MMB
MOTT MACDONALD
BENTLEY

NWG
living water

DS12 Fluoridation of Durham

Investigation and Definition Report

May 2019

Northumbrian Water Group Ltd

Mott MacDonald Bentley
Spectrum 5
Spectrum Business Park
Seaham
SR7 7TT
United Kingdom

mottmacbentley.co.uk

Northumbrian Water Group Ltd
Spectrum 5, Spectrum Business Park, Seaham, SR7 7TT

DS12 Fluoridation of Durham

Investigation and Definition Report

May 2019

Northumbrian Water Group Ltd

Issue and Revision Record

Revision	Date	Originator	Checker	Approver	Description
A		[redacted]	[redacted]	[redacted]	I&D Report to Gateway 5

Document reference: DS12 | 002 | A

Information class: Standard

Contents

NWG Runway 2 Delivery Process

Initiate and Plan Phases

The process through which the 'notional solution' and 'affordability target' is reviewed and investigated with supplier partners to challenge and provide innovative solutions to meet the business outcome. This phase is to provide just enough investigation input to confirm and define a buildable and sustainable solution that will deliver the business outcome, that meets the standard required, to enable an affordable and realistic delivery target cost to be set.

Investigate Phase

The process through which the 'notional solution' and 'affordability target' is reviewed and investigated to challenge and provide innovative solutions to meet the business outcome. This phase is to provide just enough investigation input to advise on affordability and confirm a buildable outcome, which will meet the standard required. The phase should culminate in agreement of the 'preferred solution'.

Define Phase

The Core Team has challenged and scrutinised the defined preferred solution, delivery target cost and programme and agreed that it is suitably developed to allow the project to progress to the delivery phase**.**

The issue has undergone final technical, commercial, risk and value challenge, contract documents are fully signed off and the Core Team has agreed to proceed to the delivery phase.

Delivery Phase

The Core Team has agreed the design is sufficiently progressed, with agreed design acceptance and H&S documentation in place, to allow the design to be submitted to PHE for approval**.**

Once construction has finished and all contractual obligations are met, the ECC PM issues the completion certificate & handover achieved.

Integrated Delivery Team

Project Manager (NWG) – [redacted]

Sponsor (NWG) – [redacted]

User (NWG) – [redacted] ([redacted])

User (NWG) – [redacted] ([redacted])

User (NWG) – [redacted] ([redacted])

Project Engineer (NWG) – [redacted]

Contract Manager (MMB) – [redacted]

Design Lead (MMB) – [redacted]

Project Leader (MMB) – [redacted]

Process Support (MMB) – [redacted]

1 Gateway 0 – 1: Issue Review

1.1 Project Description from Asset Needs Statement

1.1.1 Background

Mott MacDonald Bentley Ltd (MMB) has been appointed by Northumbrian Water Group (NWG) on behalf of Durham County Council (DCC) to investigate the feasibility of fluoridating the water supplied to specific regions of NWG's distribution system. DCC subsequently secured support from Sunderland City Council and South Tyneside Council to act in consortium as the most practical way of developing this project. The three Councils wish to fully explore the feasibility of extending the coverage of water fluoridation for their populations. To secure capital funds from Secretary of State for Health, they are required to provide a detailed engineering study to assist the Secretary of State as to whether the project is 'operable and efficient'. Several options to provide fluoridation were explored in an initial network analysis report carried out by [redacted] (Fluoridation Report for Durham County Council, [redacted]), link for which can be found below.

NWG issued MMB with an Asset Needs Statement (ANS), detailing the scope of the work to be carried out. The initial scope includes installation/modification of equipment at three sites: [redacted] WTW, [redacted] WTW and [redacted] WTW. The fluoride dosing installation is required to dose the maximum deployable output (DO) from all three works to 1.0 mg/l of fluoride. None of the sites currently have any provision for fluoride dosing. A feasibility review of the reconfiguration of mains at [redacted] Groundwater Pumping Station (GWS) proposed in [redacted] report was agreed to be added to the project scope in January 2019. Reconfiguration of mains is required to produce a new mixing location to achieve a target fluoride concentration of 0.8 mg/l – for further details please refer to [redacted] report.

[redacted] WTW has a maximum Deployable Output (DO) of [redacted] Ml/d which currently supplies [redacted] properties.

[redacted] WTW has a maximum DO of [redacted] Ml/d which currently supplies [redacted] properties.

[redacted] WTW is considerably larger and has a maximum DO of [redacted] Ml/d which currently supplies [redacted] properties.

[redacted] GWS has a maximum DO of [redacted] Ml/d which currently supplies the [redacted] system.

This report has been prepared to outline the site requirements necessary to achieve the required fluoride levels in the treated water from [redacted], [redacted], [redacted] WTW and to facilitate increased fluoride levels at [redacted] GWS.

The ANS can be found on NWG's SharePoint at the following location:

Asset Needs Statement

[redacted] report can be found on NWG's SharePoint at the following location:

Fluoridation Report - [redacted]

Minutes from the kick off meeting for the addition of [redacted] GWS to the scheme can be found here:

[redacted] Scope

1.1.2 Problem Identification

None of the three WTW sites have any provision for artificial fluoridation of their water supply. [redacted] GWS has a naturally occurring average fluoride concentration of 0.35 mg/l.

New process, civil and mechanical infrastructure will be required at the three water treatment works to enable fluoridation of the entire range of the works' Deployable Output (DO).

[redacted] GWS will require new civil and mechanical infrastructure to enable naturally fluoridated water from [redacted] GWS to be blended with artificially fluoridated water originating from [redacted] WTW.

1.1.3 Project Objectives

To install chemical dosing equipment and all associated delivery, storage and monitoring equipment to safely achieve the target of 1 mg/l of fluoride in the treated water output for all three named WTWs. To evaluate the buildability of the proposed reconfiguration of mains at [redacted] GWS to achieve the target of 0.8 mg/l of fluoride downstream of the new mixing location. The project is to comply with NWG's applicable codes and standards as well as the DWI Fluoridation Code of Practice on 'Technical Aspects of Fluoridation of Water Supplies 2016'.

Scheme principles are:

- Provision of a new fluoride dosing kiosk and associated equipment which follows the general design principle of the existing fluoride dosing kiosk at [redacted] WTW.
- Provision of new pipe, valves and associated equipment at [redacted] GWS.

1.1.4 Overall Project Programme

The current agreed duration for Investigate and Define (I&D) is 6 months from 3rd September 2018 to 15th March 2019.

No DWI undertaking or other deadlines have been identified.

1.2 Plan for I&D Phase

Framework Runway 2 delivery.

1.3 CP2: I&D Budget Approval

The NEC3 PSC Option E Contract budget (I&D phase) was set at [redacted] excluding [redacted] GWS.

1.4 I&D Phase Contract

A copy of the contract is available on NWG's SharePoint at the following location:

I&D Contract

The contract excludes the later addition to scope of [redacted] GWS.

1.5 Scope

Detailed and budget costed engineering specification. The installations shall be designed to deliver a means of achieving 1mg/l of fluoride in the desired water supplies in the most operable and efficient manner.

The design shall be compliant with the 2016 DWI Fluoridation Code of Practice and seek to adjust the level of fluoride in the water supplies at the point of application to 1 mg/l.

The project shall be a ”turnkey” project. The design and specification shall consider; the potential need to provide; required new and potential new investment in:

- Site security
- Road / delivery tanker access
- Tanker delivery bund and drainage / interceptor tank design and arrangements
- Emergency drench showers
- Design of the fluoride dosing rig for WTW installations including housing / building, to include:
  - Building ventilation
  - Bulk HFSA acid delivery / removal point
  - Bulk storage
  - Day tank
  - Pipe and valve arrangements
  - Transfer pumps
  - Dosing pumps
  - Dosing lines
  - Equipment safety guards / shielding
  - Control equipment and telemetry
  - Electric supply and electrical services
  - Fluoride monitors
  - Fluoride monitor water sampling
- Point of application (POA) cabinet
- Fluoride dosing lance and valve arrangements
- Water main static mixers
- Fluoride monitor sample points
- Civil works to include:
  - Concrete slab and building / brickwork requirements for any structures / buildings
  - Fluoride dosing line / fluoride monitor sample water line ducting
  - Fluoride dosing and sample line chambers
  - Delivery tanker stand / bund, interceptor tanks, drainage and valving arrangements
  - Site installation and commissioning
  - Any other costs or considerations for construction and commissioning
  - Timescales for delivery into service once a valid instruction to proceed is given by PHE
- Annual operating cost following commissioning, including:
  - Fluoride chemical costs
  - Other chemical costs such as monitor reagents
  - Electricity costs
  - Operating workforce costs
  - Monitoring and reporting costs
  - Consumables (e.g. dosing lines)

  - Management costs
  - Any other costs
- The study will:
  - Require full site reviews of treatment works as appropriate and will confirm that, where required, static mixers can be installed (constructability and hydraulics). A view is also required from NWG as to whether there are any anticipated issues or problems regarding obtaining planning consent such as conditions or restrictions of planning around design, aesthetics or construction materials (e.g. requirement to build in local stone to blend in).
  - Identify any need to purchase land if the required development will necessitate increases beyond existing site boundaries, including any necessary requirements to improve access to existing facilities.
  - Confirm that major operability risks can be controlled in line with 2016 DWI Fluoridation Code of Practice.
  - Update the capital cost to reflect any changes from above.
- Engineering Design and Specification. This is key in defining the project cost and should be considered as "Full Business Case" costs. This will need to provide as accurately as possible final project cost; therefore, the project outputs should include building & layout drawings, identifying plant and equipment to a good level of detail i.e. 50:1 minimum scale for some elements (see below for details).
  - 1:200 site drawings (1:500 site drawing if site is very large), identifying fluoride rig, POA, water main to be dosed into, route of dosing and sample lines / ducts, access roads, tanker bunds and any other relevant information.
  - 1:50 drawing of Fluoride rig plus POA, identifying layout and major components / equipment.
  - 1:50 civil engineering drawings for major civils works i.e. Plinth for fluoride rig, dosing chamber, and tanker bund and spillage tanks.
  - Schematic drawings identifying relevant site services and pipe runs and any known detail i.e. pipe size, flow rate etc.
  - That the design will be based on using HFSA at a 20%ww concentration.
- [redacted] GWS Feasibility Review. This will include:
  - Design of reconfiguration options
  - 1:100 site drawing, identifying preferred mains reconfiguration option, relevant site services and pipe runs and any known detail i.e. pipe size, flow rate etc.

1.5.1 Scope Items provided by Northumbrian Water in the Pre-Contract Information

- As part of the study NWG should confirm whether there are any potential conflicts with the interests of any industrial customers.
- A HAZOP assessment is not formerly required as part of this study. However, NWG will take risk and Health & Safety into account when designing and building the fluoride rig and may wish to use the HAZOP framework as part of the basis for addressing risk and Health & Safety for the project.
- Undertake detailed mapping exercise. A detailed fluoride mapping exercise is required to be undertaken to identify the area and extent of fluoridation for the proposed project. This should be based on an assumed target fluoride level of 1 mg/l to be achieved in the areas to be served by the scheme. This exercise should qualify:

- Areas that will receive fluoridated water, including a narrative on any re-zoning of Water Quality Zones that might be necessary.
- Details of the population that would receive fluoridated water.
- Any dilution effects due to mixing with non-fluoridated water after the points of application i.e. areas where 1mg/l fluoride will be achieved in the distribution; and areas receiving a lower level of fluoride (calculated dilution levels should be identified).
- Sources of any dilution.
- Any water resilience issues that might be relevant to the proposed scheme such as predictable seasonal flows or planned network changes.

1.5.2 Expectations for I&D Outcomes

For each WTW site, the following is to be undertaken:

- Confirm the maximum deployable output per site.
- Review the chemical composition of the raw water, determine the existing chemical dosing routine.
- Review the existing chemical dosing points for suitability for dosing fluoride.
- Identify where further modifications are required to comply with the 2016 DWI Fluoridation Code of Practice
- Locate suitable dosing points and sampling locations that comply with the 2016 DWI Fluoridation Code of Practice, recommending options as appropriate.
- Locate suitable kiosk locations to house dosing equipment and storage tanks.
- Propose a preferred solution per site and update the high-level budget where appropriate.

For the Pumping Station (PS) site, the following is to be undertaken:

- Confirm feasibility of proposed mains reconfiguration.
- Locate suitable reconfiguration pipe layout alternatives.
- Propose a preferred solution for the site and update the high-level budget where appropriate.

1.5.3 Budget

The Investigate and Define contract budget is [redacted] (excluding [redacted]).

The total notional solution affordability target issued by NWG is [redacted] (excluding [redacted]).

1.5.4 Programme

Gateway	Outcome	Date
1	Issue reviewed	08/10/18
2	Issue validated	02/11/18
3	Notional Solution / Affordability reviewed	16/01/19
4	Preferred Solution identified	21/03/19
5	Preferred Solution defined. I&D Report signed off	29/05/19
6	Delivery Contract validated	N/A

1.6 Risk Register

The initial risks identified for inclusion in the risk register were:

[redacted] **WTW**

- Potential mixing issues downstream of RGF's (Sulfuric Acid – Static Mixer).
- Anticipated issues with obtaining planning consent.
- Space constraints may cause issues with construction of kiosk and interceptor tank as well as bulk delivery of chemical.
- Inaccuracy of using summated flow signals for chemical dosing.
- Potential for fluorapatite formation in the boilers of customers who are supplied with water that has an artificially elevated fluoride concentration.

[redacted] **WTW**

- Chlorine process loop time [redacted] as pointed out by site manager.
- RGF [redacted] does not work (site staff unsure why).
- Inaccuracy of using summated flow signals for chemical dosing.
- Potential for fluorapatite formation in the boilers of customers who are supplied with water that has an artificially elevated fluoride concentration.

[redacted] **WTW**

- Likelihood of having to use multiple/external storage tanks WTW due to the large DO.
- Potential clashes with proposed large-scale capital improvement project.
- Potential for insufficient mixing downstream of the RGF's.
- Inaccuracy of using summated flow signals for chemical dosing.
- Potential for fluorapatite formation in the boilers of customers who are supplied with water that has an artificially elevated fluoride concentration.

[redacted] **GWS**

- Pressure control dependent on the installation of a new valve at [redacted] (not included within this scope of work).
- Potential for conflicts with concurrent dechlorination system design and construction on site.
- Potential listed status of boundary wall.
- Environmental risk due to large number of trees on site.

Risks will be continuously collated as the project progresses; risk register to be developed for Gateway 4.

1.7 Customer Engagement Plan

[redacted], [redacted] and [redacted] WTW are all sited rurally. NWG/MMB customer liaison to be engaged during detailed design phase, councils to liaise with public during consultation phase.

1.8 Gateway 1: Issue Reviewed

1.8.1 Gateway 1 Requirements

The following criteria must be met in order to pass through Gateway 1:

"*The Integrated Delivery Team has a shared understanding of the Asset Needs Statement. A collective agreement has been made as to what additional information is required to verify the issue and validate the Notional Solution, if any*".

1.8.2 Additional Data / Information Requirements

- [redacted] WTW
  - Existing static mixer performance
  - Asbestos
  - Raw water quality
  - Works maximum and minimum deployable outputs
  - Existing utilities
- [redacted] WTW
  - Potential static mixer locations
  - Investigate out of service flow meter
  - Asbestos
  - Raw water quality
  - Works maximum and minimum deployable outputs
  - Existing utilities
- [redacted] WTW
  - Determine where a static mixer can be installed as per CoP requirement
  - Asbestos
  - Raw water quality
  - Works maximum and minimum deployable outputs
  - Existing utilities
- [redacted] GWS
  - Coordinate with Wood Group dechlorination system design
  - Asbestos
  - Historical protections (Building is Type II Historically Listed)
  - Existing Utilities

1.8.3 Re-define ANS / Re-prioritise

Not applicable.

2 Gateway 1 – 2: Issue Validation

2.1 Collation of Existing Data

Pre-Contract Information and Asset Planning initial information provided by NWG was uploaded to NWG's SharePoint. This includes:

- Asset Needs Statement
- 2016 DWI Code of Practice on Technical Aspects of Fluoridation of Potable Water Supplies
- Fluoridation Report for Durham County Council Final Draft GWS – [redacted] Report

These documents can be found at the following location:

NWG - Existing Data

2.2 Acquisition of Additional Data

2.2.1 Water Quality Data

No water quality data was provided under the contract. However, lab sample water quality data was supplied by NWG upon request for all three WTW sites. Site water quality targets were also provided by NWG as well as digital 'Arlosh' operational diagrams for [redacted] WTW and [redacted] WTW. Arlosh diagrams for [redacted] have been sourced from project [redacted].

2.2.2 Flow / Load Data

[redacted] report contains work's flows for the three Durham treatment works; NWG later confirmed these are average flows. No other flow data was supplied under contract. NWG agreed to use flow data for [redacted] WTW acquired under a previous MMB project, [redacted]. Outstanding flow data was supplied upon request by NWG for [redacted] WTW and [redacted] WTW.

Water quality data and flow data was collated into a water quality envelope for design purposes, use of which was agreed with NWG (06/11/2018). Document(s) available here:

Flow & Load Data

No additional flow or load data was collected for [redacted] GWS.

2.2.3 Chemical Data

Chemical cost data was not provided as part of the contract data, but information on the cost of sodium hydroxide and d was provided on request. Chemical Material Safety Data Sheets (MSDS) were provided upon request for sodium hydroxide, hexafluorosilicic acid and ferric sulphate.

2.2.4 Review of As-built Information

As-built drawings were found for each site during drawing searches at [redacted] (12/11/2018), [redacted] (20/11/2018), [redacted] WTW (29/11/2018) and [redacted] (12/02/2019).

Limited information found at [redacted], [redacted] WTW and [redacted] GWS; more substantial amounts of information collated at [redacted] WTW.

2.2.5 Future Projects

Wood Group supplied plans for the proposed UV disinfection project at [redacted] WTW, that may disrupt proposed kiosk locations. Wood Group also provided plans for a proposed dechlorination system at [redacted] GWS. Files can be found here:

Conflicting Projects

UV may also be installed in the future at [redacted] WTW, this is something for the project team to consider when proposing kiosk locations.

2.2.6 Topographical Survey

NWG agreed that topographical surveys carried out under a previous scheme, [redacted], will be used for [redacted] WTW (26/11/2017).

Additional surveys may be required to extend the survey area, depending on the proposed design.

Information from Wood Group included topographical surveys for both [redacted] WTW (04/10/2017) and [redacted] GWS (13/02/2019)

A topographical survey for [redacted] WTW is required.

The files mentioned above can be found here:

Topographical Surveys

2.2.7 Utility Record Searches and GPR

Utility record search undertaken for all sites by MMB (24/09/2018).

NWG agreed that that GPR survey carried out for project [redacted] will be used for [redacted] WTW (26/11/2017).

GPR survey procured by Wood Group at [redacted] WTW has also been supplied (04/10/2017).

GPR surveys for [redacted] WTW and [redacted] GWS are required.

Files mentioned above can be found here:

GPR Surveys

2.2.8 Asbestos Survey

Asbestos surveys for all sites carried out, they can be found here:

Asbestos Surveys

2.2.9 Archaeological / Historical Survey.

MMB carried out a ‘Magic Map’ archaeological desk study for each site which can be found here:

Archaeological Surveys

No conflicts with areas of archaeological or historical significance were identified. Further investigation of historical protection is required at [redacted] GWS.

2.2.10 Geotechnical Investigation

Geotechnical Investigation may be required later in the I&D process and was not carried out at this stage due to the relatively low loads imposed by the kiosks.

2.2.11 Environmental Assessment

Ecological surveys can be carried out by NWG once areas identified for construction have been submitted by MMB.

2.3 Data Assessment and Verification

Data assessment to be undertaken by MMB during the I&D stages.

2.3.1 Basis of Design / Assumption

Design to be compliant to 2016 DWI Code of Practice on Technical Aspects of Fluoridation of Water Supplies and any applicable NWG Asset Standards. Design will also satisfy the Asset Needs Statement provided by NWG. Basis of design to follow once passing Gateway 3.

2.4 Re-define?

Re-definition not required as issue is valid.

3 Gateway 2 – 3: Notional Solution and Affordability Review

3.1 Feasibility of Notional Solution

After collation of data and visits to site, MMB determined multiple solutions for each site. MMB developed options detailing storage tank sizes and appropriate delivery mass; kiosk locations; and dosing/sampling arrangements at the WTW sites.

Investigation into the use of the NWG Treatment Management Guidelines for liquid chemical storage was carried out for all three WTW sites. The criteria were deemed suitable for [redacted] WTW due to the anticipated level of fluoride consumption. The storage solutions for [redacted] WTW and [redacted] WTW aimed to incorporate [redacted] weeks of chemical storage as agreed by NWG, to mitigate historical issues with volatile fluoride supply.

Potential kiosk locations were investigated at all three sites. Initial selections were deemed as suitable and consideration to potential upcoming UV projects at [redacted] and [redacted] WTW was given.

Several options surrounding points of application; provision for mixing; sampling points; and flow measurement were discussed at an internal review (30/10/2018). The outcome of the meeting was four options at [redacted] WTW; three options at [redacted] WTW; and two options at [redacted] WTW. All options were outlined in a comparison study and the results were put forward to NWG at a Gateway 3 meeting with NWG (16/11/2018).

These options were assessed on the following criteria:

- Estimated Relative CAPEX
- Estimated OPEX
- Maintenance
- Estimated sample loop times
- Quality of mixing at POA
- Quality of flow measurement
- Reliability of system
- Construction complexity
- Site shut down requirements
- DWI Code of Practice Compliance

Works at [redacted] GWS were not included in the MMB project scope prior to the Gateway 3 meeting as this was not included until January 2019, therefore content regarding [redacted] up to this point has been added to this report retrospectively. Three alternative reconfiguration solutions were identified following a site visit at [redacted] GWS with NWG staff and [redacted] on 01/02/2019. These can be found in Section 4.2.1.4.

3.2 Notional Solution

Various dosing solutions were presented to NWG at the Gateway 3 meeting on 16/11/2018. The notional solution for each site consisted of a design which strived to be fully DWI Code of Practice compliant. The Gateway 3 presentation can be found at the following link:

Gateway 3 Presentation

For [redacted] WTW, the notional option would be to replace the existing static mixer with one that has additional dosing lance connections as well as being sized correctly to provide adequate mixing across the range of works flow to all dosed chemicals (new and existing). A new flow meter would be installed downstream for the purposes of chemical dosing control.

At [redacted] WTW, the notional option is to reuse the existing flow meter chamber and replace the non-functional flow meter. A new static mixer would be installed downstream of the flow meter along with a new sample point that will feed the fluoride analysers as well as new pH and turbidity monitors.

It was highlighted that Public Health England (PHE) is not likely to fund the installation of a new flow meter at [redacted] WTW or [redacted] WTW. As such, flow meter installations may fall outside this scope of these projects and require NWG capital insourcing.

The notional option at [redacted] WTW is to make use of the two existing flow meters and place new static mixers downstream of them. A new sample point will also be installed on both water mains to feed the new fluoride, pH and turbidity analysers.

Static mixers do fall into the PHE scope of work outlined in the ANS, so it would be beneficial to pursue the installation of these if permittable (constructability and hydraulics), for improved mixing of the fluoride.

At [redacted] GWS, the notional solution is to branch off of the existing 355 mm HPPE pipe inside (west of) the existing stone wall boundary and cross underneath. A connection would be made to the existing 315 mm HPPE pipe on the east side of the wall along [redacted]. This solution is dependent on the allowance of pipe installation below the wall which may fall under the site's Grade II listing, however provides flexibility for the reduced impact to protected trees in the verge along [redacted]. If either of these constraints are limiting, it is recommended that the reconfiguration is connected near to the site entrance and be routed along the verge to avoid conflicts with the wall or protected trees.

3.3 Other Options for Consideration

Other options considered during the Gateway 3 meeting, in addition to the 'notional solution' are as follows:

3.3.1 Process Options

- [redacted] WTW
  - Option 2a – Point of Application (POA) at RGF common outlet weir, new flow meter downstream of existing static mixer.
  - Option 2b - POA at RGF common outlet weir, summation of filter flow and new flow meter on backwash header tank inlet pipe.
  - Option 2c - POA at RGF common outlet weir, summation of filter flow and an estimated backwash header tank flow rate from the fixed speed filler pumps.
- [redacted] WTW
  - Option 2 - POA in flash mixer 4, use of existing flow meter/replace as necessary.
  - Option 3 - POA in flash mixer 4, summation of filter flow.
- [redacted] WTW
  - Option 2 - POA in filter gallery, use of summated flows of downstream flow meters.

Details of these options were given in the Gateway 3 presentation and can be found here:

Gateway 3 Presentation

3.4 Preferred Solution

After discussion with NWG during the Gateway 3 meeting, it was agreed that the notional solutions for each site as outlined in Section 3.2 were not suitable to be carried forward as the preferred solution. The reasoning primarily surrounded buildability concerns – see Gateway 3 minutes linked below. Furthermore, it was determined by the NWG Maintenance department, that the existing flowmeter at [redacted] could not be repaired. For the agreed preferred solutions see Table 1 below:

Gateway 3 Meeting Minutes

Table 1: Agreed Options to Progress to Gateway 4

Site	Agreed Option
[redacted] WTW	Option 2c
[redacted] WTW	Option 3
[redacted] WTW	Option 2

3.5 Kiosk Locations Options

- [redacted] WTW
  a) Outside the wash water clarifier building, adjacent to the boundary wall.
  b) Adjacent to the generator building.
  c) In front of Chemical Block B.
  d) On the grass opposite Chemical Block B.
- [redacted] WTW
  a) On the grass behind the filter block, adjacent to the access road.
  b) On the grass adjacent to the road leading to the reception, near the existing flow meter.
- [redacted] WTW
  a) On the hill adjacent to the filter block.
  b) Behind the coagulant storage tanks, adjacent to the access road for chemical deliveries.
  c) Adjacent to the filter block wall alongside the access road to the reception.

3.6 Affordability Target Review

NWG proposed an affordability target in the region of [redacted] per site, amounting to a total of [redacted] (affordability target not including [redacted]).

MMB carried out a high-level affordability assessment which indicated that the budget cost will likely be closer to the following figures:

Table 2: Budget Cost Estimate

Site	Estimated Budget Cost
[redacted]	[redacted]
[redacted]	[redacted]

Site	Estimated Budget Cost
[redacted]	[redacted]
[redacted]	[redacted]

Source: MMB

3.7 Gateway 3: Proceed with Notional Solution or Consider Options

3.7.1 Gateway 3 Requirements

The following criteria must be met in order to pass through Gateway 3:

"*The Integrated Delivery Team has reviewed the Notional Solution and Affordability Target and has agreed to proceed with the Notional Solution or consider agreed options*".

Integrated Delivery Team Sign-off

Gateway 3 Meeting Minutes

4 Gateway 3 – 4: Preferred Solution Identification

4.1 Description of Notional Solution

As per the ANS and after communication with NWG, the preferred solution is interpreted as:

- Installation of fluoride dosing equipment at [redacted], [redacted] and [redacted] WTW.
- Target fluoride dose of 1.0 mg/l at a point of application that provides adequate mixing.
- Design to comply with the 2016 DWI Code of Practice on Fluoridation of Water Supplies.
- Hexafluorosilicic acid (20%) to be stored and dosed.
- Kiosk for storage and day tanks as well as bunded delivery point.
- Use of either [redacted] weeks chemical storage or following the NWG asset standard for liquid chemical storage (full tanker delivery), depending on which is more appropriate for the site in question.
- Ducts for dosing lines, power and telemetry.
- Fluoride sampling and monitoring.
- EICA upgrades where required.
- Reconfiguration of mains at [redacted] GWS to allow water from the GWS to mix downstream of [redacted] ([redacted]) valve.

4.2 Description of Options Considered

4.2.1 Option Selection

4.2.1.1 [redacted] WTW

Following review with NWG (01/03/2019), it was agreed that process Option 2c as outlined in Section 3.3 was to be progressed. Furthermore, NWG agreed on kiosk Option 3a as shown in the following sketch:

[redacted] Sketch

4.2.1.2 [redacted] WTW

Following review with NWG (01/03/2019), it was agreed that process Option 3 as outlined in Section 3.3 was to be progressed. Furthermore, NWG agreed on kiosk Option 1 as shown in the following link:

[redacted] Sketch

4.2.1.3 [redacted] WTW

Following review with NWG (01/03/2019), it was agreed that process Option 2 as outlined in Section 3.3 was to be progressed. Furthermore, NWG agreed to progress kiosk Option 2 as shown in the link below. Option 2 minimises dosing length lines as far as is practicable, without encroaching on the potential future UV project area.

[redacted] Sketch

4.2.1.4 [redacted] GWS

Following a site visit to [redacted] GWS on 01/02/2019, three reconfiguration options were identified:

1. Continuation of the existing 355 mm HPPE pipe from the existing bend to the west of the existing stone wall, crossing below, and bending south to meet the existing 315 mm HPPE pipe east of the wall in the verge along [redacted].
2. Branching (tee) from the existing 355 mm HPPE pipe to the west of the existing stone wall, crossing below, and meeting the existing 315 mm HPPE pipe in the verge east of the wall along [redacted].
3. Branching (tee) from the existing 355 mm HPPE pipe outside of the existing stone wall near the site entrance, running alongside the existing 315 mm HPPE pipe in the verge and connecting with a bend north of the existing chamber.

Option 2 provides the most direct connection while allowing flexibility to locate new pipework and valves and minimise potential ecological impacts with protected trees. A portion of the stone wall will need to be demolished and reconstructed from the existing materials. This option presents the simplest configuration and efficiently utilises limited space in the verge along [redacted]. Option 2 has been proposed to NWG as the preferred solution.

4.2.2 Fluoride Option Development

4.2.2.1 Process Flow Diagrams

To assist in defining the scope requirements for fluoride addition, process flow diagrams were developed for the existing site and proposed works. These can be found on SharePoint at the following location:

Process Flow Diagrams

4.2.2.2 Outline Process Calculations

Outline process calculations were carried out by MMB process engineers to size the dosing and storage equipment. Bulk cost of HFSA was provided by NWG (07/06/2018). Conclusions from the calculations are provided below:

[redacted]

To dose the correct amount of HFSA the dosing system needs to be capable of delivering a maximum flow of [redacted] $l.h^{-1}$, an average of [redacted] $l.h^{-1}$ and a minimum of [redacted] $l.h^{-1}$. The estimated maximum, average and minimum annual bulk chemical usage is [redacted] tons, [redacted] tons and [redacted] tons respectively equivalent to costs of [redacted], [redacted] and [redacted]. Dosing pumps require a turn down ratio of [redacted].

At Gateway 3 (16/11/2018) it was agreed with NWG that a bulk tank of [redacted] m^3 would be provided, this corresponds to approximately [redacted] weeks of chemical storage at average works flow plus 10 days for delivery; this approach was agreed with NWG at Gateway 3 (16/11/2018). The day tank was agreed to have a volume of [redacted] L, providing enough capacity for 24 hours dosing at maximum works flow.

[redacted]

To dose the correct amount of HFSA the dosing system needs to be capable of delivering a maximum flow of [redacted] $l.h^{-1}$, an average of [redacted] $l.h^{-1}$ and a minimum of [redacted] $l.h^{-1}$. The estimated maximum, average and minimum annual bulk chemical usage is [redacted] tons, [redacted] tons and [redacted]

tons respectively equivalent to a costs of [redacted], [redacted] and [redacted]. Dosing pumps require a turn down ratio of [redacted].

At Gateway 3 (16/11/2018) it was agreed with NWG that a bulk tank of [redacted] m^3 would be provided, this corresponds to approximately [redacted] weeks of chemical storage at average works flow plus 10 days for delivery; this approach was agreed with NWG at Gateway 3 (16/11/2018). The day tank was agreed to have a volume of [redacted] L, providing enough capacity for 24 hours dosing at maximum works flow.

[redacted]

In order to dose the correct amount of HFSA the dosing system needs to be capable of delivering a maximum flow of [redacted] $l.h^{-1}$, an average of [redacted] $l.h^{-1}$ and a minimum of [redacted] $l.h^{-1}$. The estimated maximum, average and minimum annual bulk chemical usage is [redacted] tons, [redacted] tons and [redacted] tons respectively equivalent to costs of [redacted], [redacted] and [redacted]. Dosing pumps will require a turn down ratio of [redacted].

At Gateway 3 (16/11/2018) it was agreed with NWG that two bulk tanks of [redacted] m^3 each ([redacted] m^3 total capacity) would be provided, this will allow the site to receive a full tanker delivery and will provide approximately [redacted] weeks storage at average flow and dose. The day tank was agreed to have a volume of [redacted] L, providing enough capacity for 24 hours dosing at maximum works flow. The bulk tanks will be located within a kiosk – this provides certain advantages over externally located bulk tanks which include: integral bund, no need for heating/lagging on tanks, offsite construction for ease of installation and partial offsite commissioning. There is also significantly less civils enabling works required. Furthermore, the kiosk will reduce visual impacts to the surrounding residents which has been noted as an historical issue by NWG.

A copy of the process calculations is available on SharePoint at the following location:

Fluoride Dosing and Storage Requirements

Process calculations for the fluoride blending downstream of [redacted] GPS were carried out by NWG.

4.2.2.3 pH Correction

In addition to sizing the dosing and storage equipment; high level estimates of the effect that fluoridation would have on the final pH correction systems were carried out. This included a pH model for each of the works from inlet to supply both with and without fluoridation. The increase in caustic dose was used to estimate an increase in each site's consumption and the estimated equivalent cost. Conclusions from the calculations are provided below:

[redacted]

Fluoridation will incur an estimated increased dose of caustic of [redacted] $mg.l^{-1}$. This value should be used with some caution as values used in the water quality model were works average; this includes raw water quality as well as pH targets. The effects of poor raw water quality have not been considered.

[redacted]

Fluoridation will incur an estimated increased dose of caustic of [redacted] $mg.l^{-1}$. This value should be used with some caution as values used in the water quality model are works average; this includes raw water quality as well as pH targets. The effects of poor raw water quality have not been considered.

[redacted]

Fluoridation will incur an estimated increased dose of caustic of [redacted] $mg.l^{-1}$. This value should be used with some caution as values used in the water quality model were works average; this includes raw water quality as well as pH targets. The effects of poor raw water quality have not been considered.

A copy of these calculations is available on SharePoint:

Water Quality Models

4.2.2.4 pH Correction OPEX

Lastly, the OPEX impact of HFSA dosing was taken into consideration, calculations were carried out to estimate the impact on the caustic dosing systems for final pH correction. Bulk cost of sodium hydroxide was provided by NWG (05/11/2018) Conclusions from the calculation is provided below.

[redacted]

In order to correct the pH after disinfection the stream will require an estimated average extra dose of [redacted] $mg.l^{-1}$ this will result in an estimated average increase in the annual consumption of caustic of [redacted] $ton.yr^{-1}$. This mass of caustic will incur an estimated cost of [redacted] or [redacted] Ml^{-1}.

[redacted]

In order to correct the pH after disinfection the stream will require an increased estimated average dose of [redacted] $mg.l^{-1}$ this will result in an increased estimated average annual consumption of caustic of [redacted] $ton.yr^{-1}$. This mass of caustic will incur an estimated cost of [redacted] or [redacted] Ml^{-1}.

[redacted]

In order to correct the pH after disinfection the stream will require an increased estimated average dose of [redacted] $mg.l^{-1}$ this will result in an increased estimated average annual consumption of caustic of [redacted] $ton.yr^{-1}$. This mass of caustic will incur an estimated cost of [redacted] or [redacted] Ml^{-1}.

It is important to remember these values are based on average water quality and average outputs and as such should only be used as a guide.

A copy of these calculations is available on SharePoint:

Caustic OPEX

No calculations have been produced for [redacted] GWS. It is assumed by MMB that the solution proposed in [redacted] report is based on vetted flow calculations.

4.2.2.5 Chemical Sampling

To remain compliant with NWG engineering specifications, dedicated sample lines will be required. For more information refer to Section 4.6.2.

4.2.2.6 Fluorapatite Formation

Historical issues with fluorapatite formation in customers boilers resulting from the onset of fluoride dosing was raised by NWG during a review on 01/03/2019. Background research was conducted by MMB which found a UK Water Industry Research report on the subject. A summary email was sent to NWG, this can be found here:

Fluorapatite Formation Email

NWG opted to internally review the issue with their Water Quality team and would inform MMB of any resulting conclusions.

4.2.2.7 Scope Exemptions

The following have been deemed exempt from the project scope at [redacted], [redacted] and [redacted]:

- Any work related to the provision / installation or repair of water mains or flow meters
- Any work associated with a raw water fluoride analyser
- Task lighting
- Motive water system*
- Installation of a channel or inline static mixer
- Any work associated with other chemical dosing systems
- Any work to install/modify instrumentation outside the scope of this document

*[redacted] not included – see Section 4.6.21) for further details.

The following have been deemed exempt from the project scope at [redacted]:

- Any work associated with chemical dosing systems
- Any work to install/modify instrumentation outside the scope of this document
- Installation of a flow meter or associated chambers/kiosks
- Installation of an inline static mixer
- Installation of fluoride monitoring or sample lines.

4.3 Efficiency Challenge

Potential efficiencies identified or to be further explored at D&C include:

4.3.1 [redacted]

- Separate stone clad effect finish kiosk included for safety shower and eyebath to pre-empt potential planning constraints. Depending on planning/health and safety requirements it may be possible to design out the shower kiosk.
- Stone clad effect finish kiosks have been proposed rather than construction of stone cladding.
- Prices for both flexi and fusion welded type dosing lines included in proposal.
- Optimising ducting routes will minimise costs whilst also minimising disturbance to existing site infrastructure.
- A sample waste route has been identified which utilises existing site infrastructure to dispose of fluoride analyser waste – further work is required to understand its feasibility.
- Duty/standby dosing lines and dosing pumps have been proposed as per Northumbrian and code of Practice requirements. Due to non-process critical nature of fluoride dosing this could be scaled back to duty only, however this will make maintenance of the system difficult and is not desirable from Northumbrian Water's perspective, furthermore this does not protect the security of fluoride supply.
- The existing chemical interceptor tank could be utilised, however NWG have requested that a dedicated chemical interceptor is provided due to the hazardous nature of fluoride as well as

there being a number of existing alkali chemicals which use the existing chemical interceptor tank.

4.3.2 [redacted]

- At this stage CFD modelling has not been carried out to verify the level of chemical mixing achieved. Priced option for a carrier water system has been included to provide additional mixing if required.
- Suitable potable connection sourced such that the carrier water system can be retrofitted if required - saving on additional potable connections which will no longer be required.
- Re-use of existing sample drainage system – saving on additional pipework and pumping requirements.
- Duty/standby dosing lines and dosing pumps have been proposed as per Northumbrian and code of Practice requirements. Due to non-process critical nature of fluoride dosing this could be scaled back to duty only, however this will make maintenance of the system difficult and is not desirable from Northumbrian Water's perspective, furthermore this does not protect the supply of fluoride supply.

4.3.3 [redacted]

- Existing blanked off process connections located in filter gallery could potentially be utilised for fluoride point of application.
- Detailed design required around new fluoride sampling system – may be possible to design out sample kiosk and sample chambers.
- Duty/standby dosing lines and dosing pumps have been proposed as per Northumbrian and code of Practice requirements. Due to non-process critical nature of fluoride dosing this could be scaled back to duty only, however this will make maintenance of the system difficult and is not desirable from Northumbrian Water's perspective, furthermore this does not protect the supply of fluoride supply.

4.4 Risk Review

A non-costed risk register was developed as part of this project; this can be found in Section 5.7.

4.5 Technical Review

A technical review was undertaken by MMB on 22/03/2019. A further project review was undertaken by team leaders and MMB senior management on 02/04/2019.

Overall, both reviews found the proposals for [redacted], [redacted], [redacted] and [redacted] to be satisfactory.

4.6 Preferred Solution

4.6.1 Description of Preferred Solution

4.6.1.1 [redacted]

1) Design and installation of new standalone fluoride dosing kiosk.
   a) [redacted] m^3 bulk storage tank and associated transfer pump
   b) [redacted] L day tank (24 hours storage at maximum works flow)
   c) Duty/standby fluoride dosing pumps and PLC

2) Ducts for fluoride dosing lines through existing treatment building to new fluoride point of application (in vicinity of sulphuric acid dose)
3) Fluoride Point of Application cabinet
4) Delivery point with chemical interceptor tank and interlocking drainage connection
5) Online fluoride monitoring/sampling
6) Safety shower and eyebath
7) Fluoride deliveries to be made via road tanker
8) Kiosk to have stone clad effect finish to match style of existing treatment works

The kiosk will be located against the existing lime building façade. For a detailed description of the preferred solution, refer to Section 4.6.2.

4.6.1.2 [redacted]

1) Design and installation of new standalone fluoride dosing kiosk.
   a) [redacted] m^3 bulk storage tank and associated transfer pump
   b) [redacted] L day tank (24 hours storage at maximum works flow)
   c) Duty/standby fluoride dosing pumps and PLC
2) Ducts for fluoride dosing lines through filter gallery to new fluoride point of application (at Flash Mixer 4)
3) Fluoride Point of Application cabinet
4) Delivery point with chemical interceptor tank and interlocking drainage connection
5) Online fluoride monitoring/sampling including new sample kiosk and chamber
6) Safety shower and eyebath
7) Fluoride deliveries to be made via road tanker

The kiosk will be located along the east side of the western works access road. For a detailed description of the preferred solution, refer to Section 4.6.2.

4.6.1.3 [redacted]

1) Design and installation of new standalone fluoride dosing kiosk.
   a) 2 Nr. [redacted] m^3 bulk storage tank and associated transfer pump
   b) [redacted] L day tank (24 hours storage at maximum works flow)
   c) Duty/standby fluoride dosing pumps and PLC
2) Ducts for fluoride dosing lines through filter gallery to new fluoride point of application (approximate mid-point of filter gallery)
3) Fluoride Point of Application cabinet
4) Delivery point with chemical interceptor tank and interlocking drainage connection
5) Online fluoride monitoring/sampling
6) Safety shower and eyebath
7) Fluoride deliveries to be made via road tanker
8) Option for carrier water to be included

The kiosk will be located along the northern side of the northern works access road opposite the existing RGFs. NWG have requested for an option of carrier water to be included in the event that additional mixing energy is required. There is a relatively speaking, short distance between the POA and the sample point. MMB will investigate this further at Detailed Design. For a detailed description of the preferred solution, refer to Section 4.6.2.

4.6.1.4 [redacted] GWS

1) Design and installation of new pipework.

a) New 315mm Ø HPPE connecting existing 355mm Ø HPPE to existing 315mm Ø HPPE downstream of existing [redacted] ([redacted]).
b) Hot tapping under pressure of existing 315mm and 355mm Ø HPPE pipes.
c) 2Nr gate valves.
d) 2Nr thrust blocks at new tees.
e) 1Nr line stop valve on existing 355mm Ø HPPE pipe.

2) Permanently close valve on existing 355mm Ø HPPE pipe.
3) Construct new thrust block on existing pipework downstream of valve chambers for [redacted] ([redacted]) and [redacted] ([redacted]).
4) Temporary traffic management during installation works.
5) Local demolition, storage and reassembly of boundary wall (subject to permissions).

4.6.2 Basis of Design

A basis of design document was prepared which outlined the preferred solutions as identified up to Gateway 5. The document was reviewed by MMB and NWG (01/03/2019) and was subsequently signed off by both parties following revisions on 03/04/2019.

A signed copy can be found on SharePoint:

Basis of Design

4.6.3 Critical Calculations and Requirements for Completion

For links to the process calculations and basis of design document refer to sections 4.2.2.2 and 4.6.2 respectively.

4.6.4 Acceptance Criteria

The design will strive to comply with the standards as laid out in the DWI Code of Practice on Technical Aspects of Fluoridation of Water Supply 2016. This will be continually monitored through to the Detailed Design phase and as such, an acceptance criteria review cannot be fully held at this stage.

Areas of potential non-compliance which have been identified and agreed by NWG so far are listed below:

4.6.4.1 [redacted]

- Quality of mixing at the proposed POA is not known however, it is assumed to be adequate given the presence of weirs, a long section of channel and a static mixer. The impending commission of the new sulphuric acid dosing system is expected to support/refute this.
- POA is placed downstream of the wash water draw-off connection; this is not currently accounted for in the flow summation programme.

4.6.4.2 [redacted]

- No areas identified to be non-compliant.

4.6.4.3 [redacted]

- Quality of mixing at the POA may prove inadequate; option to include motive water has been included in subcontractor quotes.

4.6.5 Procurement Strategy

MMB have engaged with Sheers (approved framework supplier) to provide design support and cost for provision and installation of the chemical dosing works.

4.6.6 Planning / 3rd Party Consents

Project will be curtailed at gateway 5 while NWG present findings to Public Health England. Public Health England and NWG will then carry out public consultation, project unlikely to enter Design and Construction phase for another 2-3 years.

Gaining planning permission at [redacted] will require more careful consultation with local authority due to the protected status of the surrounding area. This will be carried out by NWG.

The pumping station building at [redacted] holds Grade II listed status. Further works are required to review whether the boundary wall is covered by the listing.

4.6.7 Land Acquisition

All works at the 3 No. WTW are anticipated to take place within NWG owned land, so no additional land is required.

It is anticipated that access to the pipe corridor outside of the boundary wall at [redacted] GPS can be attained.

4.6.8 Delivery Programme

The I&D programme has been uploaded to SharePoint and can be found here:

I&D Programme

4.6.9 Customer / Stakeholder Co-ordination

Project will be curtailed at Gateway 5 while NWG present findings to Public Health England. Public Health England and NWG will then carry out public consultation, project unlikely to enter Design and Construction phase for another 2-3 years.

4.7 Gateway 4: Preferred Solution Validated

4.7.1 Gateway 4 Requirements

The following criteria must be met in order to pass through Gateway 4:

"*The Integrated Delivery Team has challenged the Preferred Solution for technical merit, risk and value and has agreed to proceed with the Preferred Solution through to Definition Phase. Passed Technical Scrutiny and achieved Solution Freeze*".

Gateway 4 Meeting Minutes

5 Gateway 4 – 5: Preferred Solution Definition

5.1 Scope Definition of Preferred Solution

5.1.1 I&D Completion

It has been agreed with NWG that the I&D process for this project will be curtailed at Gateway 5. This is because this project is funded by Public Health England and the scheme may go through a lengthy public consultation period, therefore contract documentation and a fully defined target cost is anticipated to be inaccurate and out dated by the time the project is confirmed. The following outputs were agreed with NWG:

- Submission of an outline D&C programme;
- Provision of a budget cost;
- Provision of an I&D report completed up to GW5;
- Project scope, methodology and outline construction/commissioning procedure and assumptions;
- Outline scheme drawings to provide visual clarity on the above;
- Current site information, and;
- Outline risk register – not costed.

The following would not be provided:

- Completed contract data;
- Costed risk register;
- Target cost, or;
- Finalised PCI.

For conformational correspondence please see the following link:

Durham Project Close Out

5.1.2 Overview

This section will aim to describe in further detail the preferred solutions as defined in Gateways 3-4. Section 5.1 will focus on the fluoridation dosing sites at [redacted], [redacted], and [redacted]. For information regarding the pipework reconfiguration at [redacted] GWS, see Section 5.2.

The scope discussed in Section 4.6 was further developed after Gateway 4 for project define freeze. Individual scoping documents were prepared for all named sites which can be found on SharePoint here:

Scoping Documents

The basis of design can be found here:

Basis of Design

5.1.3 Required Outcomes / Drivers etc

To provide an accepted design that can provide a dose of 1 mg/l fluoride at the point of application.

5.1.4 Access to Site

5.1.4.1 [redacted]

[redacted] Vehicle access to site is restricted per main access gate. The Subcontractors will make their own assessment and allowances for any delivery requirements; inclusive of site visit prior to delivery.

5.1.4.2 [redacted]

[redacted] Vehicle access to site is restricted per main access gate. The Subcontractors will make their own assessment and allowances for any delivery requirements; inclusive of site visit prior to delivery.

5.1.4.3 [redacted]

[redacted] Vehicle access to site is restricted per main access gate. The Subcontractors will make their own assessment and allowances for any delivery requirements; inclusive of site visit prior to delivery.

5.1.5 Temporary Site Compound

5.1.5.1 [redacted]

Provisionally, the area across from Chemical Building B (proposed kiosk location) in the grassed area alongside the existing car park. It is crucial that site traffic and deliveries be given adequate space to move through the construction and site compound area. Due to the nature of the project, work is unlikely to commence on site for a number of years after the close of the I&D phase therefore a temporary site compound will be reviewed at a later date.

5.1.5.2 [redacted]

Provisionally, the area to the north of the main building in front of the existing sludge thickener has been identified as a potential site compound location. Due to the nature of the project, work is unlikely to commence on site for a number of years after the close of the I&D phase therefore a temporary site compound will be reviewed at a later date.

5.1.5.3 [redacted]

Provisionally, the northwest corner of the site along the access drive has been identified as a potential site compound location. Due to the nature of the project, work is unlikely to commence on site for a number of years after the close of the I&D phase therefore a temporary site compound will be reviewed at a later date.

5.1.6 Kiosk Design

The proposed kiosks will follow the general design principles of the fluoride dosing kiosk installed at [redacted] WTW.

5.1.6.1 [redacted]

The fluoride kiosk will be modular two-room GRP design. The tank room will house the bulk storage tank and day tank. The dosing skid, HMI, PLC, lighting, ventilation and other equipment

will be located in the dosing and panel room. A small doored compartment will be recessed into the tank room from the outside to house the fill panel, alarm beacon, flanged connection point and drain valve. The kiosk will be fully bunded and sealed with a chemical resistant coating inside the bund.

A safety shower and eye bath will be housed in a separate GRP kiosk next to the fluoride kiosk.

Stone clad exterior finish will be provided on both kiosks to match the existing site buildings to meet planning requirements.

The kiosks will sit on a common concrete plinth be surrounded by a concrete apron for deliveries.

5.1.6.2 [redacted]

The fluoride kiosk and safety shower and eye bath kiosk will be similar to the kiosks provided at [redacted]. A stone clad exterior finish will not be necessary for the kiosks at [redacted].

5.1.6.3 [redacted]

The fluoride kiosk will be larger than the kiosks at [redacted] and [redacted] in order to accommodate additional storage capacity. As at [redacted] and [redacted], the fluoride kiosk will be modular two-room GRP design. The tank room will house the bulk storage tanks and day tank. The dosing skid, HMI, PLC, lighting, ventilation and other equipment will be located in the dosing and panel room. A small doored compartment will be recessed into the tank room from the outside to house the fill panel, alarm beacon, flanged connection point and drain valve. The kiosk will have an integral bund and sealed with a chemical resistant coating inside the bund.

The fluoride kiosk will sit on a concrete plinth be surrounded by a concrete apron for deliveries.

A safety shower and eye bath will be located next to the fluoride kiosk.

5.1.7 Kiosk Location

5.1.7.1 [redacted]

The kiosk will be located adjacent to the lime building, in front of the decorative louvre. A site plan has been uploaded to SharePoint which can be found here:

[redacted] Site Plans

5.1.7.2 [redacted]

The kiosk will be located against along the western access road to the works, along the east side on the grass verge. A site plan has been uploaded to SharePoint which can be found here:

[redacted] Site Plans

5.1.7.3 [redacted]

The kiosk will be located to the north of the main building along the hillside opposite the existing RGFs. This location was selected due to the ability of the existing hillside and trees to limit visibility of the kiosk to surrounding properties. As such, a short retaining wall may be required around the kiosk, depending on final location. A site plan has been uploaded to SharePoint which can be found here:

[redacted] Site Plans

5.1.8 Chemical Choice

In the ANS, NWG specified the chemical to be used is 20% w/w hexafluorosilicic acid. It is proposed to use bulk deliveries by road tanker, the current (09/02/2018) cost of which is [redacted] per tonne. See link below for correspondence from NWG confirming the cost:

Fluoride Cost Confirmation

5.1.9 Chemical Storage

5.1.9.1 [redacted] & [redacted]

The NWG Treatment Management Guidelines call for sufficient capacity to receive a full tanker delivery, plus 7 days consumption at average flow and dose. Due to the smaller size of [redacted] and [redacted], a full 28 tonne tanker delivery would not be appropriate. Furthermore, MMB understand that the lead time for hexafluorosilicic acid is 10 days and can be higher due to the volatile nature of its supply chain.

Following discussions had during a previous fluoridation scheme it was agreed that MMB would size the bulk tanks on a delivery volume that would provide approx. [redacted] weeks storage capacity with an additional 10 days.

At [redacted] NWG agreed to install a [redacted] m^3 (working volume) bulk storage tank, at [redacted] NWG agreed to install a [redacted] m^3 (working volume) bulk storage tank. Both tanks provide approx. [redacted] weeks storage capacity with an additional 10 days.

5.1.9.2 [redacted]

The capacity called for by the NWG Treatment Management Guidelines was considered more appropriate for a site of [redacted] size, where the maximum DO is up to four times greater than at [redacted] and [redacted]. However, in an effort to keep the tanks housed within a prefabricated kiosk NWG have agreed to install two No. [redacted] m^3 (working volume) bulk storage tanks instead of constructing external tanks; refer to Section 4.2.2.2 for justification. A combined [redacted] m^3 volume will provide the works with approx. [redacted] weeks storage capacity with an additional 10 days.

5.1.10 Site Infrastructure

Refer to Section 5.1.7.

5.1.11 Power Supply

The power supplies for all sites shall be derived from the existing works power distribution network. In all cases a detailed load schedule has not been provided therefore we have assumed the electrical supply to be 2x 440V, 32A, 3ph + N, 1x supply for dosing plant control panel and 1x supply for kiosk services DB. Given that it is anticipated that there will be a 2-3 year consultation period, for the purposes of pricing it is assumed that no further equipment will be installed.

5.1.11.1 [redacted]

A suitable power supply is available at Motor Control Centre (MCC) 4, compartments B2 (100A, 4P MCCB) & B3 (200A, 4P MCCB) are fitted out spares with compartments D3, D4, & G1 unequipped spares. It is estimated that a cable route length of 120m will be sufficient to connect to the existing power distribution system, however this is subject to further investigation during detailed design.

5.1.11.2 [redacted]

A suitable power supply shall be provided from a dedicated feeder for both the Dosing Plant Control Panel and kiosk services Distribution Board (DB), it has been noted that spare capacity exists within the assemblies located in the basement, with numerous compartments available within MCC ‘C’ and ‘D’.

For the purpose of costing the point of supply has been designated as compartment 24 and 25 within MCC ‘D’ which are spare unequipped compartments. It shall be necessary to undertake a Gambica survey on the MCC to establish suitability for modification, the compartments shall then be fitted out to provide a 32A 4P feeders. It is estimated that a cable route length of 210m will be sufficient to connect to the existing power distribution system, however this is subject to further investigation during detailed design.

5.1.11.3 [redacted]

A suitable power supply is available at the Filter Control Panel, compartments A1 & A2 (32A 4P fuse switches), it is estimated that a cable route length of 150m will be sufficient to connect to the existing power distribution system, however this is subject to further investigation during detailed design.

5.1.12 Control and Instrumentation

During a previous fluoride scheme MMB advised progressing chemical control with a flow proportional fluoride dose, trimmed via a dual validated fluoride analyser. NWG stated that in their experience fluoride analysers tend to drift and therefore a trim function was not preferred (despite dual validated monitors detecting this drift). NWG instructed MMB to progress with a flow proportional dose that could be manually trimmed by site operators if required. One analyser would be provided for fluoride monitoring only – this control methodology applies to all named sites.

5.1.12.1 [redacted]

A dedicated sample will be taken downstream of the static mixer, the sample will be pumped up to the analyser away from the confined space. The analyser is to be mounted on a new backboard within the room that houses the static mixer.

5.1.12.2 [redacted]

A dedicated sample will be taken upstream of the contact tank, the sample will be pumped to the analyser. The analyser is to be housed within a new dedicated sample kiosk in an effort to keep the process loop time below 3 minutes. A new sample chamber will be required.

5.1.12.3 [redacted]

A dedicated sample will be taken at the end of the filtered water channel, the sample will be pumped to the analyser. The analyser is to be located on a new backboard as during a site visit it was established with NWG that there is insufficient space remaining on the existing one.

5.1.12.4 [redacted]

It is not proposed to provide a fluoride analyser at [redacted].

5.1.13 Point of Application / Chemical Mixing

5.1.13.1 [redacted]

- The POA will be the filtered water channel downstream of the RGFs; likely downstream of the existing sulfuric acid POA.
- It has been agreed with NWG that turbulence introduced by the RGF outlet weirs, coupled with a long section of channel as well as the existing static mixer should provide ample mixing energy.
- NWG deemed that CFD modelling to determine the extent of mixing was not necessary at this time.

5.1.13.2 [redacted]

- It is proposed to make use of two existing process connections located in the filtered water channel, upstream of Flash Mixer 4.
- It has been agreed with NWG that turbulence present within the filter channel followed by the outlet weir of Flash Mixer 4, coupled with a long section of pipework with bends should provide ample mixing energy.
- NWG have requested that the mixing capability at the proposed POA will be further investigated during detailed design prior to installation.

5.1.13.3 [redacted]

- The POA is to be the filtered water channel downstream of the RGFs.
- It has been agreed with NWG that turbulence introduced by the RGF outlet weirs, coupled with a long section of channel with bends should provide ample mixing energy.
- NWG have requested that the mixing capability at the proposed POA will be further investigated during detailed design prior to installation.

5.1.14 Security Rating

5.1.14.1 [redacted]

All kiosks and covers over externally located fluoride dosing equipment will be [redacted].

5.1.14.2 [redacted]

All kiosks and covers over externally located fluoride dosing equipment will be [redacted].

5.1.14.3 [redacted]

All kiosks and covers over externally located fluoride dosing equipment will be [redacted].

5.1.15 Hard and Soft Landscaping

At [redacted], the preferred location for the kiosk is at the foot of a hillside in order to limit the visual impact to nearby properties. As such, a new retaining wall must be installed to enable excavation at the foot of the slope. It is anticipated that any arisings can be spread on site.

5.1.16 Planning / Land Acquisition

To be reviewed at Detailed Design. As the works are being carried out on behalf of Durham County Council, it is not anticipated that significant constraints will be imposed.

5.1.17 Commissioning Requirements

The kiosk design allows for much of the equipment to undergo some of the commissioning tests before it is brought to site. Once the kiosk and all associated equipment has been installed on site, the subcontractor has allowed for a commissioning engineer to be present for a week.

Requirements for the commissioning process will include slowly ramping up the fluoride dose to prevent risk of over dosing and testing of automatic system shut downs.

5.2 [redacted] GWS

Section 5.2 will focus on the pipework reconfiguration at [redacted] GWS. For information regarding the fluoridation dosing sites at [redacted], [redacted], and [redacted], see Section 5.1.

5.2.1 Define Freeze

It has been agreed with NWG that the I&D process for this project will be curtailed at Gateway 5. For further detail refer to Section 5.1.

5.2.2 Access to Site

[redacted]

5.2.3 Temporary Site Compound

Provisionally, the area to the north of the pumping station building in the grassed flats has been identified as a potential site compound location. Due to the nature of the project, work is unlikely to commence on site for a number of years after the close of the I&D phase therefore a temporary site compound will be reviewed at a later date.

5.2.4 Site Infrastructure

A new pipework connection will be constructed between the existing 355mm Ø pipe from the [redacted] GWS and the existing 315mm Ø pipe downstream of the [redacted] ([redacted]). Under pressure tapping of each pipe will be required, and a new 315mm Ø pipe will be provided to connect the mains including gate valves and thrust restraint. A thrust block will be cast on the existing 315mm Ø pipe to ensure restraint following the FUS.

The existing gate valve at the original connection and mixing point will be permanently closed.

Existing and proposed site plans for the works have been uploaded to SharePoint located here:

[redacted] Drawings

5.2.5 Hard and Soft Landscaping

Reinstatement of grassed areas will be required following the construction of the reconfigured pipework at [redacted] GWS. NWG has advised that the trees belong to the city council and that engagement with the tree officer is required during detailed design to agree mitigation measures and methods to safeguard the trees. Additional pavement replacement may be necessary along [redacted] depending on the size of the excavation required for the installation of a connection to the existing pipe and thrust blocks.

5.2.6 Demolition of Existing Structures

A section of the existing stone wall along the verge on [redacted] will need to be temporarily demolished to allow for construction of the pipe connection. It is not currently known whether the wall falls under the Grade II listing of the pumping station, and therefore, construction constraints are not fully known. The wall will be reconstructed using existing materials as part of the site reinstatement following construction of the pipe connection.

5.2.7 Site Security

All externally located fluoride dosing equipment will be [redacted] rated.

5.3 [redacted] Control Valve

Late into the project additional works were identified at [redacted] as part of [redacted]. MMB advised that if this work was included within the scope of work, completion of the study would be delayed; NWG elected not to add this work to the scope. As such, appraisal of these works has not been carried out as part of this study and instead, a high-level estimate price was developed by NWG. Details of the scope, estimate and potential risks have not been assessed nor appraised by MMB, and as such, the price has not been included within the figures described within this report.

5.4 Define Freeze

A define freeze meeting was held with NWG on the 01/03/2019. A copy of the minutes from the meeting can be found here:

Define Freeze Meeting Minutes

Scoping Documents

5.5 Project Budget Estimate

5.5.1 Delivery Contract Budget Estimate

The budget estimate for [redacted] is [redacted].

The budget estimate for [redacted] is [redacted].

The budget estimate for [redacted] is [redacted].

The budget estimate for [redacted] is [redacted].

Please note that these costs are inclusive of inflation and 10% risk, in addition to subcontractor's risk, which will be reassessed in detailed design.

5.5.2 Operational Expenditure Estimate

MMB completed high level estimates of the potential OPEX incurred by fluoride dosing, the conclusions of the calculations can be found in Section 4.2.2. A summary of the calculations is given within each sub section below. Note that these calculations assume a background fluoride concentration of 0 mg/l so actual usage may be slightly lower. Also note that operational and maintenance costs have been based on NWG historical forecasts.

5.5.2.1 Fluoride Dosing Cost

A summary of the cost associated with the estimated usage of HFSA at the three named sites can be seen below in Table 3.

Table 3 Estimated Fluoride Usage

		Maximum	Average
[redacted]			
Fluoride usage	ton.yr^{-1}	[redacted]	[redacted]
Cost	£.yr^{-1}	[redacted]	[redacted]
[redacted]			
Fluoride usage	ton.yr^{-1}	[redacted]	[redacted]
Cost	£.yr^{-1}	[redacted]	[redacted]
[redacted]			
Fluoride usage	ton.yr^{-1}	[redacted]	[redacted]
Cost	£.yr^{-1}	[redacted]	[redacted]

Source: MMB Process Calculations

Cost of HFSA is based on bulk deliveries to site by road tanker.

5.5.2.2 Additional Caustic Dosing Cost

HFSA is acidic and will therefore depress the pH of the receiving water, an increase in the alkali dose is required before the water enters supply if the site is to achieve its pH target. As the cost associated with this is a direct result of the fluoride dose, it is recoverable by NWG from PHE. Both MMB and NWG have conducted a high-level assessment on the amount of additional alkali required and the associated cost (caustic is used at all named sites).

The NWG assessment found that the additional cost to fluoridate any water supply by 1.0 mg/l is approximately [redacted]/ML. This assumed bulk deliveries of caustic at 47% strength.

The MMB assessment found that the additional cost is approximately [redacted]/Ml at both [redacted] and [redacted], whereas the additional cost is approximately [redacted]/Ml at [redacted]. This assumed bulk caustic deliveries of 47% strength at all named sites. This corresponds to the figures presented in Table 4. It should be noted that the NWG assessment utilised historical data as well as theoretical, whereas the MMB assessment was purely theoretical.

Table 4 Additional Caustic Dose Requirement

		Maximum	Average
[redacted]			
Flow	Ml.d^{-1}	[redacted]	[redacted]
Estimated extra annual caustic requirement (47% strength)	ton.yr^{-1}	[redacted]	[redacted]
Estimated extra annual caustic cost	£.yr^{-1}	[redacted]	[redacted]
[redacted]			
Flow	Ml.d^{-1}	[redacted]	[redacted]
Estimated extra annual caustic requirement (47% strength)	ton.yr^{-1}	[redacted]	[redacted]
Estimated extra annual caustic cost	£.yr^{-1}	[redacted]	[redacted]
[redacted]			
Flow	Ml.d^{-1}	[redacted]	[redacted]

		Maximum	Average
Estimated extra annual caustic requirement (47% strength)	ton.yr^{-1}	[redacted]	[redacted]
Estimated extra annual caustic cost	£.yr^{-1}	[redacted]	[redacted]

Source: MMB Process Calculations

5.5.2.3 Operation and Maintenance Cost

Although the total OPEX cost of the proposed fluoridation solutions will be largely dictated by the quantity of HFSA and caustic dosed, there will also be other costs associated with operation and maintenance. NWG provided historical and forecasted OPEX data for existing fluoride dosing systems within their distribution network, a link for which can be found below. This data included information on: man-hours spent operating and maintaining, materials, electricity, sampling as well as 'on cost'. The on cost is taken as 20% of the materials, electricity and sampling costs. Breakdown and a total of all OPEX costs associated with the proposed fluoride dosing systems at all named sites can be found below in Table 5.

Table 5 OPEX Breakdown

	Budget/site
Staff Costs	£.yr^{-1}
Operational labour & maintenance	[redacted]
Sampling	[redacted]
Running Costs	
Materials (small allowance)	[redacted]
Electricity	[redacted]
On cost – sampling, materials and electricity (20%)	[redacted]

[redacted]	Maximum	Average
	£.yr^{-1}	£.yr^{-1}
HFSA annual usage	[redacted]	[redacted]
Caustic annual usage	[redacted]	[redacted]
Total OPEX	[redacted]	[redacted]
[redacted]		
HFSA annual usage	[redacted]	[redacted]
Caustic annual usage	[redacted]	[redacted]
Total OPEX	[redacted]	[redacted]
[redacted]		
HFSA annual usage	[redacted]	[redacted]
Caustic annual usage	[redacted]	[redacted]
Total OPEX	[redacted]	[redacted]

Source: NWG & MMB Process Calculations

5.6 Project Programme

MMB have produced a programme for the D&C phase of works. This can be found at the following link:

D&C Programme

5.7 Risks and Constraints

NWG asked MMB to produce a non-costed risk register. This can be found at the following link:

Risk Register

5.8 Contract Data Part 1 and Employer's Works Information

N/A – see Section 5.1.1 for more information.

5.9 Gateway 5: Preferred Solution Validated

5.9.1 Gateway 5 Requirements

Refer to Section 5.1.1.