Appendix 11l:

Kelda Knostrop Tarmac FE Pipeline

YorkshireWater

Kelda Group Ltd

Tarmac – FE Supply Pipeline

Outline Feasibility Assessment

253033-00/ARP/XXX/EXG/RP/Z/00/00001

A 06/01/2017

Job number 253033-00

Ove Arup & Partners Ltd
Admiral House Rose Wharf
78 East Street
Leeds LS9 8EE
United Kingdom
www.arup.com

ARUP

Contents

Appendices

Appendix A
Tarmac Site Details

Appendix B
Existing Washwater/FE Infrastructure

Appendix C
Sketches

Appendix D
Indicative Pumping Station Layout

Appendix E
UCD Costings

Executive Summary

Arup have been instructed by Kelda Group Ltd to carry out an outline feasibility investigation into the installation of a Final Effluent (FE) supply from the Knostrop Waste water Treatment Works (WwTW) to the nearby Tarmac works.

Two options have been considered for the potential provision of Final Effluent to the Tarmac site.

Option 1 takes an FE supply from the Treated Water Storage tank within the incinerator complex.

Option 2 takes an FE supply from the now redundant BAFF plant.

Due to the reduced pumping requirements and shorter pipe length, Option 1 has a considerably lower CAPEX than Option 2 in the order of £154,000. However, Option 2 is not dependent on the Treated Water Storage tank, which is operated by the incinerator. It is expected that the incinerator will be decommissioned once the Energy and Recycling scheme is complete.

The desktop exercise undertaken shows that both options appear to be technically feasible. There are some significant space constraints present for both options especially Option 1 which could impact upon the project. These would need to be considered further in the detailed design phase.

1 Introduction

Arup have been instructed by Kelda Group Ltd to carry out an outline feasibility investigation into the installation of a Final Effluent (FE) supply from the Knostrop Waste water Treatment Works (WwTW) to the nearby Tarmac works.

This report will provide the following:

- Identification of an appropriate FE source
- An outline design for a pipeline from the Knostop site to the Tarmac site and pumping station
- Technical input to allow Kelda/YWS to complete the Unit Cost Database (UCD) costing
- Estimated Opex budget

The Tarmac Ltd facility uses up to 30,000 m^3 of potable water per annum. This water is mainly used for the mixing of cement and washing purposes and does not necessarily need to be of potable quality. There is a potential synergy between Kelda/YWS and Tarmac by using FE from the Knostrop WwTW instead of potable water. This will reduce demand for potable water on the YWS water distribution network, increasing supply resilience.

A large proportion of the potable water demand at the Tarmac Ltd site is for use in making batched mortar, special mixes of concrete and for washing down cement vehicles. For standard concrete, the Tarmac Ltd plant uses recycled wash down water. For cement mortars and special concrete mixes, potable water is used to maintain colour consistency in the product. Tarmac Ltd are currently assessing the quality of FE for these purposes. Initial assessments suggest that FE may be appropriate for producing cement.

On previous Arup Projects that have re-used sewage derived water, the American EPA guidelines for water reuse (EPA/625/R-04/108) have been used to identify common water quality requirements. The EPA guidelines discuss the various applications for water reuse and the methods of treatment that are appropriate for these applications. These guidelines and examples have been the basis of the recommendations within this report.

2 Assumptions

This assessment is based on the following assumptions:

- It is possible to route the proposed pipework around existing services. No obvious issues have been identified during the desk study. However, a risk of encountering unidentified underground service remains.
- The project will not be required to tie in with the YWS/Black and Veatch "Energy and Recycling" scheme that is currently taking place at the High Level Works.
- Anecdotal information from site Operators is correct.
- The area on the Low Level (LL) works is able to accept the required infrastructure for pumping/filtering FE for Option 1 (described in the following section).
- Significant changes are not required to be made to the Biological Aerated Flooded Filter (BAFF) that would negatively impact Option 2 (described in the following section).
- The FE is suitable for the use by Tarmac Ltd. It is understood that samples have been provided to Tarmac by YWS.
- Electrical connections are available and there is sufficient capacity.
- Access to the Tarmac site for pipework installation is possible.
- The supply pipework will be installed below ground where possible.
- UV or other treatment is required to ensure that there are no live pathogens within the FE.
- An FE supply of 10 l/s would be sufficient to meet the expected demands for the Tarmac site.

3 The Tarmac Site

The Tarmac site is a large user of potable water, using approximately 30,000 m^3 of potable water per annum. The Concrete plant is one of the higher users of potable water on the Tarmac site, followed by the Mortar plant and the Recycling plant.

It is expected that FE can be used for washing, dust suppression, making concrete and potentially making mortar, depending on the quality of the FE. This will reduce the potable water demand for the site.

In 2015, the potable water demand for the Tarmac site was 27,556m m^3. However, the recycled water system was not in use (see Appendix A).

The concrete and mortar plants have their own water storage tanks. It is envisaged that the FE will be supplied to these tanks.

4 Technical Considerations

The main technical considerations are:

- Sufficient volumes
- Water quality requirements
- Water transfer – pumping
- Water treatment

It has been assumed that the existing potable water supply can be used as a backup water supply to the Tarmac site.

4.1 Water Supplies

Two potential locations have been identified for the FE water supply:

Option 1 – Treated Water Storage tank in the incinerator compound

Option 2 – Final Effluent supply: taken from the redundant BAFF plant.

These are described and considered in section 5.

4.2 Water Quality Requirements

The water used for the production of concrete is required to be compliant with BS EN 2008:2002. It is understood that Tarmac Ltd have performed an analysis on FE produced by the Knostrop WwTW and this FE has been identified as being suitable for some specific Tarmac products.

This analysis has initially suggested that FE would be appropriate for use. The next step has been identified as using FE to make some concrete and testing the properties of the concrete. Arup are not aware of the outcome of this testing. It is recommended these tests are completed at the earliest possible time to ensure that any treatment required is identified soon and incorporated into the design.

The use of FE to replace potable water will require some changes in how water is handled at the Tarmac plant. The following items will need to be considered by Tarmac:

- In order for FE to be safely used offsite, it needs to be treated to reduce the presence of pathogens. Two possible methods of ensuring that pathogens are destroyed is by UV treatment or chlorination. There is a small, but present risk from pathogens present in the FE which could lead to an unacceptable risk to Tarmac operators if ingested.
- Anywhere where potable water may be used in conjunction with the FE at the Tarmac site, the connection must comply with the Water Supply Regulations 1999 and a suitable air gap installed on the potable water pipework. This is for the prevention of cross-connection to the potable system.

  This is a key consideration at the Tarmac water make up tanks, where potable water would be required in the event of a FE supply failure.
- Adequate safeguards will be required to ensure that the FE cannot be used in any applications other than those for which it has been specifically tested and approved.
- Colour coded pipework in order to prevent cross-connection between the FE supply pipeline and potable water supplies. The FE pipeline will require colour coding and clearly labelling. Underground, the pipework should be colour coded in black. Above ground, the pipework shall be colour coded with green, black, green markings when above ground and black below ground in line with WRAS guidelines[1].
- Bespoke pipework fittings on the FE supplies to prevent plant items from being cross-connected with the potable water supply.
- Kelda Group Ltd and Tarmac will need to agree the water quality requirements for the FE supply, along with an acceptable level of supply availability. Kelda Group Ltd and Tarmac will also have to negotiate which party is responsible for the monitoring of the FE quality.

4.3 Pumps

A Hydrovar® type variable speed booster pumping station is recommended as the most suitable method of supplying the FE to the Tarmac site. This is widely recognised as the most suitable method of providing pressurised washwater on YW sites. This variable speed pumping arrangement has the ability to accurately regulate pressure, reducing pressure fluctuations that lead to pipe bursts, while responding automatically to demand changes.

---

1 https://www.wras.co.uk/downloads/public_area/publications/general/water__and__wastewater.pdf

Figure 1 shows an indicative layout for a booster pumping station of the scale required for this installation.

The pumping station is likely to be configured to operate in a Duty/Assist/Standby configuration, with pressure controlled Variable Speed Drives, and an accumulator to manage pressure variations and limit pump start/stops.

The pumps and associated control panel will be located within a kiosk.

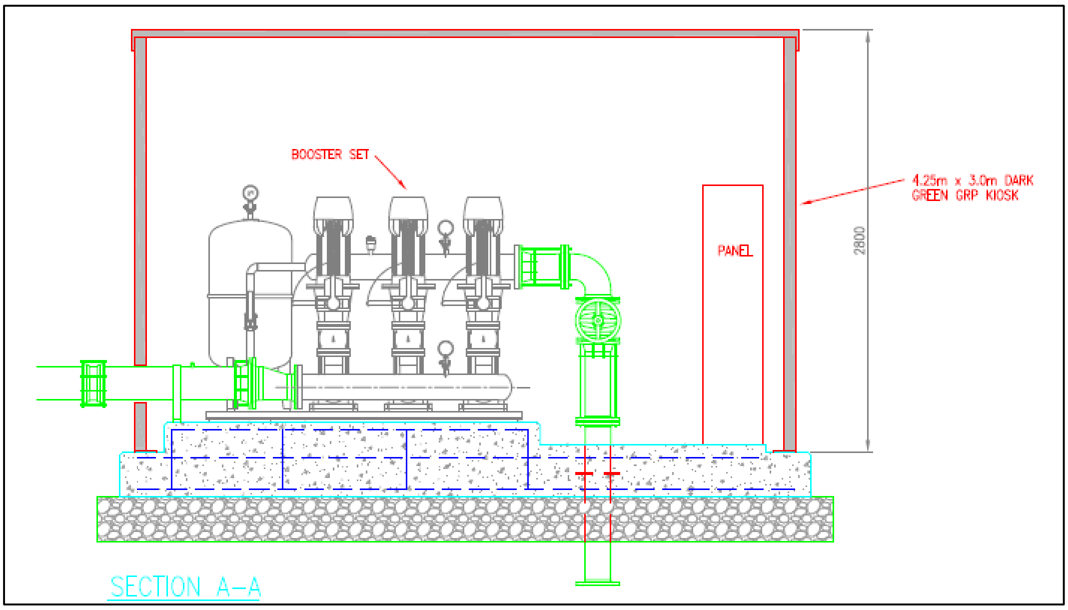


Figure 1 – An indicative layout of a FE booster pumping station.

4.4 Water Treatment

4.4.1 Pathogen Reduction

To ensure that the FE is safe for use at the Tarmac facility, additional treatment is required. The main options considered are chemical and UV treatment.

UV treatment is the suggested treatment method of FE as it does not require hazardous Chlorine gas or Sodium Hypochlorite to be stored and handled. UV treatment is also expected to have a lower OPEX cost as chemicals are not consumed. However, UV treatment does require ongoing maintenance including cleaning and replacement of the UV lamps.

UV also requires low levels of turbidity and a reduction in particulate matter for the light to penetrate through the water and reach the pathogens therefore pre-treatment will be required.

4.4.2 Filtration

In order to improve the water quality prior to UV treatment, the FE will require filtration. The Treated Water Storage Tank currently has a 500 µm Bollfilter®

installed on the intake. If Option 1 was selected, Additional filtration would be required downstream of the Treated Water Storage Tank.

In order to remove the required proportion of the suspended solids to increase the effectiveness of UV treatment. It is recommended that the FE is filtered to 50 µm prior to UV treatment. This is in line with the Esholt WwTW Thermal Hydrolysis scheme. The final requirements for filtration would need to be agreed with the UV equipment supplier and Tarmac to suit their requirements. Filtration will capture loose flocs from settlement tanks. However, the impact of 50 µm filtration on turbidity will be minimal.

For this proposal it has been chosen to pre-filter the FE to 200 µm then to 50 µm, to prevent the blinding of the 50 µm filters. A duty/standby arrangement of each filter has been selected. Figure 2 shows an existing installation of filtration and UV treatment, on this site the equipment may be configured differently however the component parts are likely to be similar.

The existing potable water supply could potentially be used as a standby supply to the Tarmac site. The use of potable water as a standby could allow for the removal of the standby filtration and sterilisation plant reducing the capital costs of the options.

4.4.3 Tank Cleaning

Despite the treatment processes, a higher Biological Oxygen Demand (organic Carbon) content will remain within the FE compared to potable water. UV treatment will destroy the majority of pathogens, however some microbes may still be present in treated water. This may lead to the accumulation of solids in tanks caused by the microbes feeding on the residual BOD and multiplying.

There may be a requirement to periodically empty tanks to rectify these fouling issues. However, with regular water use and replacement, fouling is not expected to be a significant issue.

4.5 Pipework

For above ground pipework, Ductile Iron pipework has been selected. For below ground pipework, HDPE pipework has been selected.

A pipe diameter of 150mm has been selected.

During an initial pumping calculation, a diameter of 100mm, was found to have unacceptable head losses, and would have led to higher energy costs associated with pumping than using the larger main in the order of £2,000 per annum.

For option 1, a pipebridge has been allowed for, to cross two site roads. The incinerator complex has a high volume of traffic and is a very congested area of the site. Pipebridges are therefore recommended as this would cause less disruption, compared to excavating to install buried pipework.

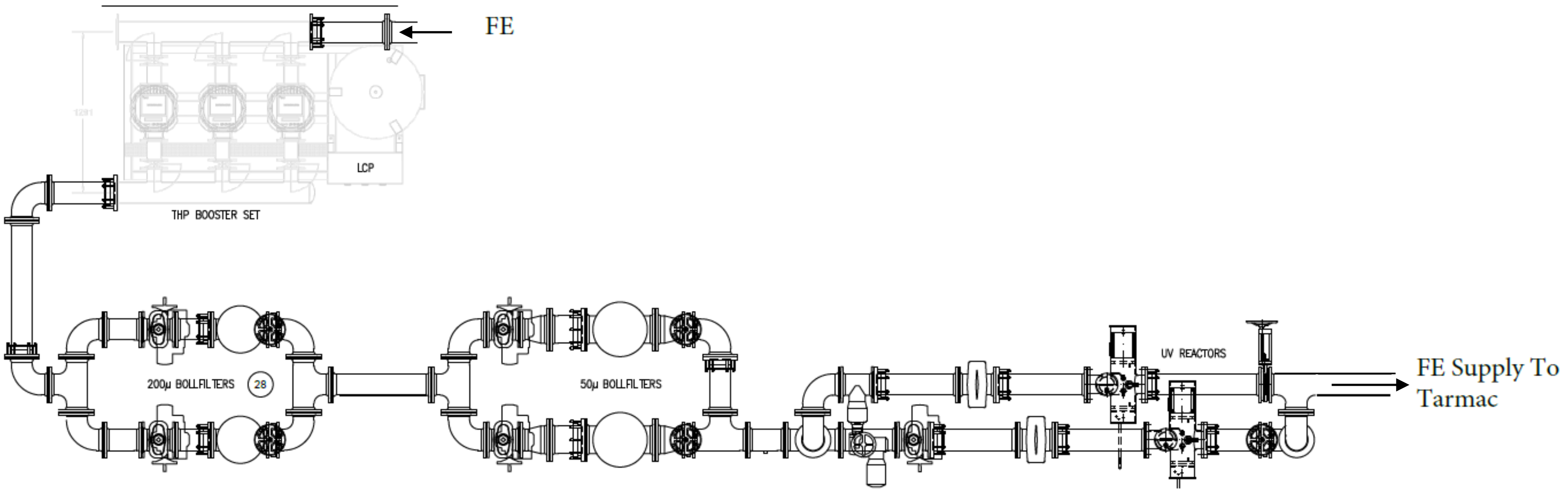


Figure 2 - Example filtration and UV treatment pipework (adapted from Esholt WwTW).

5 Outline Design – Potential Options

The supply adjacent to the BAFF plant is understood to have high quality FE with a turbidity level of 3-11 NTU depending on conditions.

Two potential sources of FE have been identified as options to provide FE to the Tarmac site as detailed below. The possible solutions for both these locations are described in the following section.

The basic principle for the FE supply system will be as follows:

- 3 No D/A/S Hydrovar® type pumps with receiver and MCC installed inside a kiosk
- Associated non-return and isolation valves
- Bollfilter ® type filtration (mounted outside) with backwashing flows routed to local drainage
- UV treatment plant installed inside a separate kiosk
- Pipework, both above and below ground
- Washout chamber at low point

Metering has been excluded from the design as it has been assumed that the metering would be installed on the Tarmac site.

5.1 Option 1

A potential source of FE is from the Existing Treated Water Storage Tank, Located on the Low Level Works. This tank holds and provides FE to be used as washwater for the incinerator plant.

This tank is fed from a tie-in to the BAFF plant feed pumps (see Figure 3).

Figure 3 - Tie-in feeding the incinerator compound Treated Water Storage Tank.

Figure 4 - The Treated Water Storage (FE) Tank installed near the incinerator

The water entering the Treated Water Storage Tank is filtered to 500 µm through a Bollfilter® installed adjacent to the tank.

There is an existing tank near to the incinerator that is fed by the BAFF plant feed pumps via an existing 400mm pipe.

Conversations with YWS incinerator operations have revealed that when the BAFF plant feed pumps are pumping water to the treated water storage tank, the tank overflows. This suggests that there is sufficient additional supply in this area.

The Incinerator treated water storage tank is also filtered to 500 µm. This would help in the finer filtration to 50 µm.

Option 1 will require a supply pipeline of approximately 750m in length. 500m of this pipeline will be above ground following the existing fence line/roads. The pipe will then be buried as it travels along Knowsthorpe lane, before entering into the Tarmac site.

Advantages:

- Shorter pipework route compared to Option 2.
- It is understood that the tank overflows regularly due to the high flows form the BAFF plant pumping station. This suggests that there may be sufficient supply available to supply the Tarmac Ltd site.

Disadvantages

- Congested area of the site.
- May pose a risk to the operation of the incinerator, by competing for FE from the treated water storage tank, in the event of low flows to the tank. The tank is currently fed by a tie-in to the BAFF plant feed pumps. These pumps are capable of passing considerable flows (in the order of 200 l/s).
- There is limited space for installing another filter, UV sterilisation and pump booster set (approximate footprint of 20 m^2).
- May require above ground pipework, which is costly and can be difficult/ disruptive to install on a congested site.
- A risk to the viability to Option 1 has been identified. Early design proposals from the Energy and Recycling scheme suggest that the BAFF feed pumping station will be reconfigured during the scheme. With two existing pumps being used to feed the treated water storage tank and two new pumps being used to feed a new final effluent tank (Washwater feed tank). Any changes to the pumping arrangement to the treated water storage tank may impact on this option. The proposal as it currently stands is expected to be able to provide sufficient FE to the incinerator and tarmac via the treated water storage tank.

Figure 5 indicates where it may be possible to locate the kiosks and pipework. The area is extremely congested and space may be difficult to obtain. The area appears to be suitable however, further investigation of the area would be required.

An alternative route that travels around the south of the site was considered. Due to the FCC environment site, the pipe length would be similar to the proposed route of Option 1.

Figure 6 shows the proposed pipework layout marked in magenta (A larger version is available in Appendix C1).

Figure 5 - Indicative layout of the pipework and kiosks for Option 1 (shown in proportion to existing infrastructure)

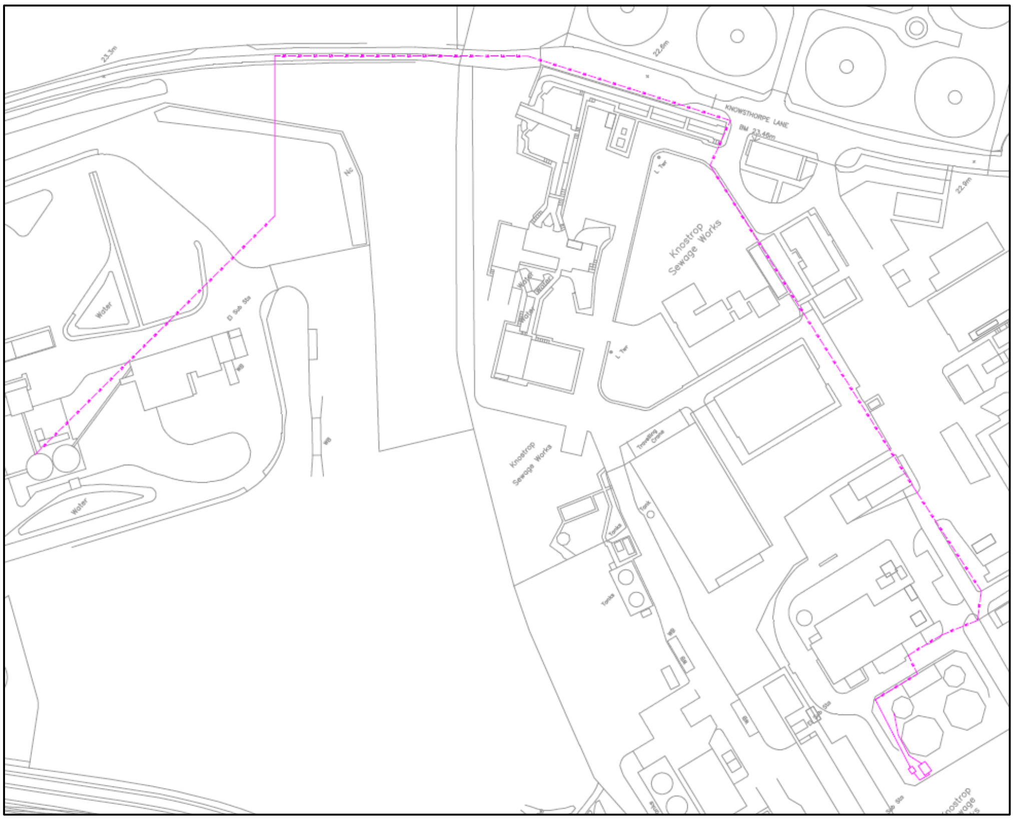


Figure 6 – Indicative pipework layout for Option 1

There are concerns that the Treated Water Storage tank may become redundant once the incinerator is decommissioned.

5.2 Option 2

An alternative source of FE could be a new pumping station adjacent to the BAFF plant.

The BAFF plant itself is redundant and does not form a part of the treatment process, it does however still receive and store FE which could be used for this purpose. It is proposed to extract FE form the BAFF Plant by using the same methodology as the High Level (HL) works fine screen washwater pumping station.

Figure 7 - The now redundant BAFF plant, showing HL works washwater pumping station (photo courtesy of B&V).

The BAFF feed pumping station receives FE from the HL works. The FE is understood to be of high quality, only experiencing significant turbidity in storm conditions.

Option 2 will use a similar configuration to the existing HL works fine screen washwater pumping station, with the addition of a Bollfilter® and UV treatment.

There are a number of FE pumping installations in the vicinity of the BAFF plant. This may lead to this area of site becoming congested and competing demands must be assessed to ensure one systems does not starve another of supply. It is anticipated that there are no insurmountable obstacles to installing the pipework

Adjacent to the BAFF plant there is an existing washwater pumping station. The pumping station is of a similar scale to the pumping requirements for providing FE to the Tarmac plant.

Option 2 will require a supply pipeline of approximately 1550m in length. 50m of this pipeline will be above ground. The pipe will be buried and will travel along the site road and out to Knowsthope lane before entering into the Tarmac plant.

Advantages

- There is less risk of impacting on other site operations, sourcing FE directly from the HL WwTW.
- There is more available space to install the required plant.
- There is a lower risk of conflict with the Knostrop Energy and Recycling Scheme.

Disadvantages

- Long pipework length
- There are a number of FE assets in this area, and there may be competition for FE/electrical connections.

Figure 8 indicates where it may be possible to locate the kiosks and pipework. A detailed investigation of the area would be required to ensure that there are no constraints.

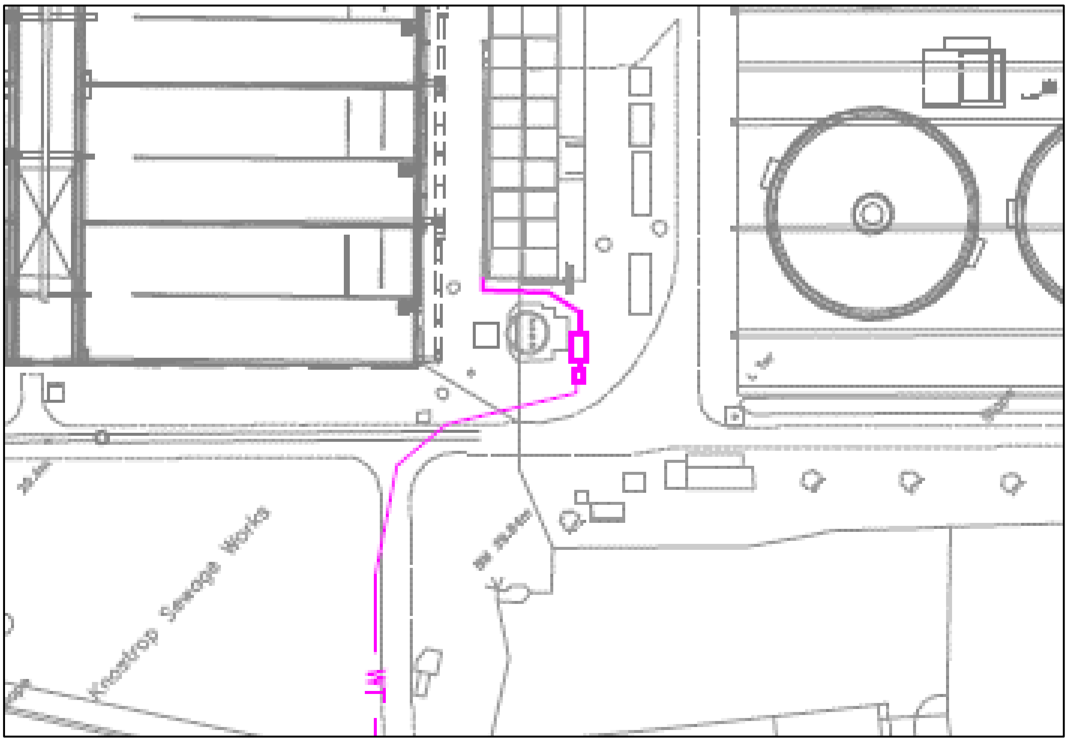


Figure 8 - Indicative layout of the pipework and kiosks for Option 2 (shown in proportion to existing infrastructure)

Figure 9 shows the proposed pipework layout drawn in magenta (A larger version is available in Appendix C2).

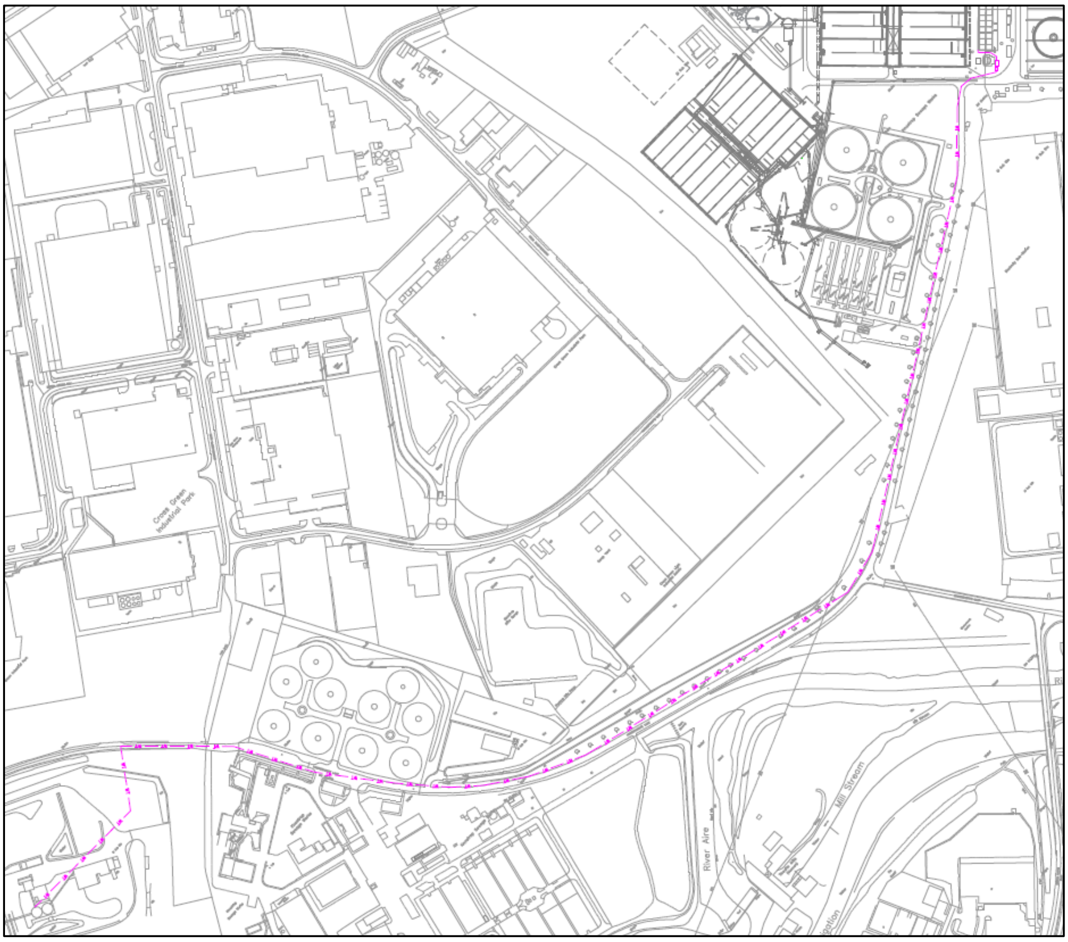


Figure 9 - Indicative pipework layout for Option 2

5.3 Interfaces with the Energy and Recycling Scheme

YWS/Black and Veatch are currently engaged in the "Energy and Recycling" scheme to install an anaerobic digestion plant at the Knostrop WwTW. The anaerobic digestion plant will require the provision of washwater. The Black & Veatch team has been approached to see how they are looking to provide FE to their scheme.

It has been acknowledged that a new FE system will be required for this scheme.

There is an appetite to upgrade the pumps adjacent to the BAFF plant to variable speed pumps and to make the FE tank near to the incinerator redundant.

A conversation with the incinerator team has suggested that there are redundant tanks in the LL works that were used for the aerobic treatment of dirty liquor. These tanks may be appropriate for re-use for this scheme, in the event that the treated water storage tank were to be decommissioned with the incinerator. The status and integrity of these tanks is currently unknown, and these tanks have not been assessed further at this time.

Coordination with the ongoing scheme may provide benefits if a combined design can be accommodated. This is especially relevant to the LL inlet works. The LL inlet works currently uses settled sewage water as washwater. FE is widely recognised as being more suitable for use as washwater.

The Energy and Recycling scheme is also looking at increasing FE supplies to its own plant. It is likely that the same area as Option 2 will be used for this supply. There may be an option to combine assets with this scheme, reducing capital outlay.

6 Electrical Supply

6.1.1 Option 1

Located just outside the incinerator compound is the incinerator plant substation, there is a kiosk that houses the Ancillary Works Transformer which has an LV feeder pillar with spare ways which may be suitable for proving a fed to a 2 pump panel located adjacent to the FE tank. There appear to be ducts running in the correct direction however this area has previously been flooded and the condition of the ducts are unknown at this time.

An alternative supply could be obtained from the "Waste Incineration Directive Knostrop WwTW S.E.T. Plant MCC" as this contains an un-equipped spare compartment. Both options also have Distribution Boards with spare ways, although it is not good practise to mix process equipment (pumps) with building service due to possible interference.

It is known that the incinerator is due to be decommissioned once the Energy and recycling scheme is completed. We have therefore excluded taking a supply from within the incinerator building. The pumps are anticipated to be small (around 15 kW, Duty/Assist/Standby) and it has therefore been assumed that there is sufficient capacity within the electrical network due to the relative small increase in load.

A small three pump panel shall be located adjacent to the FE tank (location to be shown on a plan). The delivery of this scheme would need to consider if this would be added to YWS SCADA and Telemetry. As the FE tank is an existing asset shown on SCADA it is recommended that any new arrangements would need to be shown, allowing YWS Operations staff visibility of the process. Again YWS frameworks, Engineering Specifications and Assets standards should be followed. An alternative to this would be to locate the equipment within an enclosure that clearly demarks the equipment as "Not to YWS Specification".

6.1.2 Option 2

There is an FE pumping station kiosk near to the BAFF plant that has limited wall space for new pump starters for 3 No.15 kW. It is possible to provide a 3ph power supply from the BAFF MCC kiosk as there is a Process Distribution Board with spare ways to power the new pumps.

There are 3 No. wash water pumps and also 2 No. starters for the FE to the BAFF pumps (to allow FE to be pumped to the LL works) located within the kiosk.

7 Value Added Options

In addition to providing FE to the Tarmac site, there are also a number of potential options to consider that may add value to this scheme. The value added options apply to Option 1and Option 2. These include:

- Provision of FE to the LL inlet works instead of potable water.
- Provision of FE to the FCC Environment plant.

If option 2 was considered favourable, there may be a value added option to provide FE to the intake screens on the Low Level works. These screens currently use potable water as washwater. This would lead to further reduction in potable water demand which we understand is a key driver for this scheme. The pumps, pipework and screens used on Option 2 can be sized to accommodate these value added options. Option 1 is more dependent on the FE supply to the Treated Water Storage Tank.

The adjacent FCC Environment facility is also a large user of potable water. There may be additional potential benefit by providing them with FE as the processes are less likely to be affected by water quality issues such as turbidity. This is because FE could be used for residue washing, creating lime slurry, tank washing and general washing duties. These duties are not as sensitive to water quality as the production of mortar. FCC Environment also predict an increase in water demand in the future.

If there is an appetite to supply further FE to either the LL Inlet Works or the FCC Environment, the suggested options may be able to handle the additional demand with minor pumping upgrades, and additional connections.

8 Costing

8.1 CAPEX

The cost for the provision of FE to the Tarmac Ltd plant has been completed using the YWS Unit Cost Database (UCD) by YWS costing department.

Option	Total CAPEX Cost
Option 1 – Duty/Standby Filters and Screens	£782,700
Option 1 – Duty only Filters and Screens	£705,100
Option 2 – Duty/Standby Filters and Screens	£936,700
Option 2 – Duty only Filters and Screens	£859,000

The UCD cost calculations can be found in Appendix E and includes the YWS on costs.

8.2 OPEX

The OPEX has been calculated using the YWS OPEX calculator, based on the UCD costs by YWS costing department.

Separate OPEX calculations have been carried out for the options with a Duty/Standby filtration and UV treatment and with Duty only filtration and UV treatment.

Option	Annual OPEX Cost
Option 1– Duty/Standby Filters and Screens	£14,884.16
Option 1 – Duty only Filters and Screens	£12,731.72
Option 2 – Duty/Standby Filters and Screens	£19,292.19
Option 2 – Duty only Filters and Screens	£17,139.75

The OPEX calculations can be found in Appendix E and includes the YWS on costs.

8.3 Discussion

Due to the considerably shorter length of smaller diameter pipework, Option 1 is the lowest cost option by £154,000. Option 1 also has a lower OPEX cost due to lower powered pumps being required to pump the FE to the Tarmac site.

9 Summary

Other areas of the UK are beginning to experience water scarcity, especially during the summer months. Water re-use for commercial customers like this can help to reduce potable water demand. Especially in applications where potable quality water is not required.

This scheme has the potential to demonstrate this technology and acting as a learning exercise for developing future water re-use projects, as well as reducing potable water demand.

Due to Tarmac's relatively low demand rate of 10l/s, the supply of FE appears to be technically viable. The Knostrop WwTW is expected to have the ability so supply sufficient quantities of FE without any operational issues.

However, the reduction in raw water abstraction is likely to have a positive impact on YW potable water supply resilience.

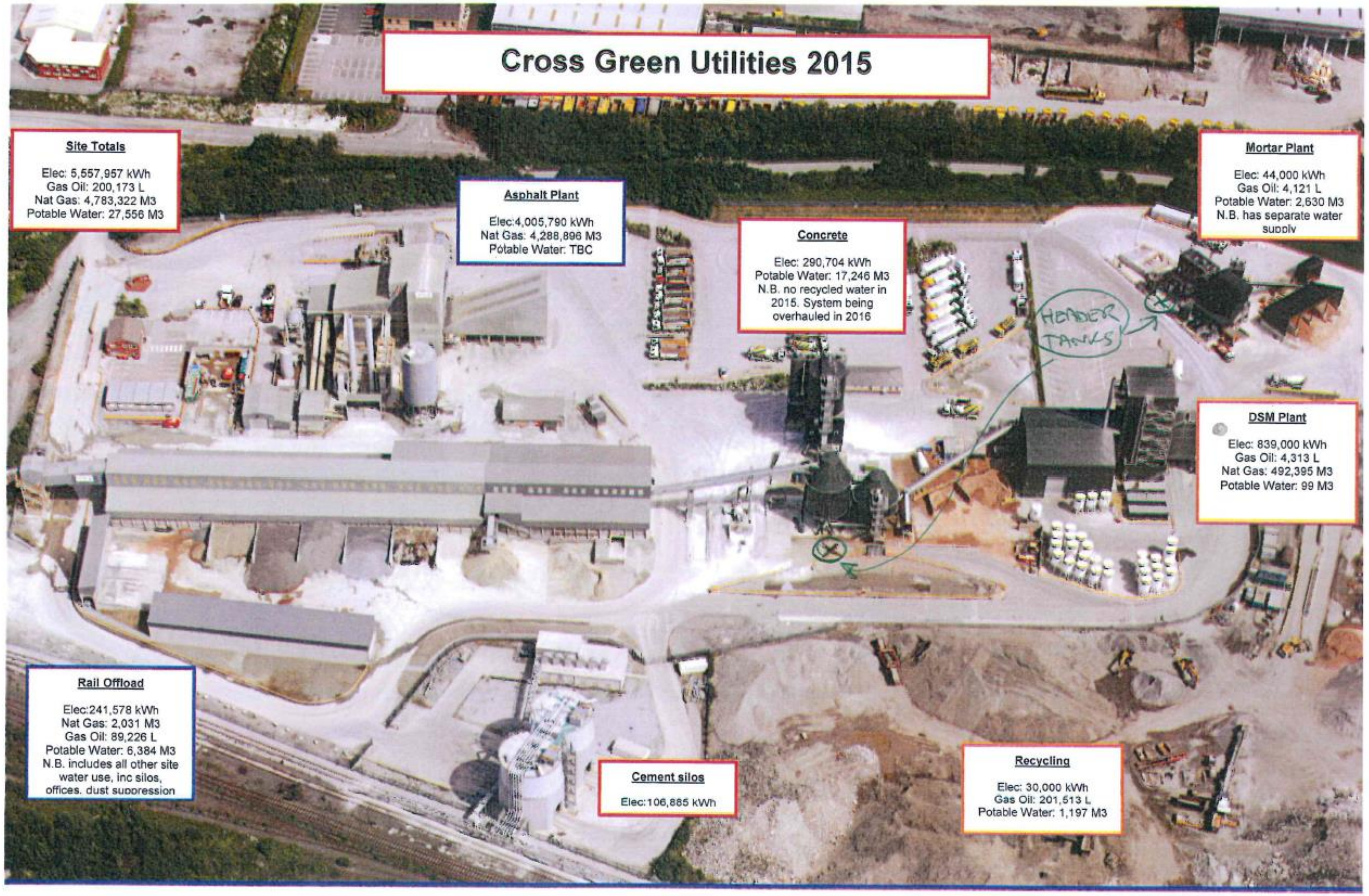
There are also likely to be environmental benefits associated with lower CO_2 emissions associated with the abstraction, treatment and pumping of potable water.

Due to the shorter length of smaller diameter pipework and lower powered pumps Option required, 1 has a significantly lower OPEX and CAPEX cost than option 2. However, Option 2 has the potential to be a more robust solution as it is not dependent on other parties such as the incinerator for its FE supply.

Options 1 and 2 appear to be technically feasible. Option 1 has a risk that the future decommissioning of the incinerator may cause future problems.

Appendix A

Tarmac Site Details

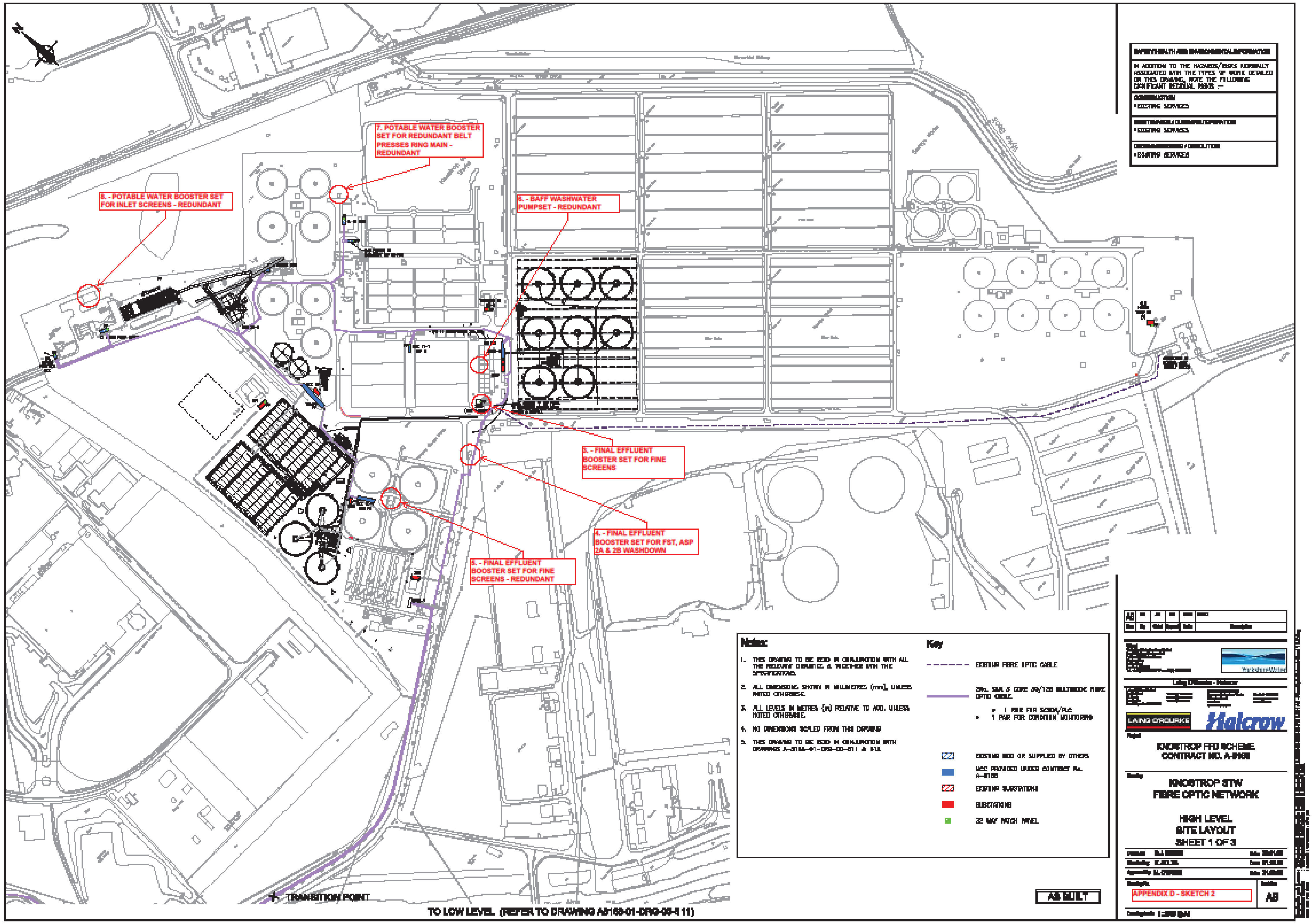


TARMAC
A CRH COMPANY

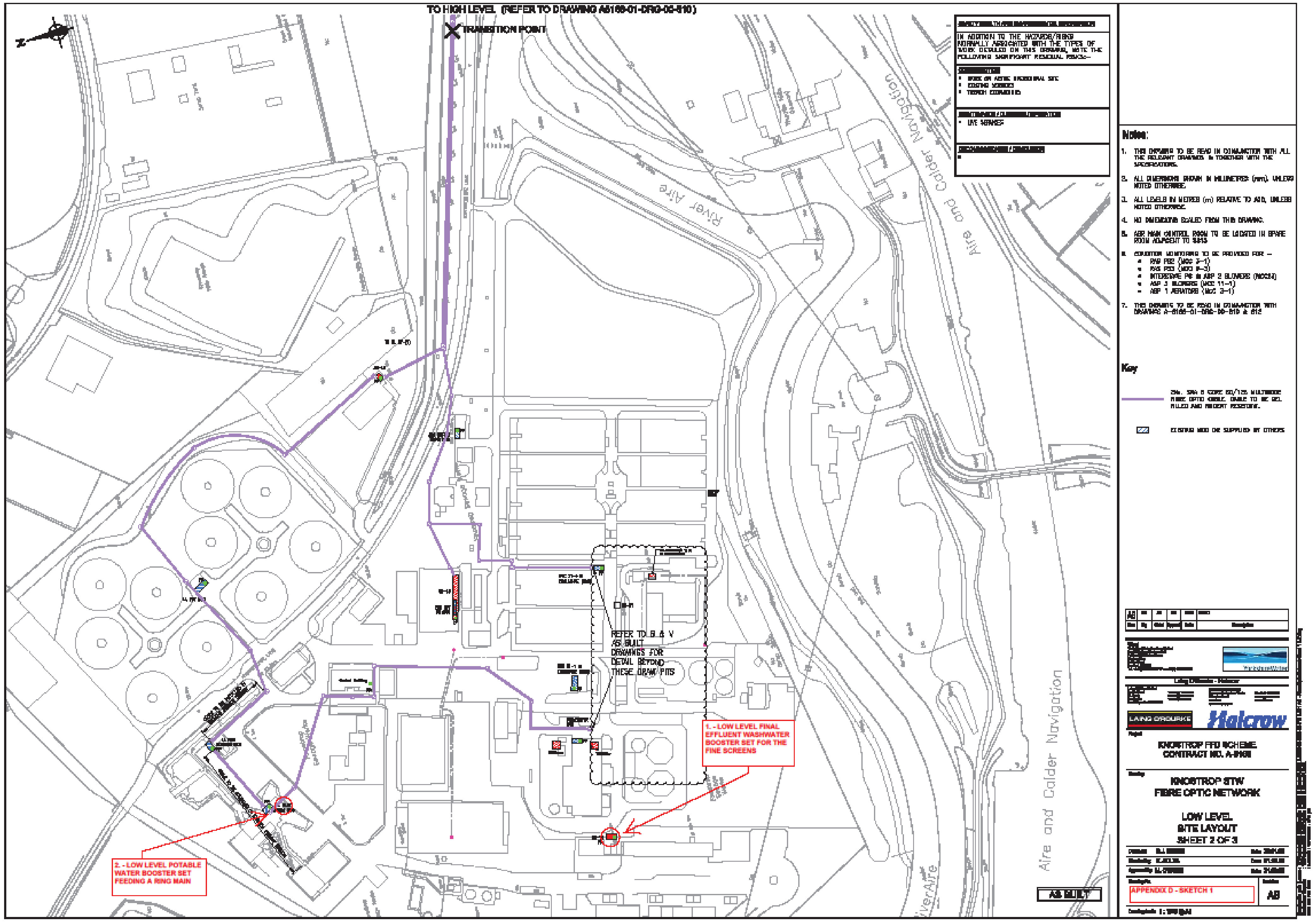
Appendix B

Existing Washwater/FE
Infrastructure

B1 Existing Washwater Infrastructure – High Level Works



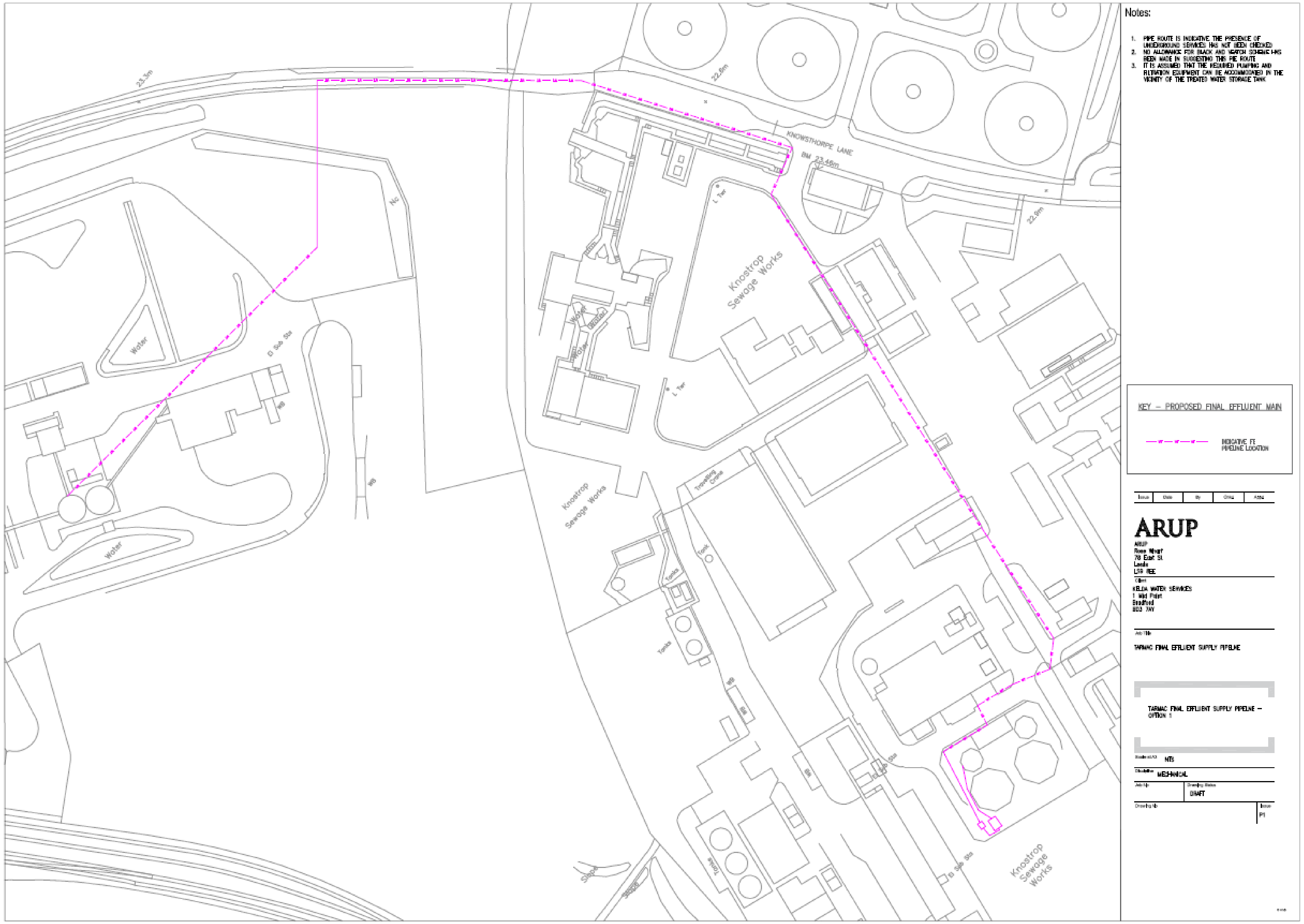
B2 Existing Washwater Infrastructure – Low Level Works



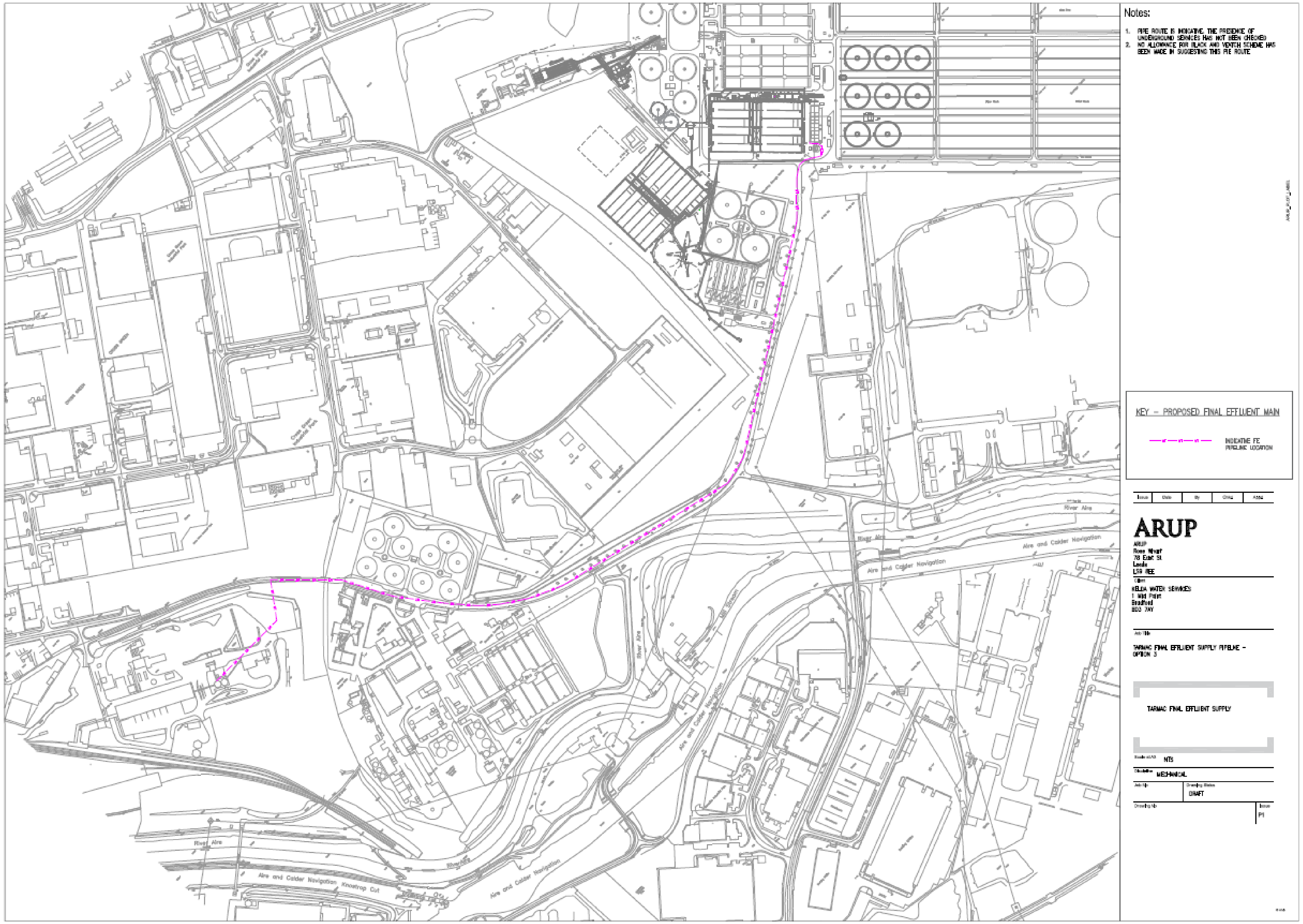
Appendix C

Sketches

C1 Option 1


Notes:
1. PIPE ROUTE IS INDICATIVE THE PRESENCE OF UNDERGROUND SERVICES HAS NOT BEEN CHECKED
2. NO ALLOWANCE FOR BLACK AND VEATCH SCHEME HAS BEEN MADE IN SUGGESTING THIS FE ROUTE
3. IT IS ASSUMED THAT THE REQUIRED PUMPING AND FILTRATION EQUIPMENT CAN BE ACCOMMODATED IN THE VICINITY OF THE TREATED WATER STORAGE TANK
KEY – PROPOSED FINAL EFFLUENT MAIN
INDICATIVE FE PIPELINE LOCATION
ARUP
KELDA WATER SERVICES
TARMAC FINAL EFFLUENT SUPPLY PIPELINE
TARMAC FINAL EFFLUENT SUPPLY PIPELINE – OPTION 1
NTS
MECHANICAL
DRAFT
P1
KNOWSTHORPE LANE
Knostrop Sewage Works
Water
Tanks
Tank
El Sub Sta
Travelling Crane
Slope

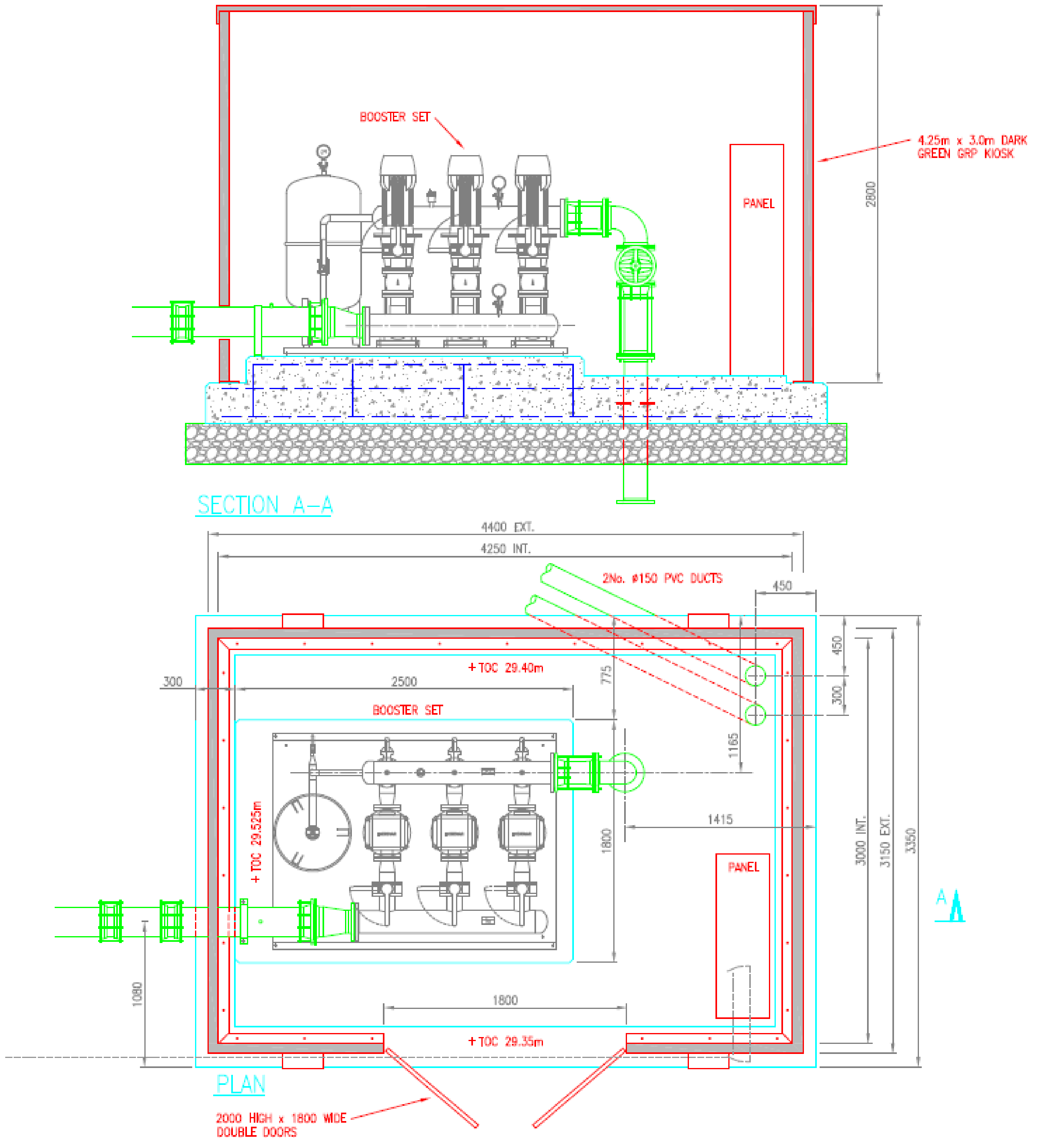
C2 Option 2


Notes:
1. PIPE ROUTE IS INDICATIVE. THE PRESENCE OF UNDERGROUND SERVICES HAS NOT BEEN CHECKED
2. NO ALLOWANCE FOR BLACK AND VEATCH SCHEME HAS BEEN MADE IN SUGGESTING THIS FE ROUTE
KEY – PROPOSED FINAL EFFLUENT MAIN
INDICATIVE FE PIPELINE LOCATION
Issue
Date
By
Chkd
Appd
ARUP
ARUP
Rose Wharf
78 East St
Leeds
LS9 8EE
Client
KELDA WATER SERVICES
1 Mid Point
Bradford
BD3 7AY
Job Title
TARMAC FINAL EFFLUENT SUPPLY PIPELINE – OPTION 3
TARMAC FINAL EFFLUENT SUPPLY
NTS
MECHANICAL
DRAFT
P1
River Aire
Aire and Calder Navigation
Knostrop Cut

Appendix D

Indicative Pumping Station Layout

D1 Indicative Pumping Station Layout



Appendix E

UCD Costings

E1 Option 1 - CAPEX

Solution RPI →	244.7	Model Version 1.01 09/08/2016
Solution Type:		
Sewage Treatment		
BRM+ Solution ID:	Site Name	
0000000		

COSTS SHOWN ARE FOR BUSINESS PLANNING ONLY

Solution Cost	YW OnCost
£719,200	£63,500
Total cost =	£782,700

↓↓↓ Enter solution scope details below ↓↓↓

Work Type	UCD Code	Description	Column1	New/Replace /Refurb	Measure 1	Units 1	Value 1	and / or	Measure 2	Units 2	Value 2	Comments	Column2	BRM+ Cost Element Value	UL	LL
	ZZ1511	UV Dosing	UV Dosing	New	flow	m3/ day	1,730	and	number	of	2	D/S Cells.		£116,025	36380	17.28
	ZY6104	Bollfilter		New	flow	m3/ day	3,460	and	number	of	4	2 No. 200 and 2 No. 50 um Bollfilter/automatic backwash filters		£60,404	6480	39.6
	ZZ7031	Pipebridge	Pipe bridges	New	length	m	15	*	*	*		2 No. pipebridges at 15m in length crossing site roads		£28,000	6489	1
	ZY6110	Pumps	Pumps - All	New	power	kW	30	and	number	of	3	3 No. VSD pressure regulated Hydrovar® type pumps. Packaged pumping skid (Such as Northern Pumps) with receiver and valves etc. Similar installation to the one installed at Knostrop by ETM in 2006	Power = specify if power is total or individual State type of pump e.g. diaphragm, centrifugal, RAM etc, and if submersible	£83,150	120	1.45
		MCC	Motor Control Centre	New	power	kW	30	*	*	*		Entire panel only. See elsewhere for components Power = sum of all starters in panel	Included in pump model			
		Pipework - Below Ground	Pipework - All	New	length	m	250	and	diameter	mm	100	HDPE Below Ground (buried in/adjacent to road) Rising Main	State material, if above or below ground, depth, purpose (e.g. rising main, interprocess, gas, etc) LS from sewerage model	£124,976		
		Pipework - Above Ground	Pipework - All	New	length	m	500	and	diameter	mm	100	Ductile Iron Above ground Rising Main	State material, if above or below ground, depth, purpose (e.g. rising main, interprocess, gas, etc) LS from sewerage model	£187,679		
	ZY1220	Pump Kiosk	Kiosks	New	area	m2	20	and	material	type	GRP	LPCB 2	Area = footprint of kiosk not base State security LPCB rating	£56,015	148	0.65
	ZY1626	Washout Chamber	Chambers - All	New	volume	m3	3	*	*	*		Washout Chamber	Volume = total internal volume of structure See elsewhere for tanks, pumping wells	£41,394	724.04	0.4
	ZY1220	UV Kiosk	Kiosks	New	area	m2	5	and	material	type	GRP	LPCB 2	Area = footprint of kiosk not base State security LPCB rating	£21,528	148	0.65

E2 Option 1 with Duty only Filtration and UV Treatment - CAPEX

Solution Type:	**COSTS SHOWN ARE FOR BUSINESS PLANNING ONLY**	Solution Cost	YW OnCost
Sewage Treatment		**£645,200**	**£59,900**
BRM+ Solution ID:	**Site Name**	**Total cost =£705,100**	
0000000	**↓↓↓ Enter solution scope details below ↓↓↓**		

Work Type	UCD Code	Description	Column1	New/Replace/ Refurb	Measure 1	Units 1	Value 1	and / or	Measure 2	Units 2	Value 2	Comments	Column2	BRM+ Cost Element Value	UL	LL
	ZZ1511	UV Dosing	UV Dosing	New	flow	m3/day	1,730	and	number	of	2	Duty only Cels.		£58,013	36380	17.28
	ZY6104	Bollfilter		New	flow	m3/day	1,730	and	number	of	2	1 No. 200 and 1 No. 50 um Bollfilter/automatic backwash filters		£44,466	6480	39.6
	ZZ7031	Pipebridge	Pipe bridges	New	length	m	15	*	*	*		2 No. pipebridges at 15m in length crossing site roads		£28,000	6489	1
	ZY6110	Pumps	Pumps - All	New	power	kW	30	and	number	of	3	3 No. VSD pressure regulated Hydrovar® type pumps. Packaged pumping skid (Such as Northern Pumps) with receiver and valves etc. Similar installation to the one installed at Knostrop by ETM in 2006	Power = specify if power is total or individual State type of pump e.g. diaphragm, centrifugal, RAM etc, and if submersible	£83,150	120	1.45
		MCC	Motor Control Centre (MCC)	New	power	kW	30	*	*	*		Entire panel only. See elsewhere for components Power = sum of all starters in panel	Included in pump model			
		Pipework - Below Ground	Pipework - All	New	length	m	250	and	diameter	mm	100	HDPE Below Ground (buried in/adjacent to road) Rising Main	State material, if above or below ground, depth, purpose (e.g. rising main, interprocess, gas, etc) LS from sewerage model	£124,976		
		Pipework - Above Ground	Pipework - All	New	length	m	500	and	diameter	mm	100	Ductile Iron Above ground Rising Main	State material, if above or below ground, depth, purpose (e.g. rising main, interprocess, gas, etc) LS from sewerage model	£187,679		
	ZY1220	Pump Kiosk	Kiosks	New	area	m2	20	and	material	type	GRP	LPCB 2	Area = footprint of kiosk not base State security LPCB rating	£56,015	148	0.65
	ZY1626	Washout Chamber	Chambers - All	New	volume	m3	3	*	*	*		Washout Chamber	Volume = total internal volume of structure See elsewhere for tanks, pumping wells	£41,394	724.04	0.4
	ZY1220	UV Kiosk	Kiosks	New	area	m2	5	and	material	type	GRP	LPCB 2	Area = footprint of kiosk not base State security LPCB rating	£21,528	148	0.65

E3 Option 2 - CAPEX

Solution Type:		COSTS SHOWN ARE FOR BUSINESS PLANNING ONLY	Solution Cost	YW OnCost
Sewage Treatment			£865,900	£70,800
BRM+ Solution ID:	Site Name		Total cost = £936,700	
0000000		↓↓↓ Enter solution scope details below ↓↓↓		

Work Type	UCD Code	Description	Column1	New/Replace /Refurb	Measure 1	Units 1	Value 1	and / or	Measure 2	Units 2	Value 2	Comments	Column2	BRM+ Cost Element Value	UL	LL
	ZZ1511	UV Dosing	UV Dosing	New	flow	m3/day	1,730	and	number	of	2	D/S Cells.		£116,025	36380	17.28
	ZY6104	Bollfilter		New	flow	m3/day	3,460	and	number	of	4	2 No. 200 and 2 No. 50 um Bollfilter/automatic backwash filters		£60,404	6480	39.6
	ZZ7031	Pumps	Pumps - All	New	power	kW	45	and	number	of	3	3 No. VSD pressure regulated Hydrovar® type pumps. Packaged pumping skid (Such as Northern Pumps) with receiver and valves etc. Similar installation to the one installed at Knostrop by ETM in 2006	Power = specify if power is total or individual State type of pump e.g. diaphragm, centrifugal, RAM etc, and if submersible	£110,041	120	1.45
	ZY6110	MCC	Motor Control Centre (MCC)	New	power	kW	45	*	*	*		Entire panel only. See elsewhere for components Power = sum of all starters in panel	Included in pump model			
		Pipework - Above Ground	Pipework - All	New	length	m	50	and	diameter	mm	150	Ductile Iron Above ground Rising Main	State material, if above or below ground, depth, purpose (e.g. rising main, interprocess, gas, etc) Lump sum from sewerage model	£58,234		
		Pipework - Below Ground	Pipework - All	New	length	m	1,500	and	diameter	mm	150	HDPE Below Ground (buried in/adjacent to road) Rising Main	State material, if above or below ground, depth, purpose (e.g. rising main, interprocess, gas, etc) Lump sum from sewerage model (NB this is quite long… headloss ok?)	£428,481		
	ZY1220	Pump Kiosk	Kiosks	New	area	m2	20	and	material	type	GRP	LPCB 2		£56,015	148	0.65
	ZY1220	Washout Chamber	Chambers - All	New	volume	m3	3	*	*	*		Washout Chamber	Volume = total internal volume of structure See elsewhere for tanks, pumping wells	£15,135	148	0.65
	ZY1220	UV Kiosk	Kiosks	New	area	m2	5	and	material	type	GRP	LPCB 2	Area = footprint of kiosk not base State security LPCB rating	£21,528	148	0.65

E4 Option 2 with Duty only Filtration and UV Treatment - CAPEX

Solution Type:		COSTS SHOWN ARE FOR BUSINESS PLANNING ONLY	Solution Cost	YW OnCost
Sewage Treatment			**£791,000**	**£67,100**
BRM+ Solution ID:	Site Name		**Total cost =**	**£859,000**
0000000		↓↓↓ Enter solution scope details below ↓↓↓		

Work Type	UCD Code	Description	Column1	New/Replace/ Refurb	Measure 1	Units 1	Value 1	and / or	Measure 2	Units 2	Value 2	Comments	Column2	**BRM+ Cost Element Value**	**UL**	**LL**
	ZZ1511	UV Dosing	UV Dosing	New	flow	m3/day	1,730	and	number	of	2	Duty only Cells.		£58,013	36380	17.28
	ZY6104	Bollfilter		New	flow	m3/day	1,730	and	number	of	2	1 No. 200 and 1 No. 50 um Bollfilter/automatic backwash filters		£44,466	6480	39.6
	ZZ7031	Pumps	Pumps - All	New	power	kW	45	and	number	of	3	3 No. VSD pressure regulated Hydrovar® type pumps. Packaged pumping skid (Such as Northern Pumps) with receiver and valves etc. Similar installation to the one installed at Knostrop by ETM in 2006	Power = specify if power is total or individual State type of pump e.g. diaphragm, centrifugal, RAM etc, and if submersible	£110,041	120	1.45
	ZY6110	MCC	Motor Control Centre (MCC)	New	power	kW	45	*	*	*		Entire panel only. See elsewhere for components Power = sum of all starters in panel	Included in pump model			
		Pipework - Above Ground	Pipework - All	New	length	m	50	and	diameter	mm	150	Ductile Iron Above ground Rising Main	State material, if above or below ground, depth, purpose (e.g. rising main, interprocess, gas, etc) Lump sum from sewerage model	£58,234		
		Pipework - Below Ground	Pipework - All	New	length	m	1,500	and	diameter	mm	150	HDPE Below Ground (buried in/adjacent to road) Rising Main	State material, if above or below ground, depth, purpose (e.g. rising main, interprocess, gas, etc) Lump sum from sewerage model (NB this is quite long… headloss ok?)	£428,481		
	ZY1220	Pump Kiosk	Kiosks	New	area	m2	20	and	material	type	GRP	LPCB 2		£56,015	148	0.65
	ZY1220	Washout Chamber	Chambers - All	New	volume	m3	3	*	*	*		Washout Chamber	Volume = total internal volume of structure See elsewhere for tanks, pumping wells	£15,135	148	0.65
	ZY1220	UV Kiosk	Kiosks	New	area	m2	5	and	material	type	GRP	LPCB 2	Area = footprint of kiosk not base State security LPCB rating	£21,528	148	0.65

E5 Option 1 - OPEX

												OPTION 1 - OVERALL ANNUAL OPEX EFFECT	14,884.16

ENERGY												ANNUAL ENERGY EFFECT	10,579.28
A	B	C	D	E	F	G	H	I	J	K	L	M	N
Asset Ref	Asset Description	Type	Name Plate (kW)	Overall Efficiency Rating (%)	Load Rating (%)	Use Factor (%)	Power Absorbed (kWh)	Hours / Year	Annual Power Consumed (kW)	Consumption / Generation	Cost / kWh (£)	Total (£)	Comments
1.001	UV	New	1.00	100%	100%	100%	1.00	8,760	8,760.00	Consumption	0.10	881.61	
1.002	Bollfilters	New	1.00	100%	100%	100%	1.00	8,760	8,760.00	Consumption	0.10	881.61	
1.004	Pumps	New	30.00	100%	33%	100%	10.00	8,760	87,600.00	Consumption	0.10	8,816.06	

MAINTENANCE												ANNUAL MAINTENANCE EFFECT	4,304.88
A	B	C	D	E	F	G	H	I	J	K	L	M	N
Asset Ref	Asset Description	Type	Capex (£)	Maintenance Type	Opex Modifier (%)							Total (£)	Comments
1.001	UV	New	116,025.48	E&M	2.44%							2,831.02	
1.002	Bollfilters	New	60,404.17	E&M	2.44%							1,473.86	
1.003	Pipebridges	New	28,000.00										
1.004	Pumps	New	83,150.00										
1.005	Pipework - Below Ground	New	124,975.73										
1.006	Pipework - Above Ground	New	187,679.08										
1.007	Pump Kiosk	New	56,015.29										
1.009	UV Kiosk	New	21,528.09										

E6 Option 1 – Duty only Filters and Screens - OPEX

												OPTION 1 - OVERALL ANNUAL OPEX EFFECT	12,731.72

ENERGY												ANNUAL ENERGY EFFECT	10,579.28
A	B	C	D	E	F	G	H	I	J	K	L	M	N
Asset Ref	Asset Description	Type	Name Plate (kW)	Overall Efficiency Rating (%)	Load Rating (%)	Use Factor (%)	Power Absorbed (kWh)	Hours / Year	Annual Power Consumed (kW)	Consumption / Generation	Cost / kWh (£)	Total (£)	Comments
1.001	UV	New	1.00	100%	100%	100%	1.00	8,760	8,760.00	Consumption	0.10	881.61	
1.002	Bollfilters	New	1.00	100%	100%	100%	1.00	8,760	8,760.00	Consumption	0.10	881.61	
1.004	Pumps	New	30.00	100%	33%	100%	10.00	8,760	87,600.00	Consumption	0.10	8,816.06	

MAINTENANCE												ANNUAL MAINTENANCE EFFECT	2,152.44
A	B	C	D	E	F	G	H	I	J	K	L	M	N
Asset Ref	Asset Description	Type	Capex (£)	Maintenance Type	Opex Modifier (%)							Total (£)	Comments
1.001	UV	New	58,012.74	E&M	2.44%							1,415.51	
1.002	Bollfilters	New	30,202.09	E&M	2.44%							736.93	
1.003	Pipebridges	New	28,000.00										
1.004	Pumps	New	83,150.00										
1.005	Pipework - Below Ground	New	124,975.73										
1.006	Pipework - Above Ground	New	187,679.08										
1.007	Pump Kiosk	New	56,015.29										
1.009	UV Kiosk	New	21,528.09										

E7 Option 2 - OPEX

												OPTION 2 - OVERALL ANNUAL OPEX EFFECT	19,292.19

ENERGY												ANNUAL ENERGY EFFECT	14,987.31
A	B	C	D	E	F	G	H	I	J	K	L	M	N
Asset Ref	Asset Description	Type	Name Plate (kW)	Overall Efficiency Rating (%)	Load Rating (%)	Use Factor (%)	Power Absorbed (KW)	Hours / Year	Annual Power Consumed (kW)	Consumption / Generation	Cost / kWh (£)	Total (£)	Comments
2.001	UV	New	1.00	100%	100%	100%	1.00	8,760	8,760.00	Consumption	0.10	881.61	
2.002	Bollfilters	New	1.00	100%	100%	100%	1.00	8,760	8,760.00	Consumption	0.10	881.61	
2.003	Pumps	New	45.00	100%	33%	100%	15.00	8,760	131,400.00	Consumption	0.10	13,224.10	

MAINTENANCE												ANNUAL MAINTENANCE EFFECT	4,304.88
A	B	C	D	E	F	G	H	I	J	K	L	M	N
Asset Ref	Asset Description	Type	Capex (£)	Maintenance Type	Opex Modifier (%)							Total (£)	Comments
2.001	UV	Process Plant - 10 years	116,025.48	E&M	2.44%							2,831.02	
2.002	Bollfilters	Process Plant - 20 years	60,404.17	E&M	2.44%							1,473.86	
2.003	Pumps	Pumps (20)											
2.004	Pipework - Below Ground	Water < 300mm (70)	58,234.15										
2.005	Pipework - Above Ground	Water < 300mm (70)	428,480.93										
2.006	Pump Kiosk	Op Structrs (30)	56,015.29										
2.007	Washout Chamber	Op Structrs (30)	15,134.72										
2.008	UV Kiosk	Op Structrs (30)	21,528.09										

E8 Option 2 – Duty only Filters and Screens - OPEX

OPTION 2 - OVERALL ANNUAL OPEX EFFECT	17,139.75

ENERGY												ANNUAL ENERGY EFFECT	14,987.31
A	B	C	D	E	F	G	H	I	J	K	L	M	N
Asset Ref	Asset Description	Type	Name Plate (kW)	Overall Efficiency Rating (%)	Load Rating (%)	Use Factor (%)	Power Absorbed (KW)	Hours / Year	Annual Power Consumed (kW)	Consumption / Generation	Cost / kWh (£)	Total (£)	Comments
2.001	UV	New	1.00	100%	100%	100%	1.00	8,760	8,760.00	Consumption	0.10	881.61	
2.002	Bollfilters	New	1.00	100%	100%	100%	1.00	8,760	8,760.00	Consumption	0.10	881.61	
2.003	Pumps	New	45.00	100%	33%	100%	15.00	8,760	131,400.00	Consumption	0.10	13,224.10	

MAINTENANCE												ANNUAL MAINTENANCE EFFECT	2,152.44
A	B	C	D	E	F	G	H	I	J	K	L	M	N
Asset Ref	Asset Description	Type	Capex (£)	Maintenance Type	Opex Modifier (%)							Total (£)	Comments
2.001	UV	Process Plant - 10 years	58,012.74	E&M	2.44%							1,415.51	
2.002	Bollfilters	Process Plant - 20 years	30,202.09	E&M	2.44%							736.93	
2.003	Pumps	Pumps (20)	110,041.41										
2.004	Pipework - Below Ground	Water < 300mm (70)	58,234.15										
2.005	Pipework - Above Ground	Water < 300mm (70)	428,480.93										
2.006	Pump Kiosk	Op Structrs (30)	56,015.29										
2.007	Washout Chamber	Op Structrs (30)	15,134.72										
2.008	UV Kiosk	Op Structrs (30)	21,528.09										