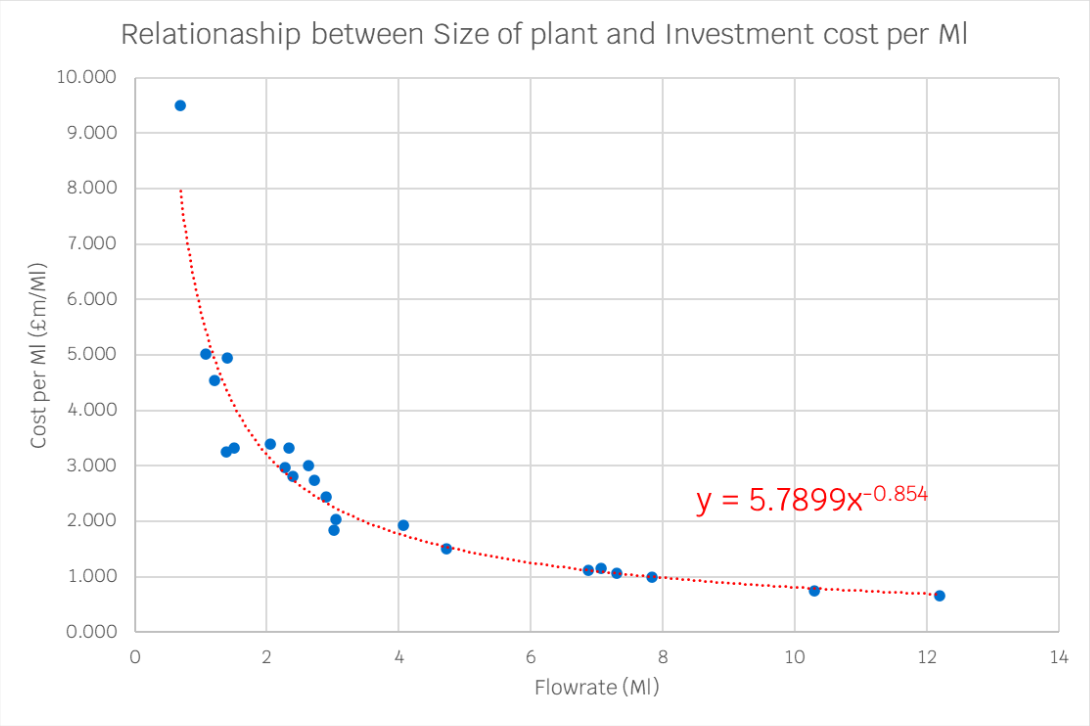
IX technology (inc. vessels, resin, pipework and installation)	£7.06m
Buildings, groundworks & service connections	£1.40m
Network control and automation	£1.02m
Pipework connections at [redacted] WTW	£0.25m
Improve access roads for tanker delivery of salt	£0.25m
Modifications to existing treatment process	£0.40m
Identification / Correction of [redacted] BH Turbidity	£0.50m
[redacted] WTW resilience & Draught Prep	£1.55m
Total	**£12.43m**

[redacted] SR Blending system

[redacted] valve automation and control	£0.75m
Blending chamber at [redacted] SR	£0.45m
Network control and automation	£0.35m
Improve access for [redacted]	£0.10m
[redacted] distribution pump uprating	£0.25m
Total	**£1.9m**

Sub Total for Nitrate Protection (2 schemes)	**£14.33m**
Risk and Contingency @10%	£1.43m
Project Management Overhead @15%	£2.15m
Sub-total	**£17.91m**
Delivery efficiency reduction @ -13.8%	-£2.48m
Grand Total (Nitrate Resilience Programme)	***£15.43m***

Ofwat benchmark comparison - conclusion



From data in Ofwat determination spreadsheet (PR24-DD-W-Raw_water_quality-deterioration.xls) and tab Nitrate Query data, the costing curve on LHS can be derived.

The Nitrate programme proposed has been created by reviewing on a catchment level rather than site asset level producing 2 distinct projects related to:

1. [redacted] SR – 21 Ml/d in normal conditions
2. [redacted] SR – 13.5 Ml/d in normal conditions

Using the curve, the benchmark for the total programme cost should be c.£17.50m.

This is below to the pre-efficiency sub-total of £17.91m.

The business plan figure of £15.43m appears good value when compared to other Nitrate schemes.