PREPARED FOR
WATERCARE SERVICES LIMTED

Huia Water Treatment Plant Upgrade Implementation Strategy

NOVEMBER 2013

REPORT

MWH®

BUILDING A BETTER WORLD

QUALITY STATEMENT

PROJECT MANAGER		PROJECT TECHNICAL LEAD	
Amy Campbell		Chris Povey	
PREPARED BY			
J. Peveril, G. Glasgow	[signatures]		15/10/13; 15/10/13
CHECKED BY			
A. Campbell	Amy Campbell		16/10/13
REVIEWED BY			
C. Povey	[signature]		15/10/13
APPROVED FOR ISSUE BY			
R. Neate	[signature]		16/10/13

AUCKLAND LEVEL 3
Level 3 Building C Millennium Centre, 600 Great South Road, Greenlane, Auckland 1051
PO Box 12-941, Penrose, Auckland 1642
TEL +64 9 580 4500, FAX +64 9 580 7600

REVISION SCHEDULE

Rev No	Date	Description	Signature or Typed Name (documentation on file)			
			Prepared by	Checked by	Reviewed by	Approved by
D1	07/02/13	Draft following optioneering	JP, GG	AC	CP	RN
D2	07/03/13	Draft full report	JP, GG	AC	CP	RN
01	15/10/13	Final	JP	AC	CP	RN

Executive Summary

Background

MWH was engaged to develop an implementation strategy and overall concept layout plan for the Huia Water Treatment Plant (WTP) which incorporates several existing concept designs for immediate upgrades to the WTP and supply network together the future process design for upgrading of the WTP process for the treatment of water from the Upper and Lower Nihotupu and Huia reservoirs. This plan will enable Watercare to proceed with the development of the immediate WTP and network upgrades without compromising the long term development requirements of the Huia WTP site.

The development of the overall concept layout plan has been undertaken using the following overall process:

- Review Huia WTP process upgrade and prepare technical note outlining proposed configurations and sizing for all key process units
- Review 4 existing concept designs and prepare technical notes
    - Powdered activated carbon facility (PAC)
    - Sludge dewatering facility
    - Muddy Creek overflow pipeline
    - Manuka Road reservoir
- Develop alternative site layout plans for Huia WTP
- Shortlist to 3 site layout plans using the MCA process
- Further develop shortlisted layouts (including costs, sections, hydraulic grades)
- Select preferred option using the MCA process

The proposed upgrade process that has been adopted for Huia WTP includes chemical dosing and flocculation, dissolved air flotation, ozonation, biologically activated carbon filters and disinfection with chlorine.

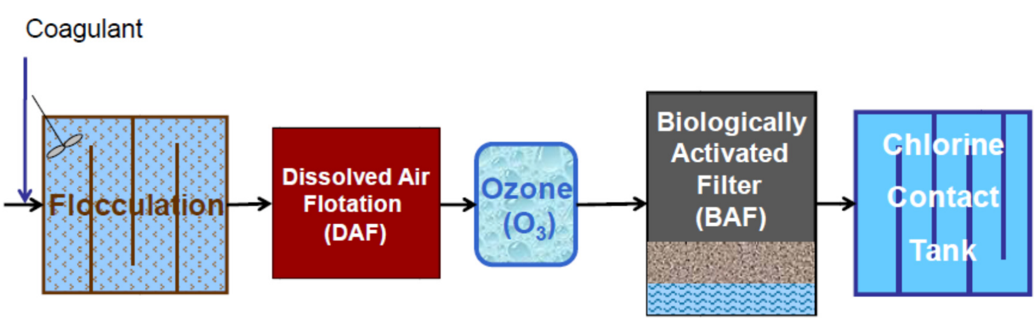


Figure 2 – Preferred Process Option

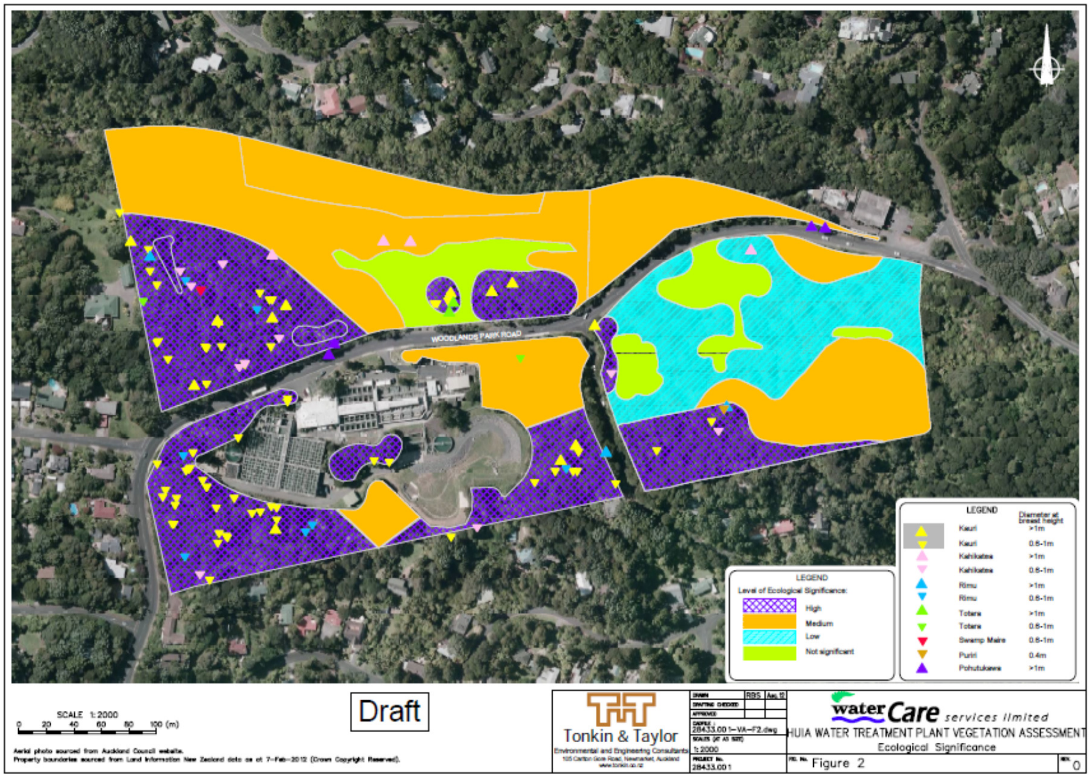
Site constraints

The existing WTP is located in the southern portion of the overall site and is bounded by Woodlands Park Road to the north and west and Manuka Road to the east. Watercare owns land north of Woodlands Park Road and east of Manuka Road.

The land is undulating with steep slopes, especially along the northern boundary, the west side of Manuka Road and in the SW corner.

The plan below indicates areas of highest ecological significance in dark blue and identifies a large number of high value trees and native species that should be retained where possible.

The site is surrounded by residential properties and a screen or buffer should be provided to limit any visual, site lighting and noise impacts.



The existing plant also has some heritage features scheduled in the Waitakere District Plan which should be retained where possible, these being:

- The form and scale of the 1928 Huia Filter Station building and 1947 additions, including decorative facade elements and excluding later additions.
- Original (1928-1947) windows and doors.
- The basic form of the 1928 filter tanks (but not surfaces, which may be subject to maintenance work and repair from time to time).
- Significance attributed to historical, architectural and pattern values.

Site layout development

A set of 15 preliminary site layout options were developed based on 5 main configurations:

Options	General configuration
1A, B & C	New WTP located within the general constraints of the existing site area south of Woodlands Park Road and west of Manuka Road
2A, B, C, D & E	New WTP located on the north side of Woodlands Park Road
3A & B	New WTP spread across both sides of Woodlands Park Road
4A & B	Relocation of Woodlands Park Road to the north and a new WTP located to the north of the existing plant
5A, B & C	New treatment plant constructed on the land east of Manuka Road

For general configurations 1 to 4 the new service reservoirs are located on the land east of Manuka Road and for configuration 5 the new reservoirs are located on the north side of Woodland Park Road.

Assessment of options

The initial shortlisting was undertaken through two workshops using the project specific MCA tool. General site layout configurations 1, 2 and 5 were preferred with options 1B, 2E and 5B being selected as the shortlisted layouts carried forward for further development. Configuration 3 was rejected on environmental grounds, and configuration 4 rejected on operational aspects of having public road through an operational WTP site

Following further development of the shortlisted options to include preliminary cost estimates, hydraulic profiles and general cross sections over the site a second MCA assessment workshop was undertaken with the results summarised as follows:

MCA	Option 1B	Option 2E	Option 5B
Construction Phase	0.35	0.41	0.68
Operations Phase	0.67	0.71	0.77
Total Score	0.59	0.63	0.75
Rank	3	2	1

Option 5B scored significantly better than the other two options during the construction phase as it is located on a greenfield site and has least impact on all stakeholders during construction. During the subsequent long term operations phase the three options have similar overall impacts/benefits and as such the relative scores are much closer. The overall site layout plan for option 5B is shown on the following page.

Preliminary capital costs for the three WTP layout options were developed. These costs excluded the PAC, sludge, Muddy Creek overflow pipeline and service reservoir projects which were common to all options. Option 5B has the lowest estimated capital cost as it is a greenfield construction and will be completed within the shortest duration.

Operating costs for the three options were not considered to be substantially different with the exception of the power costs associated with raw and treated water pumping. A net present cost (NPC) assessment of these specific pumping costs was undertaken for the three options over the period 2020 to 2060. The additional pumping costs for Options 2E and 5B over Option 1B have been included in the comparative cost table. From the assessment it can be seen that the relative difference in pumping costs is not significant in comparison to the differences in overall capital cost of the works.

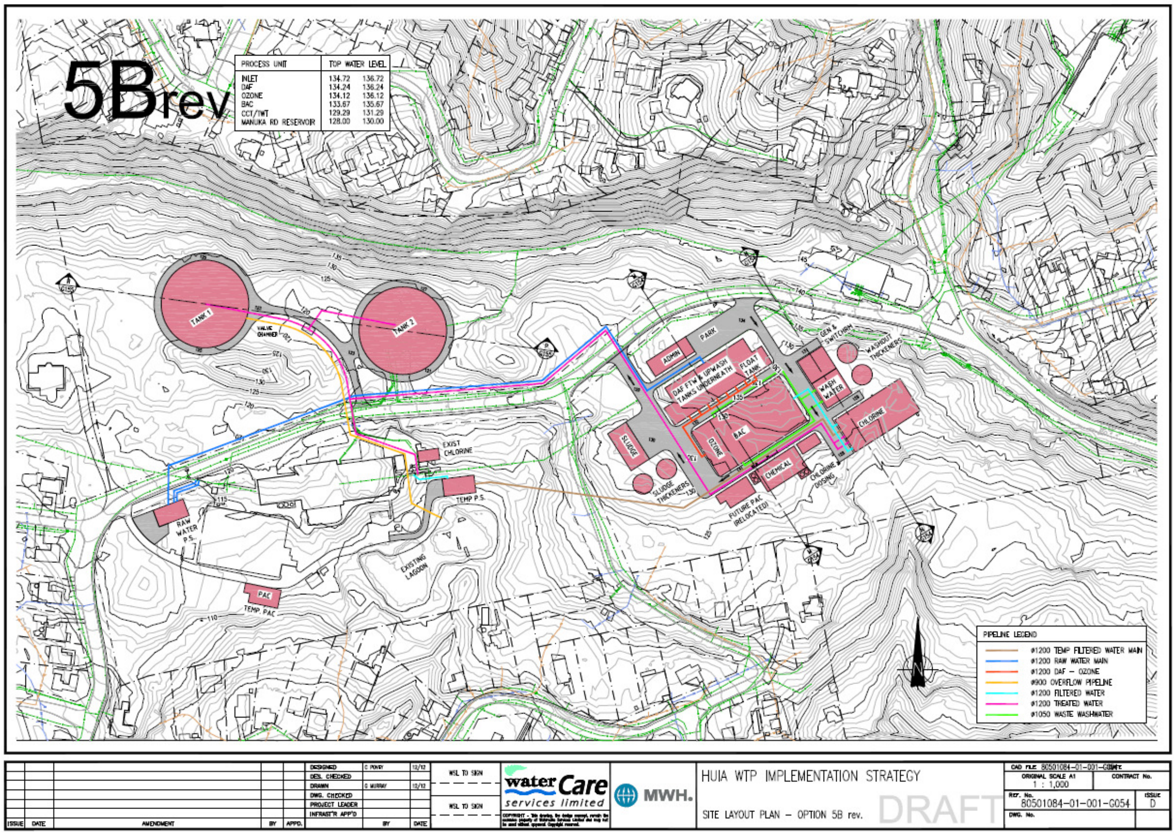
Costs	Option 1B	Option 2E	Option 5B
Capital Cost $M	140.3	135.7	132.7
Additional Pumping NPC $M	-	1.4	3.5
Total Cost $M	140.3	137.1	136.2
Rank	3	2	1

Recommendation

A two-stage optioneering and MCA process has identified layout option 5B as the preferred option to be become the concept layout for the future WTP. The four existing concept designs can now be developed with confidence, in the knowledge that they will be compatible with the future WTP.

MWH recommend that the new PAC facility and Muddy Creek overflow pipeline proceed as proposed and that Watercare consider deferral of the new CCT / TWT and sludge upgrade until the new plant is constructed. The new service reservoirs will now be sited to the north of Woodlands Park Road.

MWH also recommend that further topographical survey and geotechnical investigation are undertaken at the proposed WTP and service reservoir sites prior to further design development.



Watercare Services Ltd

Huia WTP Upgrade Implementation Strategy

CONTENTS

Executive Summary i

Background i

Site constraints i

Site layout development ii

Assessment of options iii

Recommendation iii

1 Introduction 1

1.1 Purpose 1

1.2 Project Background 1

1.3 Definition of Terms 2

1.4 Report Structure 2

2 Design Basis, Considerations and Criteria 3

2.1 Proposed Future Treatment Process 3

2.1.1 Unit Treatment Process 3

2.1.1.1 Huia Master Plan 3

2.1.1.2 Agreed Assumptions 4

2.1.1.3 Key Unit Processes 4

2.1.2 Residuals Management 6

2.1.2.1 Key Processes 6

2.1.3 Pipes, Chambers and Main Connections 7

2.1.4 Roads 7

2.1.5 Electrical 7

2.1.6 Chemical Facilities 7

2.1.7 Buildings 8

2.2 Manuka Road Reservoir, PS and TWT 8

2.3 Sludge Dewatering Building 9

2.4 PAC Plant 10

2.5 Muddy Creek Pipeline 10

2.6 Site Development Constraints 11

2.6.1 Environmental 11

2.6.2 Physical 12

2.6.3 Operational 13

2.7 Site Layout Options Development 13

2.8 Initial Shortlisting of Site Layout Options 13

3 Options Development and MCA 14

3.1 Presentation of Shortlisted Options 14
3.1.1 Option 1B........ 14
3.1.1.1 General Description........ 14
3.1.1.2 Modifications to the Layout following the Initial Shortlisting 14
3.1.1.3 Pumping Requirements........ 14
3.1.1.4 Network Connections........ 14
3.1.1.5 Process Unit Levels (TWLs) 15
3.1.1.6 Staging Issues 15
3.1.1.7 Advantages........ 15
3.1.1.8 Disadvantages 15
3.1.2 Option 2E........ 16
3.1.2.1 General Description........ 16
3.1.2.2 Modifications to the Layout following the Initial Shortlisting 16
3.1.2.3 Pumping Requirements........ 16
3.1.2.4 Network Connections........ 16
3.1.2.5 Process Unit Levels (TWLs) 17
3.1.2.6 Staging Issues 17
3.1.2.7 Advantages........ 17
3.1.2.8 Disadvantages 17
3.1.3 Option 5B........ 18
3.1.3.1 General Description........ 18
3.1.3.2 Modifications to the Layout following the Initial Shortlisting 18
3.1.3.3 Pumping Requirements........ 18
3.1.3.4 Network Connections........ 19
3.1.3.5 Process Unit Levels (TWLs) 19
3.1.3.6 Staging Issues 19
3.1.3.7 Advantages........ 19
3.1.3.8 Disadvantages 19
3.2 Selection of Preferred Option........ 19
3.2.1 Multi-criteria Analysis (MCA) 20
3.2.2 Comparative Costs 20
3.3 Conclusion and Recommendations 20
4 Preferred Option Development 21
4.1 Map Layout 21
4.2 Details and Explanation........ 21
4.3 Sections........ 22
4.4 Hydraulic Profile 23
4.5 Updated Costs........ 27
4.6 Staging and Strategy........ 29
4.7 Risk Assessment 30

5 Conclusion and Recommendations 31
5.1 General 31
5.2 Manuka Road Reservoir, PS and CCT/TWT 31
5.3 Sludge System 31
5.4 PAC Plant 31
5.5 Muddy Creek Pipeline 31

LIST OF TABLES

Table 3-1 MCA Score Summary 20
Table 3-2 Comparative Cost Summary 20

LIST OF FIGURES

Figure 2-1 Huia Master Plan Preferred Process Option 3
Figure 2-2 Vegetation Assessment Plan 12
Figure 4-1 Preferred Option Layout Plan 21
Figure 4-2 Preferred Option Sections – WTP Site 22
Figure 4-3 Preferred Option Sections – Service Reservoirs 22
Figure 4-4 Preferred Option Hydraulic Profile – Sheet 1 of 2 25
Figure 4-5 Preferred Option Hydraulic Profile – Sheet 2 of 2 26
Figure 4-6 Preferred Option Rough-order Cost Estimate 27
Figure 4-7 Preferred Option Cashflow Estimate – AMP Spend 28
Figure 4-8 Preferred Option Cashflow Estimate – Early Start 28
Figure 4-9 Preferred Option OPEX Estimate 28

APPENDICES

Appendix A Manuka Road Reservoir Tech Memo
Appendix B Sludge Upgrade Tech Memo
Appendix C PAC Upgrade Tech Memo
Appendix D Muddy Creek Pipeline Tech Memo
Appendix E MCP Interface Drawings
Appendix F Overflow & Off-spec Discharge Locations
Appendix G Process Design Worksheet
Appendix H Site Layout Option Drawings
Appendix I Site Layout Short-listing Memo
Appendix J Initial MCA Document
Appendix K Preliminary Load List
Appendix L Shortlisted Options Layouts
Appendix M Unit Process Drawings

Appendix N MCA Document
Appendix O Cost Estimate
Appendix P Shortlisted Cross Sections and Hydraulic Profiles
Appendix Q Preliminary Geotechnical Appraisal Report
Appendix R Risk Assessment
Appendix S Cashflow
Appendix T OPEX Estimate
Appendix U Email Confirming RL 128 TWL

1 Introduction

1.1 Purpose

MWH has been engaged by Watercare Services Limited (Watercare) to develop an implementation strategy and overall concept layout plan for the Huia Water Treatment Plant (WTP). The concept plan incorporates several existing concept designs for immediate upgrades to the WTP, and supply network, together with the future process design for upgrading the WTP process for the treatment of water from the Upper and Lower Nihotupu and Huia reservoirs. This concept plan will enable Watercare to proceed with the development of the immediate WTP and network upgrades without compromising the long term development requirements of the WTP site.

This report summarises key background information and the methodology undertaken throughout the project to get to an agreed implementation strategy.

1.2 Project Background

Watercare has undertaken a series of investigations for the upgrade of the Huia WTP site. These investigations include:

- The assessment and adoption of a future new process treatment train at the Huia WTP. Watercare's preferred future process option is flocculation, dissolved air flotation (DAF), ozonation, biological activated carbon (BAC) filtration and chlorination. This process has been selected to manage future raw water quality with the ability to handle greater algal loading and remove increased amounts of dissolved organics to improve disinfection stability and minimise disinfection by products.
- Concept designs for the Manuka Road Reservoir, a new powdered activated carbon (PAC) preparation and dosing facility, a new Sludge Dewatering facility and the Muddy Creek pipeline to transfer plant overflows directly to the harbour.

The development of the implementation strategy and overall concept layout plan has been undertaken using the following process:

1. MWH undertook a review of the background material and reports and held a workshop with Watercare Planning and Operations staff to discuss the contents and findings in order to confirm the preferred future process option and functional requirements for the four existing concept designs and identify gaps in existing information.

2. Following this initial review, MWH undertook a more detailed assessment of each of the four existing concept designs and upgrade process. Five technical memorandums were prepared outlining the key assumptions and confirming the basis for design in order to size facilities and define interfaces suitable to include the proposed works within the concept layout plans. The technical memorandums include:

   Technical Memorandum No. 1 – Upgrade Treatment Process and Layout
   Technical Memorandum No. 2 – Manuka Road Reservoir
   Technical Memorandum No. 3 – Muddy Creek Pipeline
   Technical Memorandum No. 4 – Powdered Activated Carbon Upgrade
   Technical Memorandum No. 5 – Sludge Dewatering Upgrade

   These technical memorandums include a confirmation of overall unit/facility sizing, general hydraulic requirements and interconnectivity to the existing and future WTP and supply network.

3. Using feedback from Watercare on the Technical Memorandums, a total of 15 alternative site layout plans were developed. These layouts were presented to Watercare in Technical Memorandum No. 6 which was the basis for the first MCA assessment undertaken to reduce the long list of options down to three options for more detailed analysis. A MCA workshop was held to discuss and score each option and a second internal follow up workshop was held by Watercare to finalise the short-listed options.

4. Further assessment of the three short-listed options was undertaken to develop the required information to undertake the final MCA evaluation and selection of the preferred layout for the future development of the Huia WTP site. This assessment includes some desktop geotechnical evaluation, preliminary site survey to confirm the voracity of the contour information on the district plans, hydraulic analysis and further development of individual process unit details.

5. A final MCA evaluation was completed to determine the preferred layout option. A workshop was held to discuss and agree option scoring and an internal follow up workshop was held by Watercare to finalise the scoring process. The preferred option has subsequently been developed to provide discussion around proposed construction staging, assess risk and to re-visit the impact of the preferred option on the four existing concept designs.

1.3 Definition of Terms

The following list references terms used throughout the document:

BAC – Biologically Active Carbon
CCT – Chlorine Contact Tank
DAF – Dissolved Air Flotation
EBCT – Empty Bed Contact Time
FTW – Filter to Waste
ICA – Instrumentation Controls and Automation
KW - kilowatts
LOX – Liquid oxygen
MCA – Multi Criteria Analysis
MLD – Mega litres per day
MVA – Mega Volt Amps
MWH – MWH New Zealand Pty Ltd
TWT – Treated Water Tank
UV – Ultra Violet
VPSA – Vacuum Pressure Swing Adsorption
VSD – Variable Speed Drive
WATERCARE – Watercare Services Ltd
WTP – Water Treatment Plant

1.4 Report Structure

This report is structured as follows:

Section1: Introduction and Background
Section 2: Design Basis, Considerations and Criteria
Section 3: Options Development and MCA
Section 4: Preferred Option Development
Section 5: Conclusion and Recommendations

2 Design Basis, Considerations and Criteria

2.1 Proposed Future Treatment Process

2.1.1 Unit Treatment Process

2.1.1.1 Huia Master Plan

The Huia Master Plan (March 2010) documents the thought processes and decision making that led to the selection of the preferred upgrade option for the WTP. The Master Plan brings together key areas relating to the water supply concurrently in order to optimise long term decisions with respect to the provision of infrastructure. The Master Plan assesses the risks associated with the raw water, the processes, condition, performance and capacity of the existing assets at the WTP in the context of a range of key strategic outcomes. These included level of service, best practise, asset integrity, prices, social, cultural, environmental and economic wellbeing, Watercare core values, the Three Waters Vision and management of risk. The conclusion of the study was the selection of the preferred Master Plan option 2.2B for the WTP (illustrated in **Figure 2.1**). Option 2.2B comprised:

- Construction of a new 140 MLD capacity treatment process including:
- Dissolved air flotation (DAF)
- Ozonation
- Biological activated carbon (BAC) filtration
- Chlorination

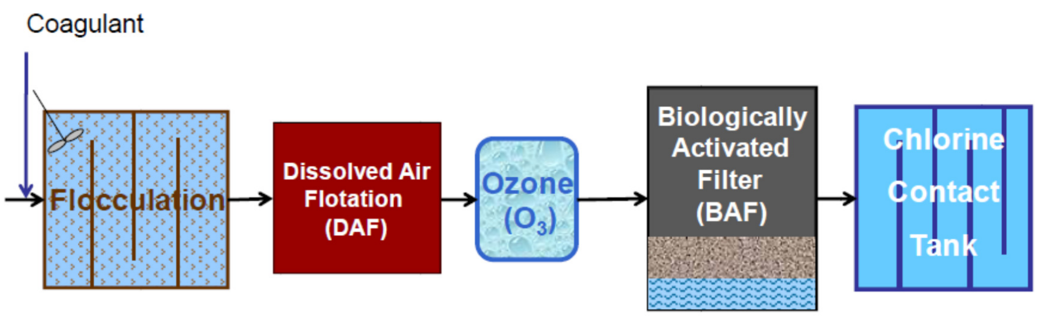


Figure 2-1 Huia Master Plan Preferred Process Option

The Huia WTP Facility Plan Design Criteria and Huia WTP Facility Plan Unit Process Datasheets report describe the key design criteria to be used as the basis for the future upgrade of the WTP to an expanded capacity of 140 MLD treated water. The intention is to undertake the upgrade of the WTP in stages as follows:

Stage 1
- Remove bottlenecks to provide a capacity of 126 MLD, address regulatory and plant condition issues,
- Undertake the Manuka Road Reservoir, pump station for treated water, Powdered Activated Carbon (PAC) facility and optional chlorine contact tank upgrades, and;
- Upgrade site power.

Intermediate Stage (to be determined)
- Upgrade of the sludge dewatering facility and;
- Upgrade of the chemical storage and dosing facilities.

Stage 2
- Chlorine contact tank (subject to stage 1),
- DAF,
- Ozone, and;
- BAC filters.

The reports present design criteria for a range of disciplines including mechanical, electrical, civil, structural, ICA and process for each treatment stage of the plant. These are primarily focussed on the Stage 2 upgrade. In addition it is noted that the process and plant layout will facilitate the possible substitution of ozone treatment with UV/Peroxide.

2.1.1.2 Agreed Assumptions

Kick off meetings were held with MWH and Watercare on the 4th and 5th October 2012 to begin the implementation strategy and concept design process. General assumptions for the new treatment process were discussed and agreed as follows:

- Maximum output capacity 140Ml/day,
- Separate supply to new Manuka Road and Titirangi Reservoirs,
- Raw water supply from the existing aqueduct ,
- Flocculation 15 minutes detention with two trains minimum,
- DAF 10m3/m2/hr surface loading rate including 10% recycle with all units operating,
- Ozone 15 minutes 'nominal' contact time, 3.2mg/L max dose, two tanks each rated to 75% plant capacity i.e. 105Ml/day,
- BAC – deep activated carbon media 15min EBCT for N-2 filters operating with underlying sand layer (same media as the Waitakere pilot trial)
- Chlorine 'effective' contact time 30minutes, 1-2mg/L dose, two tanks each rated at 75% plant capacity
- Final pH adjustment after disinfection,
- Treated water tanks 'nominal' detention time 10minutes, two tanks each rated at 75% plant capacity,
- All plant and reservoir overflows to new Muddy Creek pipeline, onsite detention capability to enable controlled plant shutdown for overflow/spill events which produce flows outside default discharge quality limits, i.e. high solids, high aluminium, and;
- All recycle streams except filtrate from sludge dewatering to be returned to the head of the plant (washout thickener and sludge thickener supernatants not returned during major algal bloom events)

Further development of the key unit processes sufficient to prepare the site layout options has been undertaken and is detailed in the Process Design Sheet included as **Appendix G.** A summary of each key unit process is provided in the sub-sections below.

Sketch plans for the DAF, ozonation, BAC filters, chlorine contact and treated water tanks, pump stations and wash water tanks are provided as **Appendix M.** These layouts have been used as the basis for developing the overall site layout plans.

2.1.1.3 Key Unit Processes

Raw Water Feed Pumpstation

Where a new raw water feed pump station is required a connection to the existing aqueduct will be made using twin pipelines due to the limited overall water depth in the aqueduct. The pipes will connect to the raw water pump station inlet wet well. Wet well submersible or lineshaft pumps will provide the most compact arrangement but are not preferred by Watercare. Consequently a wet well - dry well configuration is proposed with a vertically mounted centrifugal pump configuration to limit the size of the dry well. Four duty and one standby pumps with variable speed drives are proposed and a flow range from 35-140Ml/day.

Flocculation and Dissolved Air Flotation

A total of eight dissolved air flotation tanks are proposed. These tanks are sized based on a hydraulic loading rate of $10m^3/m^2/hr$ including a 10% internal recycle rate with all tanks in operation. This is a conservative rate and assumes conventional open tank DAF units. More efficient proprietary high rate DAF tanks that operate at hydraulic loading rates in excess of $20m^3/m^2/hr$ could be piloted for suitability as part of detailed process selection. Clarified water has been assumed for the recycle flows to the saturator vessel. A nominal tank depth of 3m has been adopted. The DAF tanks will be fully covered.

Each DAF tank has its own integral two stage flocculation sized for a nominal hydraulic detention time of 15 minutes. For DAF, a typical flocculation a constant mixing energy of approximately $G=70sec^{-1}$ is normally adopted. Mechanical flocculation is proposed to suit the hydraulic profile and maintain mixing energy at low flow. Horizontal paddle mixers are proposed to best suit the overall tank configuration. The flocculation tanks do not need to be covered.

Four air saturator vessels are proposed with each vessel shared by two DAF tanks. The process water feed to the saturators will be via variable speed driven pumps with one pump per tank and a common standby. With the standby also in operation the recycle rate could be increased to 15% to better cater for algal bloom events.

Ozonation

Two ozonation tanks are proposed. Each tank is conservatively sized for nominal 15 minutes contact time at 75% of plant flow rate i.e. 105Ml/day per tank. Consequently, no additional allowance has been made for hydraulic inefficiency. Six and a half metre deep tanks have been adopted to reduce the overall footprint. Channel widths of 3.25m have been adopted but hydraulic modelling of the tanks should be undertaken to confirm suitable channel widths to limit short-circuiting and flow stratification. The tanks will have concrete roofs.

Ozone generation from oxygen produced on-site is proposed. Two duty and one standby ozone generators operating at 10% wt are proposed. Ozone generators operate most efficiently producing ozone at approximately 10% wt but can produce greater quantities of ozone at 5% wt. This requires greater unit energy and double oxygen consumption. An alternative option to having a standby unit would be to size three units for the duty requirement at 10% wt and if a duty unit is unavailable operate the remaining two at 5% wt. Duty and standby vacuum pressure swing adsorption units are proposed rated at 200Nm^3/hr. A lower cost alternative may be to provide a single VPSA unit with a standby LOX storage and evaporation system.

The ozone generators will be water cooled to increase efficiency. Due to the proposed depth of the contact tanks a side stream ozone injection system would be used. The contact tanks will be vented to the external atmosphere through openings in the tank roofs. Ozone destructors would be included.

The ozone tanks will have a thermal off gas destructor unit and sodium bisulphite dosing facilities for the reduction of any residual ozone before the BAC filters. Oxygen and ozone generation equipment will be housed in a building on top of the ozone contact tank.

Biological Activated Carbon Filtration

A total of 14 BAC filters each 14.5m long x 7.6m wide in a back to back configuration is proposed. When operating at N-2 i.e. one out of service and one backwashing the design EBCT is 15 minutes. A filtration rate of 6m^3/m^2/hr has been adopted. A higher filtration rate should be piloted which will reduce the overall filter footprint. A BAC depth of 1.54m is required to achieve the EBCT. The size of the BAC media is expected to be approximately 1.3mm.

To ensure that the filtered water quality meets turbidity limits a sand layer is proposed under the BAC media. The Huia Concept Design proposed a 1m deep sand layer. From the recent pilot work at Waitakere WTP it is considered that a 400mm layer of 0.56mm sand would be suitable for this purpose. The BAC filters can be open or enclosed.

The concept design of the backwash system is for air scour at 55Nm^3/m^2/hr and upwash at 43m^3/m^2/hr. The upwash water tank, backwash balance tanks (2 No.) and filter to waste tank are all sized for two backwashes in rapid succession.

In developing site layout options the new filter upwash water tank and filter-to-waste tank have typically been located underneath the DAF tanks or the BAC filters to make best use of the overall site space and/or tank levels.

Chlorine Contact Tanks and Treated Water Tanks

Two chlorine contact tanks are proposed. Each tank is 3645m^3 and is sized for a T_{90} contact time of 30 minutes based on 75% of plant capacity (i.e. 105Ml/day) and a hydraulic efficiency of 60%.

The proposed tanks are seven metres deep to minimise the overall footprint and better suit site ground conditions. Tanks should be covered to prevent any recontamination. An overflow weir is provided between the chlorine contact tank and the treated water tank to ensure that the minimum contact time is achieved.

Two treated water tanks are proposed. Lime is injected downstream of the overflow weir. Each tank is 730m^3 and is sized at 75% of plant capacity. This will provide a nominal 15 minute detention for lime dissolution under normal conditions and 10 minutes at the reduced flow of 105Ml/day when one tank is out of service. These are smaller than those proposed in the Huia WTP Facility Plan which proposed tanks of 1200m^3 capacity. Treated water tanks are covered to prevent any recontamination.

An overflow to the site detention storage lagoon will be provided.

Treated Water Pump Station

Two of the shortlisted layout options (1B and 2E) require treated water pumping from the new plant to the Manuka Road Reservoir. Site option 1B also requires low lift pumping into the aqueduct to supply the Titirangi Reservoirs. A new treated water pump station is proposed as part of the treated water tank structure.

Four duty and one standby split case centrifugal pumps are proposed to supply Manuka Reservoir, and two duty and one standby axial flow pumps are proposed for the pumped supply to Titirangi. All pumps are variable speed to match plant outflow to inflow to maintain a constant level in the CCT/TWT and limit the number of pump start/stops.

UV/peroxide

Watercare are considering the use of UV/peroxide as an alternative to ozonation for taste and odour and toxin removal.

UV/peroxide would be most efficient after filtration to maximise the UV transmissivity but the preferred location in the process is before the BAC filters as these will quench most of the residual peroxide and reduce the required post chlorination dose.

The footprint required for a peroxide storage and dosing facility and in-channel UV system is expected to be less than that of the ozone generation and contact facility discussed above. The space provided for ozone on the site layout options (adjacent to the BAC filters) is considered to be sufficient for provision of UV/peroxide should this become the preferred technology.

2.1.2 Residuals Management

2.1.2.1 Key Processes

DAF Float

The solids from the DAF tanks will be removed via float or mechanical roll and transferred into the float tank from which it is pumped directly to a gravity sludge thickener. DAF sludge is typically 1% solids. Dry mounted submersible pumps have been proposed for transferring the float to the sludge thickeners.

Filter Waste Washwater

The waste from the filter backwash will be transferred to the wash water recovery tanks under gravity flow. Two tanks are provided with a combined capacity of 1000m3 which is 110% of two backwashes. Each tank is provided with a duty and standby pump to transfer flows to the wash water thickeners.

A typical configuration for the waste wash water tanks is shown in **Appendix M.**

Washwater Thickeners

Two wash water gravity thickeners are proposed; each rated at 75% of design capacity. Overflow will be transferred to the common thickener supernatant return pump station and thickener underflow to the sludge feed balance tanks. Polymer dosing to the thickener will be provided for improved solids capture.

Sludge Feed Balance Tanks
Sludge feed balance tanks will balance DAF float and underflow from the washwater thickeners to ensure a consistent feed to the sludge thickeners. Two 40m3 tanks are provided.

Sludge Thickeners

Two sludge gravity thickeners are proposed; each rated at 75% of design capacity. DAF float and wash water thickener underflows will be pumped from the sludge feed balance tanks into the sludge thickeners with overflow to be transferred to the common thickener supernatant return pump station and underflow pumped to the thickened sludge storage tanks. Polymer dosing to the thickener will be provided for improved solids capture.

Thickened Sludge Storage Tanks

Underflow from the sludge thickeners will be pumped to thickened sludge storage tanks. Two 100m3 tanks are provided.

Sludge Dewatering

A new sludge dewatering facility is proposed that includes filter presses and sludge cake storage. Supernatant from the sludge dewatering will be discharged to sewer. Refer to Section 2.3 for details of the sludge dewatering system.

2.1.3 Pipes, Chambers and Main Connections

Key plant interfaces are as follows:

- Raw water aqueduct connection with 2 No. 1200mm pipes,
- Treated water aqueduct (to Titirangi Reservoirs) connection with new chamber and 1200mm inlet pipe,
- New 1200mm service reservoir inlet,
- Detention lagoon/Muddy Creek overflow pipeline, and;
- Stormwater drainage discharge point.

2.1.4 Roads

Indicative road layouts are shown on the overall site layout plans. These layouts have been developed to accommodate chemical deliveries by B-Double and sludge cartage arrangements.

2.1.5 Electrical

A power supply upgrade to the site is required, and a 5MVA dedicated feeder is proposed. The total installed load will be in the order of 2MVA with an average demand at design throughput of approximately 24MWhr/day. A preliminary load listing is attached as **Appendix K**.

It is assumed that the Power Factor will be maintained and at least 0.95 and all motors over 55KW be fitted with soft starters unless they are already under VSD control.

Standby generators are proposed to maintain plant operation during a power supply outage. Keeping motor sizes down by using multiple pumps, etc., will help limit the generator size. The number and location of generators required will be dependent on the layout option selected. An overall standby capacity of 2MVA, has been assumed for the initial concept design, This might be significantly reduced in capacity by load shedding such as reducing overall plant flow rate, DAF recirculation rates, ceasing ozone production, ceasing air scour during backwash and/or reducing upwash flow rates.

2.1.6 Chemical Facilities

The chemical storage, preparation and dosing building will include:

- Liquid Alum storage – 3 No. 60m3 tanks,
- Liquefied CO_2 – 2 No. 50 tonne tanks,
- Polymer – 3 No. preparation systems,
- Sodium bisulphite or calcium thiosulphate solution for residual ozone destruction,
- Lime – 2 No. 45 tonne silos, 2 No. 30m3 day tanks, and;
- HFA – 2 No. 12m3 tanks and a 1m3 day tank.

A layout plan for the chemical building is included in Appendix M. Chemicals will be stored and bunded according to the Hazardous Substances & New Organism regulations.

Depending on plant layout the existing chlorination facility will remain. Where a new facility is required space has been allowed for either a new gas chlorination facility with space for 8 No. one tonne drums which is equivalent to the existing facility or the use of sodium hypochlorite with 2 No. 60m3 tanks.

A separate PAC dosing facility will be constructed on the site.

2.1.7 Buildings

The main plant buildings will comprise:

- DAF building to cover the flotation tanks and house plant and equipment,
- Ozonation building to house oxygen and ozone generation equipment and miscellaneous plant,
- Administration and facilities building,
- Chemical storage, preparation and dosing building,
- Raw water pump station (site layout Options 2E and 5B), and;
- Treated water pump station (site layout Options 1B and 2E).

Buildings will typically be precast concrete tilt up panel with steel roofing. Plant buildings shall be mechanically ventilated and electrical switch rooms shall be air conditioned.

The administration and facilities building will be approximately 700m^2 on two levels and include the following:

- Reception area 20m^2,
- Administrator office 10m^2,
- Meeting Room 30m^2,
- Workshop 80m^2,
- Laboratory 50m^2,
- Washroom and toilets 2x30m^2,
- Lunch room 40m^2,
- Mechanical store 20m^2,
- Electrical store 20m^2,
- Records store 20m^2,
- Control room and server area 40m^2,
- Staff work area (Assumes 15 staff and 10 transient personnel) 250m^2,
- Stairwells 40m^2,
- Miscellaneous 20m^2,
- Parking for 25 cars, and;
- Vehicle and equipment wash down bay 20m2.

2.2 Manuka Road Reservoir, PS and TWT

The Manuka Road Reservoir is a proposed 25ML storage to augment the existing Titirangi 1 and 2 reservoirs and enhance supply capacity to the North Shore. The future North Harbour Watermain No.2 will be supplied from this reservoir. A second 25ML storage will be required in future and should be included within the overall site planning.

The key reference documents relating to this reservoir are:

- Manuka Road Reservoir Concept Design Summary Report undertaken by SKM which considers the location for the new Reservoir, requirements for Treated Water Tank (TWT), Treated Water Pump Station (TWPS) and connecting pipelines
- Manuka Road Reservoir project & North Harbour Watermain No.2 System Review undertaken by WSL which provides the preferred location and elevation of the Manuka Road reservoir and an outline strategy of how the Manuka Road reservoir will interact with the transmission system and WTP. This review also recommends that the new chlorine contact tank is built before the Manuka Road Reservoir.

The MWH Technical Memorandum No.2 which is included as **Appendix A** presents the findings of the technical review of the proposed new Manuka Road reservoir and is structured as follows:

- A summary of the background information referenced to date

- Technical review
    - Agreed assumptions
    - Basis of design
    - Reservoir interfaces
    - Site constraints
    - Revised reservoir layouts
    - Un-resolved issues
- Further investigations required

As a result of the technical review it was confirmed that the preferred location of the new reservoirs was on the parcel of land bounded by Woodland Park Road and Manuka Roads which is the site adopted by SKM for the concept design. The elevation of this site permits a reservoir TWL in the order of RL132m which is the level preferred by Watercare.

However, in developing alternative site layout options for the new Huia WTP it was identified that the same site would also be ideal for the new treatment plant in which case the proposed new reservoir would need to be located on the northern side of Woodland Park Road directly opposite from the existing WTP. The optimal TWL at this alternative location would be RL128 to facilitate gravity flow from the new WTP into the reservoir.

Watercare undertook further network modelling to assess the impact of a lower TWL for the reservoir and concluded that a TWL of RL128m could be accommodated within the current planning horizons. Correspondence from Watercare confirming the suitability of the RL128m TWL is attached as **Appendix U.**

The surface levels at both sites will result in the reservoirs being virtually fully buried and ground conditions suggest that a piled foundation will also be required.

2.3 Sludge Dewatering Building

The key reference documents relating to the design of the sludge handling upgrade are:

- Huia WTP Facility Plan Design Criteria June 2010 – Beca,
- Huia WTP Facility Plan Unit Process Data Sheets June 2010 – Beca,
- Huia WTP Sludge System Investigation Stage 1A – Design Basis Report February 2011 – MTL.

The proposed upgrade to the sludge handling facilities comprises the following key elements:

- Duty standby sludge balance tanks 2x40m3 to replace the undersized wet well,
- New 13m diameter sludge thickener,
- One new washout water thickener when the BAC filter upgrade is undertaken,
- Separate poly systems for clarification and sludge thickening,
- Duty standby thickened sludge storage tanks 2x100m3,
- Duty standby sludge dewatering plant sized for N-1 duty at design load, N duty at max load, and;
- Chemical storage based on 30 days at maximum flow and average dose.

The MWH Technical Memorandum No. 5 which is included in **Appendix B** presents the findings of the high level technical review of the design of the sludge handling facilities for the purpose of revising the sludge dewatering building layout for inclusion in the overall site plan options development and is structured as follows:

- A summary of the background information referenced to date
- Technical review of the Sludge dewatering concept design including
    - Agreed assumptions
    - Concept functional requirements
    - Current concept design sludge unit sizing
    - Concept design piping and instrumentation diagram
    - Plant interfaces where appropriate
    - Site constraints
    - Current & new concept design layout
    - HSNO, HSE and OHS requirements

As a result of the technical review and agreed assumptions, the sludge dewatering building layout housing the filter presses was revised and is included in the overall site layout options development. The revised building layout is presented in the general arrangement drawing included in the **Appendix M**.

The proposed site layout assumes that the existing sludge thickener is decommissioned and provides for two new 13m diameter thickeners to be constructed adjacent to the new dewatering facility.

2.4 PAC Plant

The key reference documents relating to the design of the PAC storage and dosing upgrade are:

- Huia WTP Facility Plan Design Criteria June 2010 – Beca,
- Huia WTP Facility Plan Unit Process Data Sheets June 2010 – Beca,
- Ardmore and Huia WTP PAC Plant Upgrade Concept Design April 2008 – MJM.

The proposed upgrade to the PAC storage and dosing facility comprises:

- Semi-automatic duty/standby bulk bag unloading system with 2 No. 6m3 intermediate storage hoppers. Automatic duty/standby batch preparation with volumetric feeders for PAC dose control, wetting cone, eductor and carrier feed water.
- 15m x 8.5m building to house equipment and store 40 bulk bags of PAC (19.6 tonnes) to provide 14 days storage at average dose and maximum flow (140Ml/day).

The MWH Technical Memorandum No. 4 which is included in **Appendix C** presents the findings of the high level technical review of the PAC upgrade for the purpose of revising the PAC building layout for inclusion in the overall site plan options development and is structured as follows:

- A summary of the background information referenced to date,
- Technical review of the PAC concept design including
  - Agreed assumptions
  - Concept functional requirements
  - Concept design piping and instrumentation diagram
  - Plant interfaces where appropriate
  - Site constraints
  - HSNO, HSE and OHS requirements
  - Revised concept design PAC unit sizing (based on revised basis for design)
  - Revised concept design layout.

As a result of the technical review and agreed assumptions, the PAC storage and dosing building layout housing the bulk PAC storage area and hoppers was revised and is included in the overall site layout options development. The revised building layout is presented in the drawing included in the **Appendix M**.

2.5 Muddy Creek Pipeline

Watercare have identified a need for a full capacity overflow pipeline to dispose of overflows and off-specification discharges from the WTP. The nominated outfall location for the overflow pipeline is an estuarial headwater letting into Manukau Harbour. A previous study has short-listed route options between the WTP and the discharge point, with further work required to determine the preferred pipeline route.

In order to develop the overall concept layout plan for Huia WTP, review and development of the Muddy Creek pipeline concept has focussed on aspects of the design that impact on the WTP site layout, e.g. interface points with the existing and future WTP and ensuring that adequate space is retained in the layout for the inlet chamber / pipework and potentially on-site treatment of off-specification discharges.

The key reference documents for the Muddy Creek pipeline concept design are:

- Huia Overflow/Off-spec Pipeline Route Optioneering Report Vol 1, MWH, June 2010,
- Huia Overflow/Off-spec Pipeline Route Optioneering Report Vol 2, MWH, August 2010,
- Huia WTP Hydraulics / Overflow Investigation, MTL, Aug 2003.

The MWH Technical Memorandum No.3 which is included as **Appendix D** presents the findings of the technical review of the proposed Muddy Creek Pipeline upgrade and is structured as follows:

- A summary of the background information referenced to date,
- The current status of the concept design
- Technical review of the Muddy creek Pipeline concept design including:
    - Design criteria & agreed assumptions
    - Overflow locations
    - Interfaces with existing WTP
    - Interfaces with new/upgraded WTP
    - Reservoir overflows
    - Off-spec discharge scenarios
    - On-site treatment of discharges
    - Unresolved issues
- Further investigations required.

As a result of the technical review and the subsequent workshop with Watercare, the following items have been agreed as the basis of design for development of the WTP layout:

- A list of overflow and off-specification discharge locations and conditions used for layout development has been submitted to Watercare. The list is included in **Appendix F**.
- In the future, overflows from the Titirangi 1 and 2 reservoirs will pass to the Muddy Creek pipeline, rather than discharge to Bishops Stream. The preferred option for transferring overflows to the WTP site is to pressurise the treated water aqueduct, therefore the future site layout must be hydraulically compatible with a pressurised aqueduct.
- All or part of the existing lagoon will be retained to provide a facility to manage off-specification discharges prior to discharge to the Muddy Creek pipeline. Retention of this storage facility will enable off-spec flows to be detained and treated. Treatment may include settling of solids, pH adjustment, de-chlorination, dilution, etc. The requirements and methods for treatment of off-spec discharges will be established during design development.
- The interface between the WTP and the Muddy Creek pipeline will be a chamber constructed in the south west corner of the lagoon. This interface is compatible with the existing WTP and the short-listed Muddy Creek pipeline route options. The future layout options must be compatible with an interface chamber in this location. An indicative plan and elevation for the interface chamber are included in **Appendix E**.

2.6 Site Development Constraints

2.6.1 Environmental

The WTP is physically constrained by Woodlands Park Road to the West and North and steep gradients and bush to the South and East. A survey of ecological significance undertaken for Watercare by Tonkin & Taylor established that there are a large number of high value trees and native species that should be retained where possible. These areas are indicated in **Figure 2.2** below. Of most significance is the Kauri tree on the corner of Woodlands Park Road and Manuka Road.

The site is surrounded by residential properties and a screen or buffer should be provided in the future upgrades, where relevant, to limit any visual, site lighting and noise impacts. It is recommended that any new works are located at least 10m from the existing roadway and 20m from any existing properties to provide sufficient buffer. Buildings should be designed with adequate noise control. The buffer should be a combination of trees and shrubs to provide a visual barrier for the works. Properties along the northern ridgeline will be able to look down onto the plant so muted finishes to building and structures should be provided.

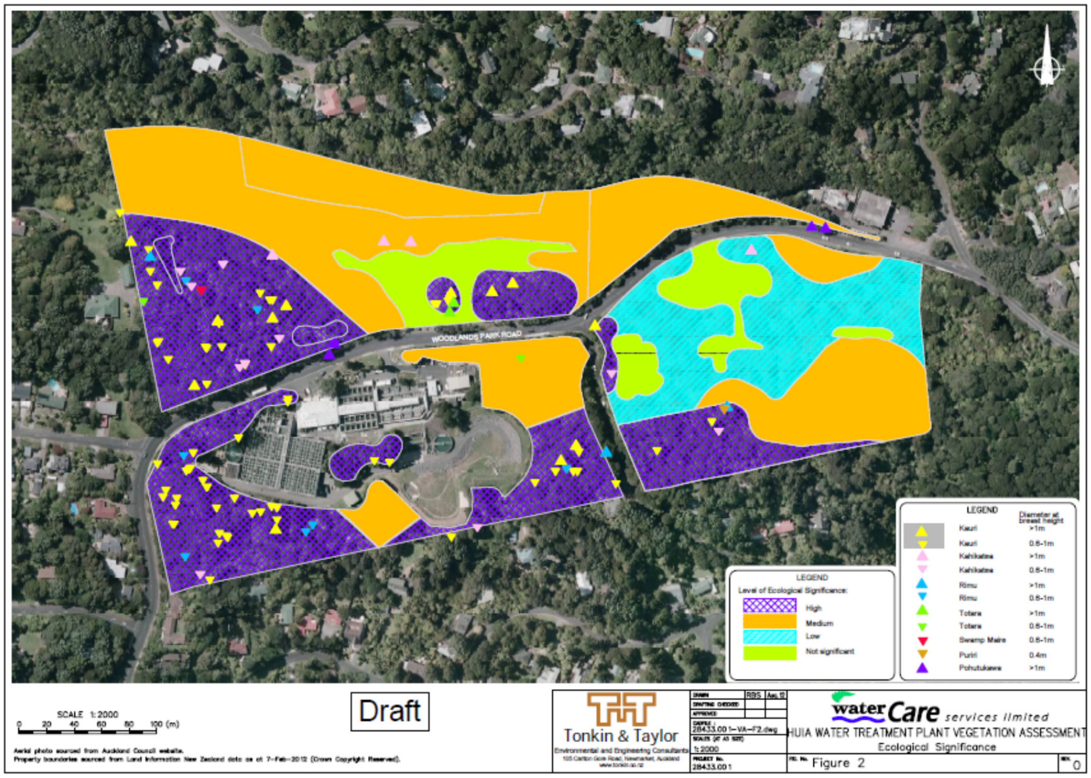


Figure 2-2 Vegetation Assessment Plan

The existing WTP also has some heritage features scheduled in the Waitakere District Plan which should be retained where possible, these being:

- The form and scale of the 1928 Huia Filter Station building and 1947 additions, including decorative facade elements and excluding later additions,
- Original (1928-1947) windows and doors,
- The basic form of the 1928 filter tanks (but not surfaces, which may be subject to maintenance work and repair from time to time), and;
- Significance attributed to historical, architectural and pattern values.

2.6.2 Physical

The existing WTP site is physically constrained by Woodlands Park Road to the West and North and bush to the South and East.

The topography of this site is challenging. The land slopes steeply away from Woodlands Park Road constraining development in the Northern section and limiting access road options. Steep gradients in the Eastern and Southern sections will necessitate significant earthworks and temporary works to facilitate construction of large structures.

The Manuka Road site and area to the North of Woodlands Park Road also have sloping terrain, but to a lesser extent than the main site.

Limited topographical survey undertaken at the site suggests that the LiDAR was sufficiently accurate for the purposes of site layout development, however a complete survey would be recommended before proceeding with any design.

The proximity to neighbouring properties, the need to retain at least part of the existing lagoon and the presence of a watercourse in the South East section of the site are other notable physical constraints. Sightlines for traffic entering and exiting the WTP site have also been considered as part of the site layout development.

MWH undertook a preliminary Geotechnical Appraisal Report in December 2012 to cover areas not included in historic studies. The summary report is included as **Appendix Q** and suggests further field studies that will be required to better understand the local conditions such as slope stability and foundation requirements.

2.6.3 Operational

Discussions with Watercare operations staff provided the following insights:

- Operational preference is not to have a treatment plant which has works on both sides of Woodlands Park Road,
- WTP operational capacity needs to be maintained during the upgrade and requirements for any cut-in shutdowns minimised,
- New facilities should include appropriate levels of redundancy,
- At least part of the existing onsite storage lagoon should be maintained to manage overflow quality,
- Good access off Woodland Park Road, one way roads or turnabouts preferable to requiring truck reversing for deliveries, and;
- The new gas chlorination facilities should be maintained if possible.

2.7 Site Layout Options Development

As part of Technical Memorandum No. 1 - Upgrade Treatment Process and Layout a set of five preliminary site layout configurations were proposed:

1. New process units located within the general constraints of the existing site area south of Woodlands Park Road,
2. New process units located on the north side of Woodlands Park Road,
3. New process units located on both sides of Woodlands Park Road,
4. Relocation of Woodlands Park Road with the new process units located to the north of the existing plant,
5. New treatment plant constructed on the Manuka Road site.

For layout configurations 1 to 4 the new service reservoir was located at Manuka Road site and for configuration 5 the new reservoir will be located on the north side of Woodland Park Road.

These alternative configurations were considered by Watercare with comments provided to assist in the further development of site layouts. The five original layouts options were further developed and expanded with sub-options to create a total of 15 alternative layout options, namely 1A, 1B, 1C, 2A, 2B, 2C, 2D, 2E, 3A, 3B, 4A, 4B, 5A, 5B, 5C. The layout drawings are included in **Appendix H**.

2.8 Initial Shortlisting of Site Layout Options

MWH prepared Technical Memorandum No.6 which described 14 alternative layout options and was used as support material for the initial shortlisting workshop which was held on 30th November 2012. Watercare developed project specific criteria for the MCA tool which was used to assess and score each option. A second internal follow up workshop was then held by Watercare to finalise the short-listed options and development of the 15th option (2E).

Technical Memorandum No.6, the 15 site layout option plans and the MCA work sheet are attached as **Appendices I, H and J** respectively**.**

Site layout options which involved having a new treatment plant spread across both sides of Woodlands Park Road (i.e. all Option 3 variants) or a new treatment plant located entirely on the north side of Woodland Park Road (i.e. all Option 4 variants) all scored poorly. Within the three remaining overall options variants 1B, 2E and 5B were ultimately shortlisted as those to be taken forward into the detailed assessment phase.

3 Options Development and MCA

3.1 Presentation of Shortlisted Options

3.1.1 Option 1B

3.1.1.1 General Description

Site Layout Option 1 provides to replace the existing Huia WTP within the existing site area and construct the new service reservoirs on the Manuka Road site. Sub-option 1B was the preferred configuration for the various site layouts developed which retained the new plant on the existing site.

The BAC filter comprises the 14 cells in a double sided arrangement to limit overall length. The width matches the ozone contact tank which is butted against the filters. Once the new filters are constructed the existing filters will be demolished to site the new DAF tanks. The overflow storage lagoon has been reduced in size to provide for the CCT/TWT/PS structure which is located in an east-west configuration to fit on the site. The location of the ozone BAC filters has been selected to enable the existing chlorine building to be maintained and to be clear of the treated water tunnel. Support of the open excavation will be required to protect the chlorine building and treated water tunnel during construction. The existing washout thickener is retained and three new thickeners constructed. The existing sludge thickener is decommissioned. New sludge dewatering and PAC facilities have been located to enable them to be built prior to the WTP process upgrade.

A layout drawing of the updated Option 1B is attached in **Appendix L**.

3.1.1.2 Modifications to the Layout following the Initial Shortlisting

A number of modifications to the shortlisted layout have been undertaken in the further development of this option:

- The existing chlorine building has been retained by moving the new ozone/BAC filters and CCT further south and including the waste wash water recovery tank underneath the BAC filters,
- A new upwash tank was to be located adjacent to the existing tank but will now be included under the BAC filters. This will enable the existing tank to be decommissioned and the land on the north side of Woodland Park road to be freed of encumbrance,
- The FTW tank was relocated from under the new DAF tanks to under the new BAC filters as this better suited the hydraulic levels of the structures,
- The sludge dewatering facility has been moved to avoid the need for a substantial retaining wall and reduce visual impact to adjacent landowners given the overall height of this building. A second new sludge thickener was added and the two units were sited to best suit the location of the new dewatering building,
- The generator and switch room needed to be relocated to suit construction sequencing and has also been re-sited more central to the plant loads. This move also required the new waste wash water thickener to be relocated within the on-site storage lagoon area, and;
- Site access roads have been adjusted to ensure suitable grades can be achieved.

Cross sections and hydraulic profiles for Option 1B are attached in **Appendix P**.

3.1.1.3 Pumping Requirements

Inflow to the plant will be by gravity. Once the new DAF clarifiers are installed the existing inlet pump station can be decommissioned.

Outflows from treated water tanks to Manuka Road reservoir will need to be pumped max 140Ml/d @ 21m 480kW. Outflows to Titirangi reservoir will also need to be pumped as the design water level in the TWT is below the level of the existing aqueduct max 140Ml/day @ 5m 115kW.

3.1.1.4 Network Connections

Inlet connection to raw water aqueduct with 2 No. 1200mm pipes.

Outlet connection to the Titirangi aqueduct will be via 1200mm pipe to a new chamber at eastern end of the site adjacent to new BAC filters.

Outlet connection to Manuka Road reservoir will be a 1200mm pipe.

3.1.1.5 Process Unit Levels (TWLs)

DAF Inlet	118.87
DAF	118.37
Ozone	118.25
BAC	117.80
CCT/TWT	113.42
Manuka Road reservoir	132.00

3.1.1.6 Staging Issues

- Muddy Creek overflow pipeline - no impact on timing of works,
- PAC facility – no impact on timing of works,
- Sludge facility – no impact on timing of works,
- Manuka Road reservoir – new CCT/TWT, pump station and connection pipeline required, although the CCT/TWT could be deferred if the Titirangi and Manuka Road reservoirs were operated at higher levels to maintain a minimum chlorine contact time but this creates operational difficulties/impacts in pH control and extending the water treatment activity beyond the actual WTP site. At least one of the TWTs would need to be constructed with the pump station to provide balance storage for pump operation,
- Staging of the new WTP construction is critical. Assuming that a new CCT/TWT, sludge dewatering (including two new sludge thickeners) and PAC facility are already in place:

  1. Construct new ozone facility and BAC filters, filter backwash balance tank, filter upwash water tank, filter waste wash water tank, second washout thickener, chemical storage and dosing facility, power supply upgrade and standby generation capacity upgrade/replacement
  2. Connect existing clarifiers to new Ozone/BAC filters
  3. Demolish existing filters and the old upwash tank, construct new DAF tanks
  4. Connect new DAF tanks to raw water supply aqueduct
  5. Demolish existing clarifiers and construct new admin/office facilities.

3.1.1.7 Advantages

- Maintains facilities on single existing site,
- Installation of Muddy Creek, Sludge and PAC upgrades can proceed immediately and on existing site,
- Lowest environmental impact,
- New admin/office facility,
- Gravity inflow, and;
- Existing chlorine building retained.

3.1.1.8 Disadvantages

- Constrained site will increase construction costs, especially if the CCT/TWT is constructed early,
- Low lift pumping to Titirangi aqueduct,
- Temporary connection from existing clarifiers to new ozone/BAC filters,
- Progressive construction of facilities will significantly extend construction period and increase costs,
- Operational impacts during construction will be high, multiple connections and full plant shutdowns required,
- Virtually no space for contractors site facilities and laydown within the existing site,
- Temporary control and office facilities required during construction of DAF tanks and new admin/office, and;
- Reduced overflow storage lagoon volume.

3.1.2 Option 2E

3.1.2.1 General Description

Site Layout Option 2 provides to relocate part of Woodland Park Road in order to provide additional area to locate the new WTP. Sub-option 2E was the preferred configuration for the various site layouts developed as it involves the shortest length of relocation of Woodland Park Road providing just sufficient additional site area to locate a new raw water pump station and DAF unit on the existing roadway.

Once the new pump station, DAF units and chemical facilities are constructed the existing clarifiers can be demolished to provide a platform for the new Ozone and BAC filters. The upwash, FTW and waste wash water tanks will be located under the BAC filters to elevate the overall structure to the required hydraulic grade. The CCT/TWT will be located within part of the eastern end of the existing overflow storage lagoon and at a level to permit gravity flow to Titirangi Reservoirs via the existing aqueduct. The new sludge dewatering and PAC facilities are located in the same place as for site layout Option 1B.

The new service reservoir will be located on the Manuka Road site.

A layout drawing of the updated Option 2E is attached in **Appendix L**.

3.1.2.2 Modifications to the Layout following the Initial Shortlisting

A number of modifications to the shortlisted layout have been undertaken in the further development of this option:

- The FTW and upwash water tanks were relocated from under the new DAF tanks to under the new BAC filters as this better suited the hydraulic levels of the structures,
- The waste wash water recovery tanks were relocated under the BAC filters to reduce site excavations and better suit the hydraulic level of the structure,
- The PAC facility was relocated to the same location as proposed in Option 1B. This enables the PAC facility to be constructed in advance of any sludge facility upgrade and frees up the area near the plant entrance for the new chemical storage facility which otherwise required significant retaining walls and was highly visible to adjacent landowners,
- The sludge dewatering facility has been moved to the same location as proposed in Option 1B. This avoided the need for a substantial filling and road works within the storage lagoon and reduces visual impact to adjacent landowners given the overall height of this building. A second new sludge thickener was added and the two units were sited to best suit the location of the new dewatering building, and;
- The generator and switch room needed to be relocated to accommodate the revised sludge dewatering building location and has been re-sited more central to the plant loads.

Cross sections and hydraulic profiles for Option 2E are attached in **Appendix P**.

3.1.2.3 Pumping Requirements

Inflow to the plant is pumped at a maximum of 140Ml/day @ 6m (148kW). This flow rate excludes all recycle flows from the filter to waste and wash water recovery systems which are returned to the mixing chamber at the DAF inlet.

Outflows from the TWTs to the Titirangi aqueduct will be by gravity. The overall plant hydraulic levels would need to be raised approximately two metres or a separate low lift pumping station be provided if the Titirangi aqueduct was internally sleeved and pressurised in future.

Outflows from Treated Water tanks to Manuka Road reservoir to be pumped max 140Ml/d @ 18m 444kW

3.1.2.4 Network Connections

Inlet pump station connection to raw water aqueduct where it crosses under Woodland Park Road with 2 No. 1200mm pipelines.

Outlet connections to existing Titirangi aqueduct and to Manuka Road Reservoir via 1200mm pipelines.

3.1.2.5 Process Unit Levels (TWLs)

DAF Inlet	122.00
DAF	121.52
Ozone	120.22
BAC	120.78
CCT/TWT	116.65
Manuka Road reservoir	132.00

3.1.2.6 Staging Issues

- Muddy Creek overflow pipeline - no impact on timing of works,
- PAC facility – no impact on timing of works,
- Sludge facility – no impact on timing of works,
- Manuka Road reservoir – new CCT/TWT, pumpstation and connection pipeline required, although the CCT could be deferred if the Titirangi and Manuka Road reservoirs were operated at higher levels to maintain a minimum chlorine contact time but this creates operational difficulties/impacts in pH control and extending the water treatment activity beyond the actual WTP site. At least one of the TWTs would need to be constructed with the pump station to provide balance storage for pump operation,
- Staging of the new WTP construction is critical. Assuming that a new CCT/TWT, sludge dewatering (including 2 new sludge thickeners) and PAC facility are already in place:

1. Relocate Woodland Park Road
2. Construct new chemical storage and dosing facility and associated site access road improvements
3. Construct new inlet pump station and connection to raw water aqueduct, DAF unit, upgrade power supply and standby generation capacity
4. Temporary connection of DAF to existing filters
5. Demolish existing clarifier, old thickener and centrifuge building and standby generator
6. Construct new Ozone tanks and BAC filters, FTW tank, wash water balance tank, filter upwash water tank, second washout thickener
7. Connect DAF to the new Ozone contact tank and the BAC filters to the CCT
8. Provide temporary control and admin facilities
9. Demolish existing filters
10. Refurbish/replace admin/office facilities.

3.1.2.7 Advantages

- Increased site area consolidated with existing plant,
- Installation of Muddy Creek, Sludge and PAC upgrades can proceed immediately and on existing site,
- Low environmental impact,
- Existing chlorine building retained.

3.1.2.8 Disadvantages

- Road relocation will require substantial consenting,
- Temporary connection from new DAF to existing filters,
- Progressive construction of facilities will substantially extend construction period and increase costs,
- Operational impacts during construction will be high, multiple connections and full plant shutdowns required,
- Virtually no space for contractors site facilities and laydown within the existing site,
- Temporary control and office facilities required during construction of DAF tanks and new admin/office,
- Reduced overflow storage lagoon volume.

3.1.3 Option 5B

3.1.3.1 General Description

Site Layout Option 5 provides to construct the new Huia WTP on the less environmentally sensitive Manuka Road site and the new service reservoir on the land north of Woodland Park Road opposite the existing WTP. Sub-option 5B was the preferred configuration for the various site layouts developed using the Manuka Road site for the new WTP.

The proposed PAC storage and dosing facility is located in the same location as proposed for Options 1B and 2E above. As PAC use is infrequent (especially once the new ozone/BAC process is installed), this facility could be retained in future once the WTP is relocated to Manuka Road site or the entire facility could be relocated. The new sludge dewatering facilities and CCT/TWT are located with the new WTP and would be isolated assets if constructed in advance of the new WTP. A new admin/workshop building is proposed. The DAF tanks have a new upwash water tank and the FTW tank underneath to provide the required hydraulic grade and foundation support. The BAC filter footprint is 14 cells in back to back configuration. The CCT/TWT tanks are located such that they will feed the new service reservoir by gravity flow. The optimum TWL for the new service reservoir is RL128m based on the available hydraulic grade from the WTP. A service reservoir TWL of RL132m would likely require low lift pumping from the CCT/TWT.

The layout plan includes a temporary outlet pump station to feed the new CCT with gravity flow back to the new service reservoir. Alternatively, if WSL do not want to build the CCT on a separate site and have a temporarily stranded asset, they could connect the temporary PS directly to the new reservoir and use the new reservoir to provide the necessary chlorine contact time. Using the proposed future inlet pump station as the temporary outlet pump station was considered but required the pump station inlet well to be approximately 6m deeper and a deep connecting pipeline constructed from the existing WTP outlet which would be difficult to construct within an operating plant.

A layout drawing of the updated Option 5B is attached in **Appendix L**.

3.1.3.2 Modifications to the Layout following the Initial Shortlisting

A number of modifications to the shortlisted layout have been undertaken in the further development of this option:

- The PAC facility was relocated to the same location as proposed in Options 1B and 2E. This enables the PAC facility to be constructed in advance of any sludge facility upgrade. This also enables the raw water pumping station to be located on the low side of the existing aqueduct and will reduce the ecological impacts of this structure,
- The locations of the sludge dewatering facility and the chemical storage facility were swapped at the suggestion of WSL. The two sludge thickeners were sited to best suit the location of the new dewatering building,
- The generator and switch room was relocated to accommodate the revised sludge and chemical building locations,
- Space for a new gas chlorine building was included together with a relocated PAC facility if required.

Cross sections and hydraulic profiles for Option 5B are attached in **Appendix P**.

3.1.3.3 Pumping Requirements

Inflow to the plant is pumped at a maximum of 140Ml/day @ 21.5m (530kW). This flow rate excludes all recycle flows from the filter to waste and wash water recovery systems which are returned to the mixing chamber at the DAF inlet.

Outflow from the TWTs to the new service reservoir is by gravity. A connection off this pipeline into the existing aqueduct near the outlet of the existing WTP will be provided to supply Titirangi 1 and 2. A separate new direct connection to Titirangi from this site might be considered in future rather than pressurising the existing aqueduct.

3.1.3.4 Network Connections

Inlet pump station connection from the raw water aqueduct where it crosses under Woodland Park Road with 2 No. 1200mm pipes

Outlet connection to the new Service Reservoir and the existing Titirangi aqueduct via 1200mm pipelines

3.1.3.5 Process Unit Levels (TWLs)

DAF Inlet	134.72
DAF	134.24
Ozone	134.12
BAC	133.67
CCT/TWT	129.29
New Service Reservoir	128.00

3.1.3.6 Staging Issues

- Muddy Creek overflow pipeline - no impact on timing of works,
- PAC facility – limited impact on timing of works, can be relocated in future if needed,
- Sludge facility – the best option would likely be to provide some upgrade to the existing works rather than construct a new facility in advance of the remainder of the new WTP, however the merits of this should be further addressed as the existing facility has limited capacity to manage increased sludge loadings due to PAC.,
- New Service Reservoir – new CCT/TWT would be on a remote site which may be considered impractical for chemical dosing purposes. The CCT/TWT could be deferred and the service reservoirs used for achieving the chlorine contact time. A temporary pump station with balance tank for pH and pump operation control would be required. A minimum operational water level in the Titirangi reservoirs and the new service reservoir would be required. For simplicity of network operation it may be better to have all flows go to the new service reservoir and then discharge back into the Titirangi aqueduct during this period.

The new WTP would be constructed in a single step with the sludge dewatering and CCT/TWT.

3.1.3.7 Advantages

- Low environmental impact,
- Complete new WTP,
- No impact on existing plant operation,
- Least impact on adjacent residents,
- Clear Greenfield site for construction of the works with sufficient space for contractor site facilities and laydown areas (exact areas dependant on works sequencing),
- Installation of Muddy Creek and PAC upgrades can proceed immediately and on existing site
- Existing WTP site could be released for other uses (excluding the overflow storage lagoon area which is to be retained),
- Future new pipeline to Titirangi reservoirs enabling the aqueduct to be abandoned.

3.1.3.8 Disadvantages

- Sludge upgrade and new CCT/TWT would need to be deferred until the new WTP is constructed,
- Optimum level for new service reservoir TWL is only RL128m,
- Approximately 13m wasted head when discharging to Titirangi,
- Temporary pump station required to supply new CCT if constructed ahead of the new WTP.

3.2 Selection of Preferred Option

The three shortlisted options have been compared on the basis of construction and operational impacts within the MCA assessment and estimated costs.

3.2.1 Multi-criteria Analysis (MCA)

The project specific MCA tool which was used for the initial shortlisting process has also been used with the three shortlisted options. A copy of the MCA spreadsheet output is included as **Appendix N**.

The results of the MCA assessment are summarised in **Table 3.1** below. Option 5B scores significantly better than the other two options during the construction phase as it is located on a greenfield site and has least impact on all stakeholders during construction. During the subsequent long term operations phase the three options have similar overall impacts/benefits and as such the relative scores are similar.

Table 3-1 MCA Score Summary

MCA	Option 1B	Option 2E	Option 5B
Construction Phase	0.35	0.41	0.68
Operations Phase	0.67	0.71	0.77
Total Score	0.59	0.63	0.75
Rank	3	2	1

3.2.2 Comparative Costs

Preliminary capital costs for the three options were developed and are shown in the **Table 3.2** below. Additional cost detail is included in **Appendix O.** Option 5B has the lowest estimated capital cost as it is a greenfield construction and will be completed within the shortest duration. Option 1B has the highest estimated capital cost due to the additional difficulty of construction within the confined site amongst an operating plant and the progressive construction and demolition of works requires an extended construction period. Option 2E also has a longer construction period than Option 5B which impacts on the overall cost.

Operating costs for the three options are not considered to be substantially different with the exception of the pumping costs. A net present cost (NPC) assessment of inlet and outlet pumping costs was undertaken for the three options over the period 2020 to 2060 and is also provided in **Appendix O**. As Option 1B has the lowest overall pumping costs, for the purposes of the overall cost comparison the relative increase in NPC pumping costs for Options 2E and 5B over Option 1B have been included in the table. From the assessment it can be seen that the relative difference in pumping costs (power supply) is not significant in comparison to the differences in overall capital cost of the works.

Table 3-2 Comparative Cost Summary

Costs	Option 1B	Option 2E	Option 5B
Capital Cost $M	140.3	135.7	132.7
Additional Pumping NPC $M	-	1.4	3.5
Total Cost $M	140.3	137.1	136.2
Rank	3	2	1

3.3 Conclusion and Recommendations

A two-stage optioneering and MCA process has been undertaken to identify layout options and assess them against agreed criteria, including non-priced attributes and cost. This process has resulted in the selection of Option 5B as the preferred layout option.

MWH recommend that the Option 5B layout is taken forward for further development. The impact of this selection on the four existing concept designs is discussed in Section 4.4.

4 Preferred Option Development

4.1 Map Layout

The preferred option layout is shown in Figure 4-1. A copy of the plan is also attached in **Appendix L**.

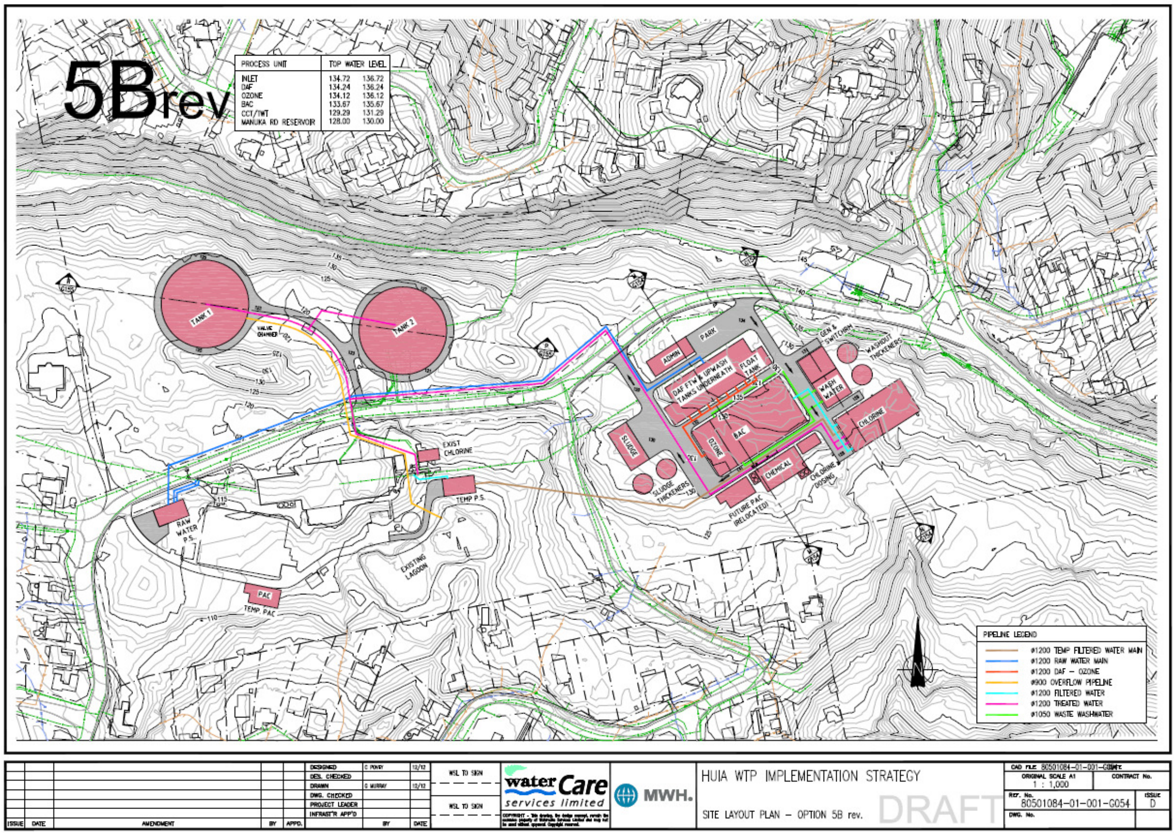


Figure 4-1 Preferred Option Layout Plan

4.2 Details and Explanation

The preferred option locates a complete new WTP at the less environmentally sensitive Manuka Road site. The WTP has been laid out to make use of the natural slope from north to south to enable gravity flow through the plant. The DAF tanks have the upwash water tank and the FTW tank underneath to provide the required hydraulic grade and foundation support. The wash water tank is a stand-alone open-top tank for ease of maintenance.

Access to the site is via Woodlands Park Road. The layout includes two access roads so as to provide separate entry and exit, creating a one-way loop for delivery vehicles. Access roads have been developed such that they are suitable for a B-train chemical delivery tanker.

The administration building and parking area are situated at the front of the WTP to enable simple separation of public and secure areas of the plant.

The new service reservoir is situated to the north of Woodlands Park Road. Space has been allocated for a second reservoir on the same site in the future.

4.3 Sections

Cross-sections through the preferred option are shown in Figure 4-2 and Figure 4-3. The section lines are illustrated on the preferred option layout plan. The section drawings are also attached in **Appendix P**.

The cross-sections illustrate the relative treatment structure levels and height above existing and future ground levels. The sections also indicate the extent of earthworks that will be required in order to construct the various treatment plant structures / buildings.

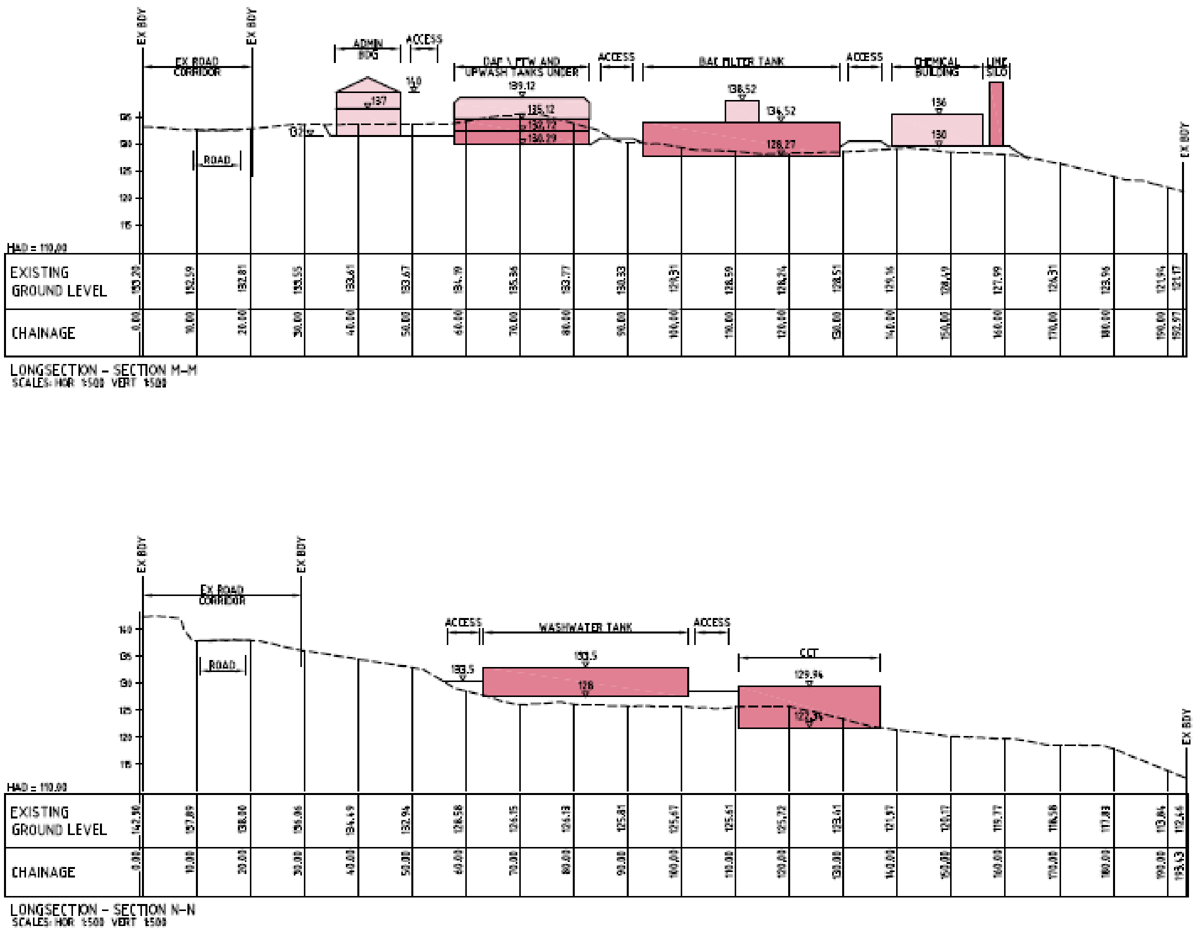


Figure 4-2 Preferred Option Sections – WTP Site

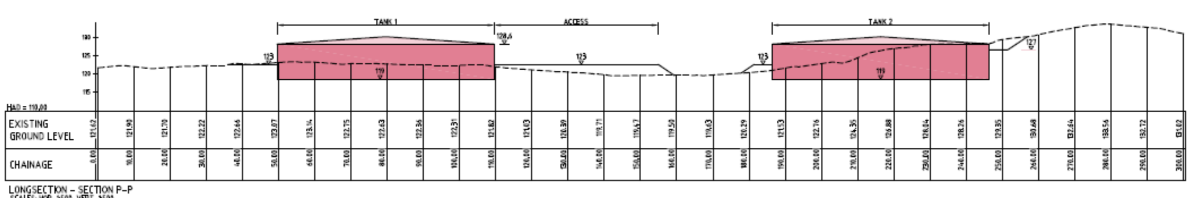


Figure 4-3 Preferred Option Sections – Service Reservoirs

4.4 Hydraulic Profile

The hydraulic profile through the preferred option is shown in

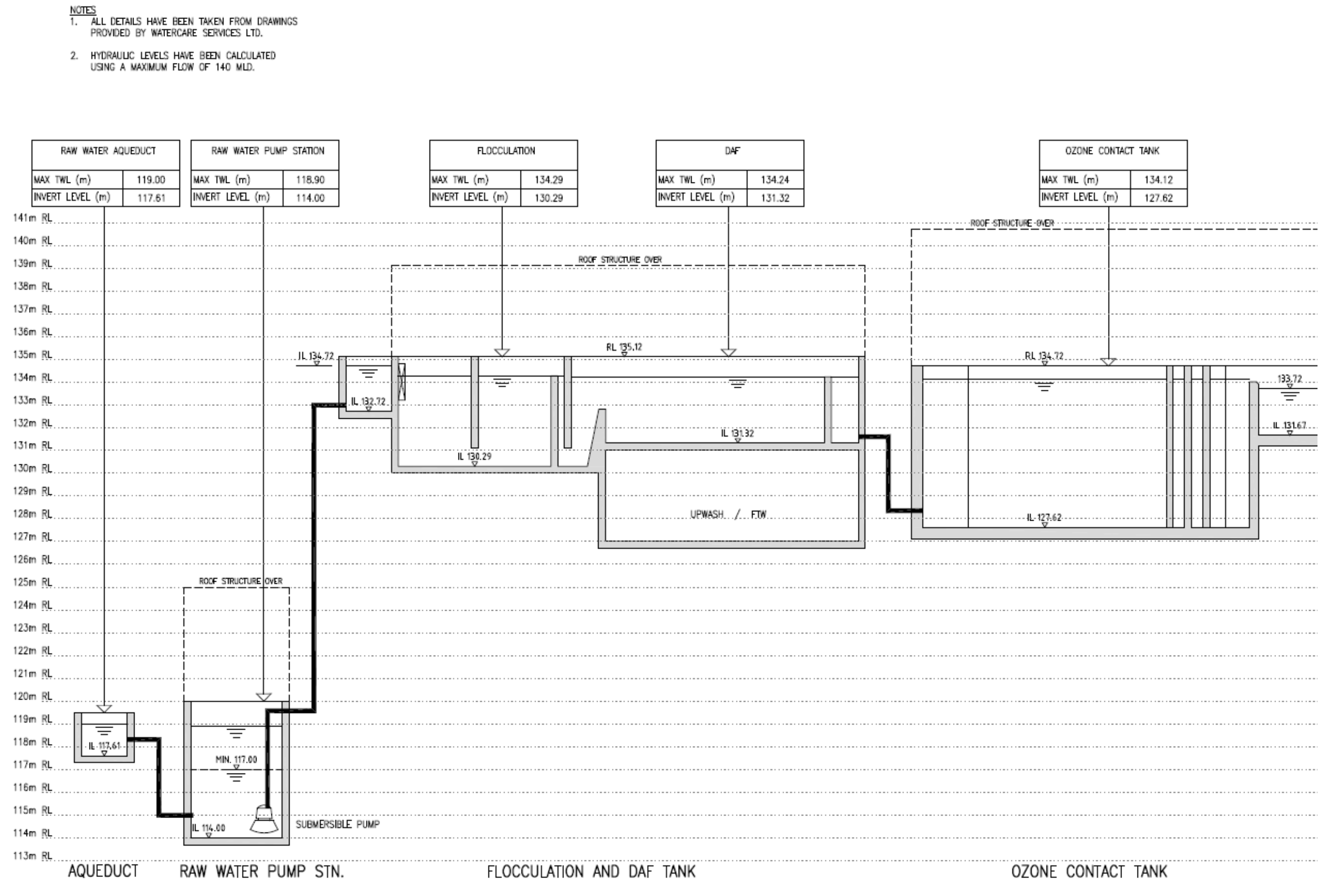


Figure 4-4 and

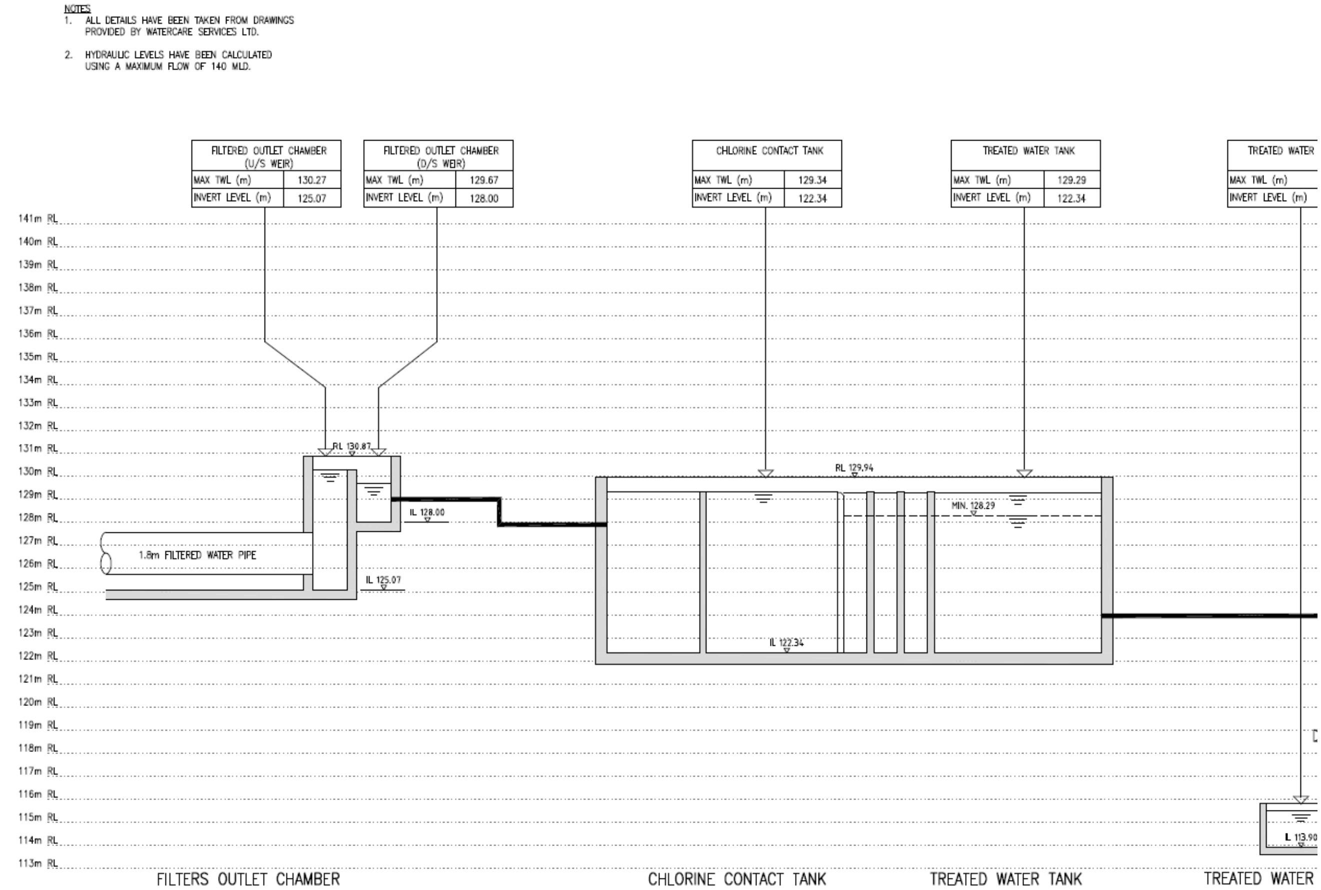


Figure 4-5. A copy of the plan is also attached in **Appendix P**.

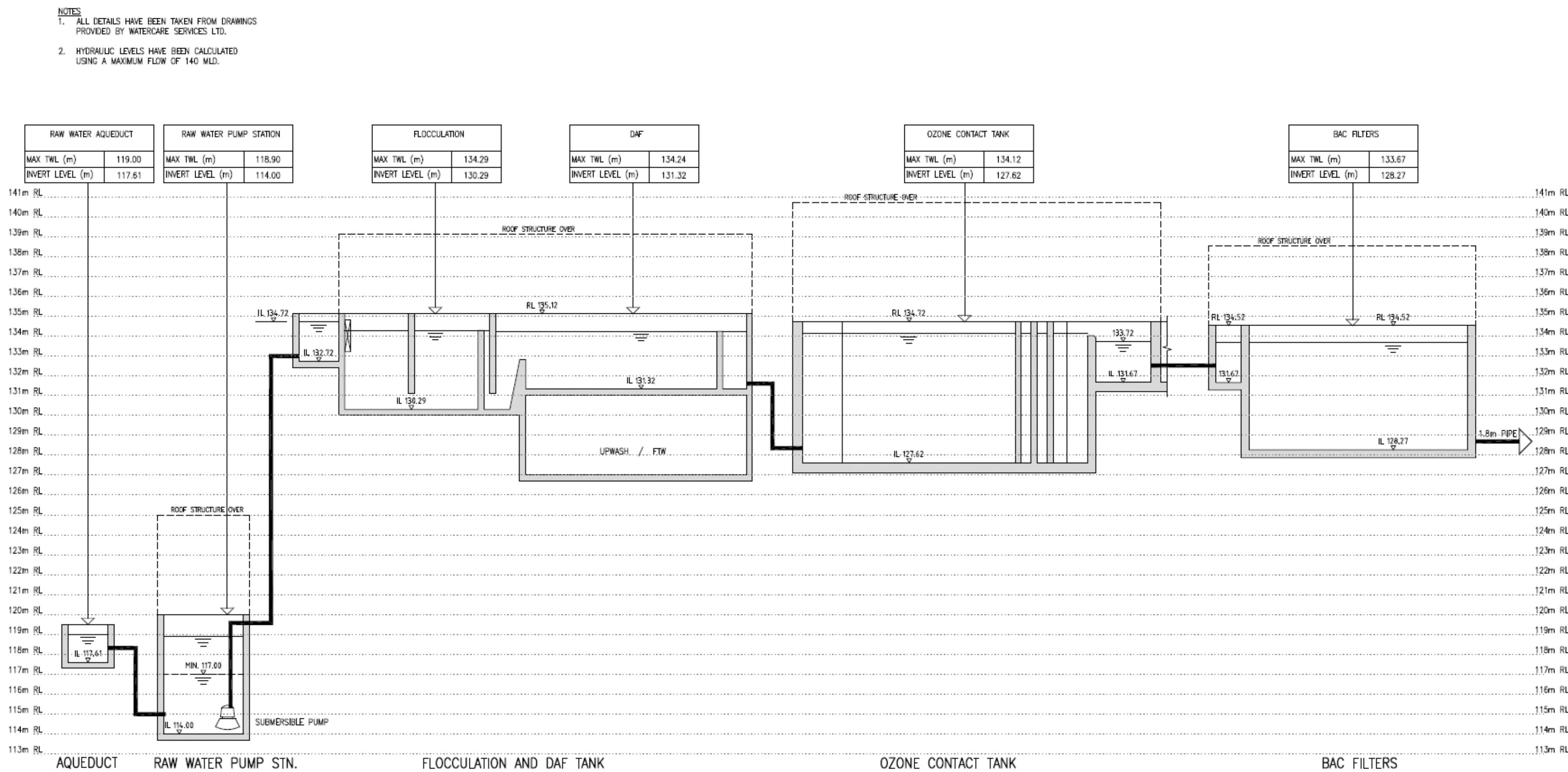


Figure 4-4 Preferred Option Hydraulic Profile – Sheet 1 of 2

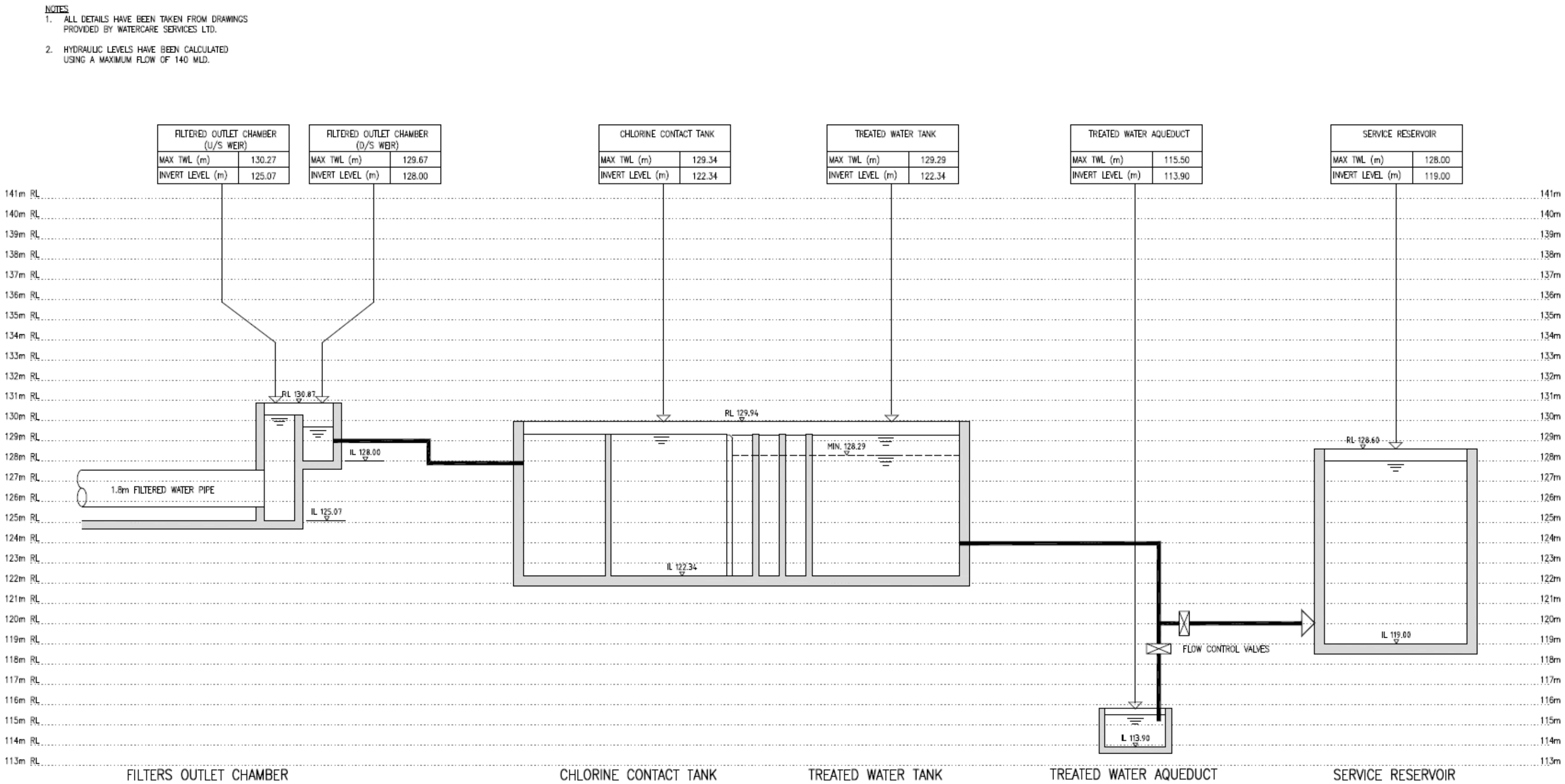


Figure 4-5 Preferred Option Hydraulic Profile – Sheet 2 of 2

4.5 Updated Costs

The preliminary capital cost estimate for construction of the preferred option is $132.7M. The four existing concept designs are not included in this estimate. Details of the cost estimate are included in Figure 4-6.

HUIA WTP - ORDER OF MAGNITUDE COST ESTIMATE

Excludes Sludge dewatering facility, PAC facility, Muddy Ck Pipeline and new reservoir

Item	Option 5B	Comment
Raw Water PS	$ 5,000,000	
DAF	$ 8,000,000	
Ozone	$ 10,000,000	
BAC	$ 16,000,000	
CCT/TWT	$ 5,000,000	
Temporary outlet PS	$ 3,000,000	Pumpstation and small TWT
FTW tank	$ 750,000	Includes return pumping
Upwash tank	$ 1,000,000	
Washwater balance tanks	$ 1,500,000	Includes transfer pumping
Washwater Thickeners	$ 1,200,000	2 No. Thickeners
Effluent return PS	$ 250,000	
Power supply and Generators	$ 6,000,000	Assumes new generator is required for the temporary TW PS
Chemical Systems	$ 7,000,000	
Site piping	$ 6,000,000	
Site works	$ 2,000,000	Includes excavation, road and drainage, retaining walls
Admin and workshop	$ 3,000,000	
SCADA	$ 2,000,000	
Demolition	$ 1,000,000	
Site mobilisation/demob	$ 2,000,000	Includes site facilities
Construction Site staff	$ 3,200,000	Estimated construction period is 2 years
Manuals and Commissioning	$ 500,000	
Spares and tools	$ 500,000	
Defects management	$ 500,000	
Site security/ traffic management	$ 500,000	
Transportation	$ 540,000	
Misc site costs	$ 2,000,000	
Sludge Thickeners		Not in WTP upgrade scope
Sludge Holding tanks		Not in WTP upgrade scope
Sludge dewatering facility		Not in WTP upgrade scope
Muddy Creek overflow pipeline		Not in WTP upgrade scope
PAC facility		Not in WTP upgrade scope
Sub-total	**$ 88,440,000**	
Contractors O&P	$ 10,612,800	12%
Design & approvals	$ 8,844,000	10%
Contract Management/QA/Safety	$ 2,653,200	3%
Sub-total	**$ 110,550,000**	
Contingency	$ 22,110,000	20%
TOTAL	**$ 132,660,000**	

Figure 4-6 Preferred Option Rough-order Cost Estimate

A basic cashflow estimate has also been developed for construction of the preferred option, based on starting in 2017 to match Watercare's AMP budget. The cashflow is shown in Figure 4-7 Preferred Option Cashflow Estimate – AMP Spend

Cashflow - Option 5B - Early Start

Design / consenting	3 years		-2	-1	0	1	2	3
Construction	2 years		2014	2015	2016	2017	2018	2019
Commissioning	0.5 years							
		AMP Spend				19.8	9.9	12.52
		Est Spend	$ 1,768,800	$ 2,653,200	$ 4,422,000	$ 59,458,000	$ 60,858,000	$ 3,500,000

and a more detailed version is attached in **Appendix S**.

A modified version of the cashflow, starting design and consultation next year (2014), is shown in Figure 4-8. A more detailed version is also included in **Appendix S.**

Cashflow - Option 5B - Match AMP Spend

Design / consenting	3 years		-2	-1	0	1	2	3	4
Construction	2 years		2017	2018	2019	2020	2021	2022	2023
Commissioning	0.5 years								
		AMP Spend	19.8	9.9	12.52	35.21	34.77	19.29	6.54
		Est Spend	$ 1,768,800	$ 2,653,200	$ 4,422,000	$ 59,458,000	$ 60,858,000	$ 3,500,000	$ -

Figure 4-7 Preferred Option Cashflow Estimate – AMP Spend

Cashflow - Option 5B - Early Start

Design / consenting	3 years		-2	-1	0	1	2	3
Construction	2 years		2014	2015	2016	2017	2018	2019
Commissioning	0.5 years							
		AMP Spend				19.8	9.9	12.52
		Est Spend	$ 1,768,800	$ 2,653,200	$ 4,422,000	$ 59,458,000	$ 60,858,000	$ 3,500,000

Figure 4-8 Preferred Option Cashflow Estimate – Early Start

An estimate of annual operation and maintenance costs has been developed for the preferred option. A summary of the OPEX cost is shown in Figure 4-9. A more detailed version is also included in **Appendix T.**

Alternative 1 - Using on-site oxygen generation

ITEM		**$/yr**
Power	$	526,447
Chemicals	$	1,083,262
Other	$	1,742,545
Total	**$**	**3,352,254**

Alternative 2 - Using LOX

ITEM		**$/yr**
Power	$	475,764
Chemicals	$	1,343,002
Other	$	1,739,945
Total	**$**	**3,558,711**

Figure 4-9 Preferred Option OPEX Estimate

4.6 Staging and Strategy

The greenfield nature of the preferred option site will enable unrestricted construction of the new WTP i.e. no phasing of the WTP build is required. The new plant can be constructed without disrupting operation of the existing plant and operation can be transferred from the existing to the new plant in a relatively short timeframe.

Construction of the new WTP must be carefully planned and the works sequenced to ensure that there are sufficient working areas and to minimise visual, noise and lighting impacts on adjacent properties and road users during construction and operation.

There are a number of new assets that we be constructed on or near the existing WTP site, some permanent, some temporary. Construction of the new assets must be planned and managed so as not to affect operation of the existing WTP. The assets and major considerations are listed below:

- Raw water pumping station – close to the existing sludge facility, Woodlands Park Road and the site boundary; provision of power supply; provision of back-up power; cut-in to the raw water aqueduct; large pipework under Woodlands Park Road; space for working areas
- Temporary PAC facility (discussed below) – significant earthworks; maintaining use of site road / access to southern part of WTP during construction; route of dosing lines to raw water aqueduct; space for working areas
- Temporary treated water pumping station (+ balance tank) – close to treated water aqueduct and lagoon; provision of power supply; provision of back-up power; cut-in to the treated water aqueduct; route of the temporary rising main to the new CCT or service reservoir; limited access; space for working areas
- Attenuation pond modifications (construction of Muddy Creek pipeline inlet structure and off-spec flow treatment (method tbc)) – close to site boundary and residential properties; significant earthworks; stormwater management; working in a live environment (lagoon); route of overflow and off-spec pipework into pond; maintaining use of site road during construction; space for working areas
- New service reservoir no. 2 - cannot be built until the existing upwash tank and pipework have been removed

Once the upgrade works are complete and the new WTP is fully operational, temporary works and facilities will be removed from the existing WTP site. The only operational assets remaining on the existing site will be the raw water pumping station, the attenuation pond (lagoon) and the treated water aqueduct downstream of the existing filter building. New treated water and overflow pipework will run through the existing site to the treated water aqueduct and attenuation lagoon. Access must be maintained to these assets for operation and maintenance.

The existing WTP will be decommissioned and made safe. Some structures may be demolished and removed but it is predicted that Watercare will retain the land and designation for future use. Vesting of heritage features, such as the original filter building façade, with Council could be explored.

Watercare's AMP proposes staging of the four existing concept designs based on asset need and the availability of funding. The impact of selecting the preferred option is outlined below.

Muddy Creek overflow pipeline – the preferred option retains the existing lagoon as an attenuation pond and is fully compatible with the Muddy Creek overflow pipeline concept design. The preferred option has no impact on the timing of the overflow pipeline works.

PAC facility – a location for a new PAC facility at the existing WTP has been identified on the preferred option layout, in the event that the PAC facility is required prior to construction of the new WTP. This facility could be retained, abandoned or relocated to the new WTP site in the future – space has been allocated on the preferred option layout for a relocated PAC facility.

Sludge facility – construction of the sludge plant prior to the new WTP would require additional enabling works, as the new sludge facility would be remote from the existing plant, necessitating temporary sludge pipework and pumping. If the construction of the sludge facility is deferred and included as part of the new WTP, this will necessitate modification of the existing sludge facility to improve reliability in the interim. Interim upgrade costs would be funded through savings due to deferment of the capital upgrade.

The option to construct the new sludge facility ahead of the balance of the WTP remains – the new sludge facility has been sited as close to the existing WTP as possible and is in a location that can be developed without significantly impacting the rest of the new WTP site.

A dedicated sewer for the WTP is proposed in the future. Should the sewer be constructed prior to the new WTP (e.g. in conjunction with the Muddy Creek pipeline), a temporary connection to the existing WTP may be required, with provision for a connection to the new WTP included as part of future works.

New service reservoir / **CCT** – the preferred option includes a new CCT/TWT on the new WTP site. A temporary pump station has been included in the layout to lift treated water to the new CCT/TWT should this be constructed in conjunction with the new service reservoir (prior to the new WTP). Alternatively, if WSL do not want to build the CCT on a separate site and have a temporarily stranded asset, they could connect the temporary PS directly to the new reservoir and use the new reservoir to provide the necessary chlorine contact time. This would reduce the length of temporary pipework required and be more practical for chemical dosing purposes.

Use of the service reservoir as a temporary CCT / TWT may necessitate a balance tank for pH and pump operation control. Alternatively, the temporary PS wet well could be sized to provide the operational volume for pH correction (5 minutes detention at 128 MLD equates to approximately 444m^3). A minimum operational water level in the Titirangi reservoirs and the new service reservoir would also be required. For simplicity of network operation it may be better to have all flows go to the new service reservoir and then discharge back into the Titirangi aqueduct during this period.

4.7 Risk Assessment

A preliminary risk assessment has been completed for the preferred option using Watercare's Project (design) Development Risk Register template. The risk assessment is attached in **Appendix R**.

5 Conclusion and Recommendations

5.1 General

This report documents the key background information, methodology, optioneering process and outcomes for the production of an upgrade implementation strategy and overall concept layout plan for Huia WTP.

A two-stage optioneering and MCA process has identified Option 5B as the preferred concept layout for the future WTP. The four existing concept design projects can now be advanced (or modified to suit the concept layout plan) with confidence, in the knowledge that they will be compatible with the future WTP.

Progression of the four existing concept designs is discussed below. MWH recommend that the new PAC facility and Muddy Creek overflow pipeline proceed as proposed and that Watercare consider deferral of the new CCT / TWT and sludge upgrade until the new plant is constructed. The new service reservoir will now be sited to the north of Woodlands Park Road.

MWH also recommend that further topographical survey and geotechnical investigation are undertaken at the proposed WTP and service reservoir sites prior to further design development.

5.2 Manuka Road Reservoir, PS and CCT/TWT

The preferred option layout includes for a new WTP on the Manuka Road site previously earmarked for the new service reservoir. The new service reservoir will now be sited to the north of Woodlands Park Road.

It is recommended that construction of the CCT /TWT is deferred and that the new service reservoir is temporarily used to provide the necessary chlorine contact time. A treated water pumping station is no longer required for the preferred layout, however a temporary pumping station and balance tank will be necessary to lift treated water into the new service reservoir should it be constructed before the new WTP.

Watercare should also consider provision of a third 25ML reservoir at the Woodlands Road site as future replacement for Titirangi 1 and 2.

5.3 Sludge System

Construction of the sludge plant prior to the new WTP would require additional enabling works, as the new sludge facility would be remote from the existing plant, necessitating temporary sludge pipework and pumping. If the construction of the sludge facility is deferred and included as part of the new WTP, this will necessitate modification of the existing sludge facility to improve reliability in the interim.

The option to construct the new sludge facility ahead of the balance of the WTP remains – the sludge new sludge facility has been sited as close to the existing WTP as possible and is in a location that can be developed without significantly impacting the rest of the new WTP site.

5.4 PAC Plant

Development of the temporary PAC facility can proceed as proposed, using the location allocated in the preferred option layout. This facility could be retained, abandoned or relocated to the new WTP site in the future – the ability to relocate the facility should be considered during its design development.

5.5 Muddy Creek Pipeline

The Muddy Creek overflow pipeline route finalisation and concept design can proceed, with the pipeline connecting to the existing plant via a chamber in the south east corner of the sludge lagoon. Overflow pipework from the new WTP and service reservoirs can be connected either directly to the Muddy Creek pipeline or discharge via the lagoon for treatment once these assets are constructed and functional.

Appendix A Manuka Road Reservoir Tech Memo

MWH
BUILDING A BETTER WORLD

PROJECT TECHNICAL MEMORANDUM FOR WATERCARE SERVICES LIMITED

Date: 25/10/12
To: Watercare Services Ltd
For the Attention of: Maria Dalouche
Project: Huia WTP Implementation Strategy
Subject: Manuka Road Reservoir

Project Technical Memo: 2 - Draft
Project Stage: Stage 1 Phase 2
Project Number: 80501084

Prepared by: Chris Povey	**Checked by:** Amy Clore
Reviewed by: -- DRAFT for discussion --	**Authorised by:** -- DRAFT for discussion --

1 Introduction

Watercare's preferred future process option for the Huia water treatment plant (WTP) is flocculation, dissolved air flotation (DAF), ozonation, biological activated carbon (BAC) filtration and chlorination. This process has been selected to manage future raw water quality with the ability to handle greater algal loading and remove increased amounts of dissolved organics to improve disinfection stability and minimise disinfection by products.

MWH has been engaged to develop an overall concept layout plan for the Huia WTP which incorporates the new process design and existing concept designs for the Manuka Road Reservoir, new powdered activated carbon (PAC) preparation and dosing facilities, a new Sludge Dewatering facility and the Muddy Creek overflow pipeline.

This Technical Memorandum 2 presents the findings of the technical review of the proposed new Manuka Road reservoir and is structured as follows:

- A summary of the background information referenced to date
- Technical review
    - Agreed assumptions
    - Basis of design
    - Reservoir interfaces
    - Site constraints
    - Revised reservoir layouts
    - Un-resolved issues
- Further investigations required

2 Background Information

Reference Documents:

- Manuka Road Reservoir Concept Design Summary Report - SKM
- Manuka Road Reservoir project & North Harbour Watermain No.2 System Review

The Concept Design report considers the location for the new Reservoir, requirements for Treated Water Tank (TWT), Treated Water Pump Station (TWPS) and connecting pipelines.

The Manuka Road Reservoir project and North Harbour Watermain No.2 System Review memo provides the preferred location and elevation of the Manuka Road reservoir and an outline strategy of how the Manuka Road reservoir will interact with the transmission system and WTP. This review also recommends that the new chlorine contact tank is built before the Manuka Road Reservoir.

Watercare has developed an overall integrated operational philosophy between the WTP, reservoirs and transmission/network system. Different scenarios have been developed and a preferred scenario (location and elevation of the Manuka Road reservoir) chosen. However, the reservoir and pump station operation depend strongly on the location and elevation of the Huia WTP TWTs.

3 Technical Review

This technical review aims to integrate the Manuka Road reservoir concept design with the WTP, treated water tanks and pump station and related operations.

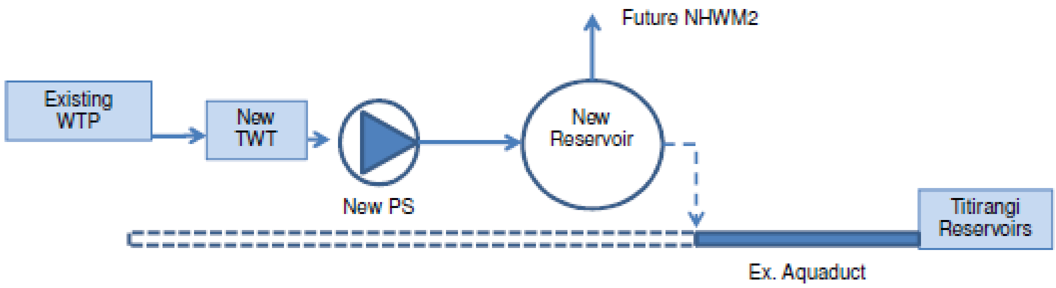
3.1 Agreed assumptions

Kick off meetings were held with MWH and Watercare on the 4th and 5th October 2012 to begin the process. General assumptions for the Manuka Road Reservoir were discussed.

A nominal reservoir capacity of 25000m3 is required. A second reservoir will be required in future.

The design TWL of the reservoir can be reduced from RL141m as provided in the Manuka Road Concept Design Summary Report. A revised TWL level of RL132m has now been proposed and a further reduced level of RL128m might also be considered if it offered significant advantages in the overall site layout and operation of the new treatment plant. This lower level would accelerate the future need for booster pumping within the water supply network (refer WSL email 16th October included as **Attachment 1**).

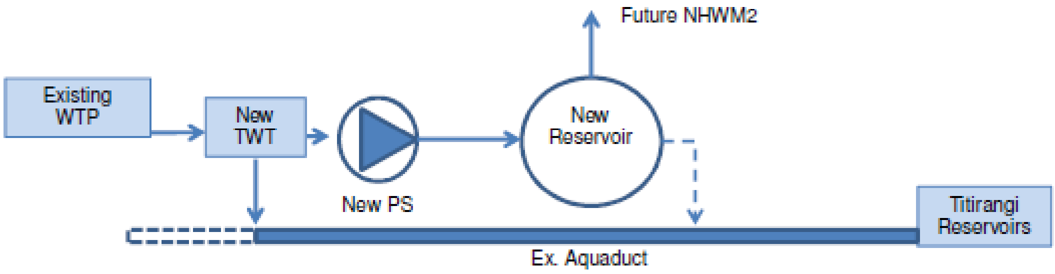
The Concept Design Summary Report proposed that the full 140Ml/day future design flow from the Huia WTP would be pumped up to the new Manuka Road reservoir and then discharged into the existing aquaduct for gravity flow to Titirangi Reservoirs with the section of aquaduct between the WTP and the Manuka Road tank being decommissioned as shown in the schematic diagram below.



This arrangement also ensures that the full flow is effectively disinfected within the Manuka Road Tank until which time a new dedicated chlorine contact tank is constructed.

The currently preferred network development option for the new North Harbour main is to construct the main on the alternate western alignment supplied directly from the new Manuka Road reservoir rather than from the Titirangi Reservoirs.

It was also agreed that a more energy efficient option would be to split the flows from the WTP to the Manuka Road and Titirangi Reservoirs and thus only pump part of the flow rather than the full 140Ml/day. A schematic of this configuration is shown below.



Under the current Asset Management Plan the Manuka Road reservoir is to be constructed well in advance of the new treatment plant. Consequently the overall design should include transition arrangements whilst the new reservoir is in operation with the existing WTP. As indicated in Section 2 above, the Manuka Road Reservoir Project & North Harbour Watermain No.2 System Review memo recommends that the new chlorine contact tank is built before the Manuka Road Reservoir.

3.2 Basis of Design

3.2.1 Service Reservoir

The updated basis of design for the Manuka Road service reservoir is shown in the following table.

Description	**Design Basis**
Reservoir	
Volume	25000m3
TWL	132mRL (this TWL will allow Manuka Road Reservoir to become the feed to the proposed new North Harbour watermain thereby supplying water by gravity to Albany etc thereby delaying the need to boost pump this main
Maximum inflow	126Ml/day
Maximum outflow	XXXMl/day **(TBC)**
Number of Reservoirs	One. Allowance for second in future
Materials	Concrete
Form	Circular as this is more efficient structural shape
Water turnover	Inlet and outlet arrangements should provide good circulation of water
Pipework and Valves	Inlet sized for velocity approx. 2-2.5m/sec at max inflow if pumped or lower 1-1.5m/sec to suit hydraulic grade if gravity **(TBC)** Outlet sized to max outflow rate at velocity approx. 1.5m/sec **(TBC)** Outlet to also match new North Harbour Main diameter Overflow sized to max inflow Scour outlet Allow for future connection to NHWM2 Allow for future connection to a second reservoir in future Mild steel cement lined pipe
Nihotupu connection	Allow a 15m x 6m area for possible future pump station to pump to Nihotupu Reservoir

3.2.2 Issues and Information Gaps

Current status of the specific issues and information gaps that were identified in the MWH Manuka Road Reservoir Discussion Note of 5/10/12 are as follows:

- Earthworks, retaining walls, roadway and structure designs incomplete. **This will be addressed progressively during the assignment.**
- Shutdown of the Huia WTP if the Manuka Road reservoir is full (this is operationally highly undesirable – the Manuka Road Reservoir and downstream network should be designed to maintain steady flow through the Huia WTP, and avoid shutdown of the WTP due to the reservoir being full – a key element of the operational philosophy). **To resolve this issue it is proposed that separate supply capacity is provided to the Manuka Road Reservoir and the Titirangi Reservoirs such that the capacity of both reservoirs can be used to manage the WTP operation.**
- TWT retention time is too long; the volume of 1,200m3 per TWT would give 17 minutes lime dosing retention time at a flow of 100MLD with one tank out of service and more than 30 minutes under average flows and both TWTs in service. Considering lime is dosed at the inlet and pH sampled at the outlet, this retention time is too long for sampling purposes. Also, the baffles design and sample locations are unlikely to be as shown on the concept design plans and should be re-evaluated (to a concept design level only). **Proposed sketch plans for the treated water tanks as part of the chlorine contact tank are attached as Attachment 2. Lime dosing would be undertaken where the flow drops over the weir at the end of the chlorine contact tank and a set of closely spaced hydraulic baffles would be provided to ensure effective mixing with the main flow. The revised tank sizing is 730m3 per tank which provides a minimum retention time of 10 minutes based on WSL requirement for 2No. tanks rated at 75% capacity ie 105Ml/day each. At the design maximum flow of 140Ml/day there will be a nominal 15minutes retention and at the minimum flow of 35Ml/day this increases to an hour when operating with both tanks in service. To provide better control of the lime dosing it is proposed that multiple locations for pH analysers be provided.**
- Lack of provision for TWT overflow; Since no overflow has been allowed in the TWTs, the water would continue to flow under gravity from the aqueduct into the free water surface in the TWT and risk damaging the TWT roof (hydraulically) unless the water can get out at the same rate it is coming in. A rapid filtered water shutdown would need to be initiated but will still take some time to complete. An overflow is therefore required at the TWT which would ideally run to the attenuation pond until the Muddy Creek pipeline is constructed. In option 1 of the Beca Huia Facility Plan, the filtered water channel has both a top of concrete level and invert level higher than the proposed treated water level for the CCT, supporting the need for an overflow at the CCT and TWT location, preferably at the inlet so that undosed filtered water could be diverted to the attenuation pond. A TWT overflow is therefore required to be included in the concept design review, together with further consideration of the TWPS bypass operation. **An overflow will be provided such that the TWTs do not overtop**.
- Operation of the treated water pumps in relation to the reservoir. **Treated water pumps should be variable speed operation to match the WTP operating capacity and the Manuka Road reservoir operating level. Part of the WTP flow would continue to discharge via the gravity aquaduct to Titirangi reservoirs.**
- Requirement for filtered water flow meter. **Flow metering will be provided for measuring filter outlet flows for chemical dosing control and for flows to Manuka Road and Titirangi reservoir. A flow meter will also be provided on the Manuka Road reservoir outlet main.**

Other considerations:

- Impact of realignment of Woodlands Park Road either to the north of the existing road or south of the WTP to connect with Manuka Road WTP. **This will be addressed in the overall WTP site layout plans.**

- Converting the existing reservoirs into pH control and chlorine contact tanks and constructing two new storage tanks might also be considered rather than constructing one new tank and a new chlorine detention tank. **This does not achieve the objectives of keeping all the treatment process at the one site and effectively separating treatment and network assets. A pump station would also be required at the constrained Konini Road site to transfer some flows back to Manuka Road and hence will not be considered further.**

3.3 Reservoir interfaces

Key reservoir interfaces are as follows:

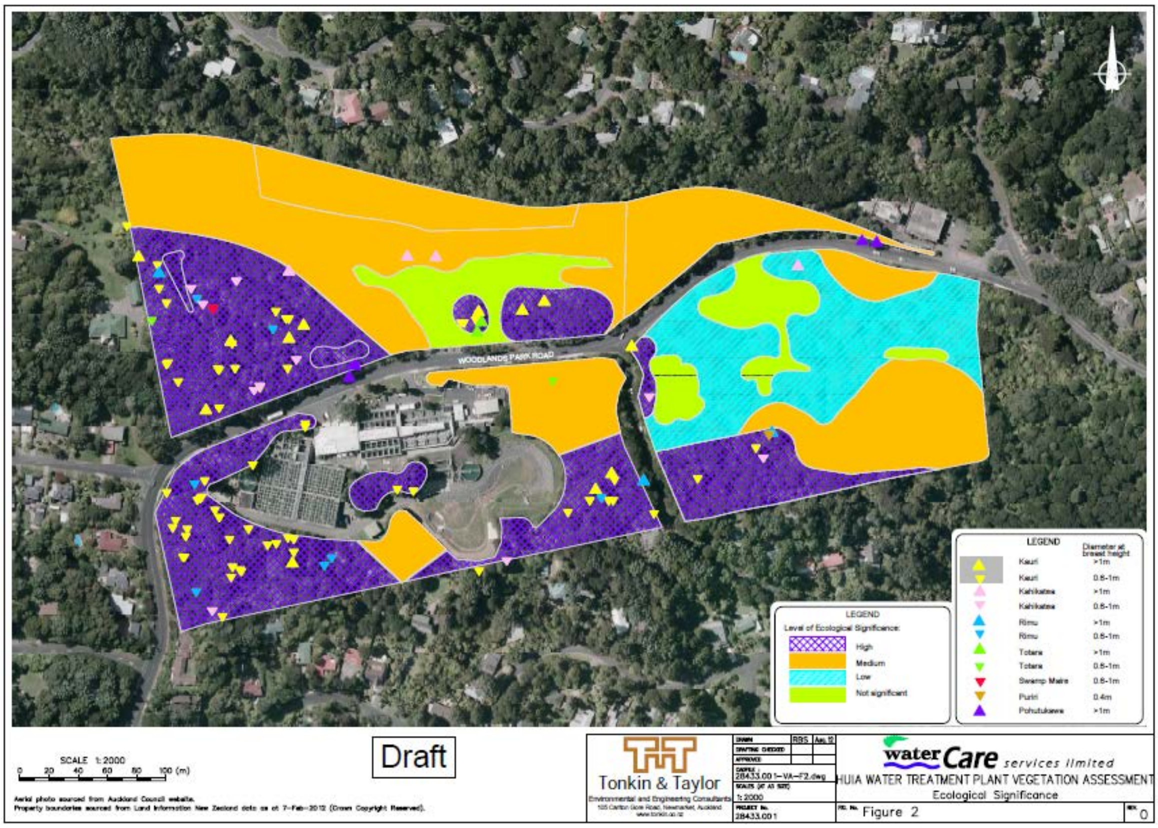
- Inlet pipeline
- Outlet pipeline
- Connection to aquaduct
- Overflow
- Scour
- Second reservoir connection

3.4 Site Constraints

The existing WTP is physically constrained by Woodlands Park Road to the West and North and steep gradients and bush to the South and East. The Manuka Road site proposed in the Concept Design is the area of low significance on the east side of Manuka Road.

A survey of ecological significance across the Watercare site established that there were a large number of high value trees and native species that should be retained where possible. These areas are indicated in the illustration below. Of most significance is the Kauri tree on the corner of Woodlands Park Road and Manuka Road.

The site is surrounded by residential properties and a screen or buffer should be provided to limit any visual, site lighting and noise impacts.



3.5 Revised Reservoir Layouts

A series of generic site layout plans for the upgraded treatment plant and new service reservoir have been developed and are included as **Attachment 3**. Within these layouts there are two alternative reservoir locations, namely:

- New service reservoir located on the Manuka Road site TWL 132mRL
- New service reservoir located on the north side of Woodlands Park Road TWL 128-132mRL

Flow to the new service reservoir will be typically be pumped from the new treated water/chlorine contact tank. The exception is for the site layout where the upgraded treatment plant is located on the Manuka Road site in which case the CCT/treated water tank maybe high enough to gravitate to the new service reservoir on the north side of Woodlands Park Road.

3.6 Un-Resolved Issues

The specific issues and information gaps currently identified with the site layout plans for the new process:

Site issues:

- Accuracy of existing contour information
- Geotechnical assessment of ground conditions for slope stability, depth to founding material and rock
- Understanding if there are any existing community issues
- Connection point for the new North Harbour main

Operational issues:

- Maximum outflow from new reservoir

4 Further Investigations Required

Proposed investigations that should be undertaken to assist in the development and selection of the preferred site layout include:

- Topographic survey
- Geotechnical investigations
- Maximum outflow from new reservoir

This Project Technical Memorandum has been prepared for the benefit of WSL. No liability is accepted by this company or any employee or sub-consultant of this company with respect to its use by any other person.

This disclaimer shall apply notwithstanding that the Project Technical Memorandum may be made available to WSL and other persons for an application for permission or approval or to fulfil a legal requirement.

Attachment 1 – WSL Email 16 October 2012

From:	Amy Clore
To:	Christopher Povey
Subject:	FW: Further Information Request - Huia WTP Implementation Strategy - Water Network
Date:	Tuesday, 16 October 2012 11:19:15 a.m.
Attachments:	image001.png image002.png

From: MDalouche (Maria) [mailto:MDalouche@water.co.nz]
Sent: Tuesday, 16 October 2012 10:35 a.m.
To: Amy Clore
Subject: RE: Further Information Request - Huia WTP Implementation Strategy - Water Network

Hi Amy,

Jack had a look at the system and it will still work as low as 128TWL but degrades benefits that we have, more specifically it will reduce the water that we will be able to send through the WMNH2 and we will need to catter for an additional PS.
We will want an alternative option at 132TWL but if we know how much savings a 128TWL could generate, we can account for PS and additional items in the transmission to make up for the loss. Jack is currently talking about these issues with projects and will bring it to the attention of Ops so that when we make a decision on the layout, it is made in account of the benefits/ loss of benefits in the transmission.

I hope this helps?

I will let you know if Jack brings more details to my attention from his discussion with Projects and Ops.

Kind Regards

Maria Dalouche
Water Treatment Planner

Watercare Services Limited
Head Office, 2 Nuffield Street, Newmarket, Auckland 1023
Private Bag 92521, Wellesley Street, Auckland 1141
DDI: (09) 539 7549
Mobile: 021 98 7549
Ph: (09) 539 7300
www.watercare.co.nz

From: Amy Clore [mailto:Amy.L.Clore@us.mwhglobal.com]
Sent: Thursday, 11 October 2012 8:18 a.m.
To: MDalouche (Maria)
Subject: FW: Further Information Request - Huia WTP Implementation Strategy - Water Network

Hi Maria,

Please see Chris' query below, can you please consider with the appropriate people and get back to us with a response.

Thanks,

Amy

From: Christopher Povey
Sent: Wednesday, 10 October 2012 8:04 p.m.
To: Amy Clore
Subject: RE: Further Information Request - Huia WTP Implementation Strategy - Water Network

Hi Amy,

There is a real advantage of a single pumping option for the new WTP layout which would really only work if we could get the tank down a little. Can you please go back and see how they feel about a TWL of 128 and a bottom level of 120m and whether they could make the high grade route still work with this.

Chris Povey
Principal Engineer

Level 21	Telephone	+61 (0) 3 8855 6061
28 Freshwater Pl	Mobile:	+61 0407 043169
Southbank VIC 3006	Email:	Christopher.J.Povey@mwhglobal.com
AUSTRALIA	Web:	www.mwhglobal.com.au

From: Amy Clore
Sent: Wednesday, 10 October 2012 2:14 PM
To: Christopher Povey
Subject: FW: Further Information Request - Huia WTP Implementation Strategy - Water Network

From: MDalouche (Maria) [mailto:MDalouche@water.co.nz]
Sent: Wednesday, 10 October 2012 2:03 p.m.
To: Amy Clore
Subject: RE: Further Information Request - Huia WTP Implementation Strategy - Water Network

Hi Amy,

Further answers below in red.
It was decided that since Tuan mentioned that the decision of the high grade route of the WMNH2 has not been signed off yet, we will need two viable options: one for the proposed high grade route and one for the low grade route similar to the WMNH1.

Thank you

Kind Regards

Maria Dalouche
Water Treatment Planner

Watercare Services Limited
Head Office, 2 Nuffield Street, Newmarket, Auckland 1023
Private Bag 92521, Wellesley Street, Auckland 1141
DDI: (09) 539 7549

Mobile: 021 98 7549
Ph: (09) 539 7300
www.watercare.co.nz

From: Amy Clore [mailto:Amy.L.Clore@us.mwhglobal.com]
Sent: Monday, 8 October 2012 4:25 p.m.
To: MDalouche (Maria)
Subject: Further Information Request - Huia WTP Implementation Strategy - Water Network

Hi Maria,

Further to my previous email requesting further information on the new Huia WTP, below please find some follow-up questions for Watercare regarding the water network to help inform our Huia work.

1. What are the 2060 - forecast flows and maximum individual transfer capacities of the North Harbour 1 and 2 mains? Max 126MLD but of course depends on the level of the reservoir as the pipe diameter won't change.

2. What is the required maximum capacity of supply into the new Manuka Road Tank and Titirangi Reservoirs assuming Huia overall capacity is 140Ml/day? 126MLD for Manuka Rd and 140MLD for Titirangi.

3. Does Watercare need 140Ml/day option into each reservoir in case system is shutdown (not much point if they cant get 140Ml/day out of a single reservoir). Watercare need to keep in mind that there is a second storage proposed at Manuka Road in future.
   This will enable us to:
   - Size the supply pipeline to the new reservoir (Manuka Rd or Huia WTP site)
   - Confirm capacity to pressurise the aquaduct over to Titirangi
   - Confirm required overflow capacities for each reservoir

No Watercare only needs 126MLD to Manuka.

4. What is the minimum required level for new service reservoir (at Manuka Road or the Huia WTP site) – can Watercare manage with say 126mRL? This is likely as low as we would be going with a highly desirable **single pumpstation option** off the aquaduct and into the WTP with gravity flow all the way through to the tank. For site layout options where we also have a pumpstation after the treatment plant we can go to whatever level suits the site conditions but certainly pump to 126m or higher ie the currently proposed 132m. We assume that the Manuka Road level will be such that we can effectively gravitate down to Titirangi reservoir and use the new storages to supplement the Titirangi/North Harbour 1 in times of peak demand if Huia WTP is off or at low production.

If we stay with the proposed high grade route, then we don't want to go below 132 TWL, otherwise we are losing some important hydraulics benefits
If we draft another option for the low grade route, then it can potentially be as low as Titirangi reservoirs.

5. Please confirm whether we could use the Titirangi No. 1 reservoir to manage any overflows from Titirangi No 2 once the new Manuka Rd storage is completed. Titirangi No1 would then be drained in a controlled manner after the event. This would avoid construction of an overflow pipeline and could even be an interim measure until the

aquaduct was pressurised after which overflows could be controlled by isolation valve at the Titirangi end of the aquaduct. Yes we can consider that the Titirangi No.1 can be demolished but we will need an alternative option.

6. Please confirm the capacity for the second Manuka Road Storage. 25,000m3 as mentioned for the second Manuka but it is still questionable whether it is needed and whether it would go ahead at Manuka. This is just a consideration.

Please let me know if you require any clarification of these questions.

Thanks

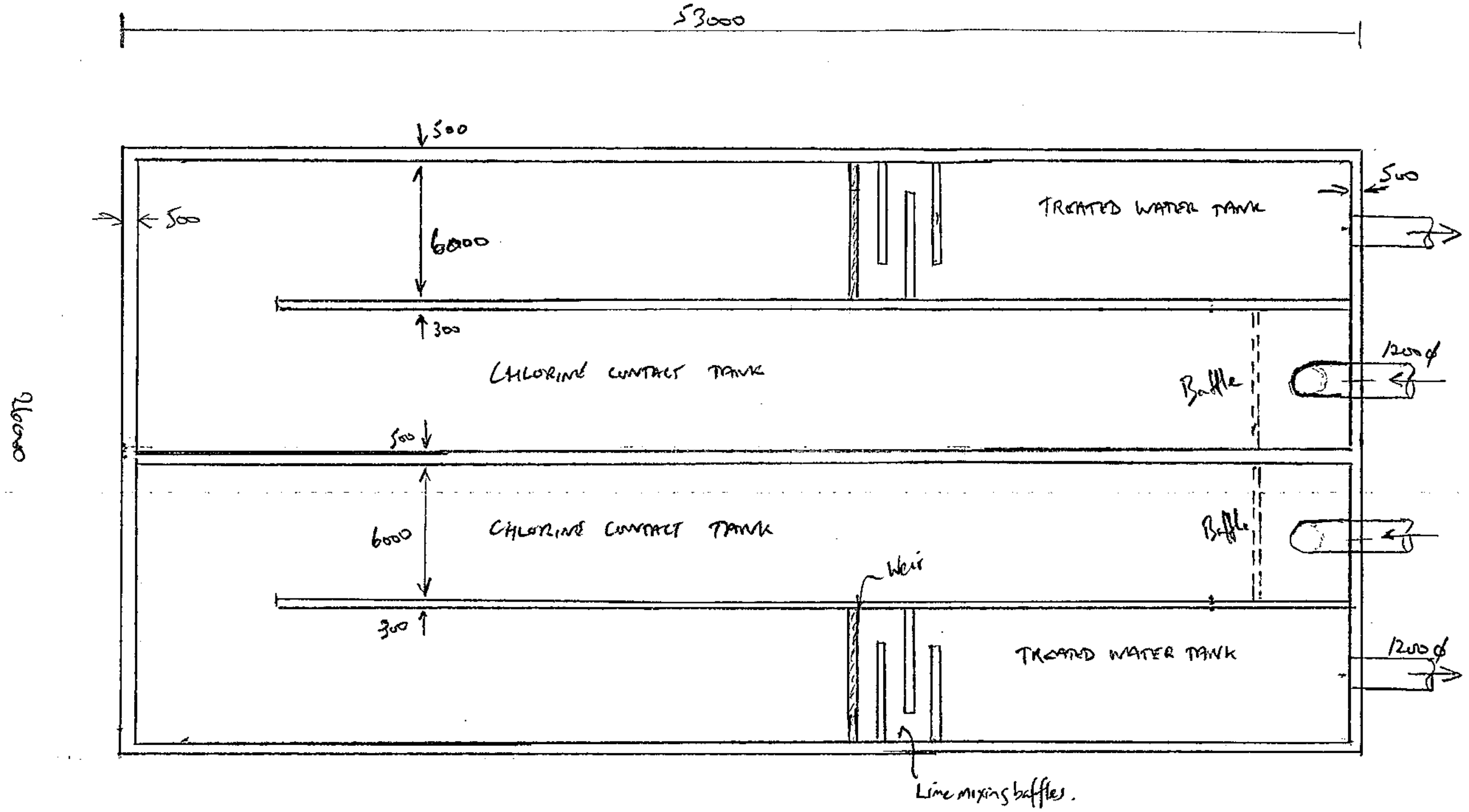
Amy

Amy Clore
Environmental Engineer
MWH New Zealand Ltd
L2 Bldg C, Millennium Centre
600 Great South Road, Greenlane
Auckland 1642

Tel: +64 9 580 7667
Mobile: +64 27 286 1395
Fax: +64 9 580 4514

www.mwhglobal.com

Attachment 2 – Treated Water Storage – Chlorine Contact Tank



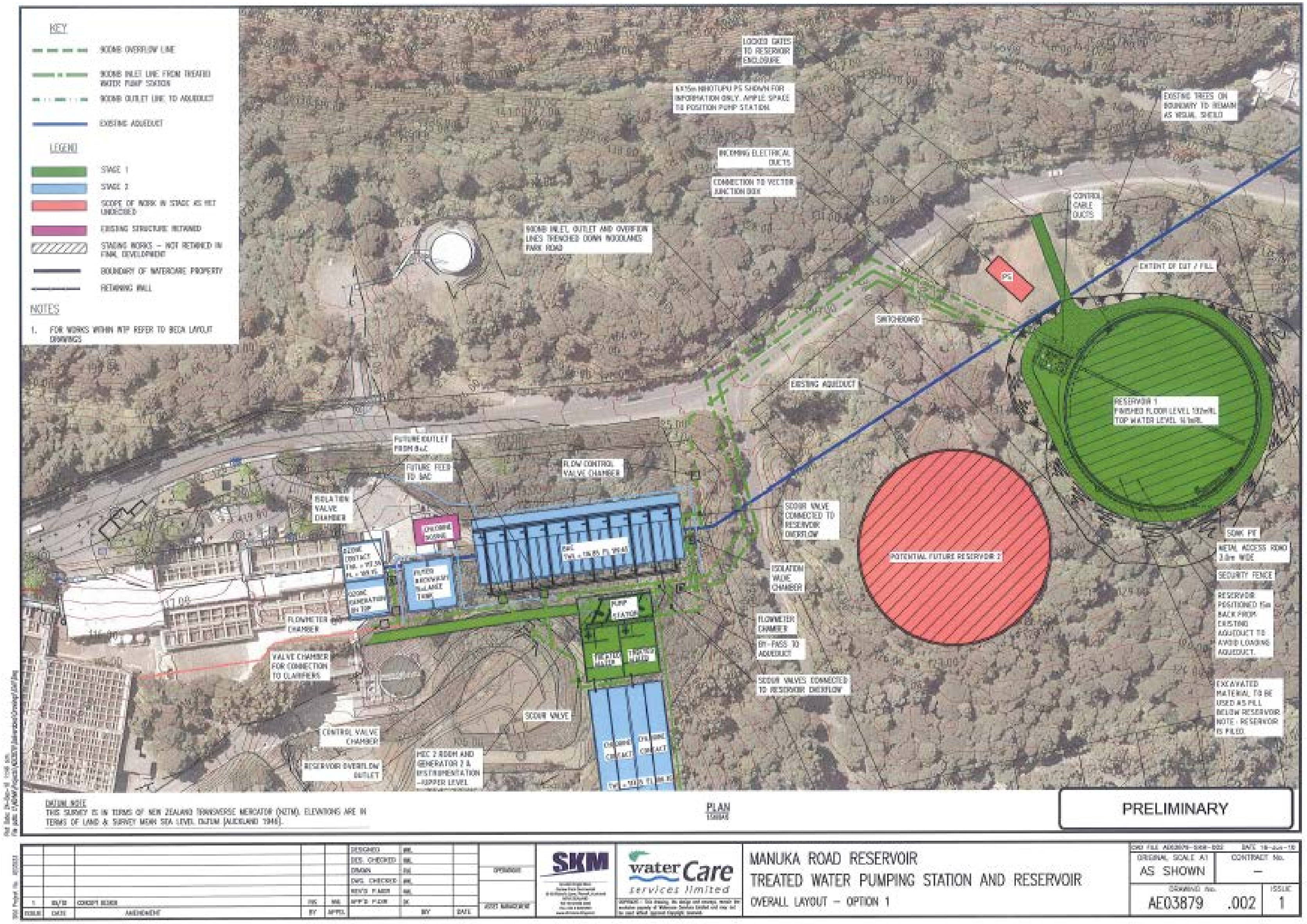
TANK DEPTH ~ 7m

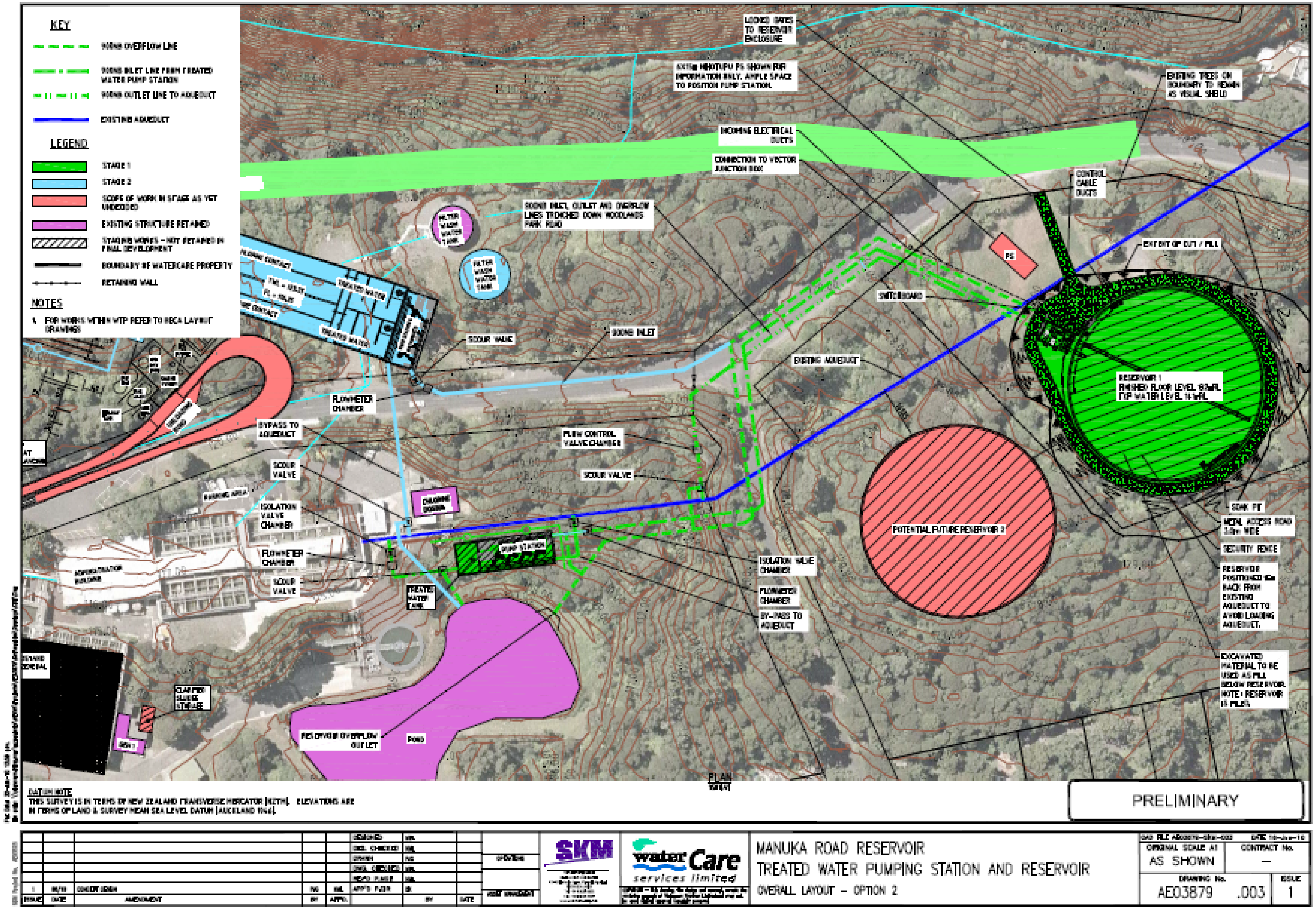
BASIS OF DESIGN: CHLORINE CONTACT - T_{50} - 30MINS @ 140ML/DAY
- ASSUMED EFFICIENCY 60%
- 2NO TANKS EACH @ 75% ie 3645 m^3 EACH
- TANK DEPTH 7m

TREATED WATER TANKS - 10 MINUTES @ 140ML/DAY
- 2NO TANKS EACH @ 75% ie 729 m^3 EACH
- HYDRAULIC MIXING FOR LIME ADDITION
- TANK DEPTH 7m.

MWH	MWH Australia Pty Ltd ABN 17 007 820 322		By C Purey	Date 9.10.12	Client WATERCARE	Sketch No.
	Project No.	Scale 1 : 2500	Checked by	Date	Project Name HUIA WTP UPGRADE PROJECT Item CHLORINE CONTACT + TREATED WATER TANKS	

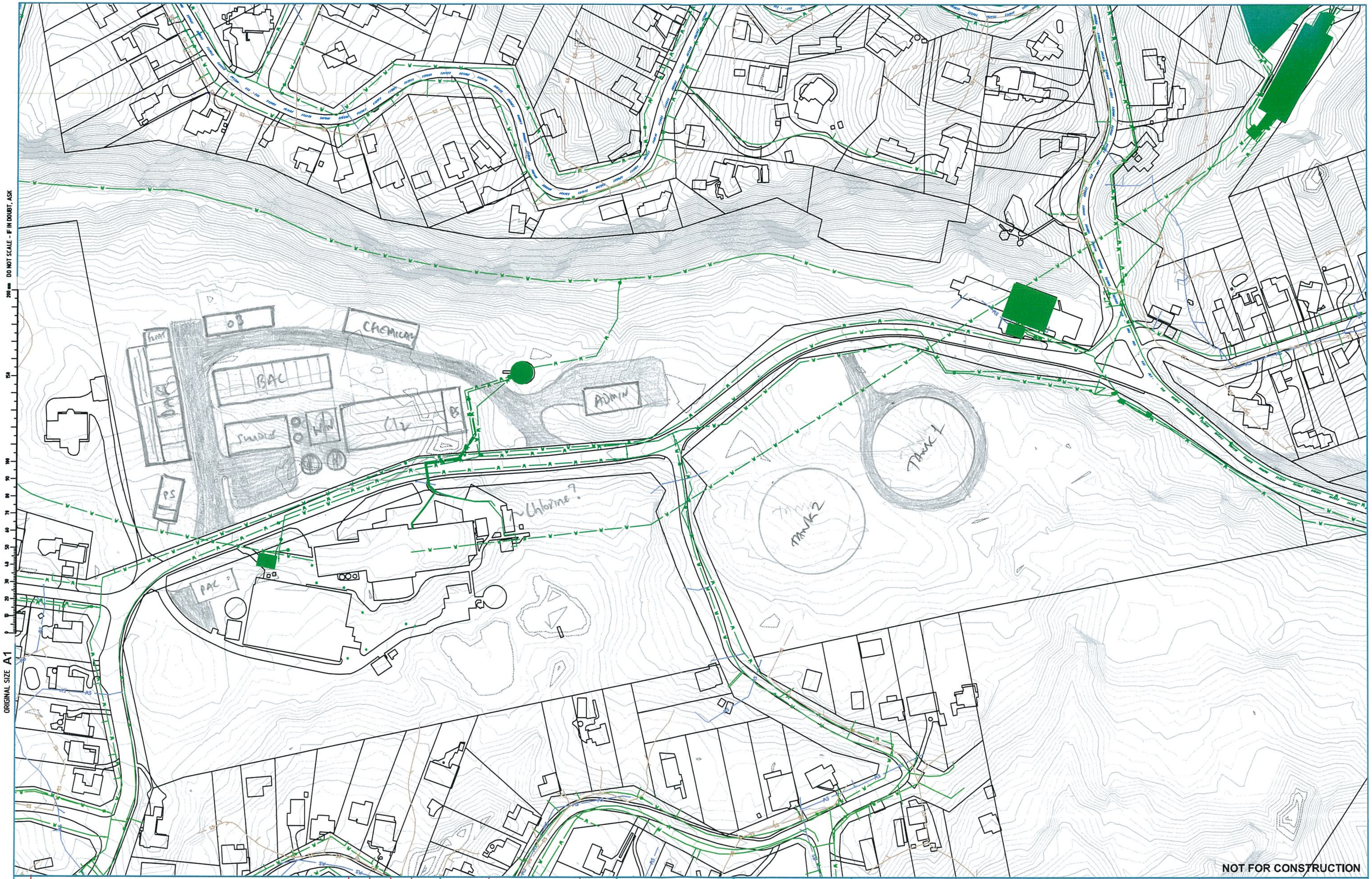
Attachment 3 – Potential Treatment Plant and Service Reservoir siting configurations


KEY
LEGEND
STAGE 1
STAGE 2
NOTES
SWITCHBOARD
EXISTING AQUEDUCT
POTENTIAL FUTURE RESERVOIR 2
SCOUR VALVE
SECURITY FENCE
PRELIMINARY
PLAN
MANUKA ROAD RESERVOIR
TREATED WATER PUMPING STATION AND RESERVOIR
OVERALL LAYOUT – OPTION 1
ORIGINAL SCALE A1
AS SHOWN
CONTRACT No.
–
DRAWING No.
AE03879 .002
ISSUE
1
SKM
water Care services limited


KEY
LEGEND
STAGE 1
STAGE 2
EXISTING STRUCTURE RETAINED
BOUNDARY OF WATERCARE PROPERTY
RETAINING WALL
NOTES
EXISTING AQUEDUCT
INCOMING ELECTRICAL DUCTS
CONNECTION TO VECTOR JUNCTION BOX
SWITCHBOARD
PS
EXTENT OF CUT / FILL
FLOWMETER CHAMBER
BYPASS TO AQUEDUCT
SCOUR VALVE
FLOW CONTROL VALVE CHAMBER
ISOLATION VALVE CHAMBER
PUMP STATION
POTENTIAL FUTURE RESERVOIR 3
POND
SECURITY FENCE
PRELIMINARY
PLAN
DATUM NOTE
MANUKA ROAD RESERVOIR
TREATED WATER PUMPING STATION AND RESERVOIR
OVERALL LAYOUT – OPTION 2
SKM
water Care services limited
AS SHOWN
AE03879 .003 1

DO NOT SCALE - IF IN DOUBT, ASK

ORIGINAL SIZE A1



NOT FOR CONSTRUCTION

REV	REVISIONS	DRN	CHK	APP	DATE

SURVEYED
DESIGNED
DRAWN
CAD REVIEW
DESIGN CHECK
DESIGN REVIEW
APPROVED
PROF REGISTRATION:

NOT APPROVED

MWH.

Client

HUIA TREATMENT PLANT

LAYOUT PLAN OPTION 3

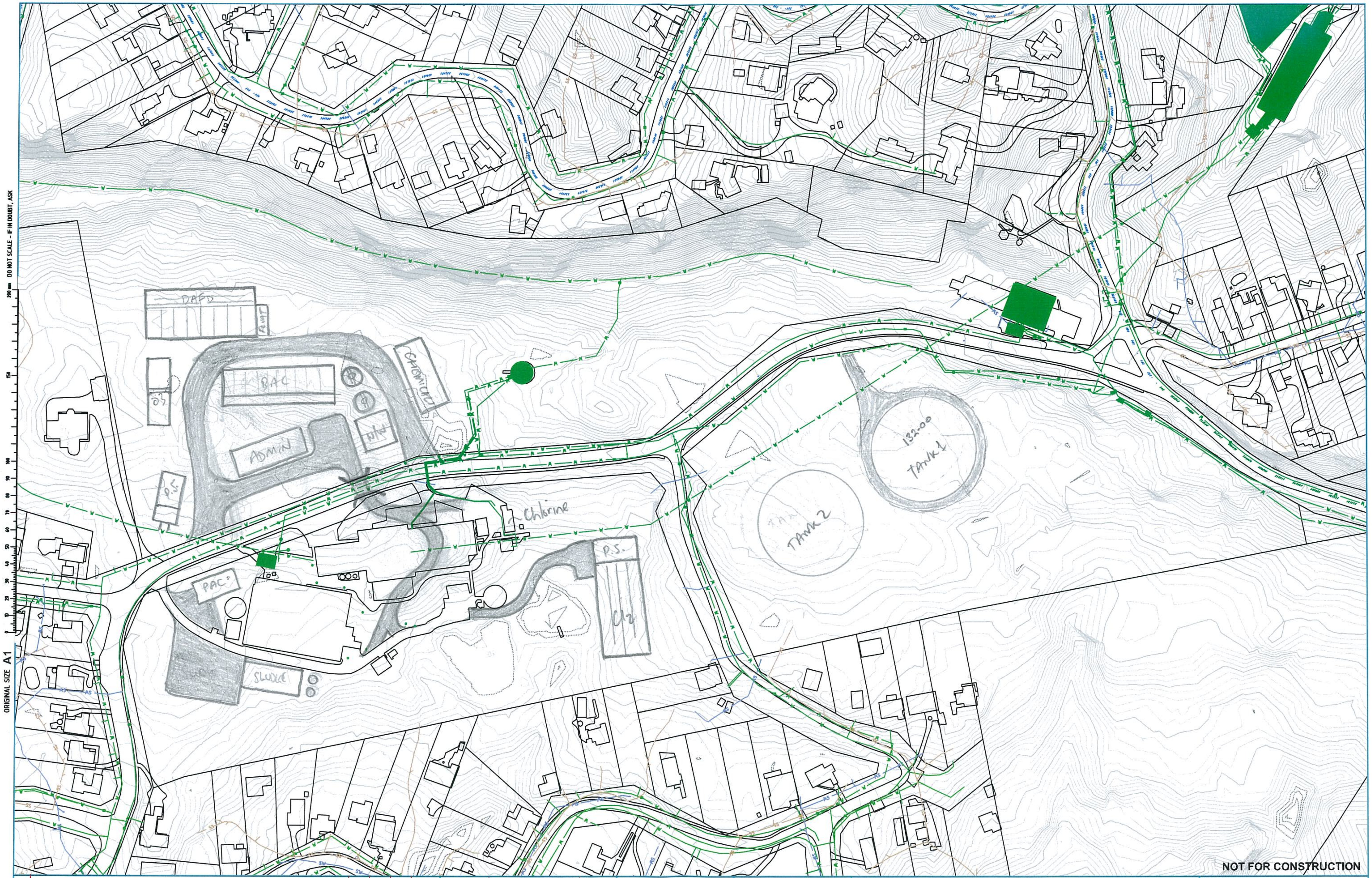
Status Stamp: WORKING PLOT

Date Stamp: C. Povey 24.10.12

Scales

Drawing No. - - -

Rev. A



NOT FOR CONSTRUCTION

REV	REVISIONS	DRN	CHK	APP	DATE

SURVEYED
DESIGNED
DRAWN
CAD REVIEW
DESIGN CHECK
DESIGN REVIEW
APPROVED
PROJ REGISTRATION

NOT APPROVED

MWH.

Client

HUIA TREATMENT PLANT

LAYOUT PLAN OPTION 4

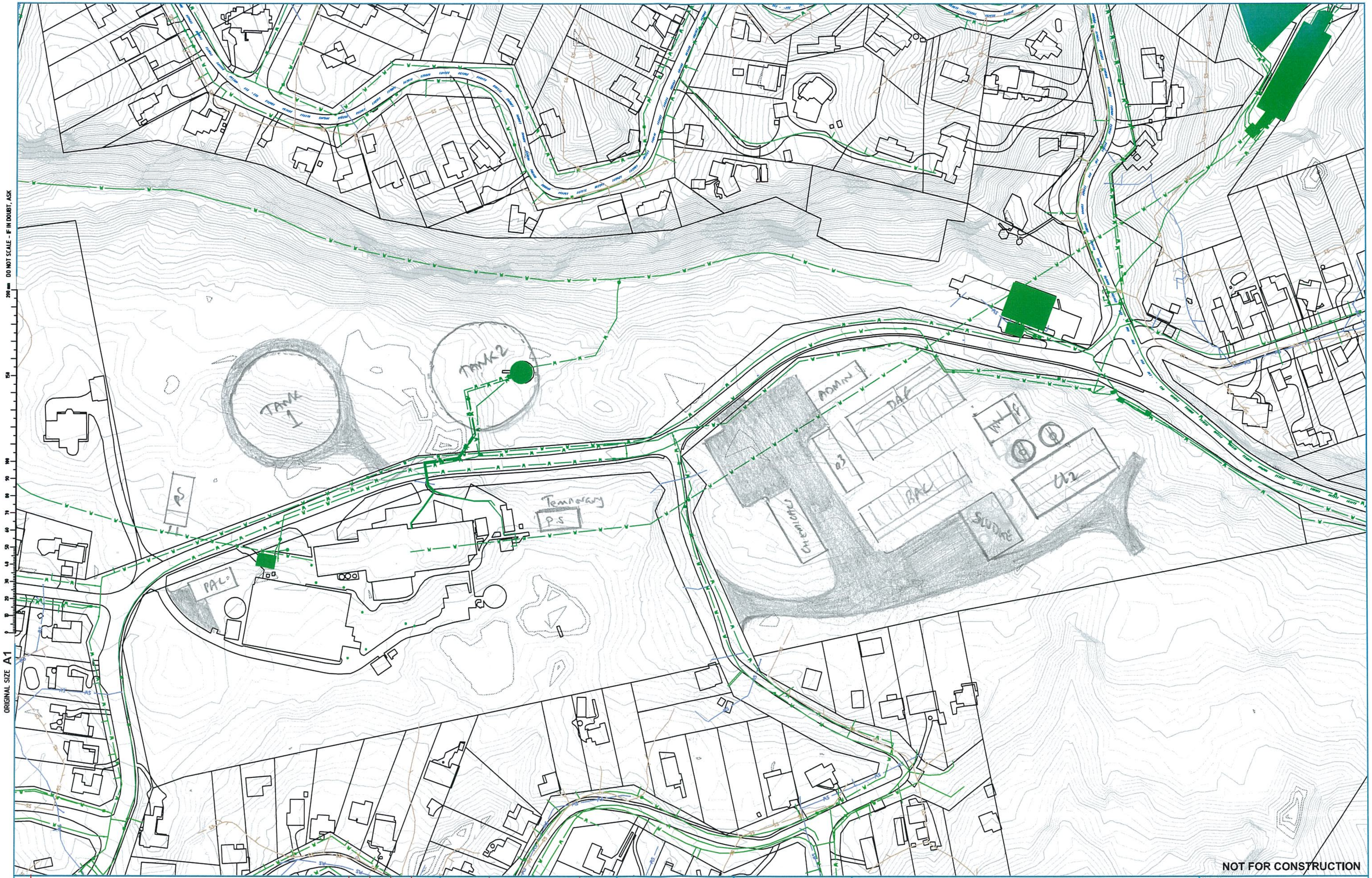
Status Stamp: WORKING PLOT

Date Stamp: C. Povey 24.10.12

Scales

Drawing No. - - -

Rev. A



ORIGINAL SIZE A1

DO NOT SCALE - IF IN DOUBT, ASK

NOT FOR CONSTRUCTION

REV	REVISIONS	DRN	CHK	APP	DATE

SURVEYED
DESIGNED
DRAWN
CAD REVIEW
DESIGN CHECK
DESIGN REVIEW
APPROVED
PROF REGISTRATION

NOT APPROVED

MWH

Client

HUIA TREATMENT PLANT

LAYOUT PLAN OPTION 5

Status Stamp: WORKING PLOT

Date Stamp: C. Povey 24.10.12

Scales

Drawing No. - - -

Rev. A

Appendix B Sludge Upgrade Tech Memo

PROJECT TECHNICAL MEMORANDUM

Date: 23/01/13
To: Watercare Services Ltd
For the Attention of: Maria Dalouche
Project: Huia WTP Implementation Strategy
Subject: Sludge Dewatering Upgrade

Project Technical Memo : 5 - Final
Project Stage: Stage 1 Phase 2
Project Number: 80501084

Prepared by: Graeme Glasgow	**Checked by:** Chris Povey
Reviewed by: Chris Povey	**Authorised by:** Amy Clore

1 Introduction

Watercare's preferred future process option for the Huia water treatment plant (WTP) is flocculation, dissolved air flotation (DAF), ozonation, biological activated carbon (BAC) filtration and chlorination. This process has been selected to manage future raw water quality with the ability to handle greater algal loading and remove increased amounts of dissolved organics to improve disinfection stability and minimise disinfection by products.

MWH has been engaged to develop an overall concept layout plan for the Huia WTP which incorporates the new process design and existing concept designs for the Manuka Road Reservoir, new powdered activated carbon (PAC) preparation and dosing facilities, a new Sludge Dewatering facility and the Muddy Creek overflow pipeline.

This Technical Memorandum 5 presents the findings of the high level technical review of the Sludge Dewatering upgrade and is structured as follows:

- A summary of the background information referenced to date
- Technical review of the Sludge dewatering concept design including
    - Agreed assumptions
    - Concept functional requirements
    - Current concept design sludge unit sizing
    - Concept design piping and instrumentation diagram
    - Plant interfaces where appropriate
    - Site constraints
    - Current & new concept design layout
    - HSNO, HSE and OHS requirements

2 Background Information

Reference Documents:
- Huia WTP Facility Plan Design Criteria June 2010 – Beca
- Huia WTP Facility Plan Unit Process Data Sheets June 2010 – Beca
- Huia WTP Sludge System Investigation Stage 1A – Design Basis Report February 2011 - MTL

The existing sludge plant processes all residuals from the water treatment process which consists of suspended solids from the headworks, water treatment chemicals (PAC, Alum & Poly) and filter washings. These are put through a thickening and dewatering process where supernatant is returned to the inlet of the plant, centrate to the Titirangi branch sewer and dewatered sludge transported to an offsite monofill located within the Waitakere Ranges Regional Park.

The existing centrifuge dewatering system presents a number of operational challenges and with PAC dosing an increase in sludge dewatering capacity is required. The key issues for the sludge handling system include storage (sludge, washwater balancing etc), polymer dosing, automation of the system, allowance for extra solids from PAC dosing, redundancy for the centrifuges, and the risks associated with returning supernatant in the event of a major cyanobacterial bloom. The preference is for the construction of a new sludge dewatering facility. Investigations to date have suggested that filter presses would provide substantial whole of life cost savings over new centrifuges.

The Huia WTP Facility Plan Design Criteria and Huia WTP Facility Plan Unit Process Datasheets describe the key design criteria. Relevant criteria relating to the proposed sludge dewatering facility upgrade in the Intermediate Stage include the following:

- One existing sludge thickener plus one new sludge thickener
- One existing washout water thickener plus one new washout water thickener when BAC filter upgrade is undertaken

- Separate poly systems for clarification and sludge thickening
- Chemical storage based on 30 days at maximum flow and average dose (minimum 14 days storage to remain at time of delivery)

The Huia WTP Sludge System Investigation Stage 1A – Design Basis Report detailed the concept design of the proposed sludge dewatering upgrade for the intermediate stage. The report provides the basis of design for the new sludge dewatering system as follows:

- Max load (140Ml/day, 15mg/L PAC) 6.6tonnes/day dry solids
- Design load (90Ml/day, no PAC) 2.9 tonnes/day dry solids
- Duty standby sludge balance tanks 2x40m3 to replace the undersized wet well
- New 13m diameter sludge thickener no. 2 (existing thickener is 11m diameter)

- Duty standby thickened sludge storage tanks 2x100m3 with four days capacity
- Duty standby sludge dewatering plant sized for N-1 duty at design load, N duty at max load.
- Spill containment 2000m3
- Dedicated polymer system

A more detailed process summary is attached in Appendix A. The proposed location for the new facility was in the SW corner of the existing site.

3 Technical Review

This section summarises the technical review undertaken to date by MWH for the proposed sludge dewatering facility (Intermediate Stage) upgrade for Huia WTP.

3.1 Sludge Dewatering Upgrade: Agreed assumptions

Kick off meetings were held with MWH and WSL on the 4th and 5th October 2012 to begin the process followed by workshops held on the 1st November 2012. Assumptions for the sludge dewatering plant upgrade were discussed and agreed and are summarised below. These form the basis for the revision of the dewatering building layout for inclusion in the overall site layout options development. It should be noted that a detailed examination of the flows and loads, mass balance calculations and unit process sizing has not been undertaken by MWH.

- Design sludge flows/loads for various scenarios:

- Maximum future flow 140 MLD at 42.6[1] mg/l solids yield (based on 10 mg/l average PAC dose and MTL solids estimates for all other parameters) = ~6.0 tonnes DS/day at 2.5%w/w
- Interim maximum flow 126 MLD at 42.6 mg/l solids yield (based on 10 mg/l average PAC dose and MTL solids estimates for all other parameters) = 5.4 tonnes DS/day at 2.5%w/w
- Average (design) flow 90 MLD at 32.6 mg/l solids yield (based on MTL report, no PAC dose) = 2.9 tonnes DS/day at 2.5%w/w

- Existing washout water thickener to be retained subject to plant layout revisions

- Existing clarifier sludge thickener to be retained subject to plant layout revisions
- New duty/standby sludge balance tanks (2 x40m4) to replace undersized sludge well
- New 13m diameter sludge thickener adjacent to existing clarifier sludge thickener subject to plant layout revisions
- New duty/standby thickened sludge storage tanks (2 x 100m3) providing four days capacity by utilizing these plus the 3 thickeners
- A second washout water thickener to be provided when the BAC filter upgrade is undertaken due to expected increased washout water production
- New duty/standby dewatering filter presses (Ishigaki) sized for N-1 operation at design sludge flow (2.9 tonnes DS/day), N operation (i.e duty/duty) at maximum sludge load (~6.0 tonnes DS/day) i.e. 2.9 tonnes DS/day/press.
- Ishigaki filter model 1500 x 38 proposed (upsized to 1500 x 42 here)
- No polyrequired for filter presses
- Dewatering building can house poly system for thickening but consider optimal location relative to the thickeners
- The clarification process has its own (separate) poly system
- Six metres clearance required for digger to access cake pile under proposed filter press mezzanine level.
- No odour control requirements for the dewatering building
- No dilute sludge storage required in addition to the new duty/standby balance tanks (i.e. the proposed 2000m^3 spill requirement adjacent to the lagoon is not required).
- RORO bins proposed in concept design not preferred. WSL does not use bins at any of its sites. Preference is for piling sludge under discharge chutes and loading to truck with bobcat or similar. Allow sufficient space for the use of bins in future if required.

3.2 Concept Functional Requirements

- The new sludge dewatering facility to be provided in the Intermediate Stage will comprise retention of the existing washout water thickener with thickened washwater sludge from here delivered to two new sludge balance tanks each of 40m^3 volume.
- Clarifier sludge from the existing clarifiers will also be delivered to these new sludge balance tanks.
- Balanced sludge flow will be pumped to the existing clarifier sludge thickener and an additional new 13m diameter clarifier sludge thickener.
- Thickened sludge from the clarifier sludge thickeners will be delivered to two new thickened sludge balance tanks each of 100m^3 volume.
- The thickened sludge balance tanks will balance the flow to the new dewatering stage comprising two new dewatering filter presses each of 2.9 tonnes dry solids capacity per day, housed in a new dewatering building facility.
- Four days (or approximately 461m^3 based on 4.8m^3/hour from MTL report) thickened sludge storage capacity will be provided by utilising the two new thickened sludge balance tanks and storing thickened sludge in the thickeners.
- The new dewatering filter presses will be located on a mezzanine level within the new building to facilitate cake discharge directly to bins or stock pile on the building floor for removal by digger.

[1] Provided by WSL. Based on future WTP maximum sludge production and 10 mg/l PAC dose = 140MLD x (14mg/l TSS + 6 mg/l DOC + 2.9 x 0.3 mg/l Fe + 1.7 x 0.003 mg/l Mn + 10 mg/l PAC + 0.26 x 45 mg/l Alum + 0.06 mg/l Poly) from MTL report Feb 2011 section 4.2.1.1 and 4.2.1.9.

- A dedicated polymer storage and make up system will be provided for the clarifier sludge thickeners which can be located within the new filter press building (subject to the revised layout). Polymer is not required for the dewatering filter presses.
- Bin vehicle and bobcat/loader access is required to the building.

3.3 Current Concept Design Sludge Unit Sizing and PID

The current concept design of the sludge upgrade proposed in the MTL report sized the new unit processes as follows:

- New duty/standby sludge balance tanks each of $40m^3$
- New 13m diameter clarifier sludge thickener
- New duty/standby thickened sludge storage tanks each of $100m^3$
- New duty/standby dewatering filter presses each of 2.9 tonnes dry solids per day capacity

The proposed concept design piping and instrumentation diagram is shown in Figure One below. The features to be provided are summarised below:

- Sludge from the clarifiers will be delivered to the new sludge balance tanks along with thickened sludge from the washout water thickener.
- The sludge balance tanks will be provided with duty/standby pumps to deliver the sludge to the existing and new clarifier sludge thickeners.
- The balance tanks will be provided with level indicator transmitters (LIT) with high and high high alarms.
- Level switches for pump control (hard wire interlock to stop on low level) are recommended here.
- Non return and isolation valves are provided on the rising main from each pump.
- A link is provided to send the sludge back to the washout water tanks.
- Polymer dosing is delivered into the rising main to the clarifier thickeners from the dedicated polymer system. Flow and sludge concentration measurement is provided to monitor the flow and strength delivered to each of the clarifier sludge thickeners.
- Each thickener is provided with a picket fence style arrangement and level measurement. Supernatant from the thickeners is returned to the plant inlet subject to quality.
- Thickened sludge from the thickeners is pumped using two sets of duty/standby thickened sludge pumps to the thickened sludge balance tanks.
- Sludge concentration measurement is provided from each thickener with single flow measurement to the thickened sludge storage tanks.
- The thickened sludge storage tanks are provided with mechanical mixers and level indication transmitters. Each thickened sludge storage tank is provided with duty/standby positive displacement pumps to feed the duty/standby filter presses.
- Non return is provided for each pump with cross over connection and blank flange connections. Polymer dosing to each feed line to the filter presses is provided with individual flow measurement.
- Each feed line to the filter presses is provided with thickened sludge flow and concentration measurement. Actuated values will be required to alternate feed to each filter press in turn if required.
- Dewatered cake from the filter presses is delivered to the dewatered sludge bins (cake will be stored on the ground[2]) for vehicle removal to landfill. Sludge spill containment is shown as provided for the sludge balance tanks and sludge bin area.

[2] Sludge cake from the new presses is expected to have high solids content which is suitable for stockpiling in static heaps rather than requiring containers.

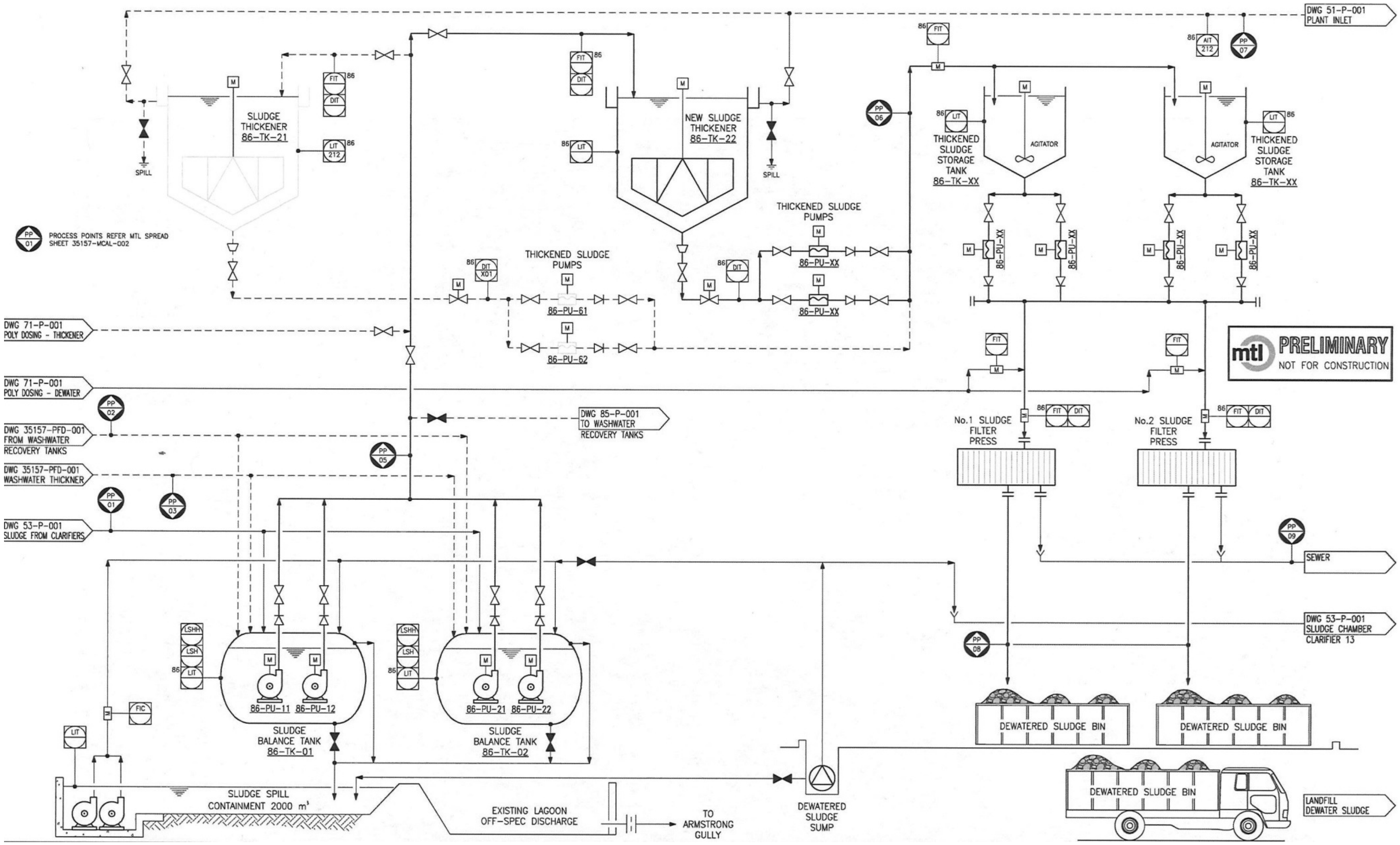


Figure 1 Proposed PID for the new sludge facility (Source: MTL report 2011)

3.4 Plant interfaces where appropriate

Key interfaces for the sludge dewatering facility are:

- Sludge outlet pipeline from clarifiers
- Washout thickener connection
- Gravity sewer connection for filtrate
- Power supply and plant control system
- Service water connection.

3.5 Site Constraints and Preferred Location

The plant is physically constrained by Woodlands Park Road to the West and North and steep gradients and bush to the South and East. A survey of ecological significance established that there were a large number of high value trees and native species that should be retained where possible. For the area close to the existing clarifier these are indicated in Figure 2 below.

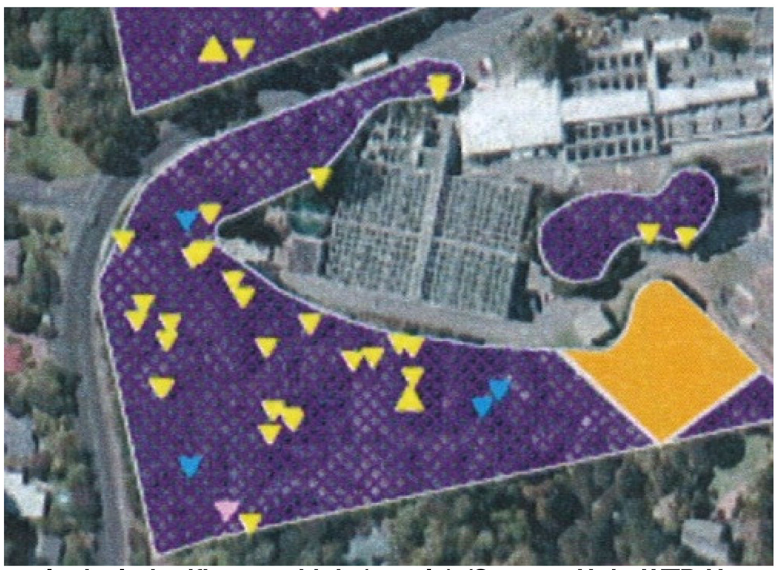


Figure 2 Areas of ecological significance, high (purple) (Source: Huia WTP Vegetation Assessment, Date TBC)

The preferred sludge dewatering facility location identified in the concept design report (MJM report) is shown in Figure Three below adjacent to the existing clarifier sludge thickener.

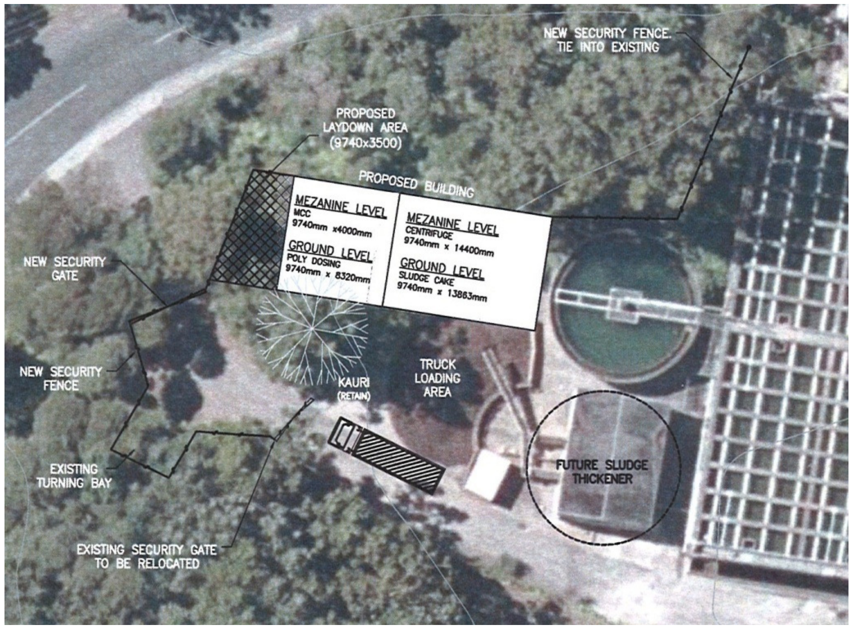


Figure 3 Proposed sludge facility location (Source: MTL report 2011)

An alternative location south of the existing clarifier was also proposed in a Huia WTP Layout options review undertaken in 2010. A new PAC storage and preparation facility is also proposed in this location and the two layouts will need to be compatible.

MWH have developed several revised site layouts where it is proposed to locate the new sludge dewatering facility to the East of the existing clarifiers (Options 1D and 2E) or at a new location across Manuka Road (Option 5D). Refer to the Stage 1 Design report for details.

3.6 Current Concept Design Layout

The current proposed general arrangement and building front elevation for the location (proposed by MTL) are shown in figures four and five below.

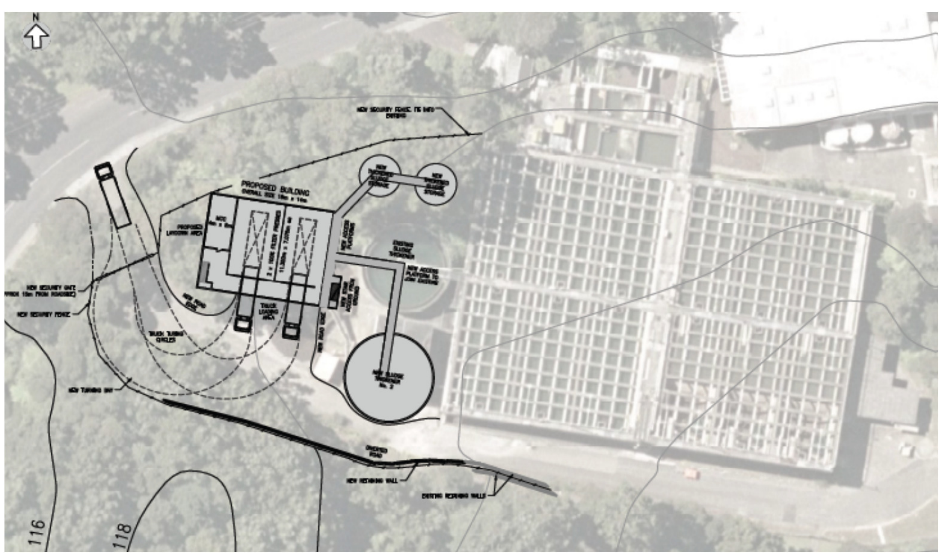


Figure 4 Proposed sludge facility layout (Source: TBC)

The proposed general arrangement shows a single entry and exit point for the sludge bin vehicle to enter and exit the site. This would presumably require the vehicle to stop on Woodland Park Road and reverse onto the site and manoeuvre into the sludge dewatering building to load/unload the bins. Alternatively a vehicle turnaround point could be created on the site somewhere east of the existing clarifier.

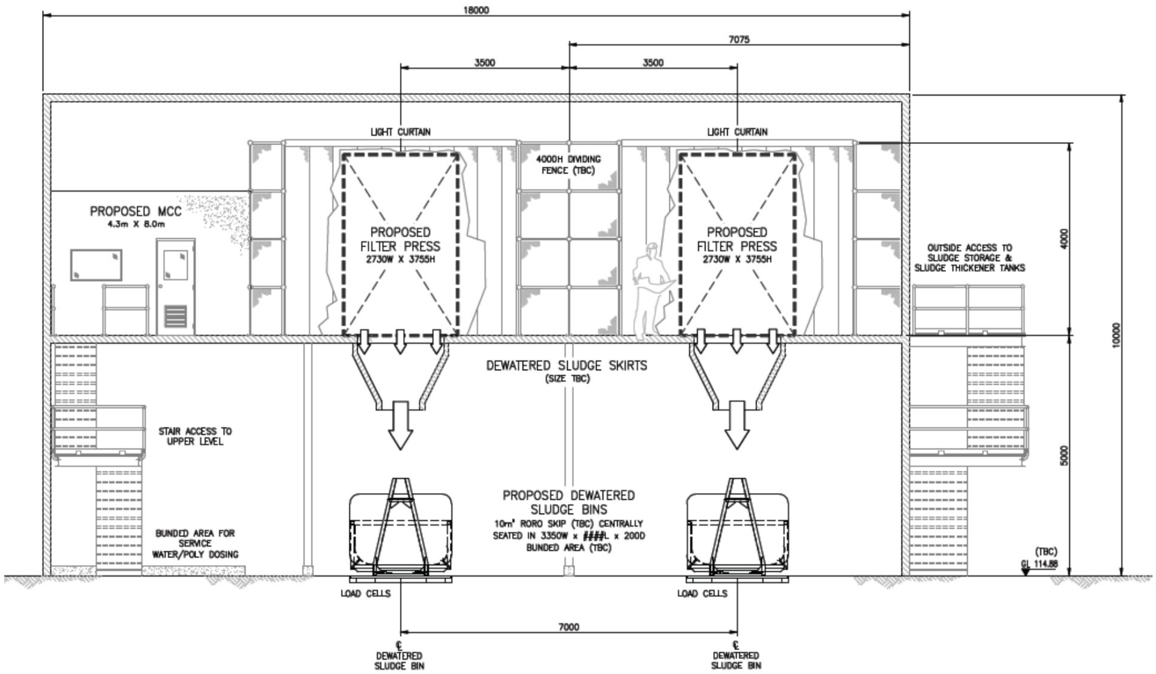


Figure 5 Current Proposed Sludge Plant Layout (Source: TBC)

The building front elevation shows clearance to the underside of the filter presses of five metres with clearance to the underside of the dewatered sludge skirts less than this figure. The front elevation shows polymer dosing located within the filter press building and RORO type bins for the dewatered cake. The dimensions of the proposed filter presses are given as 2730mm wide by 3755mm height.

3.7 New Concept Design Layout

A new concept design layout was developed by MWH and tabled at the workshop 1st November 2012 for comment. The new layout is shown in Appendix B and includes the requested clearance above the filters and is based on the Ishigaki 1500 x 42 filter press (upsized from the 1500 x 38 model). Reference should be made to the revised site layouts developed by MWH.

3.8 HSNO, OHS and HSE requirements

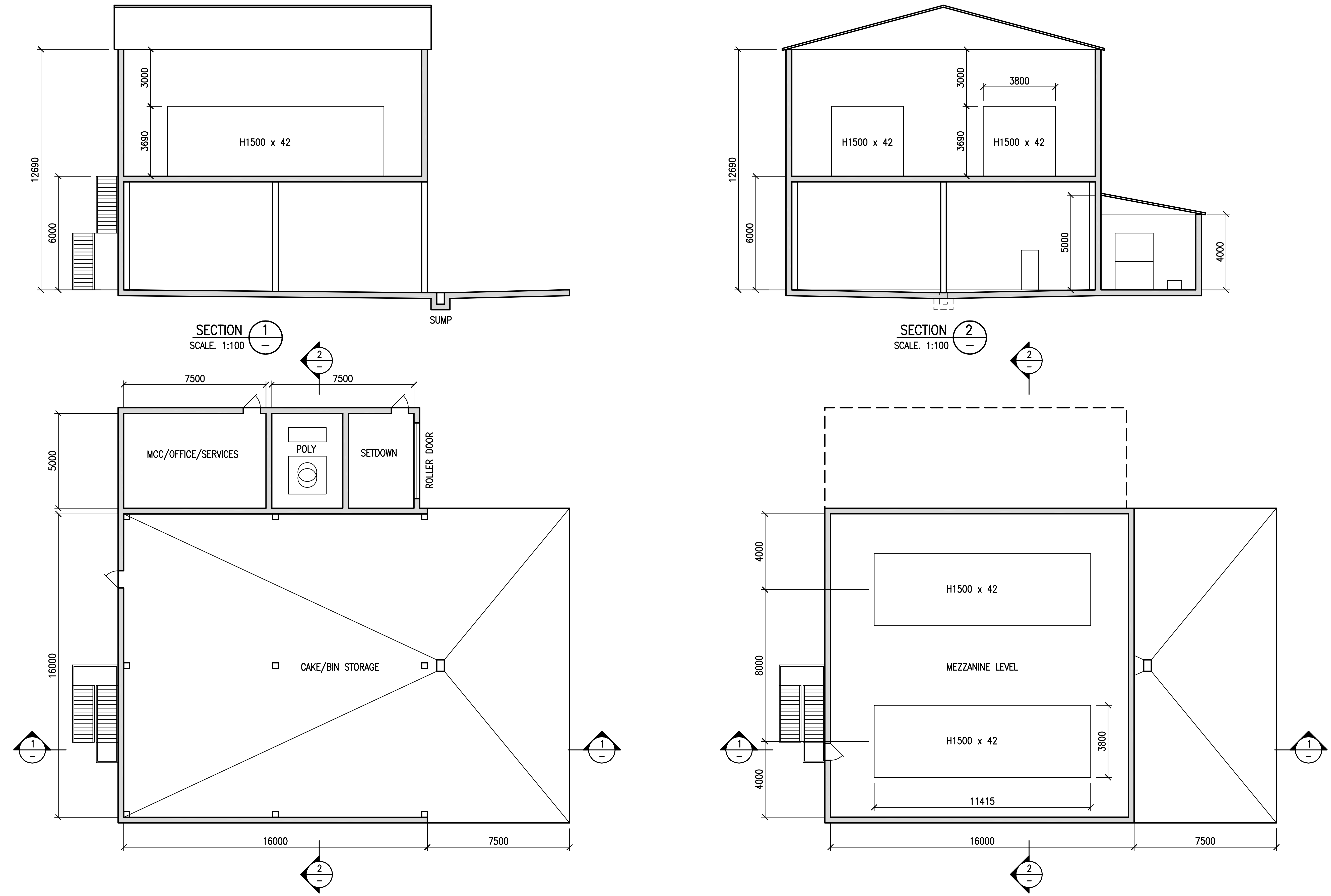
Key legislation governing plant safety is the Health and Safety in Employment Act 1992, the Hazardous Substances and New Organisms Act 1996 and the Hazardous Substances (Emergency Management) Regulations 2004. Key design features required for the new sludge dewatering building (including polymer storage and make up) should be developed during the detailed design phase for the upgrade.

Appendix A

watercare services limited		MWH BUILDING A BETTER WORLD	
Contract No.			**Equipment Data Sheet**
Date Sheet No.: 6	**Unit Process(es)**	**Sludge Storage Thickening and Dewatering**	
	Revision	**1**	
	Revision Date	**27/09/2012**	
AMBIENT CONDITIONS	**Units**	**Requirements**	**Commets**
Location		Woodlands Park Road, West Auckland	
Temperature	°C	Min: Max:	
Location		Outdoors	
Rel. Humidity	%RH	Min: Max:	
Sludge Flows and Loads	**Units**	**Requirements**	**Comments**
Average (design) sludge yield	kgDS/d @ 2.5%wt	2,909	This is at average flow of 90MLD and max solids load of 65 mg/l with no PAC dosing
Maximum (wrose case) sludge yield	kgDS/d @ 2.5%wt	6,600	This is at max flow of 140MLD and max solids load of 80 mg/l with PAC dosing at a rate of 15 mg/l.
Sludge Storage (Balance)	**Units**	**Requirements**	**Comments**
Sludge balance tanks (new)	No.	2	
Sludge balance tank volume	m3	40 ea.	Sized based on 20 minutes HRT both tanks at 50% full and 115m3/h at 0.15%DS (111@0.15 clarifier, 3.6@0.3 WW thickener)
Sludge Thickening	**Units**	**Requirements**	**Comments**
Existing thickener (clarifier sludge ?)	No.	1	I think this is the existing clarifier sludge thickener?
Existing thickener (clarifier sludge ?) diameter	m	11.0	Operated at <4kg/m2/h and 1.5m/h HLR, looks reasonable versus references
Existing thickener (washout water ?)	No.	1	I think this is the washout water thickener ?
Existing thickener (washout water) diameter	m	13.0	
New thickener	No.	1	
New thickener diameter	m	13	Same operating rates as the existing ?
Thickened Sludge Storage	**Units**	**Requirements**	**Comments**
New thickened sludge storage tanks	No.	2	
New thickened sludge storage tank diameter	m	6.00	
New thickened sludge storage tank volume	m3	100	
New thickened sludge storage tank depth (total & operating)	m	5, 4	Sized on 4 days storage at 2.4m3/h and 2.5%DS. This is the average rate with no PAC . To satisy the design rate with no pAC of 4.8m3/h at 2.5%DS (461m3) utilizes the new TS storage tanks and allwing 100m3 to accumulate in each thickener (3 No.)
Sludge Dewatering - Centrifuge Option	**Units**	**Requirements**	**Comments**
New centrifuges	No.	3	3 at 50% capacity i.e. D/A/S. This is option 1A as per PFD 002
New centrifuge loading	kgDS/d	2200 each	Hence max condition of 6,600 kgDS/d at 2.5%DS is the driver and is met by operating D/D/D
Sludge Dewatering - Filter Press Option	**Units**	**Requirements**	**Comments**
New filter presses	No.	2	2 at 100% capacity i.e. D/S. This is option 2 as per PFD 003
New filter press loading	kgDS/d	3300 each	Hence max condition of 6,600 kgDS/d at 2.5%DS is the driver and is met by operating D/D. Note the filter presses will operate in batch mode, presumably this has been examined in the Stage 1B report?
Dewatered Sludge Storage & Transport	**Units**	**Requirements**	**Comments**
RORO bins	No.	2 or 3	
RORO bins	m3	23 or 15	presumably its 2x23 for the filter press option and 3x15 for the centrifuge option ? Based on 17% DS from the centrifuges worst case.
Vehicle movement	No./week/bin	2	Design condition with no PAC dosing, 91.5m3/week
	No./week/bin	7	Max condition with PAC, 208m3/week
Spill containment	m3	2000	Adjacent to existing lagoon?

Key Issues for Consideration
Confirm if maximum PAC dose is 30 mg/l as per PAC report. The sludge report (MTL) mass balance is based on a max PAC dose of 15 mg/l. Raising this to 30 mg/l would add approx 2 tonnes per day to the sludge yield with potential impact on the sludge processing design?
Process design criteria need to be confirmed including redundancy requirements.
Discuss access, operation and maintenance of the proposed Sludge plant building (mezzanine).
Discuss location proposed for Sludge plant building (clash with the PAC plant), can PAC be located across the road near the upwash water tanks instead? Can it be located at the proposed POA ?
Facility will need to consider all OHS requirements, fire and HSNO regulations in the building layout which will influence the footprint. Does the proposed building layout need developed further?
Confirm average flow condition criteria, PAC report uses 100MLD, sludge report uses 90MLD
A discussion of contructability, staging and construction sequencing intended and what plant capacity needs to be maintained during such staged construction needs to take place to identify potential impact of these factors on the design/operation of the units and their proposed locations
Facility plan indicates the plant has been designated as level 4 post disater (AS/NZ1170.1), what are the implications/requirements for this?
Confirm proposed process flow for the sludge, PFD 003 in sludge report
Max sludge yield is based on max flow of 140MLD ignoring solids in returns and assuming solids in filtered water is negligible, do we need to revisit the solids estimates or accept as is?
Do we revisit the mass balance and basis for design of each sludge processing unit developed in the MTL report or accept it as is?
Confirm centrifuge option is 3x50% or 2x100%, some ambiguity
Discuss the building layout drawing GLA 002. It appears to show the dewatering equipment on mezzanines with both poly dosing and dewatered cake storage at ground level. It is also proposed to use the ground level for cake storage without bins if Parau is unavailable (4 days at 30m3/d). Filter presses mounted on a mezzanine will require significant structural and foundation work.
I would consider building a model of the sludge yields and cake production to examine different scenarios to ensure cake load out area and bin configuration is sufficient or has this been examined in Stage 1B report ? The cake volumes are based on 17%DS, filter presses with fill and squeeze will generate greater than this.
Design conditions used for the sludge unit sizing need re-examined ? E.g. the max condition of 208 m3/week at 20%DS used for assessing bin movements is referred to as based on "existing with PAC dosing". 208m3 a week at 20%DS (table 4.3.5.1 MTL report) equates to approx 6.5 tonnes a day (7 day week assumed) which is the max flow of 140MLD and max solids load of 80 mg/l with PAC dosing at a rate of 15 mg/l. MTL report gives max PAC dose of 30 mg/l, an addtional 2.1 tonnes DS per day which would generate an additional ~74m3 per week (with various assumptions). Probably still daily per bin though.
Confrim spill containment is proposed to be located adjacent to lagoon?
Section 5.1.3 of the Sludge report gives details of the proposed poly system for the sludge facility including 1x batching tank and 2x day tanks. Presumably located underneath the mezzanie shown on drawing GLA 002 (MTL sludge report). The various Beca reports give some details of poly mass requirements and schematic (section 2.3 Uniot process data sheets report) showing 2 separate poly s systems for the DAF and the sludge. comprising Poly A (2 silos, 2 make up tanks, 2 day tanks) and Poly B (1 silo, 1 make up, 1 day tank). Do these concpets need developed further or do we adopt the porposed building footprints for this study? DAF poly system to be located where (not shown) ?

Appendix B New Concept Design Layout



ISSUE	DATE	AMENDMENT	BY	APPD.		BY	DATE
					DESIGNED	G GLASGOW	01/13
					DES. CHECKED		
					DRAWN	IR MULLIGAN	01/13
					DWG. CHECKED		
					PROJECT LEADER		
					INFRAST'R APP'D		

WSL TO SIGN
OPERATIONS

WSL TO SIGN
INFRASTRUCTURE

water Care services limited

MWH®

HUIA WTP IMPLEMENTATION STRATEGY

SLUDGE DEWATERING BUILDING

DRAFT

CAD FILE 80501084-01-001-G076E

ORIGINAL SCALE A1: AS SHOWN

CONTRACT No.

REF. No. 80501084-01-001-G076

ISSUE A

DWG. No.

Appendix C PAC Upgrade Tech Memo

MWH
BUILDING A BETTER WORLD

PROJECT TECHNICAL MEMORANDUM

Date: 23/01/13
To: Watercare Services Ltd
For the Attention of: Maria Dalouche
Project: Huia WTP Implementation Strategy
Subject: Powdered Activated Carbon Upgrade

Project Technical Memo No.: 4 - Final
Project Stage: Stage 1 Phase 2
Project Number: 80501084

Prepared by: Graeme Glasgow	**Checked by:** Chris Povey
Reviewed by: Chris Povey	**Authorised by:** Amy Clore

1 Introduction

Watercare's preferred future process option for the Huia water treatment plant (WTP) is flocculation, dissolved air flotation (DAF), ozonation, biological activated carbon (BAC) filtration and chlorination. This process has been selected to manage future raw water quality with the ability to handle greater algal loading and remove increased amounts of dissolved organics to improve disinfection stability and minimise disinfection by products.

MWH has been engaged to develop an overall concept layout plan for the Huia WTP which incorporates the new process design and existing concept designs for the Manuka Road Reservoir, new powdered activated carbon (PAC) preparation and dosing facilities, a new Sludge Dewatering facility and the Muddy Creek overflow pipeline.

This Technical Memorandum presents the findings of the high level technical review of the PAC upgrade and is structured as follows:

- A summary of the background information referenced to date
- Technical review of the PAC concept design including
    - Agreed assumptions
    - Concept functional requirements
    - Concept design piping and instrumentation diagram
    - Plant interfaces where appropriate
    - Site constraints
    - HSNO, HSE and OHS requirements
    - Revised concept design PAC unit sizing (based on revised basis for design)
    - Revised concept design layout

2 Background Information

Reference Documents:

- Huia WTP Facility Plan Design Criteria June 2010 – Beca
- Huia WTP Facility Plan Unit Process Data Sheets June 2010 – Beca
- Ardmore and Huia WTP PAC Plant Upgrade Concept Design April 2008 - MJM

The Huia WTP Facility Plan Design Criteria and Huia WTP Facility Plan Unit Process Datasheets present the key design criteria for the Stage 2 upgrade. However, relevant criteria relating to the proposed PAC facility upgrade in Stage 1 include the following:

- Minimise treated water organics by use of coagulation, zone, and BAC to target reduction of disinfection by-product formation to less than 50% MAV in line with current best practise.
- Manage algal taste and odour and toxin risks
- Minimise chlorine demand
- Chemical dosing systems – multiple bulk storage tanks, dosing pumps
- Chemical storage based on 30 days at maximum flow and average dose (minimum 14 days storage to remain at time of delivery).

The Ardmore and Huia WTP PAC Plant Upgrade Concept Design report detailed the concept design of the PAC upgrade proposed during Stage 1 for Huia. A detailed review of the Huia temporary PAC dosing plant found that it is not suitable for long term operation and has inadequate levels of redundancy for reliable long term operation. Replacement with new facilities was proposed. The Concept Design report provides the basis of design for the new PAC Storage and Dosing facility at Huia WTP (Stage 1) as follows:

- Maximum flow – 140Ml/day
- Maximum dose 30mg/L (in duty-standby operation)
- Average dose 10mg/L
- Semi-automatic duty/standby bulk bag unloading system with 2No. 6m3 intermediate storage hoppers. Automatic duty/standby batch preparation with volumetric feeders for PAC dose control, wetting cone, eductor and carrier feed water.
- 15m x 8.5m building to house equipment and store 40 bulk bags of PAC (19.6 tonnes) to provide 14 days storage at average dose and maximum flow (140Ml/day).

A more detailed process summary is attached in Appendix A for reference. The proposed dosing location for PAC is Huia Aqueduct Hatch 5 to provide 26 minutes contact time.

3 Technical Review

This section summarises the technical review undertaken to date by MWH for the proposed PAC facility (Stage 1) upgrade for Huia WTP.

3.1 PAC Usage and Storage Requirements: Agreed assumptions

Kick off meetings were held with MWH and WSL on the 4th and 5th October 2012 to begin the process. A follow up workshop was held on the 1st November 2012. Assumptions for the PAC plant upgrade were discussed and agreed and are summarised below.

- Design flows and associated PAC dosing rates
  - Future maximum flow 126 MLD at maximum dose 15 mg/l – (140MLD at 30 mg/l capacity not required)
  - Interim maximum flow 126MLD at maximum dose 15 mg/l
  - Average flow 90 MLD at average dose 10 mg/l
- Duty/duty operation under extreme water quality conditions only to give 60 mg/l at 60 MLD is required.
- 1.8 tonnes per day maximum dry powder feed capacity per unit
- PAC dose to be applied at Hatch 5
- Upgraded PAC plant to be retained when plant is upgraded to Ozone/BAC as back up facility (cyanobacteria levels generally increasing)
- Preferred location for upgraded PAC plant is near sludge plant or existing PAC site (across Woodlands Park Road is undesirable) subject to overall site plan (refer to revised site layouts developed by MWH post workshop)
- Clarified water to be used for carrier water for the PAC
- Dual dosing lines from PAC plant to Hatch 5
- Bulk storage requirement for 1m^3 bags to be based on average dose (10mg/l) at maximum flow (126MLD) and 14 days (i.e. approximately 18 tonnes) subject to available space
- Silos to be based on 1.5 days working volume at maximum dose (15mg/l) and average flow (90MLD) per silo.
- Semi-automatic operation i.e. forklift delivery and forklift loading to bag unloaders

- Bunding requirement for PAC suction tank to be based on Ardmore approach – allow 1.5m dia sump 1.5m deep
- Slurry dosing concentration 1%w/v maximum
- Fixed carrier water flow rate of 7.5m^3/hour per dosing line (to give 1%w/v at maximum condition of 60 mg/l at 60MLD i.e. 3.6 tonnes per day dry powder feed with two dosing lines in operation)
- Dosing line internal diameter to give approx. 1 m/s velocity

3.2 Concept Functional Requirements

- The new PAC facility to be provided in Stage 1 will comprise vehicle delivery of 1m^3 bags of PAC (approximate weight of 400-500kg) to a new PAC storage and dosing facility building located near the existing Sludge Treatment Facility or the existing temporary PAC dosing system.
- 14 days of storage at maximum flow (126MLD) and average dose (10mg/l) will be provided within the new building.
- 1m^3 bags on pallets will be transferred from the delivery vehicle to the bulk storage area within the building by fork lift. 1m^3 bags will be transferred as needed from the bulk storage area to bag unloaders.
- Two bag unloaders will be provided feeding two intermediate bulk storage silos. Each silo will be sized to contain 1.5 days working capacity at a dose of 15mg/l and flow of 90MLD (ie approximately 2 tonnes). Each silo will be provided with a centrifugal carrier water pump, dry chemical feeder system with variable speed drive (i.e. a variable concentration slurry feed approach), wetting cone arrangement and eductor system.
- Wetting and carrier water will be sourced from the clarified water. Clarified water will be fed into the wetting cone to wet the dry powder fed by the dry feeder.
- Wetted PAC will be drawn into the eductor by the Venturi effect of the carrier water flow through the eductor. The carrier water pump will operate at a fixed flow rate with the dose controlled by varying the dry feeder speed. The fixed carrier water flow containing the wetted PAC will be pumped to the point of application (POA) located 1.6km away at Hatch 5 providing approximately 26 minutes contact time (based on 1m/s velocity in the aqueduct).
- Dual dosing lines will be provided and will normally operate as duty/standby except under extreme water quality conditions.

3.3 Concept Design Piping & Instrumentation diagram

The proposed concept design piping and instrumentation diagram is shown in Figure One below. The features to be provided include:

- Bulk bags will be mounted on the bag unloaders by forklift. The bag unloaders will be provided with mechanical bag massagers to prevent and break any bridging during bag unloading.
- The bag unloader will be provided with an isolation valve to hold the bag closed while the operator opens the bag. The bag unloader will be provided with manual slide gate and level switch with low level alarm to stop the conveyor to the storage silo.
- Each silo will be provided with a dedicated bag unloader and conveyor. The storage silos will be provided with high, low and low low level switches and alarms for control purposes. Each silo and bag unloader will be provided with dust control in the form of an extraction and filtration system.
- Each silo will be provided with four weight sensors to monitor available storage.
- Each silo will have a bin activator, isolation valve and volumetric feeder with variable speed drive to deliver the dry product to a wetting cone.
- The wetting cone will be provided with an overflow to a bunded area with sump. Service water to the wetting cone and eductor will be provided from duty/standby service water pumps provided with flows switches and alarms.
- Flow split to the wetting cone and eductor will be monitored by flow meter and controlled by actuated valve. Differential pressure measurement across the eductor will be provided with alarms. A bypass will be provided for the service water to enable flushing of the dosing lines.
- Slurry will be delivered to the dosing point by duty/standby dosing lines provided with non-return and cross over. Slurry flow measurement will be provided for each dosing line.

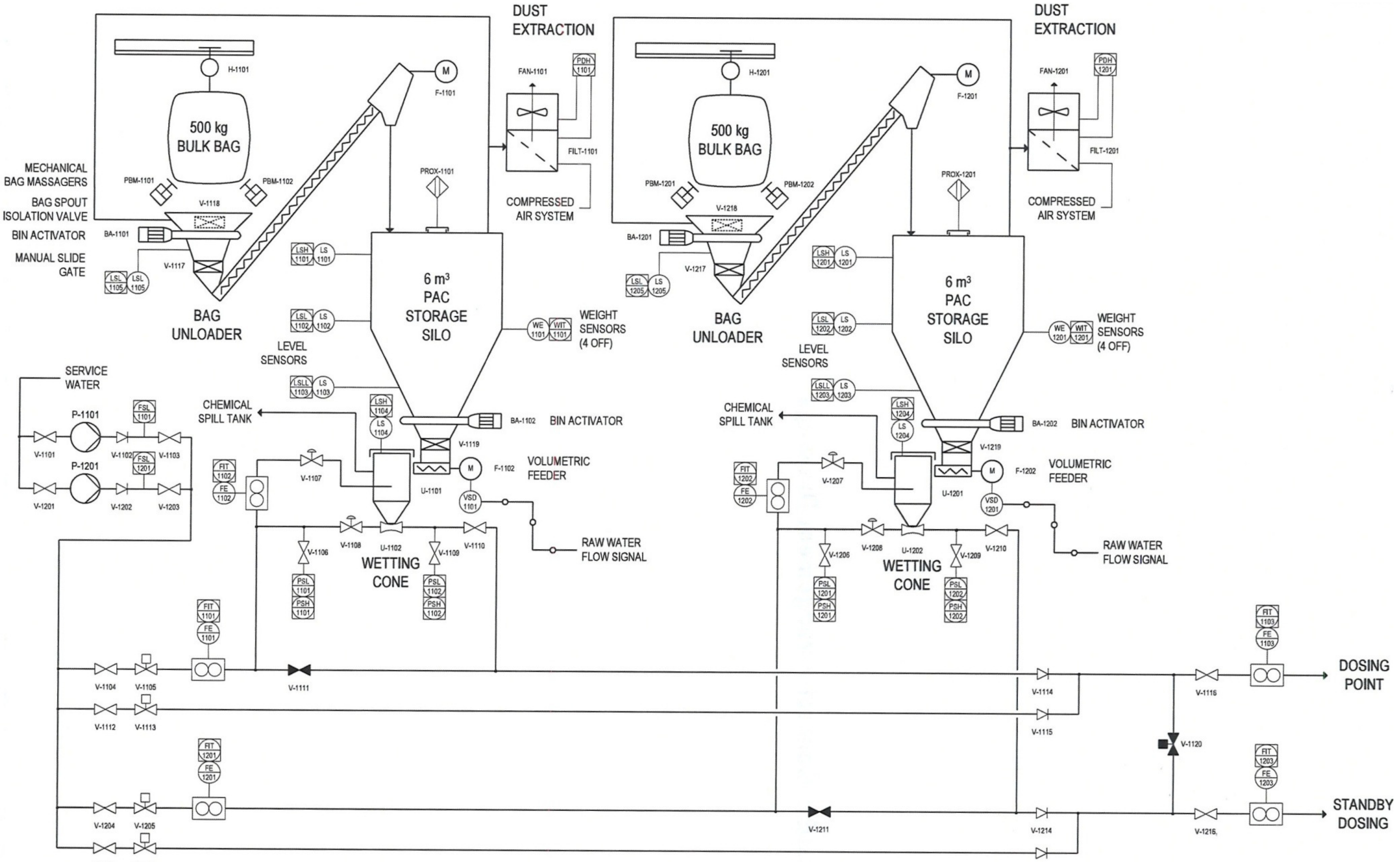


Figure 1 Proposed PID for the new PAC facility (Source: MJM report 2008)

3.4 Plant interfaces where appropriate

Key plant interfaces will include:

- Clarified water supply
- Power supply and controls
- Dosing lines to Hatch 5.

3.5 Site Constraints and Preferred Location

The plant is physically constrained by Woodlands Park Road to the West and North and steep gradients and bush to the South and East. A survey of ecological significance established that there were a large number of high value trees and native species that should be retained where possible. For the area close to the existing clarifier these are indicated in the illustration below.

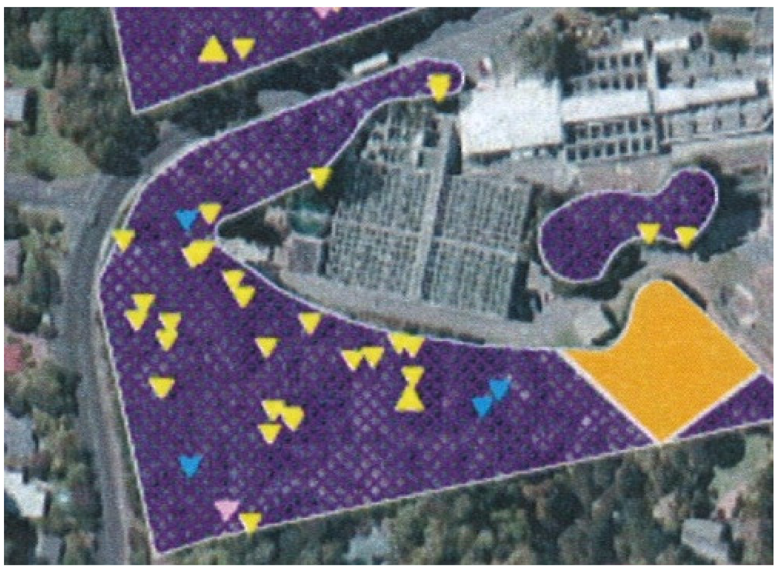


Figure 2 Areas of ecological significance, high (purple) & identified high value trees (Source: Huia WTP Vegetation Assessment, *Date TBC)*

A number of locations were assessed for the proposed PAC facility upgrade against a range of parameters including:

- Available area (including impact on areas of high ecological significance)
- Length of resulting dosing lines
- Access and routing for vehicle delivery of PAC bags
- Availability of service water for wetting and carrier
- Power
- Integration with existing systems
- Disposal of waste water and containment of spills

The preferred location was identified as near the existing sludge plant as shown in the figure below. However, it was noted that this would require the removal of a number of native trees to accommodate the proposed plant footprint and provide access and egress for delivery vehicle movements. The existing sludge dewatering facility is also proposed to be upgraded and the two layouts will need to be compatible.

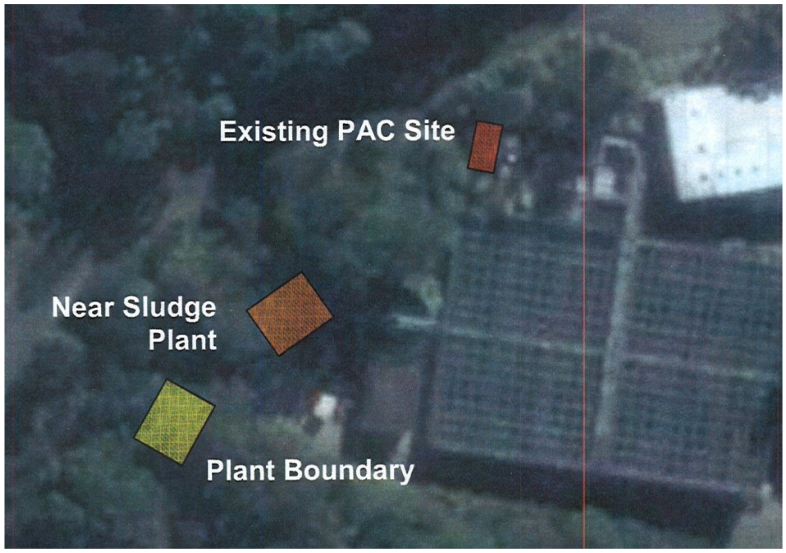


Figure 3 Preferred PAC facility location (Source: MJM report 2008)

MWH have developed several revised site layouts where it is proposed to locate the new PAC storage facility to the South of the existing clarifiers. Refer to the Stage 1 Design Report for details (Options 1D, 2E and 5D).

3.6 HSNO, OHS and HSE requirements

The plant safety requirements were summarised in the Ardmore and Huia WTP PAC Plant Upgrade Concept Design report (MJM April 2008). The key legislation governing plant safety is the Health and Safety in Employment Act 1992, the Hazardous Substances and New Organisms Act 1996 and the Hazardous Substances (Emergency Management) Regulations 2004. Key features required for the new PAC plant upgrade include (but are not limited to) the following. This list will be developed further as the project progresses and should be considered as preliminary at this stage. Detailed plant safety should be addressed during the detailed design phase for the upgrade.

- Under the HSNO regulations, PAC is given a 4.2C classification, a solid flammable substance with a low hazard risk
- PAC should not be exposed to incompatible substances except for air and oxygen
- As such, PAC must be contained within an ignition free zone
- Zone 2 for PAC[1]Electrical equipment should be protected from particulates and moisture i.e. within a building with appropriate IP rating
- The plant should be located within a building and be provided with adequate ventilation
- Level 3 emergency management is required including provision of fire extinguishers, emergency response plans and appropriate signage
- 2 fire extinguishers are required for each area storing greater than 500 kg PAC
- Fire extinguishers should be located less than 30m from any bulk bag
- Fire extinguishers should be located on the forklift
- Signage for the plant should state:
  - The PAC plant is a hazardous substance area
  - Emergency contact telephone numbers
  - Details of fire fighting measures
  - The plant is limited to the use of steam activated PAC only
  - Appropriate personal protective equipment should be worn at all times
- Secondary containment is required to contain escape of liquids from their containers
  - In this case this will require bunding around the silos to contain overflow from the wetting cones

[1] WSL workshop 1st November 2012

    - Provision of an in ground chemical spill tank i.e. a blind tank is discussed in the Concept Design Report
- Suitable compliant ladder access and walkway with guard rail, toe boards and head room is required for operator access on top of the silos
- Mechanical ventilation of the building air space is required and should consider the following:
    - The required exposure limits for PAC
    - Combustion products from any vehicles operated inside the building
    - The lower limit for explosion for PAC
    - Relevant New Zealand and Australian Standards
- Spark proof motors should be considered[2]
- PPE to be provided for all staff and worn at all times including eye protection, gloves, overalls, safety boots/shoes, respirators, ear defenders (subject to noise levels)
- Safety shower and eye wash station
- Change room with operator facilities (e.g. sink) to be considered

Other considerations identified at this time include:

- Minimise distances over which PAC needs to be transported
- Sufficient room for easy forklift access, movement and loading/unloading
- Consider stock rotation to prevent accumulation of old stock and powder consolidation
- Maintain a high standard of housekeeping and building cleanliness
- Maintain a high standard of fire protection with provision of fire extinguishers and excluding sources of ignition

3.7 Revised Concept Design PAC Unit Sizing

The concept sizing for the proposed PAC facility upgrade has been revised in the light of the recently agreed assumptions (Section 3.1) that form the new basis of design. The revised concept unit sizes are given below for consideration:

- Bulk storage of approximately 18 tonnes based on 14 days at maximum flow (126MLD) and average dose (10mg/l)
- 2 No. Intermediate storage silos of ~4.5m^3 working volume each based on 1.5 days working volume at maximum dose (15mg/l) and average flow (90MLD)
- Carrier water flow of 7.5 m^3/hour based on 1%w/v slurry concentration and maximum demand of 75kg/hour per dosing line
- Dosing line internal diameter of 51.5mm based on 7.5m^3/hour and 1 m/s velocity
- Semi-automatic bulk bag unloading system
- Automatic duty/standby batch preparation with volumetric feeders for PAC dose control, wetting cone, eductor and carrier feed water
- Building to house equipment and store 40 bulk bags of PAC

3.8 Concept Design Layout

A new concept layout has been developed based on the revised concept design parameters. It has been assumed that delivery vehicles will park outside and unloading into the building and stacking of bulk bags will be by forklift. The general arrangement is shown in Appendix B. The layout is based on providing forklift access around the rear of the bulk storage area.

[2] WSL workshop 1st November 2012

This disclaimer shall apply notwithstanding that the Project Technical Memorandum may be made available to WSL and other persons for an application for permission or approval or to fulfil a legal requirement.

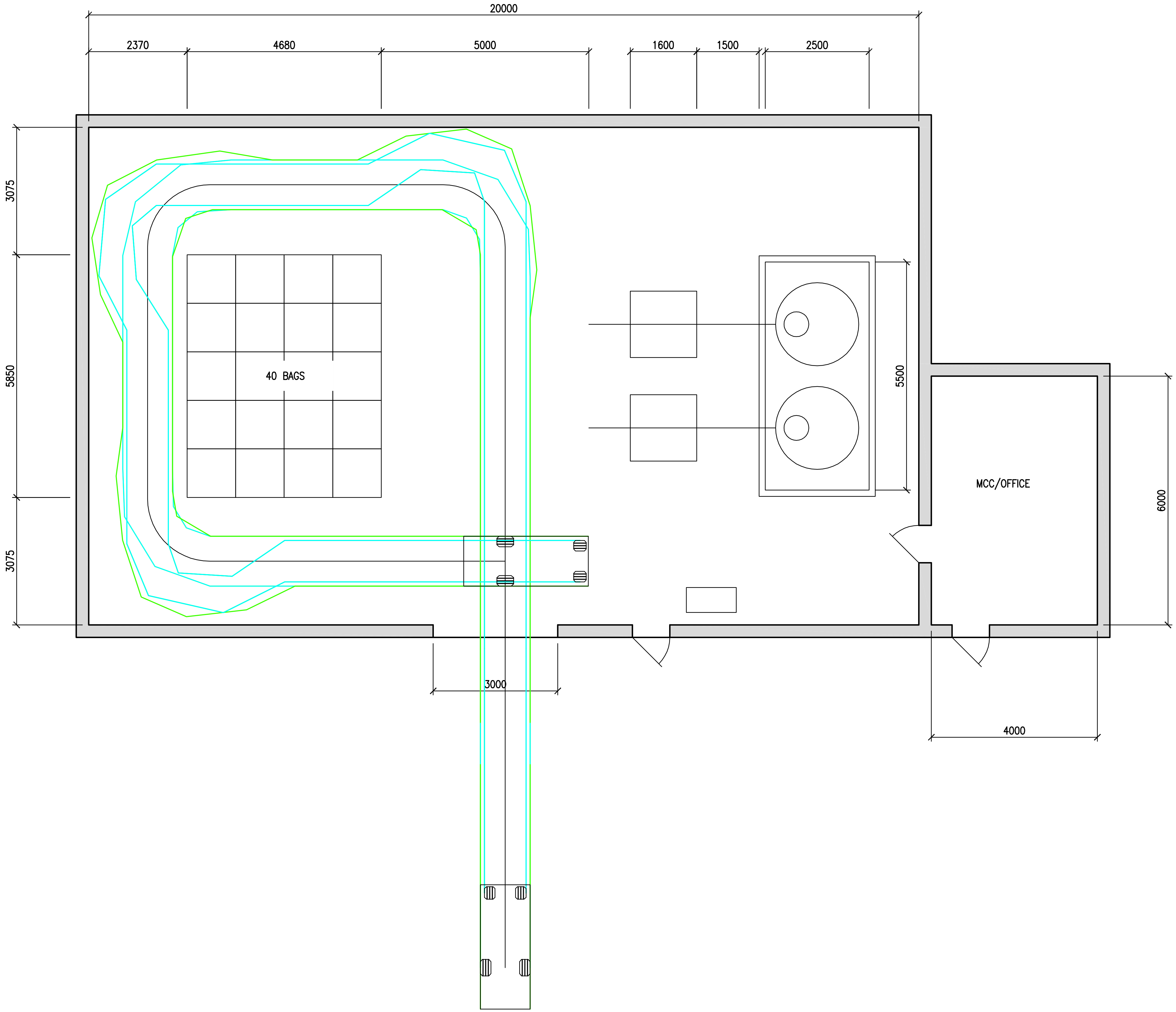
Appendix A Process Design Summary

Contract No.			**Equipment Data Sheet**
Date Sheet No.:	**5**	**Unit Process(es)**	**Powder Activated Carbon**
		Revision	**1**
		Revision Date	**27/09/2012**

AMBIENT CONDITIONS	Units	Requirements	Commets
Location		Woodlands Park Road, West Auckland	
Temperature	°C	Min: Max:	
Location		Outdoors	
Rel. Humidity	%RH	Min: Max:	
Powdered Activated Carbon	**Units**	**Requirements**	**Comments**
Point of application (POA)		Hatch 5	approx 1.58km upstream of the Alum POA.
Dosing line length	km	1.63	recommend dual dosing lines.
Plant flows	MLD	34, 100, 140	Min, av and max
PAC dosing rate	mg/l	5, 15, 30	Min, av and max. Note that the sludge report (MTL) uses a max of 15 for the mass balance.
	kg/hour	7.1, 63, 175 min av max	
Feeder turn down ratio		~25	Dry feeders can do >20:1
PAC contact time	mins	26 (at 140 MLD)	Need the aquaduct dimensions to check this.Suggests a CSA of ~1.6m2 ?
Bulk storage requirements	tonnes	19.6	This equates to 4.7 days storage at 140 MLD and 30 mg/l dose and 9.3 days at 15 mg/l. Is this sufficient?
	1m3 bags (~500kg)	~40	Bulk density can range from 0.2 to 0.75 ?
Dosing plant configuration		D/S	
Dosing system		Big bag,silo, dry feeder, eductor, carrier water	Forklift movement from bulk store to big bag unloader
Silos	No.	2	
Silo volume	m3	5.25 (working) each	One silo will hold approx 5-6 bags. At max flow and a max dose of 30 mg/l, daily requirement will be 4.2 tonnes or 8.4 m3. Hence 8 forklift movements per day continuously, is this acceptable?
Slurry concentration	%w/v	1	Typical slurry concentration for PAC to minimimse abrasion
Carrier water	m3/h	~17.5	1% at 175 kg/hour max dose rate
Dosing line ID	mm	78.7	Based on maintaining 17.5 m3/hour carrier flow and 1m/s velocity to minimise deposition.

Key Issues for Consideration
Confirm maximum PAC dose is 30 mg/l. The sludge report (MTL) mass balance is based on a max PAC dose of 15 mg/l. Raising this to 30 mg/l would add approx 2 tonnes per day to the sludge yield with potential impact on the sludge processing design?
Process design criteria need to be confirmed including redundancy requirements and in particular storage times for bulk storage of dry powder bags and silos
Discuss access, operation and maintenance of the proposed PAC plant building e.g. delivery, stacking,& movement of big bags
Discuss location proposed for PAC plant building (clash with the sludge plant), can it be located across the road near the upwash water tanks instead? Can it be located at the proposed POA ?
Facility will need to consider all OHS requirements, fire and HSNO regulations for this class of material
Reports refer to jar testing of different PACs, has this been done, will this impact on design PAC dosing rates used for the concept designs?
A discussion of contructability, staging and construction sequencing intended and what plant capacity needs to be maintained during such staged construction needs to take place to identify potential impact of these factors on the design/operation of the units and their proposed locations (e.g. the DAF is shown on top of the existing clarifiers for option 2.2b in the Master PLan and shown on top of the existing filter block on layout plant Option 1 but across the road for layout option 2)
Facility plan indicates the plant has been designated as level 4 post disater (AS/NZ1170.1), what are the implications/requirements for this?
Pneumatic tanker delivery to larger silos to eliminate the big bags would be an attractive option but understand this isn't practised/available in NZ ?

Appendix B Revised Concept Layout



					DESIGNED	G GLASGOW	01/13	WSL TO SIGN
					DES. CHECKED			OPERATIONS
					DRAWN	IR MULLIGAN	01/13	
					DWG. CHECKED			WSL TO SIGN
					PROJECT LEADER			
					INFRAST'R APP'D			INFRASTRUCTURE
ISSUE	DATE	AMENDMENT	BY	APPD.		BY	DATE	

water Care services limited

MWH.

HUIA WTP IMPLEMENTATION STRATEGY

PAC BAG STORAGE BUILDING PLAN

DRAFT

CAD FILE 80501084-01-001-G077	DATE
ORIGINAL SCALE A1 1 : 50	CONTRACT No.
REF. No. 80501084-01-001-G077	ISSUE A
DWG. No.	

Appendix D Muddy Creek Pipeline Tech Memo

PROJECT TECHNICAL MEMORANDUM

Date: 26/10/12

To: Watercare Services Ltd

For the Attention of: Maria Dalouche

Project: Huia WTP Implementation Strategy

Subject: Muddy Creek Pipeline

Project Technical Memo: 3 - Draft

Project Stage: Stage 1 Phase 2

Project Number: 80501084

Prepared by: James Peveril	**Checked by:** Chris Povey
Reviewed by: -- DRAFT for discussion --	**Authorised by:** -- DRAFT for discussion --

1 Introduction

Watercare's preferred future process option for the Huia water treatment plant (WTP) is flocculation, dissolved air flotation (DAF), ozonation, biological activated carbon (BAC) filtration and chlorination. This process has been selected to manage future raw water quality with the ability to handle greater algal loading and remove increased amounts of dissolved organics to improve disinfection stability and minimise disinfection by products.

MWH has been engaged to develop an overall concept layout plan for the Huia WTP which incorporates the new process design and existing concept designs for the Manuka Road Reservoir, new powdered activated carbon (PAC) preparation and dosing facilities, a new Sludge Dewatering facility and the Muddy Creek overflow pipeline.

This Technical Memorandum 3 presents the findings of the technical review of the Muddy Creek pipeline upgrade and is structured as follows:

- A summary of the background information referenced to date
- The current status of the concept design
- Technical review of the Muddy creek Pipeline concept design including:
    - Design criteria & agreed assumptions
    - Overflow locations
    - Interfaces with existing WTP
    - Interfaces with new/upgraded WTP
    - Reservoir overflows
    - Off-spec discharge scenarios
    - On-site treatment of discharges
    - Unresolved issues
- Further investigations required

2 Reference Documentation

The main reference documents for the Muddy Creek pipeline concept design are:

- Huia Overflow/Off-spec Pipeline Route Optioneering Report Vol 1, MWH, June 2010.
- Huia Overflow/Off-spec Pipeline Route Optioneering Report Vol 2, MWH, Aug 2010.

The following documents have also been used for reference in preparation of this technical memo:

- Huia WTP Hydraulics / Overflow Investigation, MTL, Aug 2003.
- Huia WTP Titirangi Reservoirs Inlet Chamber and Overflow Investigation, MTL, Aug 2004.
- Huia WTP Treated Water Tunnel and Titirangi Reservoir Report, Watercare, Apr 2006.

- Konini Road Reservoir Site Development Options Report, Beca, Jan 2008.
- Huia WTP Master Pan, Hunter Water Australia, Mar 2010.
- Huia WTP Facility Plan Unit Process Data Sheets, Beca, June 2010.
- Huia WTP Facilities Plan Layout Plan drawings 1 and 2, Beca, June 2010.
- Manuka Road Reservoir Concept Design Report, SKM, Jan 2011.

3 Current Status

The work undertaken by MWH on the Muddy Creek pipeline in 2010 included:

- Confirmation of design criteria.
- Development of potential pipeline alignment options and short-listing to feasible routes.
- Further development of short-listed route options to better understand major risks associated with each (structural, hydraulic, geotechnical, planning, operational and construction).
- Development of multi-faceted risk based multi-criteria analysis (MCA) tool.
- Geotechnical assessment (desk study and walkover).
- High-level investigation of consent implications.
- Rough-order costing of pipeline route elements.
- Non-price and Price MCA of feasible pipeline routes – selection of criteria weighting and option scoring with Watercare.
- Identified major risks associated with the top three route options.
- Identified additional investigation and design activities to develop route options prior to selecting a preferred option for preliminary design.

The multi-criteria analysis resulted in the selection of the top three pipeline route options (illustrated in Appendix A). Scores for the three routes were very close (less than 2% between the winner and second place).

A number of significant ‘unknowns’ were evident during the investigation. As the unknowns had potential to significantly impact on the scoring of pipeline route options, it was recommended that the unknowns were investigated and the outcomes included in further evaluation of the top three route options prior to selection of a preferred option and progression of pipeline design.

Further work is required to select a preferred pipeline route option and refine the final pipeline route.

In order to develop the overall concept layout plan for Huia WTP, review and development of the Muddy Creek pipeline concept will focus on aspects of the design that impact on the WTP site layout e.g. interface points with the existing and future WTPs and ensuring that adequate space is retained in the layout for the inlet chamber / pipework and potentially on-site treatment of off-specification discharges.

4 Review of Concept Design

This section summarises the technical review undertaken to date by MWH for the proposed Muddy Creek pipeline upgrade for Huia WTP.

Many elements of the Technical Review are currently works in progress and should be read in this context at this early stage.

4.1 Design Criteria & Agree Assumptions

The design criteria and assumptions agreed to date for development of the Muddy Creek pipeline are outlined in this section.

The agreed purpose of the Muddy Creek pipeline is to provide a pipeline for:

- Raw water overflow / bypass at the head of the WTP
- Overflow and off-spec connections at various locations through-out the WTP

- Overflows (not off-specification dumps) from the Titirangi 1 and 2 reservoirs on Konini Road.
- Overflows (not off-specification dumps) from Titirangi 3 reservoir to be constructed adjacent to Manuka Road.

Fundamental constraints that were applied to the Muddy Creek pipeline design during the initial investigation undertaken in 2010 are:

- The pipeline shall transport the full design flow (140 MLD) to the proposed discharge location at the Muddy Creek estuary – no discharges to Armstrong Gully will be considered due to the impact on local residents and onerous monitoring requirements.
- Overflows from the Titirangi 1 and 2 reservoirs on Konini Road shall be returned to the WTP site for release down the Muddy Creek pipeline.
- The existing detention pond (lagoon) will no longer be required for flow detention following construction of Muddy Creek pipeline.
- In addition to chlorinated reservoir overflows, WTP off-specification flows are to be released via the Muddy Creek pipeline. Representative values for the main potential contaminants in off-specification flow have been provided by Watercare, as follows:
  - CL2 = 2 mg/l
  - Al = 40 g/m3[1]
  - pH = 4 – 10
  - Fl = 1.5 g/m3
  - Off-spec SS = 5%

[1]It was noted that the existing Consent limit for stream discharge is 1ppm in respect of aluminium.

It has also been agreed that stormwater will continue to discharge directly to Armstrong Gully and not to the Muddy Creek pipeline. Several stormwater lines currently discharge either to, or run beneath, the WTP lagoon. Management of stormwater must be considered during development of the WTP upgrade design.

4.2 Overflow Locations

Existing Situation

The main overflows at the existing WTP include raw water from the head of the plant (after inlet dosing, before clarifiers) and clarified water from the eastern end of the clarified water channel.

The raw water overflow is a dedicated 965mm OD CLS / 900mm ID RC pipe, which discharges directly to the lagoon. This pipeline has a capacity of 140Ml/d.

Spills from the clarified water overflow discharge to the lagoon via the dirty wash water pipework. The clarified water overflow has a capacity of approximately 63Ml/d (flooding of the filters and the corridor in the treatment plant building occur above this flow rate).

A 'Chemical Conditioned' overflow acts as an overflow for the clarifiers during surges. This 310mm OD CLS overflow pipe is connected to the raw water overflow pipe at the southern end of the clarifier block.

The overflow pipe for the thickened sludge pumping station discharges directly to the lagoon.

Reservoirs

The existing Titirangi 1 and 2 reservoirs currently overflow to Bishops Stream. The overflow has a capacity of 35Ml/d. Watercare wish to move to a situation where overflows from the reservoirs are discharged to the Muddy Creek estuary via the Muddy Creek pipeline.

A new reservoir, Titirangi 3 or 'Manuka Road', is proposed as part of a wider network storage development scheme for west Auckland. The overflow from the new reservoir will discharge to the Muddy Creek pipeline.

Future WTP

A list of overflow locations for the upgraded WTP has been submitted to Watercare for comment. The overflow locations proposed are:

- Raw water (from Low lift PS inlet well)
- DAF tank
- Ozonation tank
- Filter inlet channel
- Chlorine contact/treated water tank
- Filter to waste tank, upwash tank, washwater balance tank and sludge thickeners
- Proposed Manuka Road reservoir overflow and scour
- Titirangi 1 and 2 reservoirs (potentially back-up and spill to MCP if treated water aqueduct is pressurised in future?)
- Proposed second Manuka Road reservoir (future)
- Sludge thickener supernatant (or would this go to sewer?)

The capacity requirements for each of the overflows listed above have not yet been confirmed.

4.3 MCP Interface with Existing WTP

The overflow locations at the existing WTP are described in section 4.2 above. The existing overflow pipes discharge to the lagoon located in the south-east corner of the WTP site (see Appendix B). For the purposes of concept design development it is assumed that no modifications will be made to the existing overflow arrangements or new overflow points added to the WTP until the plant is upgraded.

The investigation work undertaken in 2010 focused on identifying and optioneering potential routes for the new pipeline to the estuary. The investigation did not explore the interface between the proposed pipeline and the existing or future WTP. A location at the south-western corner of the existing lagoon was nominated as the site for the inlet to the proposed pipeline. The invert level of the existing discharge pipe from the lagoon was used as the approximate elevation for the pipe inlet for route option development purposes.

This location is considered appropriate for the inlet of the Muddy Creek pipeline as the existing raw water and clarified water overflow pipes can be connected with relative ease as they both discharge to the lagoon in close proximity to the proposed chamber site. This inlet location is also compatible with the top three Muddy Creek pipeline route options (further investigation of unknowns is required before a preferred route can be selected).

The site proposed for the collection chamber is constrained by steep topography and limited access for construction. The land falls away steeply to the south in close proximity to the lagoon, therefore significant earthworks / retaining walls may be required and working space would be at a premium if this site is selected. A more suitable option for the chamber may be to construct it in the corner of the lagoon. This would minimise topography constraints and ease access (an access road into the lagoon currently exists). Physical separation of the construction area from the body of the lagoon would likely be required for this option to ensure the works were not flooded in the event of an overflow from the WTP.

The collection chamber is expected to be a simple reinforced concrete structure which connects the existing overflow pipework to the Muddy Creek pipeline. The structure should be of sufficient size to allow stilling of incoming flows prior to discharge to the pipeline. A solution that does not incorporate valves or penstocks is preferable; therefore it is unlikely that power will be required.

There is scope to provide a high-level emergency overflow from the collection chamber to the head of Armstrong Gully for use in the event of failure or blockage of the Muddy Creek pipeline. Watercare are currently considering the impact of providing an emergency overflow on discharge consent requirements.

Further consideration of the exact location and form of the collection chamber is required as the concept design and WTP site layout are developed.

4.4 Interface with Upgraded WTP

Discussion of the overflow locations associated with the upgraded WTP is covered in section 4.2 above.

The WTP site layout options developed as part of the Facility Plan include a collection chamber for the Muddy Creek pipeline beyond the south-western edge of the existing lagoon (see drawings for Options 1 and 2 in Appendix C). As with the existing WTP, this location is considered appropriate for the inlet to the Muddy Creek pipeline as it at a low elevation in comparison to the proposed works for either site layout option, allowing gravity flow from the various overflow locations.

As discussed above, the exact location and form of the collection chamber will be established as the concept design and site layout for the WTP upgrade are developed. AMP budgeting suggests that the Muddy Creek pipeline will be completed prior to construction of the main WTP upgrade, therefore, the chamber will be configured and sized such that the overflows from the upgraded plant can be connected to the chamber following construction of the plant upgrade.

Phasing of the upgrade works to ensure minimum impact on WTP functionality is important to Watercare. This will include minimising restrictions on the use of the Muddy Creek pipeline; therefore the plant upgrade should be designed such that the new overflow pipework can be 'cut-in' when connecting to the Muddy Creek pipeline.

4.5 Reservoir Overflows

Titirangi 1 & 2

The 2004 'Titirangi Reservoirs Overflow Investigation' report by MTL indicates that the existing overflow arrangement to Bishops Stream is suitable for discharge of off-spec water at minimum plant flow during plant re-start, but the existing arrangement does not have hydraulic capacity to act as a treated water overflow (maximum capacity is approximately 35Ml/d compared to a potential treated water flow of 140Ml/d). Therefore, Watercare wish to provide a treated water overflow for the upgrade WTP that discharges to the Muddy Creek pipeline.

A full capacity treated water overflow will be provided as part of the WTP upgrade. This will be connected to the collection chamber at the inlet to the Muddy Creek pipeline. There is a need to consider options to deal with the 'slug' of water in the treated water tunnel in off-specification scenarios and overflows from the Titirangi 1 and 2 reservoirs during the period of time that it would take to divert flow to the treated water overflow at the outlet of the WTP. Three options are outlined below.

Provide a new dedicated overflow pipe from the reservoirs to the collection chamber at the inlet of the Muddy Creek Pipeline. Provision for this option was requested during the route optioneering investigation in 2010. A number of potential routes for a new overflow were considered. The route options were all considered difficult and expensive at the time of the investigation due to the topography and other constraints.

Pressurise the treated water tunnel. The existing concrete tunnel could be lined to allow the tunnel to be pressurised, so that flows can back-up from the reservoirs and spill at a treated water overflow at the WTP. The required capacity of the treated water tunnel following the construction of the Titirangi 3 (Manuka Road) has not yet been confirmed. The feasibility of lining the treated water tunnel or installing a new PE/GRP pipe within the tunnel should be confirmed once the required capacity is known. Lining the treated water tunnel would also have benefits in relation to water quality (mitigating ground water ingress) and security of supply (aging assets).

Use Titirangi 1 reservoir as a storage / attenuation tank. This option would utilise the existing Titirangi 1 reservoir as storage for overflows/off-spec waters prior to release to Bishops Stream as per existing arrangements. Titirangi 1 has a functional capacity of approximately 4500m^3. This equates to approximately 60 minutes storage at 105Ml/d (140Ml/d future full plant flow minus 35Ml/d discharge to Bishops Stream – this does not take into account flow-split with the proposed Titirangi 3 reservoir). 60 minutes is likely to be more than adequate time to allow for diversion of treated water flow to the Muddy Creek pipeline via a treated water overflow at the WTP. This option would result in a small loss of treated water storage capacity in the network, which is a consideration for the Watercare network planner.

Titirangi 3 (Manuka Road)

Construction of the 25,000m3 Manuka Road reservoir is scheduled to commence in 2014. The reservoir will supplement the existing treated water storage capacity at Huia WTP. The reservoir will include an overflow and scour drains that will discharge to the Muddy Creek pipeline. The reservoir will be constructed at an elevation that permits flows to gravitate to the collection chamber at the inlet to Muddy Creek pipeline.

As the Manuka Road reservoir is scheduled for completion before the construction of the Muddy Creek pipeline, it is assumed that the overflow from the new reservoir will be connected to the lagoon until the Muddy Creek pipeline is in place.

4.6 Off-spec Discharge Scenarios

There are a number of scenarios in which inlet water quality and / or operational issues may cause water to be outside of specified quality limits for discharge into the distribution network. In the event of 'off-specification' water being detected by monitoring / sampling equipment, the water may need to be diverted to the Muddy Creek pipeline for discharge to the estuary. Water will also need to be diverted away from the network during plant re-start. It is envisaged that off-spec discharges will be diverted to the Muddy Creek pipeline via the various proposed overflows by closing a valve or penstock downstream of the overflow and that no dedicated off-spec take-offs are required.

There is a risk that off-spec water could be considered to have a detrimental effect on the receiving environment (the Muddy Creek estuary) depending on the type and level of contaminants contained in the water. This risk will be examined in detail during the resource consent application process and limits may be imposed on the quality of the water discharge via the Muddy Creek pipeline.

An initial assessment of potential consent implications was undertaken as part of the Muddy Creek pipeline route investigation in 2010. This assessment was based on estimated contaminate values provided by Watercare (listed in section 4.1 above). The findings of the initial assessment against the five key contaminant types identified are summarised below:

- **Suspended Solids:**

  The proposed 5% value for suspended solids does not appear problematic in this estuarine area. The area is classified as settling zone and is naturally subject to some turbidity.

- **Fluoride:**

  Not seen as problematic as the estimated contaminate level is similar to background concentrations in seawater.

- **Chlorine:**

  Problematic, being one thousand times the level limit for a Permitted activity and substantially higher than indicated safe limits for the ecosystem.

- **Aluminium:**

  Problematic only within the lower and higher ends of the proposed pH ranges, with a significant improvement in consentability perhaps emerging in the range between around pH 5 through to pH 8.

- **pH:**

  In addition to its resulting effect on toxic aluminium concentrations, extreme pH, especially at the low end of the proposed range, has potentially severe effects on the receiving environment.

The findings above are heavily subject to a number of limitations and unknowns and it is strongly recommended that further detailed investigations are undertaken to better understand the impact of the off-spec discharges to the marine environment and likely discharge consent conditions. Recommendations for further investigations include:

- Identification of tidal levels and associated salinity at discharge locations.
- Field assessment to estimate the available dilution throughout the tidal cycle. Potentially, depending on the results of the field assessment, a desktop review of water quality and marine ecology data may be required.
- Sampling of water quality, aquatic macro-invertebrates and fish communities dependent upon the results of the desktop review.
- Assessment of Environmental Effects of proposed discharges based upon desktop information and field assessments.
- Desktop review to obtain stormwater runoff data into the harbour. If no data is available, estimate of stormwater flow based on ARC TP108 Guidelines for stormwater runoff modelling in Auckland region may be required.
- Depending on the results of stormwater runoff estimate, desktop review of the impact of freshwater discharge on salinity fluctuation and its effect on marine ecology may be required.
- Qualitative assessment of the physical characteristics of the harbour.

4.7 On-site Treatment of Discharges

The potential constraints around discharge water quality discussed in section 4.6 above may necessitate treatment of certain off-spec flows prior to discharge via the Muddy Creek pipeline.

The initial assessment of key contaminates indicates that Chlorine and pH are most likely to require treatment. There may also be limitations on the level of suspended solids. There are a number of options available to treat these contaminants, including chemical treatment (de-chlorination, pH adjustment), media filtration (e.g. carbon) and more simple methods such as dilution or settlement. A full assessment of the potential contaminant scenarios (level, frequency, volume) against likely discharge consent conditions is required before the design of treatment options can be developed.

Adequate physical space for treatment must be reserved during development of the WTP site layout. The option to retain the existing lagoon should be considered, as this may be a simple, practical solution for ‘treatment’ of a range of off-spec flows.

4.8 Unresolved Issued

The following items require clarification or confirmation at the time of writing this memo:

- Confirmation of overflow locations at upgraded WTP.
- Confirmation of the flow split between Titirangi 1&2 reservoirs and the proposed Titirangi 3 (Manuka Road) reservoir.
- Direction on whether an emergency overflow at the head of the Muddy Creek pipeline to Armstrong Gully is desired (subject to impact on discharge consent).
- Confirmation of treated water tunnel gradient.
- List of potential off-specification scenarios (level, frequency, volume) that need to be considered during design development.

- Direction regarding expected consenting limits for off-specification waters to enable confirmation of treatment requirements (see further investigation required section).

5 Further Investigation Required

The following items have been identified as requiring further investigation:

- Determine the hydraulic requirements for WTP and reservoir overflows - onsite levels and head losses will constrain the outlet level from the site and therefore the Muddy Creek pipeline inlet / collection chamber level and the overall pipeline design.

- Determine the preferred option for dealing with overflows from the Titirangi 1 & 2 reservoirs.

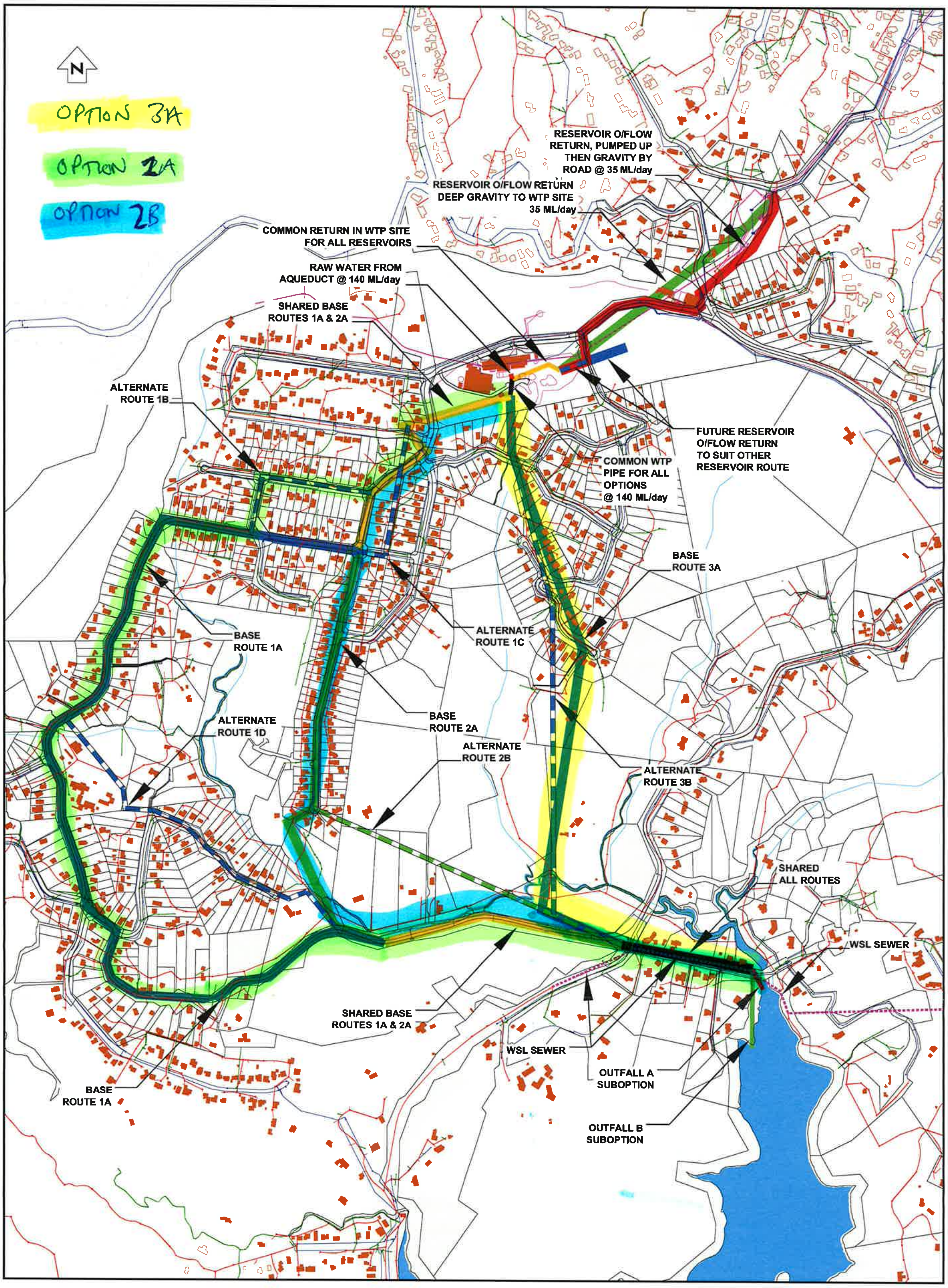
- Assessment of the quality requirements for discharge of flows to the Muddy Creek estuary, particularly off-specification waters. This should build on the initial assessment completed by MWH in 2010 (see the Consent Memo in Appendix D of the Huia Overflow/Off-spec Pipeline Route Optioneering Report Vol 1, June 2010) and may require consultation with the regulatory authority.

- For pipeline route option finalisation / concept design (Stage 2 of this investigation) – development of the recommendations listed in the Huia Overflow/Off-spec Pipeline Route Optioneering Report Vol 2, MWH, Aug 2010 is required to enable selection of a preferred route and refinement the final pipeline route.

Attachment A – Route Optioneering – Top 3 Pipeline Routes

HUIA WTP OFFSPEC & OVERFLOW DIVERSION PIPELINE

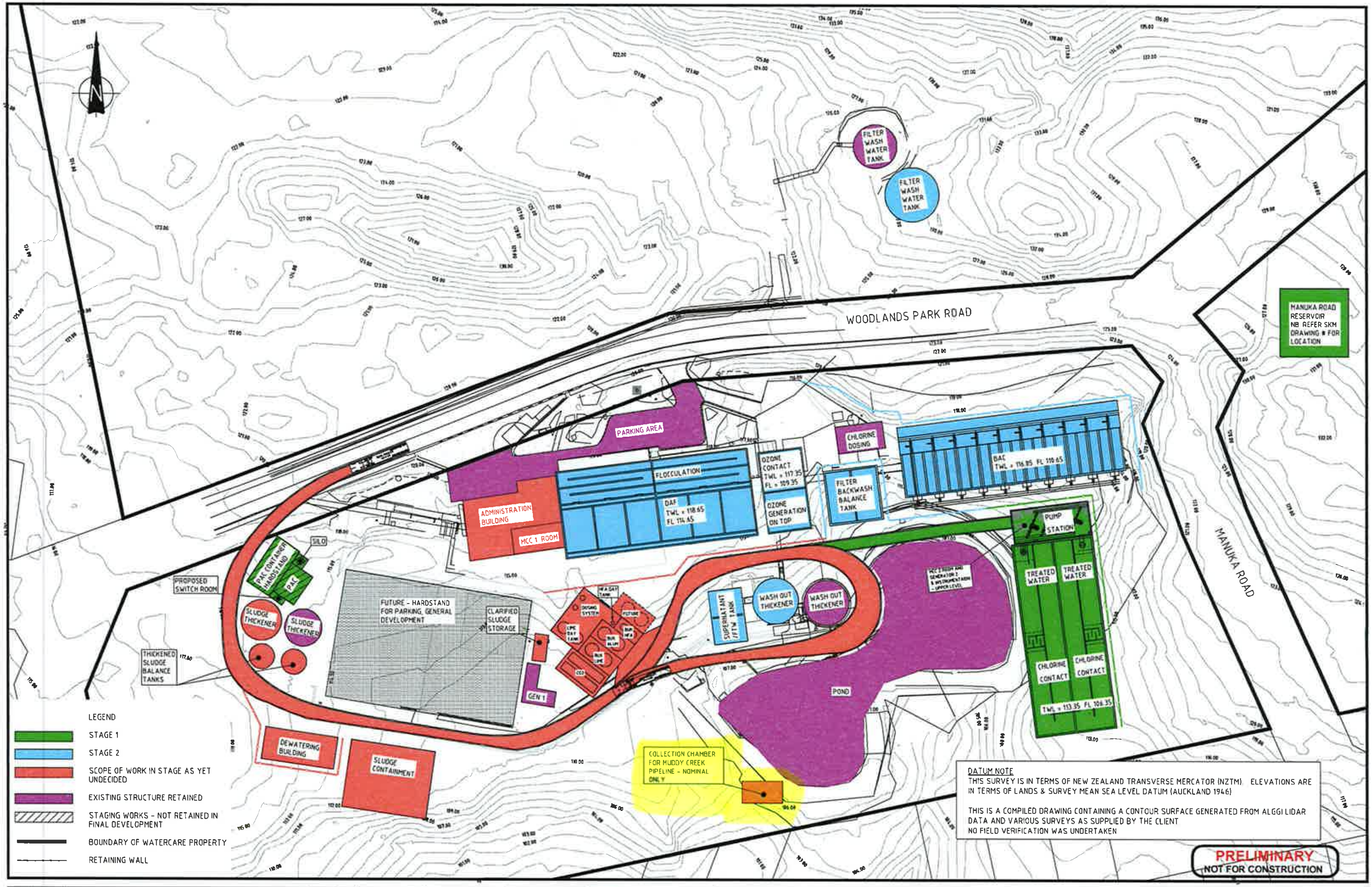
Optioneered Alignments & Reservoir Overflow Return Routes



Attachment B – Overflow Discharges to Lagoon Drawing


NOTES
KEY
WASHWATER RECOVERY TANK
WASHWATER THICKENER TANK
OVERFLOW PIPEWORK
RAW WATER
CLARIFIED WATER
SLUDGE PS
STORMWATER
AS BUILT SCHEDULE

Attachment C – Concept Site Layout Options



ISSUE	DATE	AMENDMENT	BY	APPD.
E	14.6.10	ISSUED FOR LAYOUT DECISION	HH	AMP
D	21.05.10	GENERAL UPDATE - ISSUED FOR LAYOUT OPTIONS REVIEW	HH	AMP
C	17.5.10	REVISED FOR FACILITY COSTING		
B	7.5.10	REVISED FOR WSL, OPS REVIEW		
A		ISSUED FOR INFORMATION		

	BY	DATE
DESIGNED		
DES. CHECKED		
DRAWN		
DWG. CHECKED		
PROJECT LEADER		
A.M. APPROVED		

water Care services limited

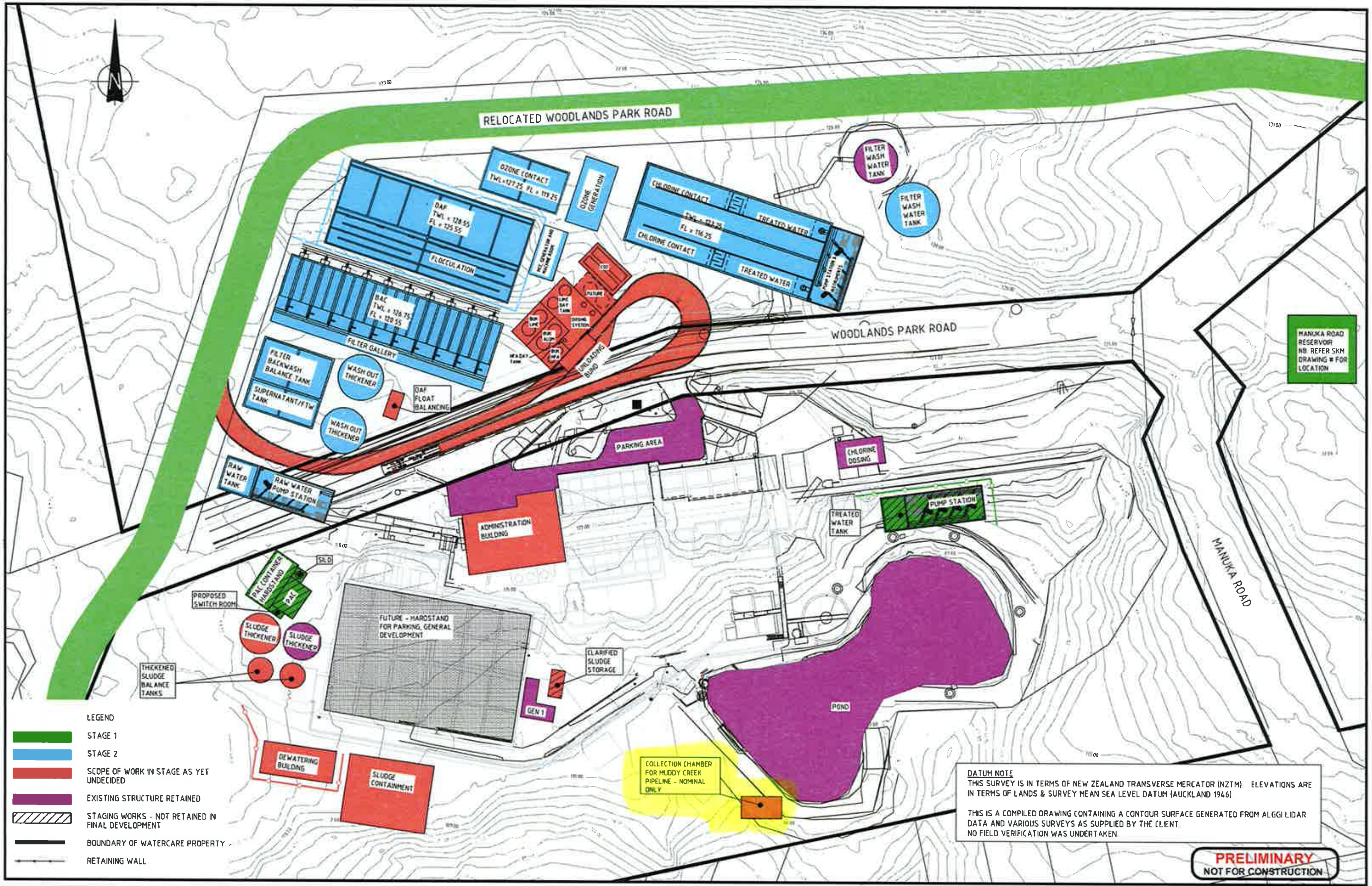
Huia TREATMENT PLANT
LAYOUT PLAN
OPTION 1

FACILITY PLAN

CAD FILE 6516050-CK-002A DATE 14-6-2010

ORIGINAL SCALE A1	CONTRACT No.
1:500	–

DRAWING No.	ISSUE
Dwg No .0XX	E



ISSUE	DATE	AMENDMENT	BY	APPD.
E	14.6.10	ISSUED FOR LAYOUT DECISION	HH	AMP
D	21.05.10	GENERAL UPDATE - ISSUED FOR LAYOUT OPTIONS REVIEW	HH	AMP
C	17.5.10	REVISED FOR FACILITY COSTING		
B	7.5.10	REVISED FOR WSL, OPS REVIEW		
A		ISSUED FOR INFORMATION		

	BY	DATE
DESIGNED		
DES. CHECKED		
DRAWN		
DWG. CHECKED		
PROJECT LEADER		
A.M. APPROVED		

water Care services limited

Huia TREATMENT PLANT
LAYOUT PLAN
OPTION 2

FACILITY PLAN

CAD FILE 6516050-CK-003 DATE 14-6-2010

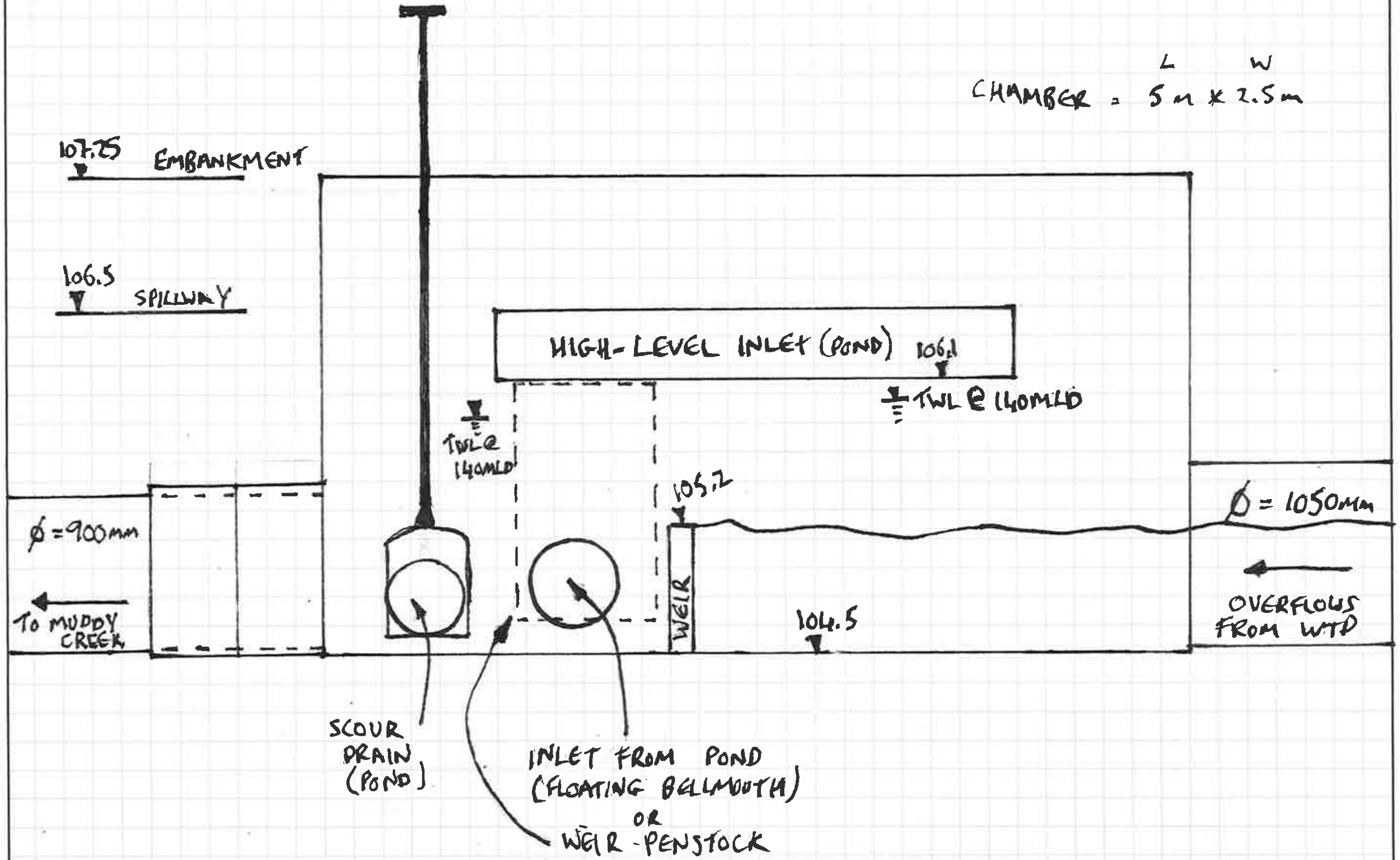
ORIGINAL SCALE A1	CONTRACT No.
1:500	-

DRAWING No.	ISSUE
Dwg No .0XX	E

Appendix E MCP Interface Drawings

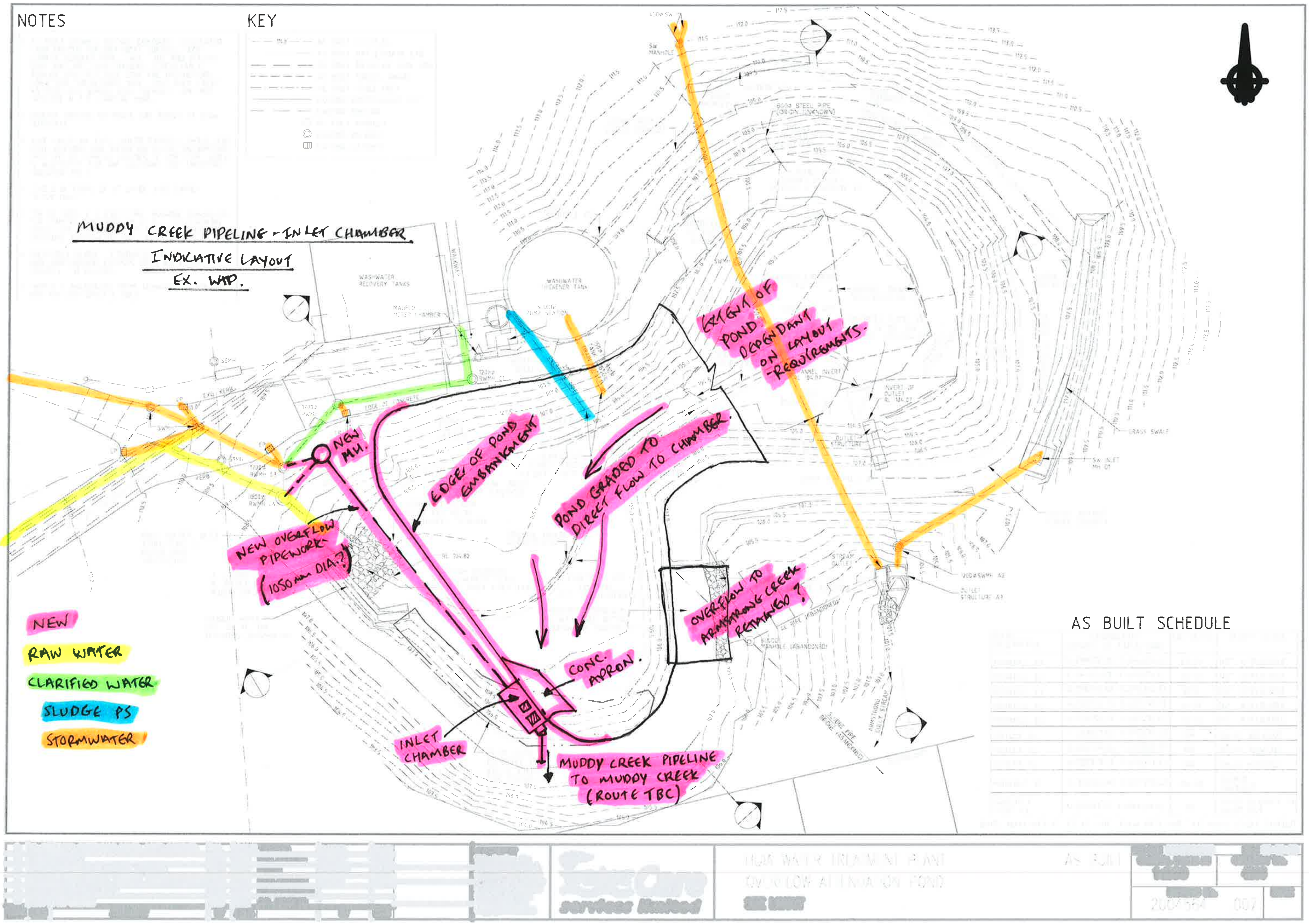
MUDDY CREEK PIPELINE - INLET CHAMBER

INDICATIVE ELEVATION



MWH
BUILDING A BETTER WORLD

PROJECT ____ PROJECT NO. ____
DESCRIPTION ____
PREPARED BY ____ DATE ____
CHECKED BY ____ DATE ____
REF/DWGS ____ SHEET ____ OF ____


NOTES
KEY
MUDDY CREEK PIPELINE - INLET CHAMBER
INDICATIVE LAYOUT
EX. WTP.
WASHWATER RECOVERY TANKS
WASHWATER THICKENER TANK
SLUDGE PUMP STATION
EXTENT OF POND DEPENDANT ON LAYOUT REQUIREMENTS.
NEW MH.
EDGE OF POND EMBANKMENT
POND GRADED TO DIRECT FLOW TO CHAMBER
NEW OVERFLOW PIPEWORK (1050mm DIA.?)
OVERFLOW TO ARMSTRONG CREEK RETAINED?
CONC. APRON.
INLET CHAMBER
MUDDY CREEK PIPELINE TO MUDDY CREEK (ROUTE TBC)
NEW
RAW WATER
CLARIFIED WATER
SLUDGE PS
STORMWATER
GRASS SWALE
AS BUILT SCHEDULE
services limited
AS BUILT

Appendix F Overflow & Off-spec Discharge Locations

Overflow and off-specification discharge locations and conditions used for layout development:

Raw water – 126Ml/day now 140Ml/day max future - generally suitable quality for direct discharge to Muddy Creek pipeline, exception would be during PAC dosing. Would this be considered an overly abnormal event? If not raw water must discharge into holding lagoon to provide as much detention as possible before discharge to Muddy Creek. Assuming lagoon is approx. 2ML volume this would be approx. 20minutes which is around the time it takes for the flow to travel from Hatch 5 where PAC is dosed. Suggest manual overflow diversion arrangement into the lagoon be available when PAC is being dosed and auto shutdown of PAC if overflow is detected.

Clarified water – 126-140Ml/day max although highly unlikely to have peak flows as all filters would need to be blocked or an isolation penstock close incorrectly. Clarified water that spills from the clarifier itself due to high level will carry floc and solids with high aluminium and should be directed to the lagoon. Clarified water that spills from the inlet to the filters or ozone tank in future will be of good quality and should be directed directly to the overflow pipeline.

Ozonated water – 140Ml/day future – directed directly to the overflow pipeline

Filtered water overflow – 126-140Ml/day – directed directly to the overflow pipeline

CCT/TWT overflow – 126-140Ml/day – directed directly to the overflow pipeline. Ability to manually divert to the lagoon when dumping excessively out of spec water.

Filter to waste tank – 12Ml/day – directed directly to the overflow pipeline

Upwash water tanks – directed directly to the overflow pipeline – say a max refill rate of 10% plant outflow 14Ml/day

Manuka Road Reservoir – 126-140Ml/day – directed directly to the overflow pipeline

Washwater balance tank – 90Ml/day (max upwash rate) – directed to lagoon

Washwater clarifiers – 11Ml/day (two washes per filter per day) – directed to lagoon

Sludge thickeners – say 4Ml/day (2% clarified water volume, 10% washwater clarifier feed) – directed to lagoon

Sludge tank overflows – directed to lagoon.

Appendix G Process Design Worksheet

HUIA WTP CONCEPT DESIGN
PROCESS DESIGN

Plant Net outflow	Ml/day	140	
DAF losses (float)	%	2%	
BAC losses (backwash/FTW)	%	8%	
Plant Inflow	Ml/day	154	Inflow includes FTW and return washwater
	m3/hr	6417	
Flocculation			
Number of units	No.	8	All duty at max flow
Detention time	min	15	
Stages	No.	2	
Total volume	m3	1604	
Volume per unit	m3	201	
Volume per stage	m3	100	
Tank width (internal)	m	7.6	
Stage length (internal)	m	3.2	Allow 300mm baffle walll between stages
Tank depth to TWL	m	4.1	Allow 700mm freeboard from TWL to top of walls
Flocculators	Type		Assume full width hoizontal paddles, chain driven
Building			Not required
DAF			
Number of units	No.	8	All duty at max flow
Surface Loading rate	m3/m2/hr	10	including normal recycle
	m3/m2/hr	11.4	at N-1 including recycle
Recycle rate		10%	normal
		15%	max
Recycle water			Use DAF underflow for recycle flows
Total tank area	m2	706	
Area per unit	m2	88	
Tank length	m	11.6	
Tank width/unit	m	7.6	
Tank depth to TWL	m	3.0	nominal
Float volumes max	m3/hr	117	
Float tank depth	m	3.0	Adopt same depth as DAF tank
Float tank width	m	7.60	Adopt same widrth as a DAF tank
Float tank minimum length reqd	m	5.1	
Recycle pump duty	m3/hr	80.2	Duty pump per unit and shared standby between 2 units, assume 60m max head
Saturators	No.	4	Assume shared between 2 units
	m3	8.0	Assume 3 minutes detention, 2.4m dia
Building			Full enclosure over DAF tanks required
Plant room	m2	200	4 No. Saturators, 12 No. recycle pumps, 3 air compressors, switchboard
Ozone			
Number of contactors	No.	2	
Contact time	Min	15	Average contact time
Flowrate per contactor	m3/hr	4725	Assumes 75% capacity at N-1
Volume per contact tank	m3	1181	
Tank depth to TWL	m	6.5	Allow 300mm freeboard to underside of roof slab
Flow channel width	m	3.25	
Flow channel length	m	55.9	Per contactor
Contactor width (internal)	m	14	Assume 4 channel widths and baffle wall thickness
Contactor length (internal)	m	16.0	Allow extra 3m overall length for overflow weir and channel
Ozone building	m2	200	Locate building on top of one contact tank
Contact tank access			Centre gallery 1200mm flange access hatch plus top access hatches.
Ozone dose	mg/L	3.2	
No of ozonators	No.	2	Plus 1 standby
Ozone capacity	kg/hr	20.16	
Sidestream flowrate	m3/hr	126	Assume 2% of total flow
Sidestream pumps	m3/hr	63	Assume 1 pump per ozonator
Oxygen generation	Nm3/hr	200	VPSA duty and standby units

BAC Filters

Number of filters	No.	14	
Filtration rate	m3/m2/hr	6	at N-1 ie one filter under backwash/FTW
EBCT for carbon	min	15	
Flowrate per filter (at N-1)	m3/hr	485	
Filter area	m2	80.8	
Filter width	m	5.6	
Filter length	m	14.4	
Carbon depth	mm	1500	1.3mm carbon
Sand depth	mm	400	0.56mm sand
Support media	mm	300	
Water depth over Carbon	mm	2000	
Upwash rate	m3/m2/hr	43	
	m3/sec	0.965	
Upwash pumps	No.	2	Plus 1 standby
Air scour rate	m3/m2/hr	55	
	m3/min	74	
Backwash volume/wash		3	Number of bed volumes to waste
Backwash volume/wash	m3	460	
Upwash volume/wash	m3	622	Includes refilling filter say 2m depth above media to launders
Filter to waste		3	Number of bed volumes to waste
Filter to waste	m3	460	

Waste washwater tanks

Number of tanks	No.	2	
Number of backwashes held	No.	2	
Volume of each tank	m3	460	
Tank Depth	m	4	
Tank Width	m	7.6	
Tank Length	m	15.2	Adopt approx 2:1 L:W

Upwash water tank (under DAF tanks)

Number of tanks	No.	1	
Number of backwashes held	No.	2	
Volume of each tank	m3	1244	
Minimum Tank Depth reqd	m	2.73	
Tank Width	m	11.6	Use same width as DAF tank as located underneath
Tank Length	m	39.2	Use 5 DAF tanks long

Filter to waste tank (under DAF tanks)

Number of tanks	No.	1	
Number of FTW volumes held	No.	2	
Volume of each tank	m3	921	
Minimum Tank Depth reqd	m	3.39	
Tank Width	m	11.6	Use same width as DAF tank as located underneath
Tank Length	m	23.4	Use 3 DAF tanks long

Overall DAF float tank width		62.9	
Combined upwash and FTW tank width		62.9	Within DAF footprint, OK
FTW return pumps - 2 duty 1 standby	L/s	37	Flow per pump assuming 1 backwash/filter/day

(alternative Upwash and FTW under BAC)

Assume FTW tank under one bank of filters and upwash tank under the other (shallow tanks, not cost effective)

Upwash and FTW tank area	m2	800	Approx area each tank
Minimum depth upwash tank	m	1.6	
Minimum depth FTW tank	m	1.2	

Alternative FTW and Upwash under one side of filterblock only

Upwash tank area	m2	460	Approx area 4 filters
FTW tank area	m2	340	Approx area 3 filters
Minimum depth upwash tank	m	2.7	
Minimum depth FTW tank	m	2.7	

Chlorine Contact Tank

Number of contact tanks	No.	2	
Contact time	Min	30	T90

Tank Efficiency factor	%	60%	
Flowrate per contact tank	ML/day	105	Assumes 75% capacity at N-1
Volume per contact tank	m3	3646	
Tank depth to TWL	m	7.0	Allow 300mm freeboard to underside of tank cover
Flow channel width	m	6	
Flow channel length	m	86.8	Per contactor
Contactor width (internal)	m	12.3	Assume 2 channel widths and baffle wall thickness

Treated Water Tank

Number of tanks	No.	2	Same as for CCT
Contact time	Min	10	Average
Flowrate per contact tank	ML/day	105	Assumes 75% capacity at N-1
Volume per contact tank	m3	729	
Tank depth to TWL	m	7.0	Same depth as CCT
Flow channel width	m	6	
Flow channel length	m	17.4	Per contactor
Overall length of CCT/TWT	m	53.0	Includes extra 900mm for baffle mixing zone

Waste Washwater thickeners

Assume 2 thickeners each rated at 75% of design capacity (1 wash per filter per day)

Design capacity per thickener	m3/hr	201
Hydraulic loading rate	m3/m2/hr	1.5
Thickener diameter	m	13
Thickener feed rate (max)	L/sec	56
Thickener feed pipe	mm	225

Sludge Thickeners

Assume 2 thickeners each rated at 75% of design capacity

Max solids loading per thickener	kg/hr	187.5	Taken from Sludge dewatering concept design (max 6T dry solids/day)
Max hydraulic loading per thickener	m3/hr	118	DAF float plus waste washwater thickener underflow (max 10% of inflow)
Solids Loading rate	kg/m2/hr	1.2	
Hydraulic loading rate	m3/m2/hr	1.5	
Thickener diameter	m	14	
Thickener feed rate (max)	L/sec	33	
Thickener feed pipe	mm	150	

Supernatentand FTW return PS

Assumes all FTW washwater and sludge thickener supernatent collected in common sump and pumped back to head of works

Assume 2 duty and 1 standby pumps, VSD

Max hydraulic loading (10% of inflow)	m3/hr	642	
Pump unit flowrate	l/s	89	
Sump min operational volume	m3	40	Limits pump starts to 4 per hour max at fixed speed operation
Sump diameter	m	4	
Sump operational depth	m	3.2	
Sump overall depth	m	5.2	Allow extra 2 m for pump submergence, level controls and freeboard

Supernatent only return PS

Assume only washwater and sludge thickener supernatent collected in common sump and pumped back to head of works, separate FTW PS

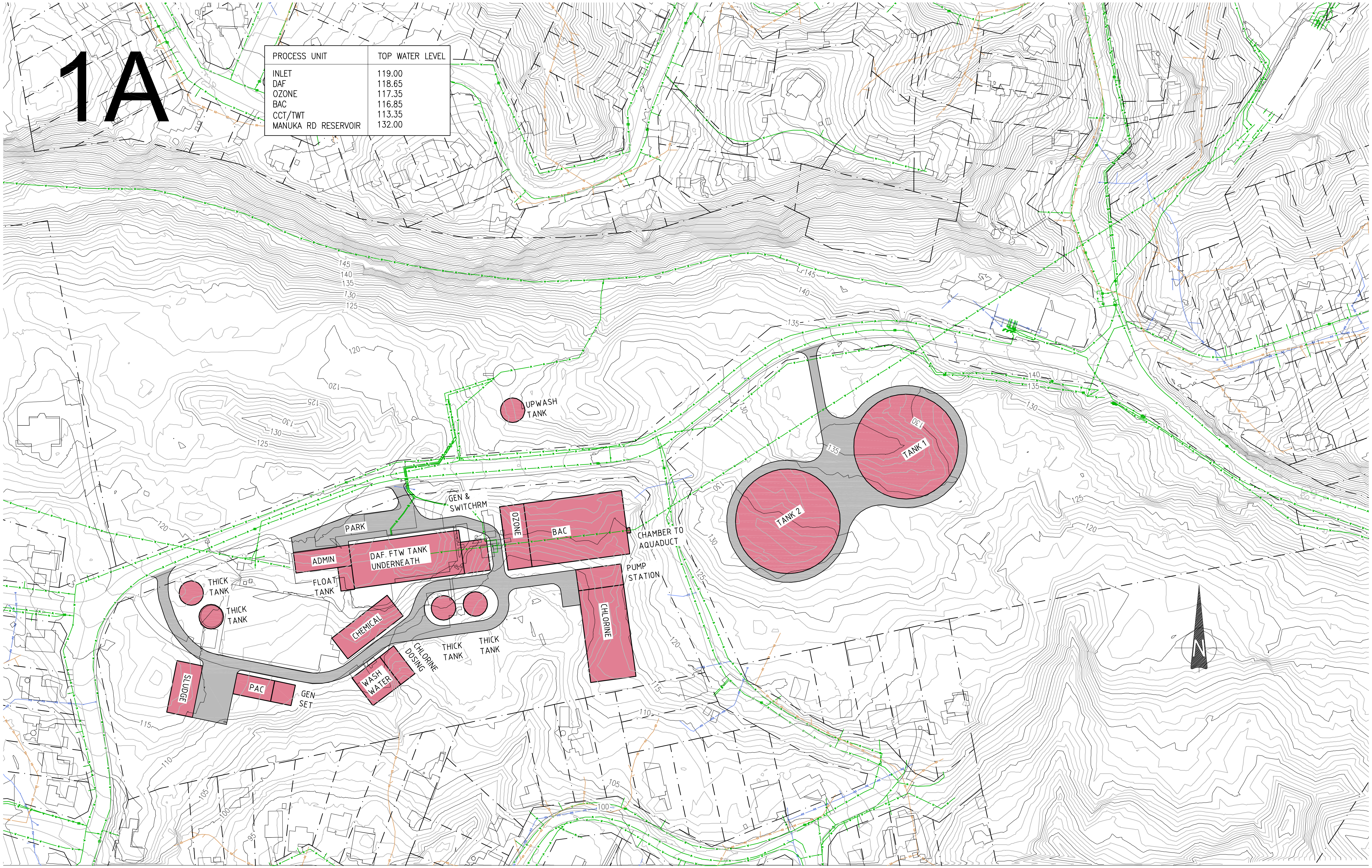
Assume 2 duty and 1 standby pumps, VSD

Max hydraulic loading (10% of inflow)	m3/hr	385	Float plus 1 wash per filter per day
Pump unit flowrate	l/s	54	
Sump min operational volume	m3	24	Limits pump starts to 4 per hour max at fixed speed operation
Sump diameter	m	3	
Sump operational depth	m	3.4	
Sump overall depth	m	5.4	Allow extra 2 m for pump submergence, level controls and freeboard

Appendix H Site Layout Option Drawings

1A

PROCESS UNIT	TOP WATER LEVEL
INLET	119.00
DAF	118.65
OZONE	117.35
BAC	116.85
CCT/TWT	113.35
MANUKA RD RESERVOIR	132.00



ISSUE	DATE	AMENDMENT	BY	APPD.

	BY	DATE
DESIGNED	C POVEY	11/12
DES. CHECKED		
DRAWN	G MURRAY	11/12
DWG. CHECKED		
PROJECT LEADER		
INFRAST'R APP'D		

WSL TO SIGN

WSL TO SIGN

water Care services limited

MWH.

HUIA WTP IMPLEMENTATION STRATEGY

SITE LAYOUT PLAN – OPTION 1A

DRAFT

CAD FILE 80501084-01-001-G0 DATE

ORIGINAL SCALE A1 1 : 1,000

CONTRACT No.

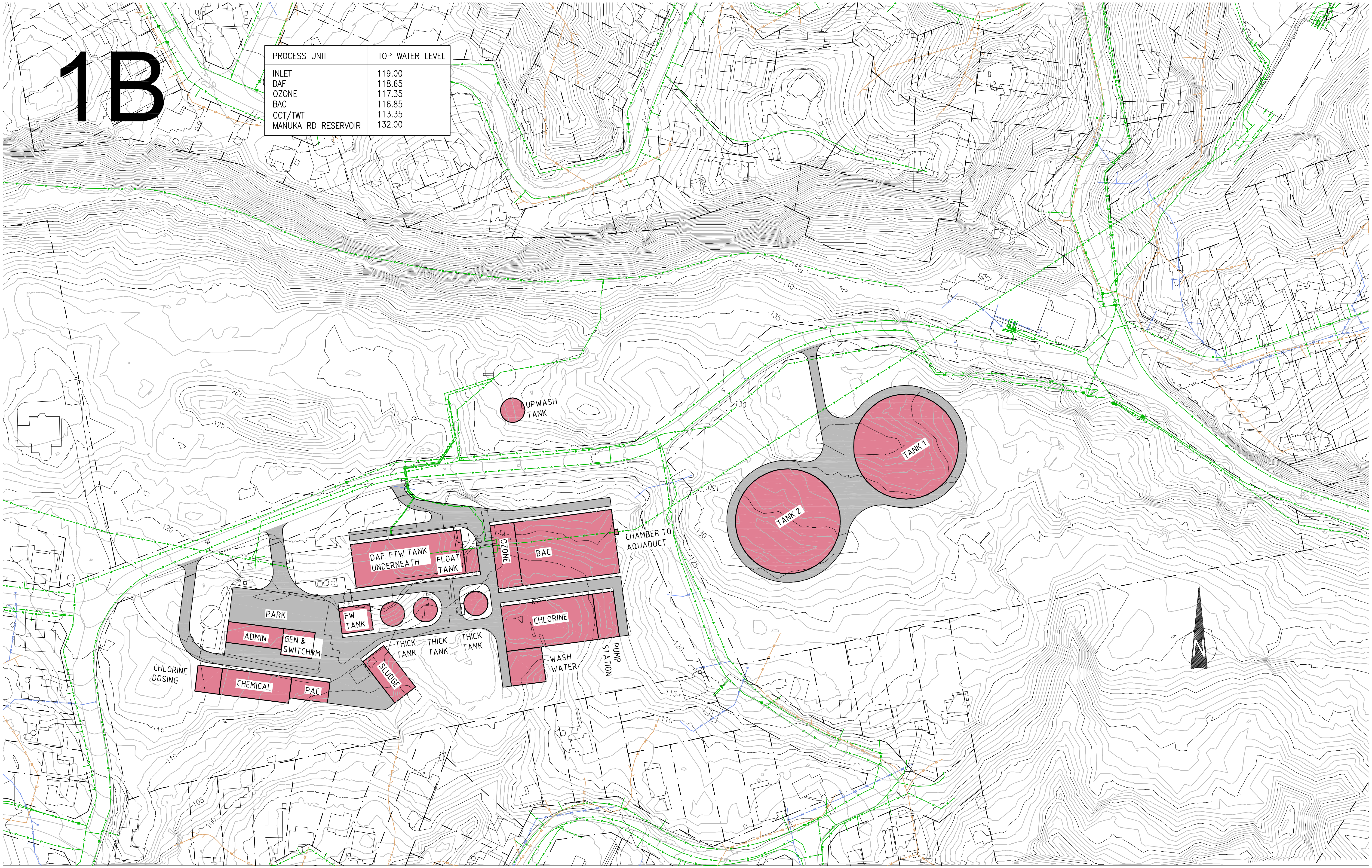
REF. No. 80501084-01-001-G011

ISSUE D

DWG. No.

1B

PROCESS UNIT	TOP WATER LEVEL
INLET	119.00
DAF	118.65
OZONE	117.35
BAC	116.85
CCT/TWT	113.35
MANUKA RD RESERVOIR	132.00



ISSUE	DATE	AMENDMENT	BY	APPD.

	BY	DATE
DESIGNED	C POVEY	11/12
DES. CHECKED		
DRAWN	G MURRAY	11/12
DWG. CHECKED		
PROJECT LEADER		
INFRAST'R APP'D		

WSL TO SIGN

WSL TO SIGN

water Care services limited

MWH

HUIA WTP IMPLEMENTATION STRATEGY

SITE LAYOUT PLAN – OPTION 1B

DRAFT

CAD FILE 80501084-01-001-G012 DATE

ORIGINAL SCALE A1 1 : 1,000

CONTRACT No.

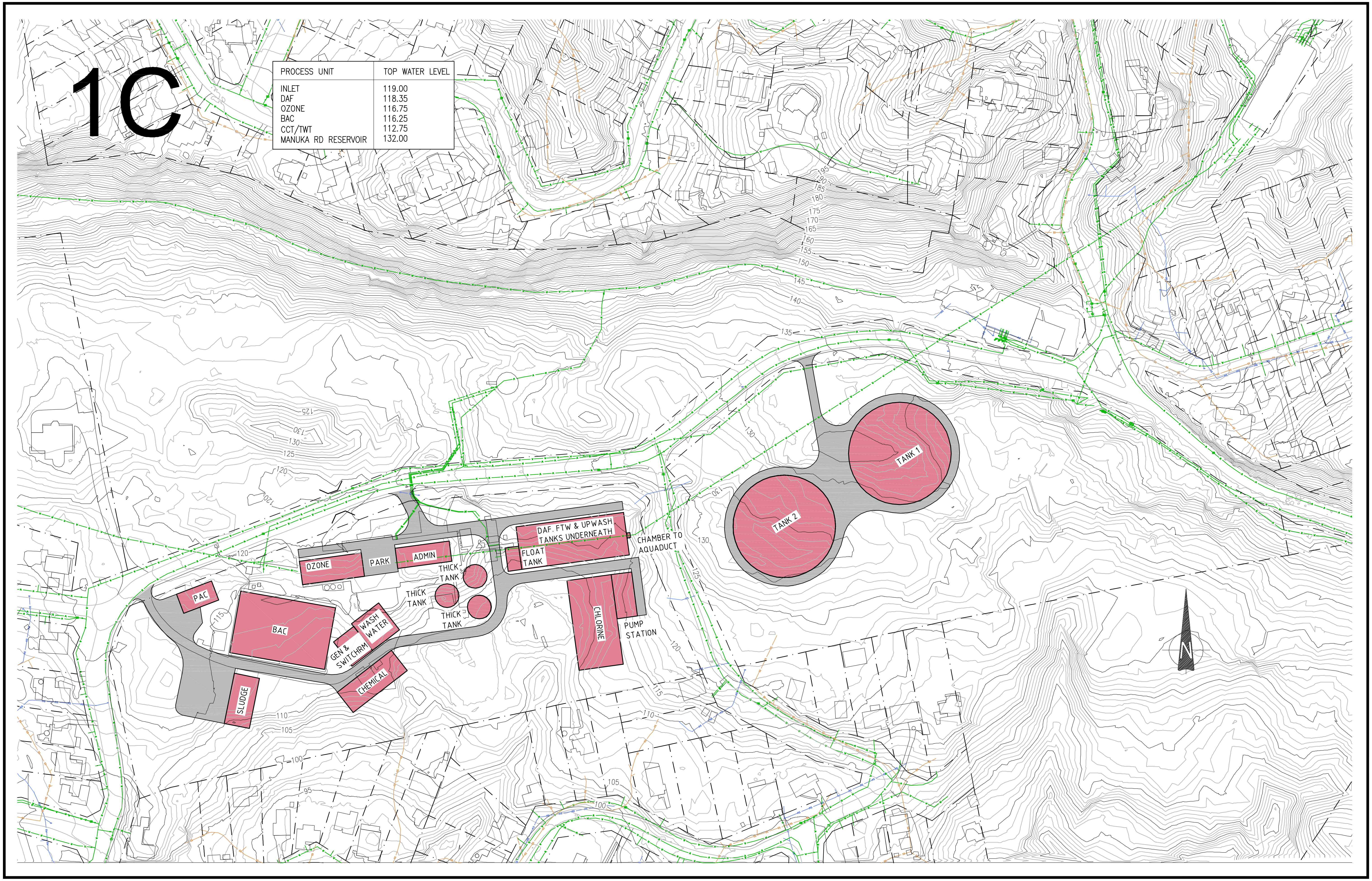
REF. No. 80501084-01-001-G012

ISSUE D

DWG. No.

1C

PROCESS UNIT	TOP WATER LEVEL
INLET	119.00
DAF	118.35
OZONE	116.75
BAC	116.25
CCT/TWT	112.75
MANUKA RD RESERVOIR	132.00



ISSUE	DATE	AMENDMENT	BY	APPD.

DESIGNED	C POVEY	11/12	WSL TO SIGN
DES. CHECKED			
DRAWN	G MURRAY	11/12	
DWG. CHECKED			WSL TO SIGN
PROJECT LEADER			
INFRAST'R APP'D			
	BY	DATE	

water Care services limited

MWH.

HUIA WTP IMPLEMENTATION STRATEGY

SITE LAYOUT PLAN – OPTION 1C

DRAFT

CAD FILE 80501084-01-001-G013 DATE

ORIGINAL SCALE A1 AS SHOWN

CONTRACT No.

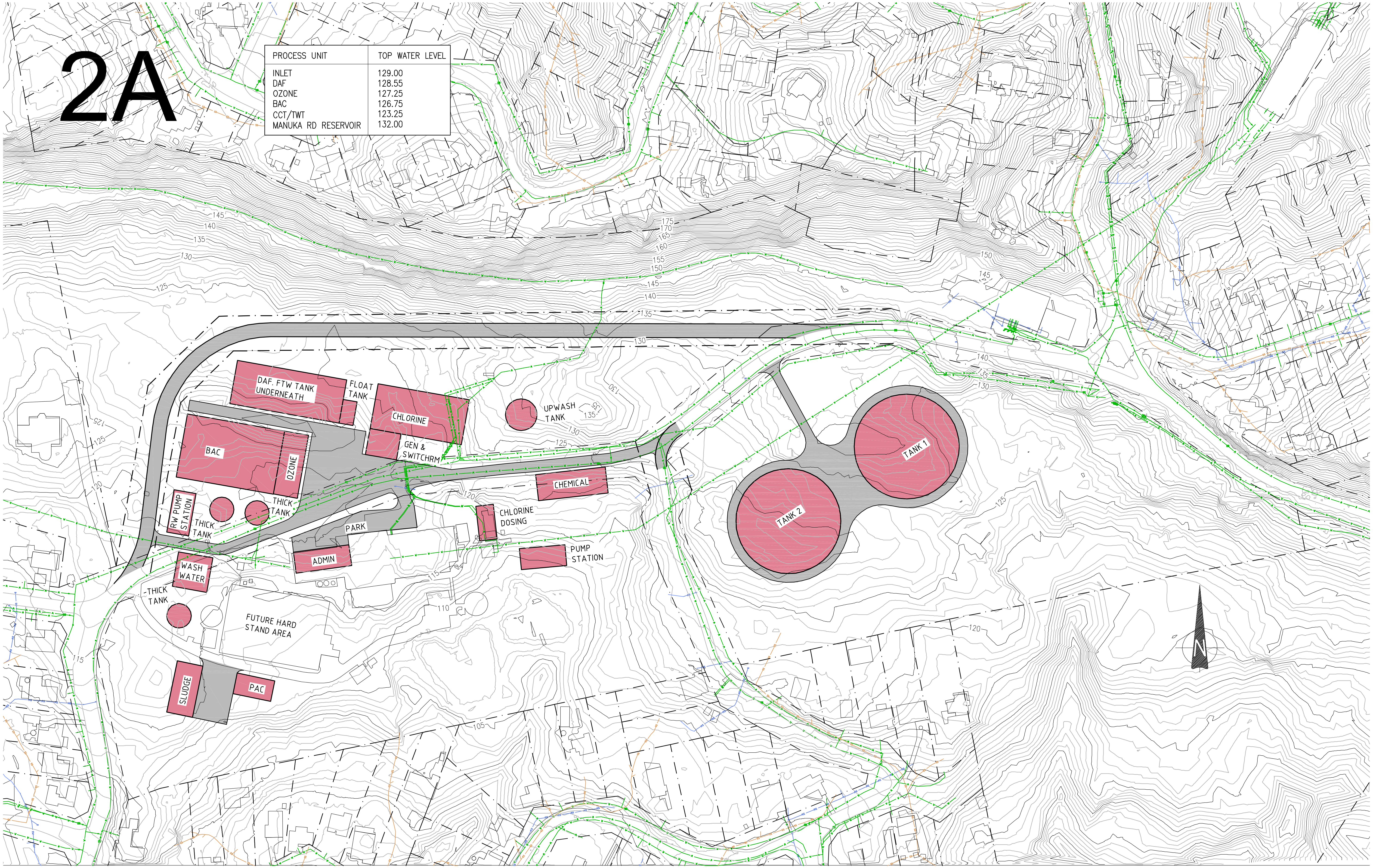
REF. No. 80501084-01-001-G013

ISSUE D

DWG. No.

2A

PROCESS UNIT	TOP WATER LEVEL
INLET	129.00
DAF	128.55
OZONE	127.25
BAC	126.75
CCT/TWT	123.25
MANUKA RD RESERVOIR	132.00



ISSUE	DATE	AMENDMENT	BY	APPD.

	BY	DATE
DESIGNED	C POVEY	11/12
DES. CHECKED		
DRAWN	G MURRAY	11/12
DWG. CHECKED		
PROJECT LEADER		
INFRAST'R APP'D		

WSL TO SIGN

WSL TO SIGN

water Care services limited

MWH.

HUIA WTP IMPLEMENTATION STRATEGY

SITE LAYOUT PLAN – OPTION 2A

DRAFT

CAD FILE 80501084-01-001-G021 DATE

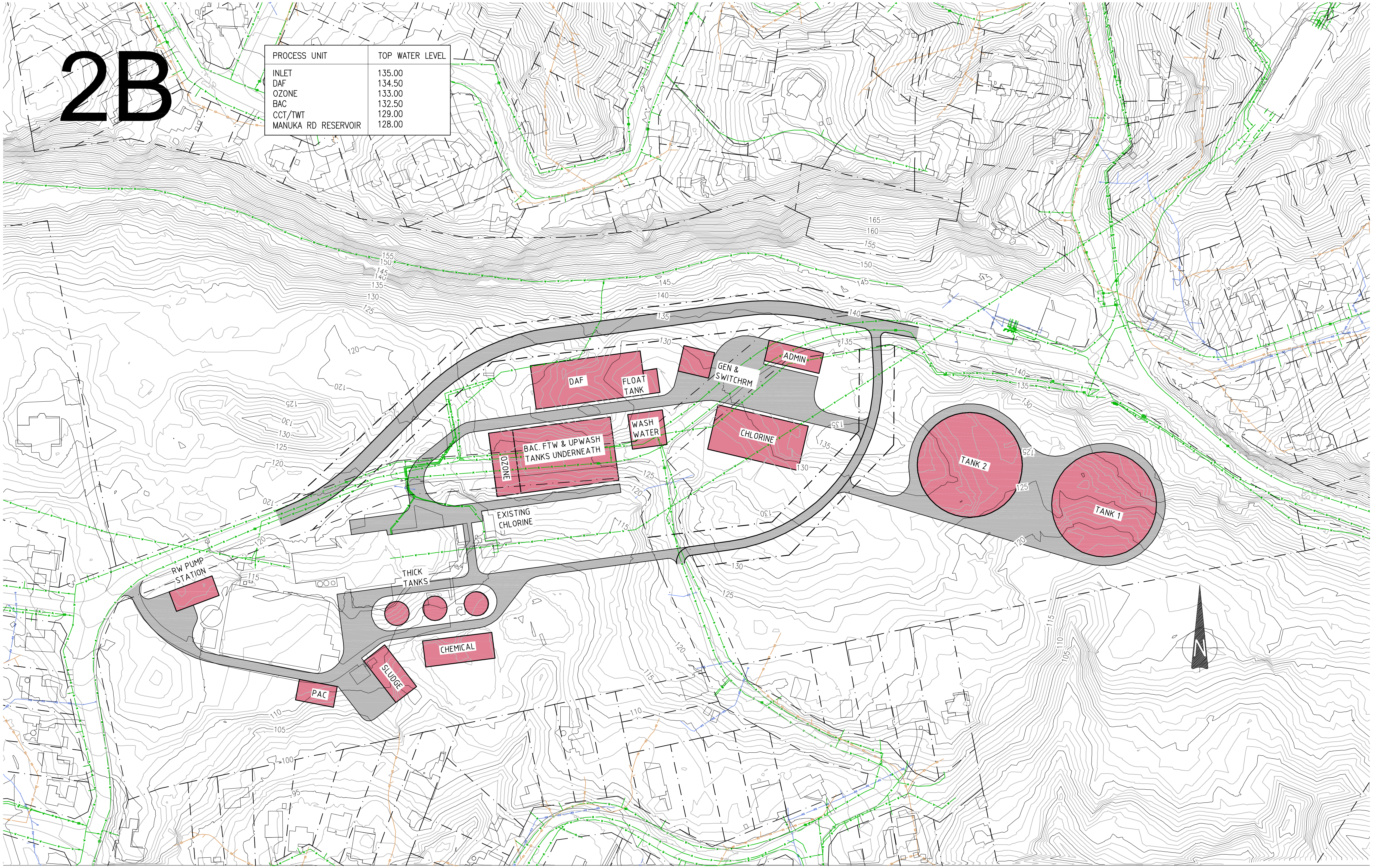
ORIGINAL SCALE A1 1 : 1,000

CONTRACT No.

REF. No. 80501084-01-001-G021

ISSUE D

DWG. No.



PROCESS UNIT	TOP WATER LEVEL
INLET	135.00
DAF	134.50
OZONE	133.00
BAC	132.50
CCT/TWT	129.00
MANUKA RD RESERVOIR	128.00

ISSUE	DATE	AMENDMENT	BY	APPD.

	BY	DATE
DESIGNED	C POVEY	11/12
DES. CHECKED		
DRAWN	G MURRAY	11/12
DWG. CHECKED		
PROJECT LEADER		
INFRAST'R APP'D		

WSL TO SIGN

WSL TO SIGN

watercare services limited

MWH.

HUIA WTP IMPLEMENTATION STRATEGY

SITE LAYOUT PLAN – OPTION 2B

DRAFT

CAD FILE 80501084-01-001-G022

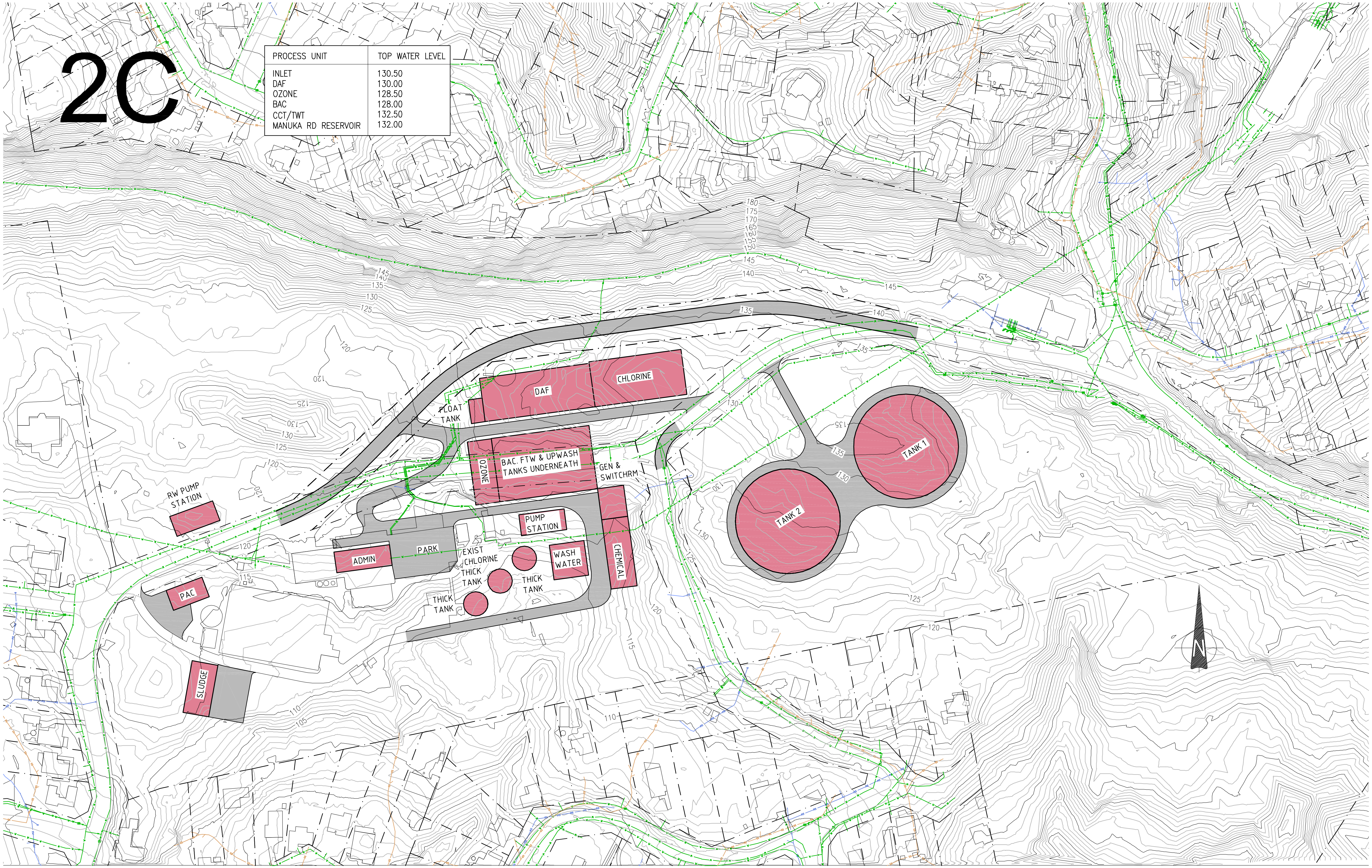
ORIGINAL SCALE A1 1 : 1,000

CONTRACT No.

REF. No. 80501084-01-001-G022

ISSUE D

DWG. No.



PROCESS UNIT	TOP WATER LEVEL
INLET	130.50
DAF	130.00
OZONE	128.50
BAC	128.00
CCT/TWT	132.50
MANUKA RD RESERVOIR	132.00

ISSUE	DATE	AMENDMENT	BY	APPD.

	BY	DATE
DESIGNED	C POVEY	11/12
DES. CHECKED		
DRAWN	G MURRAY	11/12
DWG. CHECKED		
PROJECT LEADER		
INFRAST'R APP'D		

WSL TO SIGN

WSL TO SIGN

watercare services limited

MWH.

HUIA WTP IMPLEMENTATION STRATEGY

SITE LAYOUT PLAN – OPTION 2C

DRAFT

CAD FILE 80501084-01-001-G023 DATE

ORIGINAL SCALE A1 AS SHOWN

CONTRACT No.

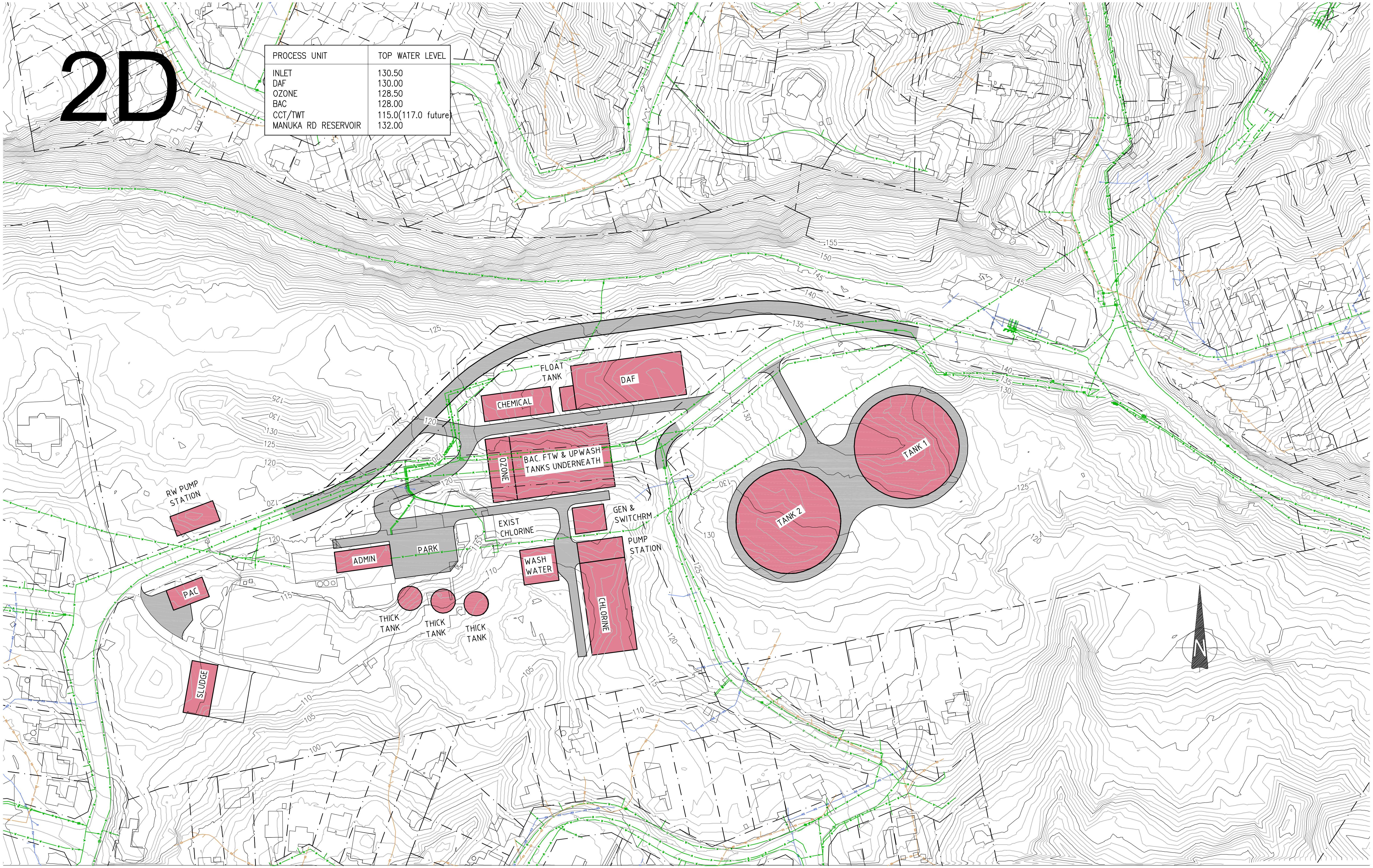
REF. No. 80501084-01-001-G023

ISSUE D

DWG. No.

2D

PROCESS UNIT	TOP WATER LEVEL
INLET	130.50
DAF	130.00
OZONE	128.50
BAC	128.00
CCT/TWT	115.0(117.0 future)
MANUKA RD RESERVOIR	132.00



					DESIGNED	C POVEY	11/12
					DES. CHECKED		
					DRAWN	G MURRAY	11/12
					DWG. CHECKED		
					PROJECT LEADER		
					INFRAST'R APP'D		
ISSUE	DATE	AMENDMENT	BY	APPD.		BY	DATE

WSL TO SIGN

WSL TO SIGN

water Care services limited

MWH.

HUIA WTP IMPLEMENTATION STRATEGY

SITE LAYOUT PLAN – OPTION 2D

DRAFT

CAD FILE 80501084-01-001-G024 DATE

ORIGINAL SCALE A1 AS SHOWN

CONTRACT No.

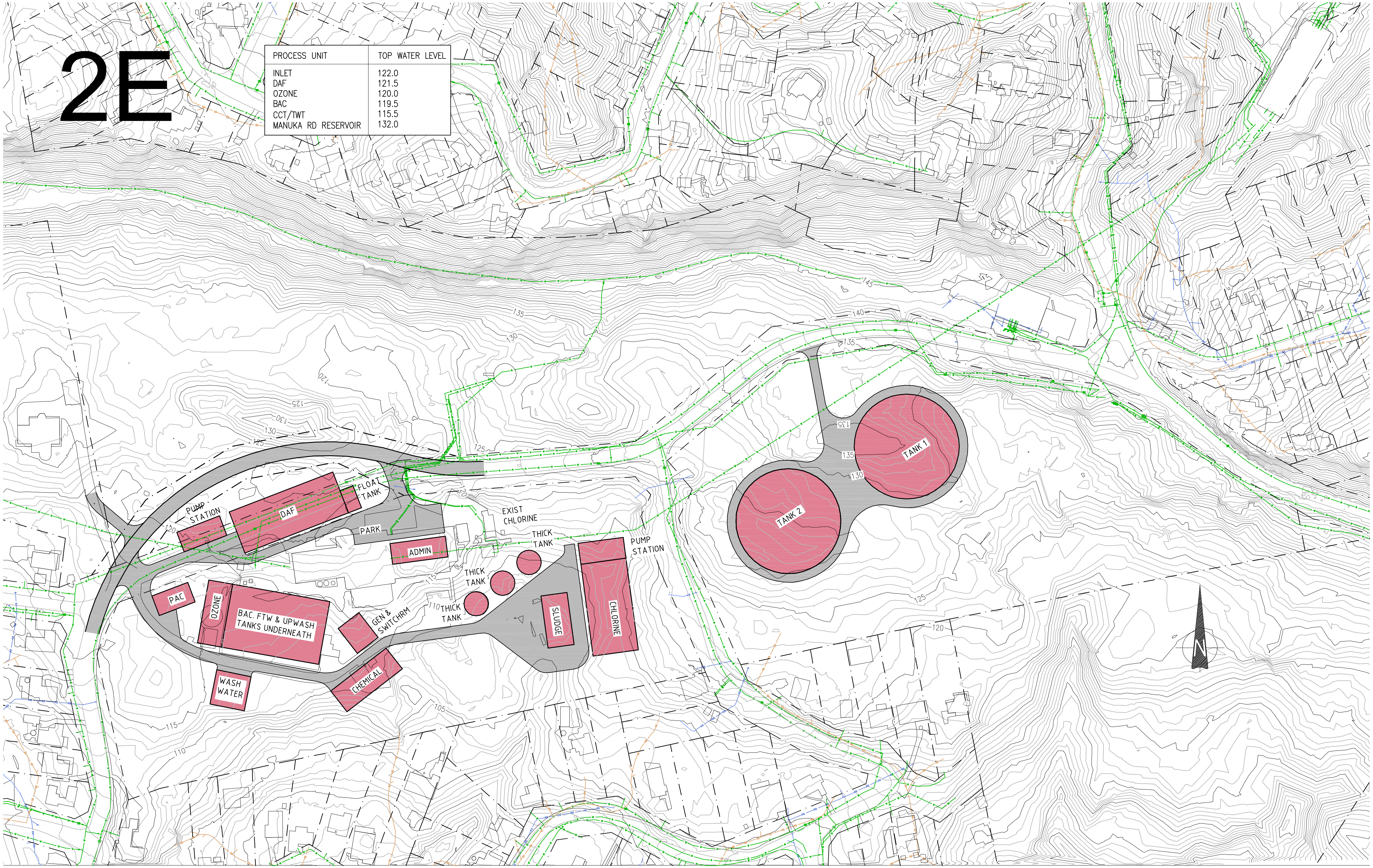
REF. No. 80501084-01-001-G024

ISSUE D

DWG. No.

2E

PROCESS UNIT	TOP WATER LEVEL
INLET	122.0
DAF	121.5
OZONE	120.0
BAC	119.5
CCT/TWT	115.5
MANUKA RD RESERVOIR	132.0



ISSUE	DATE	AMENDMENT	BY	APPD.

	BY	DATE
DESIGNED	C POVEY	12/12
DES. CHECKED		
DRAWN	G MURRAY	12/12
DWG. CHECKED		
PROJECT LEADER		
INFRAST'R APP'D		

WSL TO SIGN

WSL TO SIGN

water Care services limited

MWH.

HUIA WTP IMPLEMENTATION STRATEGY

SITE LAYOUT PLAN – OPTION 2E

DRAFT

CAD FILE 80501084-01-001-G025

ORIGINAL SCALE A1 1 : 1,000

CONTRACT No.

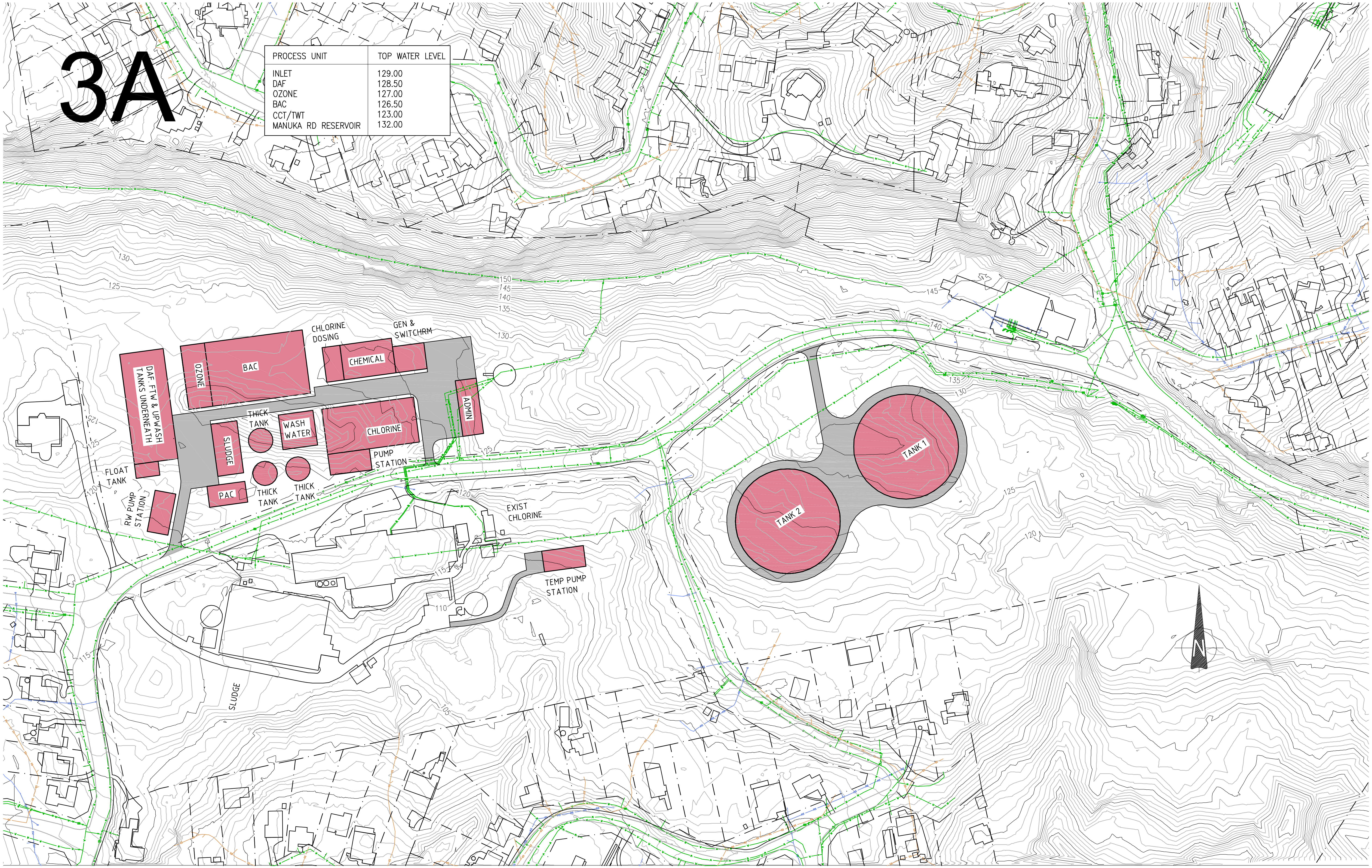
REF. No. 80501084-01-001-G025

ISSUE D

DWG. No.

3A

PROCESS UNIT	TOP WATER LEVEL
INLET	129.00
DAF	128.50
OZONE	127.00
BAC	126.50
CCT/TWT	123.00
MANUKA RD RESERVOIR	132.00



ISSUE	DATE	AMENDMENT	BY	APPD.

	BY	DATE
DESIGNED	C POVEY	11/12
DES. CHECKED		
DRAWN	G MURRAY	11/12
DWG. CHECKED		
PROJECT LEADER		
INFRAST'R APP'D		

WSL TO SIGN

WSL TO SIGN

water Care services limited

MWH.

HUIA WTP IMPLEMENTATION STRATEGY

SITE LAYOUT PLAN – OPTION 3A

DRAFT

CAD FILE 80501084-01-001-G031 DATE

ORIGINAL SCALE A1 1 : 1,000

CONTRACT No.

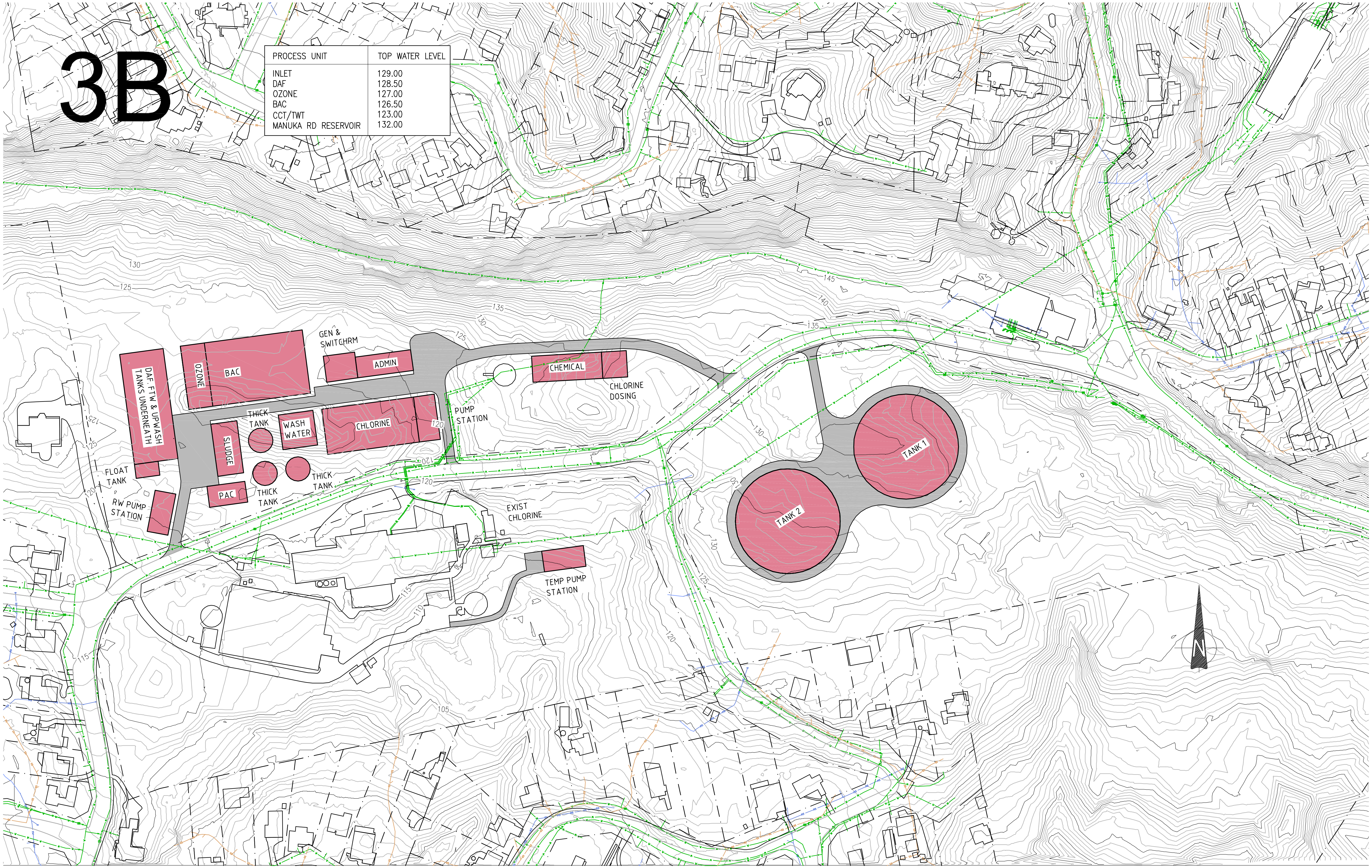
REF. No. 80501084-01-001-G031

ISSUE D

DWG. No.

3B

PROCESS UNIT	TOP WATER LEVEL
INLET	129.00
DAF	128.50
OZONE	127.00
BAC	126.50
CCT/TWT	123.00
MANUKA RD RESERVOIR	132.00



ISSUE	DATE	AMENDMENT	BY	APPD.		BY	DATE
					DESIGNED	C POVEY	11/12
					DES. CHECKED		
					DRAWN	G MURRAY	11/12
					DWG. CHECKED		
					PROJECT LEADER		
					INFRAST'R APP'D		

WSL TO SIGN

WSL TO SIGN

water Care services limited

MWH.

HUIA WTP IMPLEMENTATION STRATEGY

SITE LAYOUT PLAN – OPTION 3B

DRAFT

CAD FILE 80501084-01-001-G032 DATE

ORIGINAL SCALE A1 AS SHOWN

CONTRACT No.

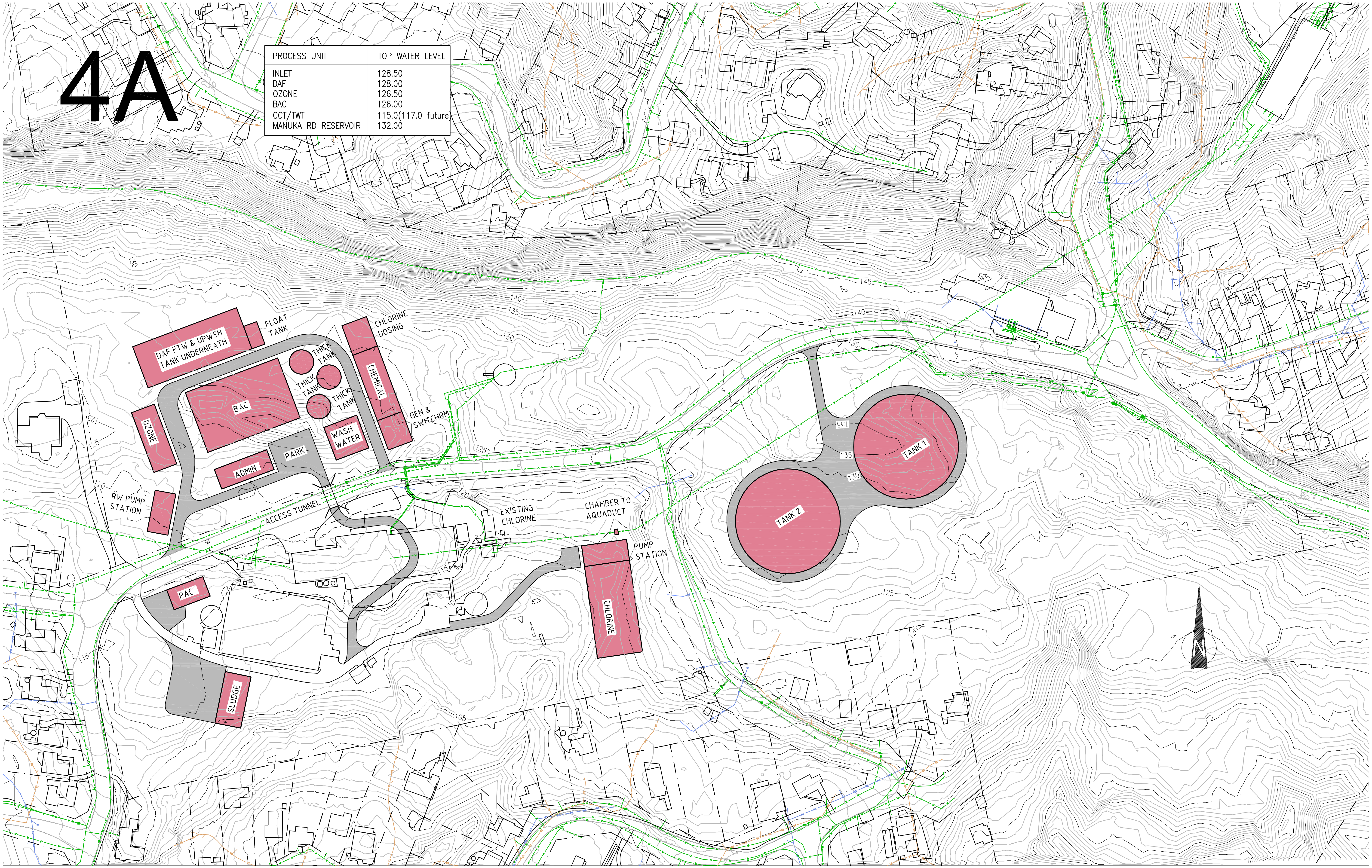
REF. No. 80501084-01-001-G032

ISSUE D

DWG. No.

4A

PROCESS UNIT	TOP WATER LEVEL
INLET	128.50
DAF	128.00
OZONE	126.50
BAC	126.00
CCT/TWT	115.0(117.0 future)
MANUKA RD RESERVOIR	132.00



ISSUE	DATE	AMENDMENT	BY	APPD.		BY	DATE
					DESIGNED	C POVEY	11/12
					DES. CHECKED		
					DRAWN	G MURRAY	11/12
					DWG. CHECKED		
					PROJECT LEADER		
					INFRAST'R APP'D		

WSL TO SIGN

WSL TO SIGN

water Care services limited

MWH.

HUIA WTP IMPLEMENTATION STRATEGY

SITE LAYOUT PLAN – OPTION 4A

DRAFT

CAD FILE 80501084-01-001-G041 DATE

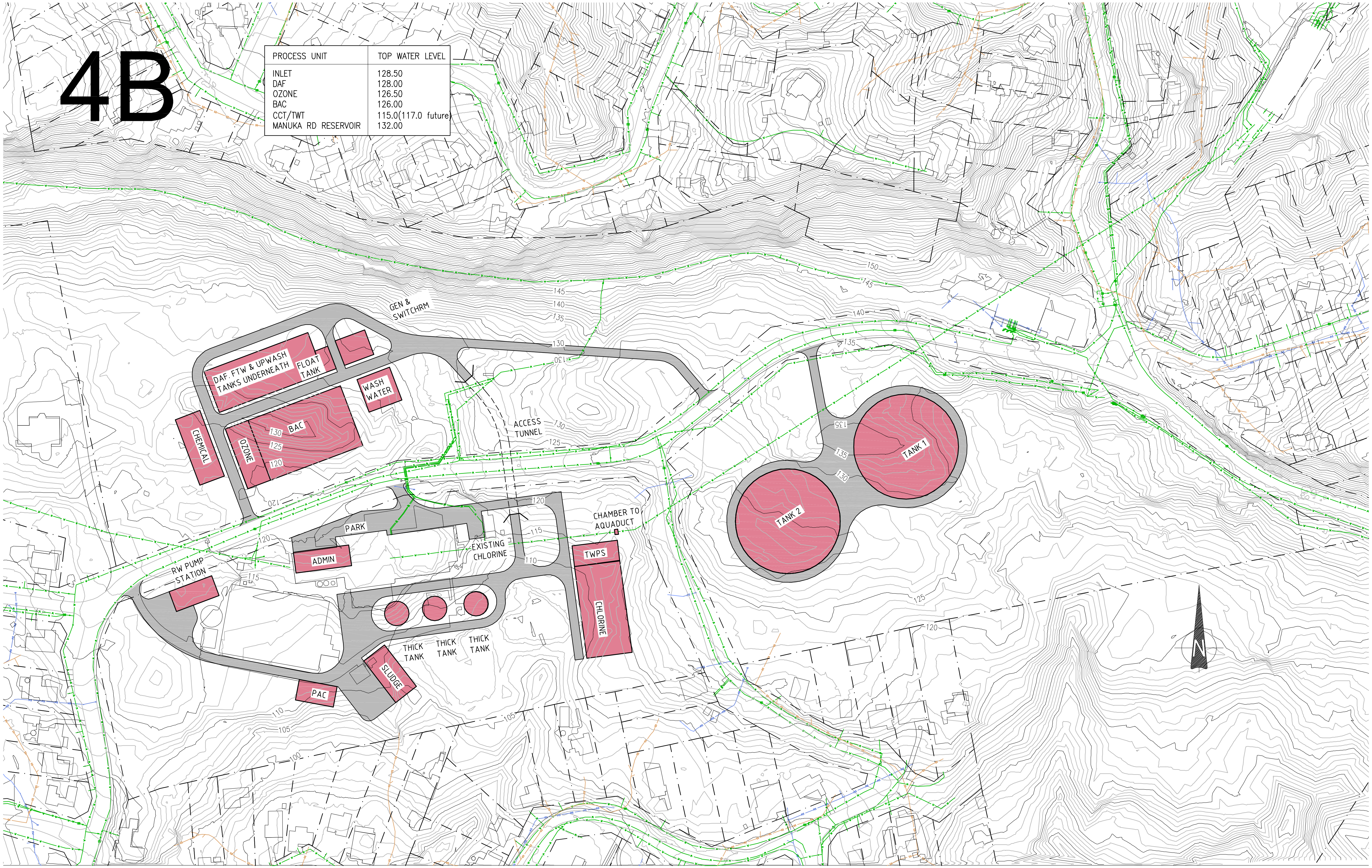
ORIGINAL SCALE A1 1 : 1,000

CONTRACT No.

REF. No. 80501084-01-001-G041

ISSUE D

DWG. No.



PROCESS UNIT	TOP WATER LEVEL
INLET	128.50
DAF	128.00
OZONE	126.50
BAC	126.00
CCT/TWT	115.0(117.0 future)
MANUKA RD RESERVOIR	132.00

ISSUE	DATE	AMENDMENT	BY	APPD.

	BY	DATE
DESIGNED	C POVEY	11/12
DES. CHECKED		
DRAWN	G MURRAY	11/12
DWG. CHECKED		
PROJECT LEADER		
INFRAST'R APP'D		

WSL TO SIGN

WSL TO SIGN

watercare services limited

MWH.

HUIA WTP IMPLEMENTATION STRATEGY

SITE LAYOUT PLAN – OPTION 4B

DRAFT

CAD FILE 80501084-01-001-G042 DATE

ORIGINAL SCALE A1 AS SHOWN

CONTRACT No.

REF. No. 80501084-01-001-G042

ISSUE D

DWG. No.

5A

PROCESS UNIT	TOP WATER LEVEL	
INLET	135.50	137.50
DAF	135.00	137.00
OZONE	133.50	135.50
BAC	133.00	135.00
CCT/TWT	129.50	131.50
MANUKA RD RESERVOIR	128.00	130.00

ISSUE	DATE	AMENDMENT	BY	APPD.

DESIGNED	C POVEY	11/12	WSL TO SIGN
DES. CHECKED			
DRAWN	G MURRAY	11/12	
DWG. CHECKED			WSL TO SIGN
PROJECT LEADER			
INFRAST'R APP'D			
	BY	DATE	

watercare services limited

MWH.

HUIA WTP IMPLEMENTATION STRATEGY

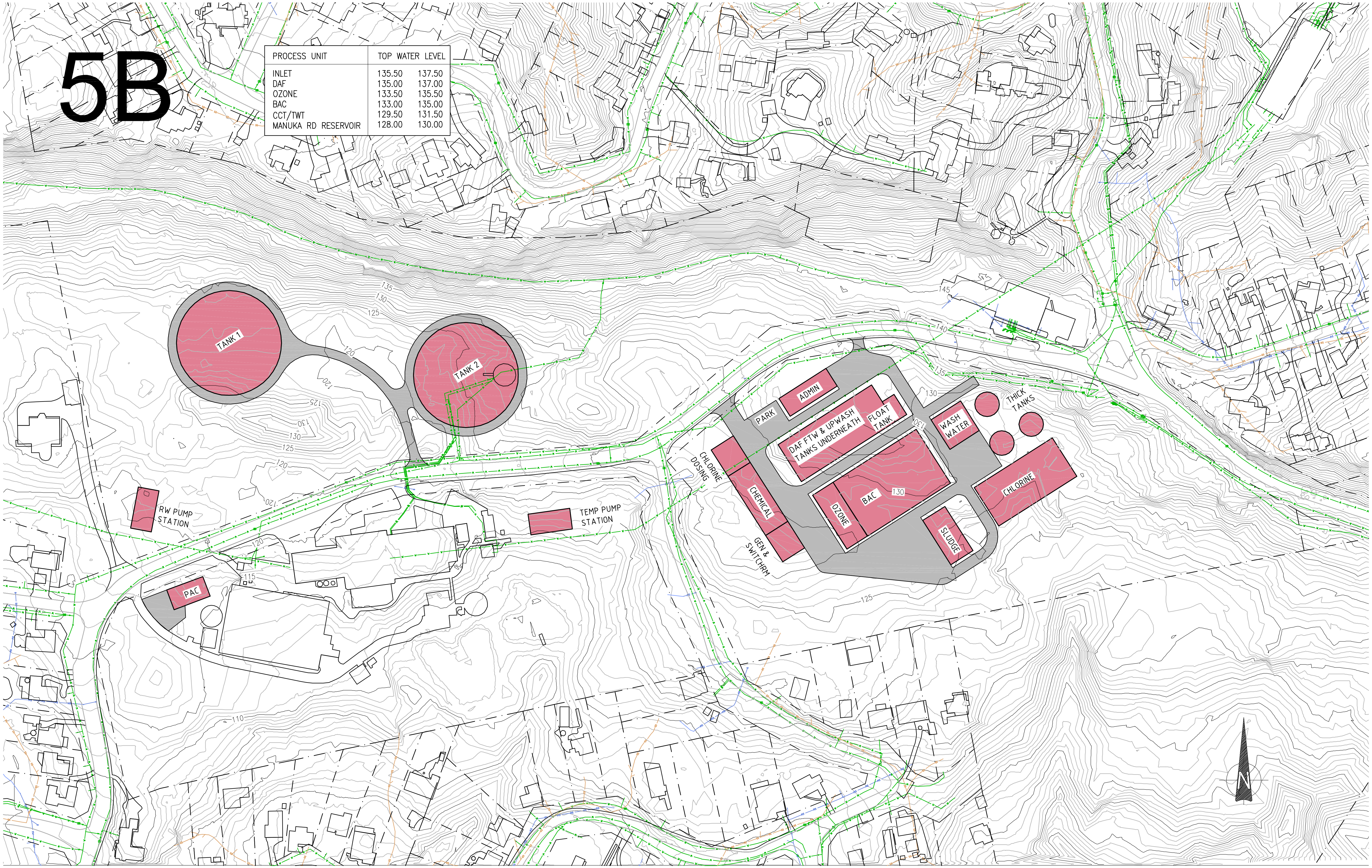
SITE LAYOUT PLAN – OPTION 5A

DRAFT

CAD FILE 80501084-01-001-G051	DATE	
ORIGINAL SCALE A1 1 : 1,000	CONTRACT No.	
REF. No. 80501084-01-001-G051		ISSUE D
DWG. No.		

5B

PROCESS UNIT	TOP WATER LEVEL	
INLET	135.50	137.50
DAF	135.00	137.00
OZONE	133.50	135.50
BAC	133.00	135.00
CCT/TWT	129.50	131.50
MANUKA RD RESERVOIR	128.00	130.00



ISSUE	DATE	AMENDMENT	BY	APPD.

DESIGNED	C POVEY	11/12
DES. CHECKED		
DRAWN	G MURRAY	11/12
DWG. CHECKED		
PROJECT LEADER		
INFRAST'R APP'D		
	BY	DATE

WSL TO SIGN

WSL TO SIGN

water Care services limited

MWH.

HUIA WTP IMPLEMENTATION STRATEGY

SITE LAYOUT PLAN – OPTION 5B

DRAFT

CAD FILE 80501084-01-001-G052 DATE

ORIGINAL SCALE A1 AS SHOWN

CONTRACT No.

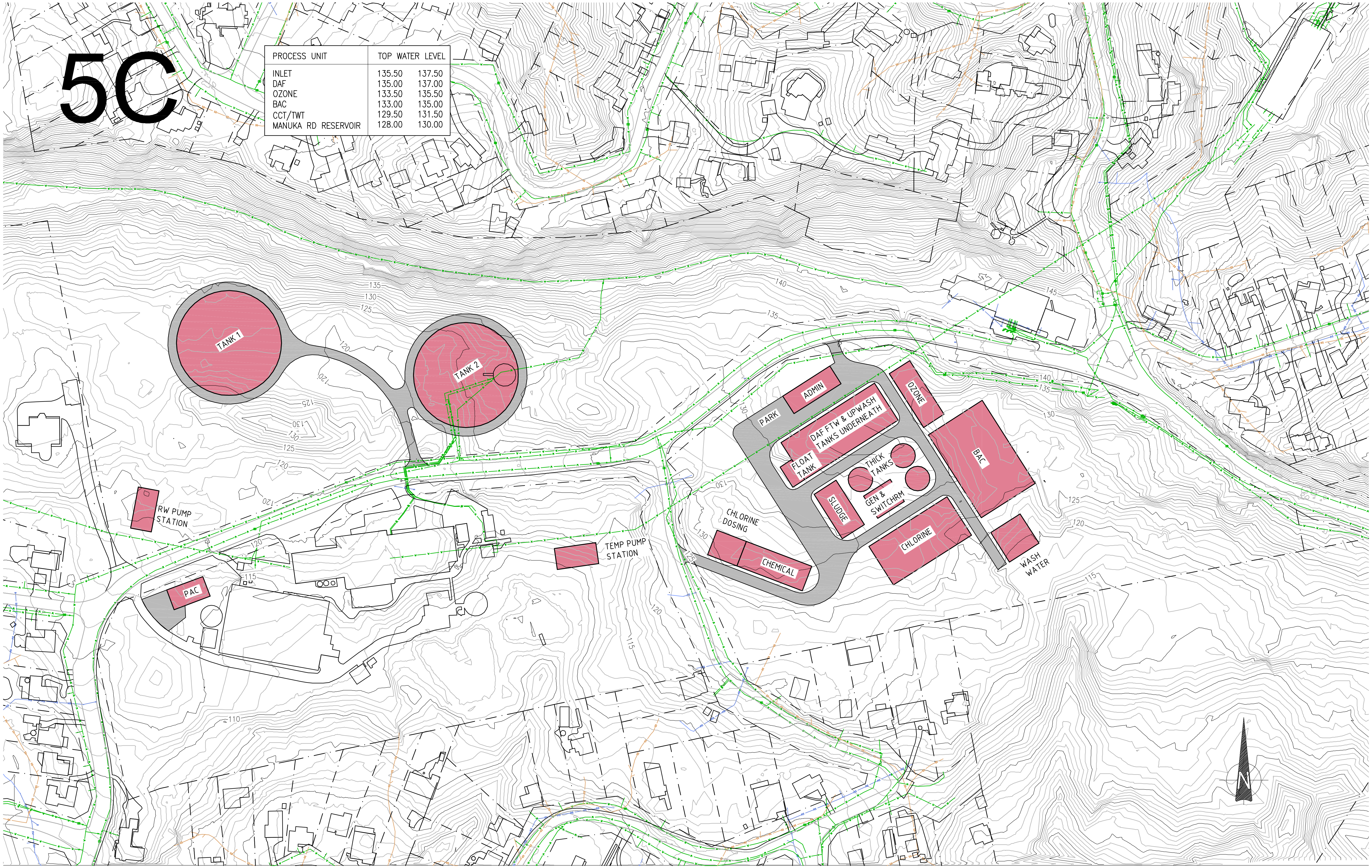
REF. No. 80501084-01-001-G052

ISSUE D

DWG. No.

5C

PROCESS UNIT	TOP WATER LEVEL	
INLET	135.50	137.50
DAF	135.00	137.00
OZONE	133.50	135.50
BAC	133.00	135.00
CCT/TWT	129.50	131.50
MANUKA RD RESERVOIR	128.00	130.00



ISSUE	DATE	AMENDMENT	BY	APPD.

	BY	DATE
DESIGNED	C POVEY	11/12
DES. CHECKED		
DRAWN	G MURRAY	11/12
DWG. CHECKED		
PROJECT LEADER		
INFRAST'R APP'D		

WSL TO SIGN

WSL TO SIGN

water Care services limited

MWH.

HUIA WTP IMPLEMENTATION STRATEGY

SITE LAYOUT PLAN – OPTION 5C

DRAFT

CAD FILE 80501084-01-001-G053 DATE

ORIGINAL SCALE A1 AS SHOWN

CONTRACT No.

REF. No. 80501084-01-001-G053

ISSUE D

DWG. No.

Appendix I Site Layout Short-listing Memo

MWH BUILDING A BETTER WORLD

PROJECT TECHNICAL MEMORANDUM

Date: 04/12/12

To: Watercare Services Ltd

For the Attention of: Maria Dalouche

Project: Huia WTP Implementation Strategy

Subject: Site Layouts Shortlisting Workshop Materials

Project Site Layouts Workshop

Project Stage: Stage 1 Phase 3

Project Number: 80501084

Prepared by: Project team	**Checked by:** Chris Povey
Reviewed by: -- Updated following Workshop --	**Authorised by:** Amy Clore

1 Introduction

Watercare's preferred future process option for the Huia water treatment plant (WTP) is flocculation, dissolved air flotation (DAF), ozonation, biological activated carbon (BAC) filtration and chlorination. This process has been selected to manage future raw water quality with the ability to handle greater algal loading and remove increased amounts of dissolved organics to improve disinfection stability and minimise disinfection by products.

MWH has been engaged to develop an overall concept layout plan for the Huia WTP which incorporates the new process design and existing concept designs for the Manuka Road Reservoir, new powdered activated carbon (PAC) preparation and dosing facilities, a new Sludge Dewatering facility and the Muddy Creek overflow pipeline.

As part of Technical Memorandum 1 - Upgrade Treatment Process and Layout a set of 5 alternative general site layout configurations were proposed:

1. New process units located within the general constraints of the existing site area south of Woodlands Park Road
2. New process units located on the north side of Woodlands Park Road
3. New process units located on both sides of Woodlands Park Road
4. Relocation of Woodlands Park Road with the new process units located to the north of the existing plant
5. New treatment plant constructed on the Manuka Road site.

For layout configurations 1 to 4 the new service reservoir was located at Manuka Road site and for configuration 5 the new reservoir will be located on the north side of Woodland Park Road.

These alternative configurations were considered by Watercare with comments provided to assist in the further development of site layouts.

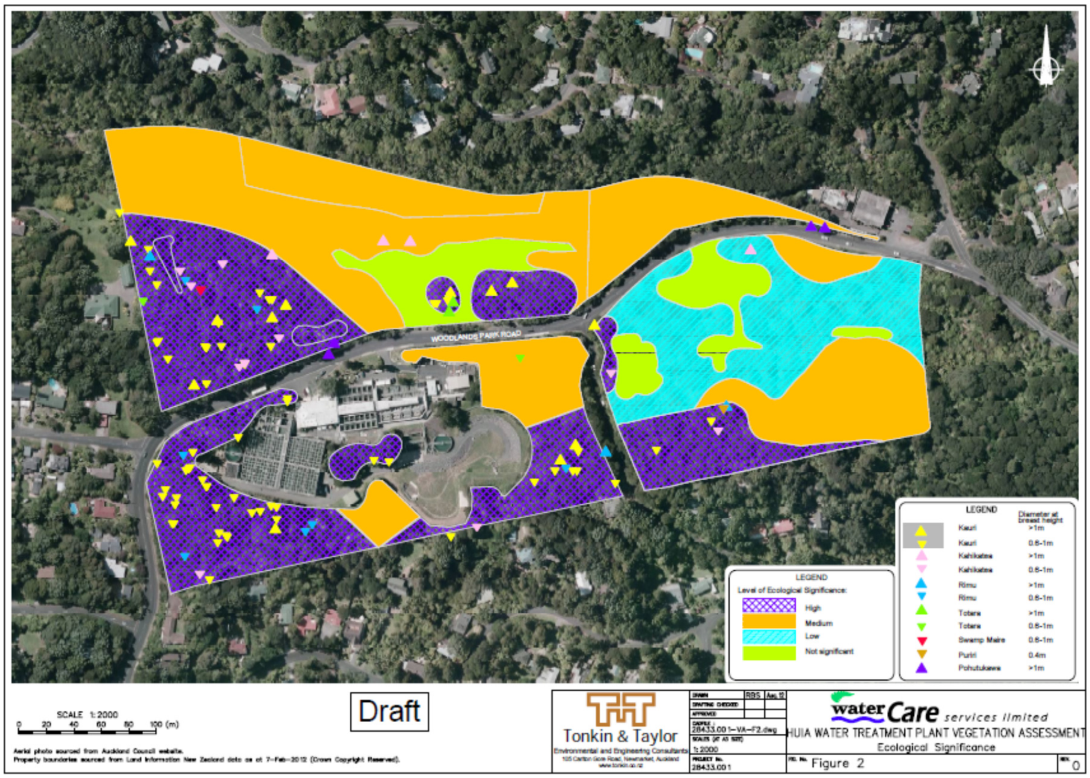
This document presents a total of 14 site layout options grouped under the original 5 main configurations outlined above and is provided as background material for the options shortlisting workshop to be held on 30th November 2012.

Following the workshop the selected shortlisted options will be further developed to enable the preferred overall site option to be selected using a detailed MCA.

2 Site Constraints

The plant is physically constrained by Woodlands Park Road to the West and North and steep gradients and bush to the South and East. A survey of ecological significance established that there are a large number of high value trees and native species that should be retained where possible. These areas are indicated in the illustration below. Of most significance is the Kauri tree on the corner of Woodlands Park Road and Manuka Road.

The site is surrounded by residential properties and a screen or buffer should be provided to limit any visual, site lighting and noise impacts.



The existing plant also has some heritage features scheduled in the Waitakere District Plan which should be retained where possible, these being:

- The form and scale of the 1928 Huia Filter Station building and 1947 additions, including decorative facade elements and excluding later additions.
- Original (1928-1947) windows and doors.
- The basic form of the 1928 filter tanks (but not surfaces, which may be subject to maintenance work and repair from time to time).
- Significance attributed to historical, architectural and pattern values.

3 Further investigations

The following investigations are proceeding:

- Traffic numbers on Woodlands Park Road
- Site survey to verify the accuracy of existing contour information
- Desktop geotechnical assessment of ground conditions for slope stability, likely depths to founding material and rock

The results of these investigations will be available to assist in the further development of the shortlisted options.

4 Revised Concept Design Layouts

4.1 General

For the purposes of setting the hydraulic grade line through the plant an overall allowance of 6metres head loss has been assumed from the plant inlet through to the treated water tanks.

Truck access is based on have delivery trucks in and out without reversing (two entrances, one entrance and one exit or one entrance/exit with loop)

The existing overflow storage lagoon is retained to manage quality of plant overflows to the future Muddy Creek pipeline.

4.2 Layout Option 1 - New WTP facilities within Existing WTP Site, Reservoir at Manuka Road site

4.2.1 Layout Option 1a

General Description

This option was developed from the original WSL Option 1 layout. The BAC filter footprint is increased from 10 to 14 cells due to the lower hydraulic loading rate requested. This required the existing chlorine building and proposed filter backwash balance tank to be relocated. FTW tank was too small and new sludge and PAC facilities relocated to suit site contours and access constraint.

Manuka Road reservoir at TWL 132.0

Pumping Requirements

Inflow to the plant by gravity.
Outflows from Treated Water tanks to Manuka Road reservoir to be pumped max 140Ml/d @ 21m 475kW. Outflows to Titirangi reservoir pumped max 140Ml/day @ 2.5m 55kW

Network connections

Connection to aquaduct via chamber at eastern end of site adjacent to new BAC filters.

Process Unit Levels (TWLs)

Inlet	119.00
DAF	118.65
Ozone	117.35
BAC	116.85
CCT/TWT	113.35
Manuka Road reservoir	132.00

Staging Issues

Muddy Creek overflow pipeline- No impact on timing of works
PAC facility – No impact on timing of works
Sludge facility – no impact on timing of works
Manuka Road reservoir – new CCT/TWT, pump station and connection chamber to aquaduct required. CCT/TWT could be deferred if new reservoir to be used for contact time but creates some operational difficulties/impacts.
New WTP - staging of construction is critical. Assumes new CCT/TWT, sludge and PAC in place

1. Chlorine facility to be relocated

2. New BAC filters, FTW tank, filter backwash balance tank, filter upwash water tank, second washout thickener
3. Connect existing clarifiers to new BAC filters
4. Demolish existing filters, construct new DAF tanks and ozone facility and upgrade power supply and standby generator capacity
5. Connect new DAF tanks to supply aquaduct and decommission existing clarifiers
6. Construct new chemical storage and dosing facilities – this could be undertaken earlier if need be
7. Upgrade admin/office facilities

Advantages

Maintains facilities on single existing site
Installation of Muddy Creek, sludge and PAC upgrades can proceed immediately and on existing site
Low environmental impact
Existing clarifier area provides a large storage/laydown space for future
Gravity inflow

Disadvantages

Cramped layout
Low lift pumping to Titirangi reservoirs
Replace existing chlorine facilities
Temporary connection from existing clarifiers to new filters
Overall site access poor.
Access to BAC and CCT/TWTs poor.
Progressive construction of facilities will extend construction period and increase costs
Operational impacts during construction will be high
Little space for contractors site facilities and laydown
Temporary control and office facilities required during construction
Proximity of CCT and sludge dewatering to landowners

4.2.2 Layout Option 1b

General Description

This option also uses the existing WTP site and is quite similar to Option 1a. The BAC filter comprises the 14 cells in a double sided arrangement to limit overall length. The width matches the ozone contact tank which is butted against the filters. The existing filters will be demolished to site the new DAF tanks. The overflow storage lagoon has been reduced in size to provide for the CCT/TWT/PS structure which is located east-west to fit on the site. The existing chlorine building will need to be relocated. The existing washout thickener is retained and two new thickeners constructed. The existing sludge thickener is decommissioned. Alternative configurations for sludge, PAC and chemicals and generators compared to Option 1a are shown, however either arrangement would be suitable.

Manuka Road reservoir at TWL 132.0

Pumping Requirements

Inflow to the plant by gravity.
Outflows from Treated Water tanks to Manuka Road reservoir to be pumped max 140Ml/d @ 21m 475kW. Outflows to Titirangi reservoir pumped max 140Ml/day @ 2.5m 55kW

Network connections

Connection to aquaduct via chamber at eastern end of site adjacent to new BAC filters.

Process Unit Levels (TWLs)

Inlet	119.00
DAF	118.65
Ozone	117.35
BAC	116.85
CCT/TWT	113.35
Manuka Road reservoir	132.00

Staging Issues

Muddy Creek overflow pipeline- No impact on timing of works
PAC facility – No impact on timing of works
Sludge facility – no impact on timing of works
Manuka Road reservoir – new CCT/TWT, pump station and connection chamber to aquaduct required. CCT/TWT could be deferred if new reservoir to be used for contact time but creates some operational difficulties/impacts.
New WTP - staging of construction is critical. Assumes new CCT/TWT, sludge and PAC in place

1. Chlorine facility to be relocated
2. New ozone facility and BAC filters, filter backwash balance tank, filter upwash water tank, second washout thickener
3. Connect existing clarifiers to new BAC filters
4. Demolish existing filters, construct new DAF tanks sludge thickener, FTW tank and upgrade power supply and standby generator capacity
5. Connect new DAF tanks to supply aquaduct and decommission existing clarifiers
6. Construct new chemical storage and dosing facilities – this could be undertaken earlier if need be
7. Upgrade admin/office facilities

Advantages

Maintains facilities on single existing site
Installation of Muddy Creek, Sludge and PAC upgrades can proceed immediately and on existing site
Low environmental impact
New admin/office facility rather than building retrofit
Good site access
Gravity inflow

Disadvantages

Cramped layout
Low lift pumping to Titirangi
Replace existing chlorine facilities
Temporary connection from existing clarifiers to new filters
Progressive construction of facilities will extend construction period and increase costs
Operational impacts during construction will be high
Little space for contractors site facilities and laydown
Temporary control and office facilities required during construction
Reduced overflow storage lagoon volume

4.2.3 Layout Option 1c

General Description

This option also uses the existing WTP site. New DAF tanks will be located in the NE corner of the site. Due to site levels the DAF tanks will have the filter upwash water storage tank and FTW tank located underneath to increase the overall depth of the structure to approximately 8metres. Once constructed this will be supplied by a new connecting main from the inlet aquaduct and will feed the existing filters via a temporary connection. Once the DAF tanks are in operation the existing clarifiers can be decommissioned to provide space for new BAC filters to be configured in a back to back arrangement. Once the new filters are completed the existing filters can be decommissioned to provide space for new ozone tanks and office facilities. The CCT/TWT structure is orientated north south with the pump station on the side to fit on the site. The existing chlorine building will likely need to be relocated due to proximity to large excavations. The existing washout thickener is retained and two new thickeners constructed. The existing sludge thickener is decommissioned. Alternative configurations for sludge, PAC and chemicals and generators compared to Option 1a and 1b are shown, however either arrangements would be suitable.

Manuka Road reservoir at TWL 132.0

Pumping Requirements

Inflow to the plant by gravity.
Outflows from Treated Water tanks to Manuka Road reservoir to be pumped max 140Ml/d @ 21m 475kW. Outflows to Titirangi reservoir pumped max 140Ml/day @ 3m 70kW

Network connections

Connection to aquaduct via chamber at eastern end of site adjacent to new DAF tanks.

Process Unit Levels (TWLs)

Inlet	119.00
DAF	118.35
Ozone	116.75
BAC	116.25
CCT/TWT	112.75
Manuka Road reservoir	132.00

Staging Issues

Muddy Creek overflow pipeline- No impact on timing of works
PAC facility – No impact on timing of works
Sludge facility – no impact on timing of works
Manuka Road reservoir – new CCT/TWT, pump station and connection chamber to aquaduct required. CCT/TWT could be deferred if new reservoir to be used for contact time but creates some operational difficulties/impacts.
New WTP - staging of construction is critical. Assumes new CCT/TWT, sludge and PAC in place

1. Chlorine facility to be relocated
2. New DAF tank, filter upwash water tank, FTW tank, thickener and inlet connection to aquaduct
3. Temporary connection of existing filters to new DAF tank
4. Demolish existing clarifiers

5. New BAC filters, filter backwash balance tank, second washout thickener, connection to CCT
6. Connect BAC to DAF tanks
7. Demolish existing filters, construct new ozone facility and upgrade power supply and standby generator capacity
8. Connect ozone facility to DAF tanks and BAC filters
9. Construct new chemical storage and dosing facilities – this could be undertaken earlier if need be
10. Upgrade admin/office facilities

Advantages

Maintains facilities on single existing site
Installation of Muddy Creek, Sludge and PAC upgrades can proceed immediately and on existing site
Low environmental impact
Gravity inflow

Disadvantages

Cramped layout
Low lift pumping to Titirangi
Replace existing chlorine facilities
Temporary connection from DAF to existing filters and DAF to new BAC filters prior to ozone completion
Overall site access poor.
Progressive construction of facilities will extend construction period and increase costs
Operational impacts during construction will be high
Little space for contractors site facilities and laydown
Temporary control and office facilities required during construction

4.3 Layout Option 2 - Relocate Woodland Park Road to expand site for WTP, Reservoir at Manuka Road site

4.3.1 Layout Option 2a

General Description

This option is principally the original WSL Option 2 layout. Woodland Park Road is relocated to the north to expand the existing WTP site area. The BAC filter footprint was increased to 14 cells in a back to back arrangement which has required the new chemical storage facilities to be relocated. The DAF tanks will be at or above ground level and the filter upwash water tank and the FTW tank could be readily located underneath instead to provide more space on the new site.

Manuka Road reservoir at TWL 132.0

Pumping Requirements

Inflow to the plant is pumped 154Ml/day @ 14m (350kW).
Outflows from Treated Water tanks to aquaduct/Titirangi 1&2 via gravity with sufficient available head to accommodate lining and pressurising the aquaduct in future.
Outflows from Treated Water tanks to Manuka Road reservoir to be pumped max 140Ml/d @ 10m 225kW

Network connections

Inlet pump station connection to aquaduct where it crosses under Woodland Park Road.
Outlet connection to existing WTP outlet chamber for supply to Titirangi. Pumped pipeline connection to Manuka Road Reservoir.

Process Unit Levels (TWLs)

Inlet	129.00
DAF	128.55
Ozone	127.25
BAC	126.75
CCT/TWT	123.25
Manuka Road reservoir	132.00

Staging Issues

Muddy Creek overflow pipeline- No impact on timing of works
PAC facility – No impact on timing of works
Sludge facility – no impact on timing of works
Manuka Road reservoir – new CCT/TWT, temporary pump station to supply CCT and permanent pump station after TWT and connection pipeline to existing WTP outlet to aquaduct required.
CCT/TWT could be deferred if new reservoir to be used for contact time but creates some operational difficulties/impacts and temporary pump station would still be required.
The new WTP would be constructed in one step after Woodland Park Road had been relocated. Once operational the existing chemical and plant rooms could be demolished in order to permit construction of the new administration facility. Temporary admin/control facilities would be required.

Advantages

Maintains facilities on single existing site
Installation of Muddy Creek, sludge and PAC upgrades can proceed immediately and on existing site

Disadvantages

Road relocation will require substantial consenting
Quite cramped layout
Inlet and outlet pumping required
Temporary outlet PS required
Temporary control and office facilities required
Approx. 6m wasted head when discharging to Titirangi

4.3.2 Layout Option 2b

General Description

Woodland Park Road is relocated to the north and Manuka Road to the east to expand the existing WTP site area. The new plant is located with a hydraulic grade that will enable gravity flow through to the new Manuka Road Reservoir. The DAF tanks are located on higher ground near the existing upwash water tank. The BAC filter footprint is 14 cells in the back to back arrangement. The new upwash water and FTW tanks are located under the southern half of the Ozone BAC filters to maintain the required TWL of these units. The new CCT/TWT is located on the existing Manuka Road site with the new Reservoir. This arrangement ultimately has a single inlet raw water pump station with gravity flow through the plant to the new Reservoirs. New chemical dosing sludge PAC facilities are all located at the existing plant.

Manuka Road reservoir at TWL 128.0

Pumping Requirements

Inflow to the plant is pumped 154Ml/day @ 19m (475kW).
Outflows from Treated Water tanks to aquaduct/Titirangi 1&2 via gravity with sufficient available head to accommodate lining and pressurising the aquaduct in future.
Outflows from Treated Water tanks to Manuka Road reservoir to be by gravity

Network connections

Inlet pump station connection to aquaduct where it crosses under Woodland Park Road.
Outlet connections to existing Titirangi aquaduct and to Manuka Road Reservoir.

Process Unit Levels (TWLs)

Inlet	135.00
DAF	134.50
Ozone	133.00
BAC	132.50
CCT/TWT	129.00
Manuka Road reservoir	128.00

Staging Issues

Muddy Creek overflow pipeline- No impact on timing of works
PAC facility – No impact on timing of works
Sludge facility – no impact on timing of works
Manuka Road reservoir – relocate Manuka Road to site new CCT/TWT, temporary pump station to supply CCT and connection pipeline to existing WTP outlet to aquaduct required. CCT/TWT could be

deferred if new reservoir to be used for contact time but creates some operational difficulties/impacts and temporary pump station would still be required.
The new WTP would be constructed in one step after Woodland Park Road and Manuka Road had been relocated.

Advantages

Larger available site area
Installation of Muddy Creek, Sludge and PAC upgrades can proceed immediately and on existing site
Only raw water inlet pumping required

Disadvantages

Road relocation will require substantial consenting
Manuka Road reservoir at TWL 128.0
Temporary outlet PS required
Approx. 13m wasted head when discharging to Titirangi

4.3.3 Layout Option 2c

General Description

Woodland Park Road is relocated to the north to expand the existing WTP site area. This option has an intermediate pump station between the BAC and the CCT/TWT tanks with gravity flow from the CCT/TWT to the new Manuka Road reservoir. The Ozone and BAC tanks are sited on the existing Woodlands Park Road and have a new upwash water tank and the FTW tank underneath to provide sufficient hydraulic grade. The BAC filter footprint is 14 cells in the back to back arrangement. New chemical dosing sludge PAC facilities are all located at the existing plant and site road modifications for drive through chemical delivery. The existing overflow storage lagoon is reduced in size to provide space for new thickeners and site road.

Manuka Road reservoir at TWL 132.0

Pumping Requirements

Inflow to the plant is pumped 154Ml/day @ 15.5m (390kW).
Outflows from Treated Water tanks to aquaduct/Titirangi 1&2 via gravity with sufficient available head to accommodate lining and pressurising the aquaduct in future.
Outflows from Treated Water Tanks to Manuka Road reservoir to be by gravity

Network connections

Inlet pump station connection to aquaduct where it crosses under Woodland Park Road.
Outlet connections to existing Titirangi aquaduct and to Manuka Road Reservoir.

Process Unit Levels (TWLs)

Inlet	130.50
DAF	130.00
Ozone	128.50
BAC	128.00
CCT/TWT	132.50
Manuka Road reservoir	132.00

Staging Issues

Muddy Creek overflow pipeline- No impact on timing of works
PAC facility – No impact on timing of works
Sludge facility – no impact on timing of works
Manuka Road reservoir –new CCT/TWT, temporary pump station to supply CCT and connection pipeline to existing aquaduct required. CCT/TWT could be deferred if new reservoir to be used for contact time but creates some operational difficulties/impacts and temporary pump station would still be required.
The new WTP would be constructed in one step after Woodland Park Road had been relocated. As the new DAF tanks will require demolition of the upwash water storage tank, the new tanks (under the Ozone/BAC) would need to be constructed first and temporary connection made to existing filters with temporary upwash water pumps to suit the required duty.
The new admin building is located within the chemical and plant room area of the existing WTP and will be constructed last

Advantages

Larger available site area consolidated with existing plant
Installation of Muddy Creek, Sludge and PAC upgrades can proceed immediately and on existing site
Only raw water inlet pumping required
Lower environmental impact

Disadvantages

Road relocation will require substantial consenting
Temporary outlet PS required but could be future modified for use as the intermediate pump station.
Approx. 17m wasted head when discharging to Titirangi
Temporary filter backwash arrangements

4.3.4 Layout Option 2d

General Description

This option is quite similar to Option 2c except the CCT/TWT tanks are located such that they will fill under gravity flow from the existing and new WTPs with a pump station to supply Manuka Road reservoir. Woodland Park Road is relocated to the north to expand the existing WTP site area. The Ozone and BAC tanks are sited on the existing Woodlands Park Road and have a new upwash water tank and the FTW tank underneath to provide foundation support.

Manuka Road reservoir at TWL 132.0

Pumping Requirements

Inflow to the plant is pumped 154Ml/day @ 15.5m (390kW).
Outflows from Treated Water tanks to aquaduct/Titirangi 1&2 via gravity. CCT and TWT constructed with sufficient freeboard to enable increased future operating level to accommodate lining and pressurising the aquaduct.

Network connections

Inlet pump station connection to aquaduct where it crosses under Woodland Park Road.
Outlet connections to existing Titirangi aquaduct and to Manuka Road Reservoir.

Process Unit Levels (TWLs)

Inlet	130.50
DAF	130.00
Ozone	128.50
BAC	128.00
CCT/TWT	115.00 (117.00 future)
Manuka Road reservoir	132.00

Staging Issues

Muddy Creek overflow pipeline- No impact on timing of works
PAC facility – No impact on timing of works
Sludge facility – no impact on timing of works
Manuka Road reservoir –new CCT/TWT and pump station required. CCT/TWT could be deferred if new reservoir to be used for contact time but creates some operational difficulties/impacts and pump station would require a balance tank.
The new WTP would be constructed in one step after Woodland Park Road had been relocated.
The new admin building is located within the chemical and plant room area of the existing WTP and will be constructed last

Advantages

Larger available site area consolidated with existing plant
Installation of Muddy Creek, Sludge and PAC upgrades can proceed immediately and on existing site
Lower environmental impact

Disadvantages

Road relocation will require substantial consenting
Approx. 9m wasted head between BAC filters and CCT/TWT for all plant flows
Inlet and Outlet pumping required

4.3.5 Layout Option 2e

General Description

This option aims to limit the extent of relocation of Woodland Park Road providing just sufficient to locate a new DAF unit and inlet PS on the existing roadway. The new Ozone and BAC filters will be located within the area currently occupied by the clarifiers. Upwash and FTW tanks will be located under the BAC filters to elevate the overall structure to the required hydraulic grade. The CCT/TWT will be located immediately east of the overflow storage lagoon and at a level to permit gravity flow to Titirangi via the existing aquaduct. The new sludge dewatering facility is located in the eastern half of the existing overflow storage lagoon.

Manuka Road reservoir at TWL 132.0

Pumping Requirements

Inflow to the plant is pumped 154Ml/day @ 7m (175kW).
Outflows from Treated Water tanks to aquaduct/Titirangi 1&2 via gravity. Low lift pumping would be required for supply to Titirangi if the aquaduct was lined and pressurised in future.
Outflows from Treated Water tanks to Manuka Road reservoir to be pumped max 140Ml/d @ 18.5m 420kW

Network connections

Inlet pump station connection to aquaduct where it crosses under Woodland Park Road.
Outlet connections to existing Titirangi aquaduct and to Manuka Road Reservoir.

Process Unit Levels (TWLs)

Inlet	122.00
DAF	121.50
Ozone	120.00
BAC	119.50
CCT/TWT	115.50
Manuka Road reservoir	132.00

Staging Issues

Muddy Creek overflow pipeline- No impact on timing of works
PAC facility – No impact on timing of works
Sludge facility – Constructed after Muddy Creek pipeline is completed as overflow storage capacity is halved.
Manuka Road reservoir –new CCT/TWT and pump station required. CCT/TWT could be deferred if new reservoir to be used for contact time but creates some operational difficulties/impacts and pump station would require a balance tank.
New WTP staging as follows, assuming that the new CCT/TWT/pump station, Muddy Creek Pipeline, sludge and PAC are already in place

1. Construct new chemical storage and dosing facilities and associated site access road improvements
2. Relocated Woodland Park Road
3. Upgrade power supply
4. Construct new raw water pump station and connection to aquaduct, DAF unit and new thickeners,
5. Temporary connection of DAF to existing filters
6. Demolish existing clarifier and old thickener
7. Construct new Ozone tanks and BAC filters, FTW tank, filter backwash balance tank, filter upwash water tank, second washout thickener, standby generators
8. Connect Ozone/BAC filters to DAF
9. Demolish existing filters
10. Upgrade admin/office facilities

Advantages

Increased site area consolidated with existing plant
Installation of Muddy Creek, Sludge and PAC upgrades can proceed immediately and on existing site
Lower environmental impact

Disadvantages

Road relocation will require substantial consenting
Temporary connection from DAF to existing filters
Progressive construction of facilities will extend construction period and increase costs
Operational impacts during construction
Limited space for contractors site facilities and laydown
Temporary control and office facilities required during construction
Reduced overflow storage lagoon volume

4.4 Layout Option 3 - New WTP located on north side of Woodland Park Road, Reservoir at Manuka Road site

4.4.1 Layout Options 3a and 3b

General Description

These two options provides for a complete new WTP facility on the north side of Woodland Park Road. The proposed PAC, sludge dewatering facilities, a new CCT/TWT and chlorine storage and dosing plant are all located within the new WTP such that the existing site can ultimately be decommissioned with the exception of the existing overflow detention lagoon. A temporary pump station will be required to supply the new CCT/TWT – Manuka Road reservoir. The DAF tanks have a new upwash water tank and the FTW tank underneath to provide the required hydraulic grade and foundation support.

The difference between options is the extended site road in option 3b placing the chemical storage facilities east of the existing upwash water tank.

Manuka Road reservoir at TWL 132.0

Pumping Requirements

Inflow to the plant is pumped 154Ml/day @ 14m (350kW).
Outflows from Treated Water tanks to aquaduct/Titirangi 1&2 via gravity with sufficient available head to accommodate lining and pressurising the aquaduct in future.
Outflows from Treated Water tanks to Manuka Road reservoir to be pumped max 140Ml/d @ 10m 225kW

Network connections

Inlet pump station connection to aquaduct adjacent to where it crosses under Woodland Park Road.
Outlet connections to existing Titirangi aquaduct and to Manuka Road Reservoir.

Process Unit Levels (TWLs)

Inlet	129.00
DAF	128.50
Ozone	127.00
BAC	126.50
CCT/TWT	123.00
Manuka Road reservoir	132.00

Staging Issues

Muddy Creek overflow pipeline- No impact on timing of works
PAC facility – Located on new site but no impact on timing of works
Sludge facility – Located on new site but no impact on timing of works
Manuka Road reservoir –new CCT/TWT and pump station required plus a temporary pump station. The CCT/TWT could be deferred if new reservoir to be used for contact time but creates some operational difficulties/impacts. Temporary pump station would require a balance tank.
The PAC and sludge facilities are located together and would be constructed first. The balance of the new WTP would be constructed in one step.

Advantages

Larger available site area

Completely new WTP facility
Existing WTP site ultimately available for other uses (except overflow holding lagoon area)

Disadvantages

Higher environmental impact
Approx. 7.5m wasted head when discharging to Titirangi
New Sludge and PAC upgrades would be across Woodland Park road from the existing plant until the new WTP was constructed.
Temporary pump station required
Inlet and Outlet pumping required

4.5 Layout Option 4 - WTP facilities spanning Woodland Park Road, Reservoir at Manuka Road site

4.5.1 Layout Option 4a

General Description

This option provides for the construction of the new PAC and sludge dewatering facilities and CCT/TWT within the existing WTP site area which will facilitate ease of operation in the short term. The new WTP would be constructed on the north side of Woodland Park Road. The new and existing facilities would be connected by an access tunnel under Woodland Park Road suitable for pedestrian and small maintenance vehicles. A new admin building is proposed which will reduce the number of operator movements between the two parts of the site. The DAF tanks have a new upwash water tank and the FTW tank underneath to provide the required hydraulic grade and foundation support. The BAC filter footprint is 14 cells in back to back configuration. The CCT/TWT tanks are located such that they will also fill under gravity flow from the existing WTP with a pump station to supply Manuka Road reservoir.

Manuka Road reservoir at TWL 132.0

Pumping Requirements

Inflow to the plant is pumped 154Ml/day @ 13.5m (340kW).
Outflows from Treated Water tanks to aquaduct/Titirangi 1&2 via gravity with sufficient available head to accommodate lining and pressurising the aquaduct in future.
Outflows from Treated Water tanks to Manuka Road reservoir to be pumped max 140Ml/d @ 19m 430kW

Network connections

Inlet pump station connection to aquaduct where it crosses under Woodland Park Road.
Outlet connection to existing WTP outlet chamber for supply to Titirangi. Pumped pipeline connection to Manuka Road Reservoir.

Process Unit Levels (TWLs)

Inlet	128.50
DAF	128.00
Ozone	126.50
BAC	126.00
CCT/TWT	115.00 (117.00 future)
Manuka Road reservoir	132.00

Staging Issues

Muddy Creek overflow pipeline- No impact on timing of works
PAC facility – No impact on timing of works
Sludge facility – no impact on timing of works
Manuka Road reservoir – new CCT/TWT, pump station and connection chamber to aquaduct required. CCT/TWT could be deferred if new reservoir to be used for contact time but creates some operational difficulties/impacts and pump station would require a balance tank.
Assuming the new CCT/TWT, sludge and PAC is in place the new WTP would be constructed as follows

1. Temporary bypass of Woodland Park Road to enable the under-road access tunnel to be constructed by cut and cover

2. Construct new WTP facilities
3. Decommissioned the old plant and demolish
4. Construct additional site access road.

Advantages

Expansive site area available
Installation of Muddy Creek, Sludge and PAC upgrades can proceed immediately and on existing site
Existing clarifier area provides a large storage/laydown space for future

Disadvantages

Greater environmental impact
Facilities on both sides of Woodland Park Road
Proximity of sludge dewatering building, CCT/TWT and new ozone contact tanks to landowners
Approx. 7m wasted head between BAC filters and CCT/TWT for all plant flows
Inlet and Outlet pumping required

4.5.2 Layout Option 4b

General Description

This option is similar to Option 4a except that more of the existing WTP site is retained for future operation. This also uses less of the available site on the north site of Woodlands Park Road, leaving the environmentally sensitive western site undeveloped. The new PAC and sludge dewatering facilities and CCT/TWT within the existing WTP site area will facilitate ease of operation in the short term. The new and existing facilities would be connected by an access tunnel under Woodland Park Road suitable for pedestrian and small maintenance vehicles. This option has a longer tunnel than Option 4a but either tunnel configuration would work. A new admin building is proposed which will be constructed within the existing filter/chemical building footprint once the new WTP is completed. The DAF tanks have a new upwash water tank and the FTW tank underneath to provide the required hydraulic grade and foundation support. The BAC filter footprint is 14 cells in back to back configuration. The CCT/TWT tanks are located such that they will also fill under gravity flow from the existing WTP with a pump station to supply Manuka Road reservoir.

Manuka Road reservoir at TWL 132.0

Pumping Requirements

Inflow to the plant is pumped 154Ml/day @ 13.5m (340kW).
Outflows from Treated Water tanks to aquaduct/Titirangi 1&2 via gravity with sufficient available head to accommodate lining and pressurising the aquaduct in future.
Outflows from Treated Water tanks to Manuka Road reservoir to be pumped max 140Ml/d @ 19m 430kW

Network connections

Inlet pump station connection to aquaduct where it crosses under Woodland Park Road.
Outlet connection to existing WTP outlet chamber for supply to Titirangi. Pumped pipeline connection to Manuka Road Reservoir.

Process Unit Levels (TWLs)

Inlet	128.50

DAF	128.00
Ozone	126.50
BAC	126.00
CCT/TWT	115.00 (117.00 future)
Manuka Road reservoir	132.00

Staging Issues

Muddy Creek overflow pipeline- No impact on timing of works
PAC facility – No impact on timing of works
Sludge facility – no impact on timing of works
Manuka Road reservoir – new CCT/TWT, pump station and connection chamber to aquaduct required. CCT/TWT could be deferred if new reservoir to be used for contact time but creates some operational difficulties/impacts and pump station would require a balance tank.
Assuming the new CCT/TWT, sludge and PAC is in place the new WTP would be constructed as follows:

1. Construct new WTP facilities
2. Construct new raw water pump station and third thickener (assuming second constructed with sludge upgrade)
3. Decommissioned the old plant and demolish
4. Construct new admin building and additional site access roads and connecting access tunnel.

Advantages

Expansive site area available
Installation of Muddy Creek, Sludge and PAC upgrades can proceed immediately and on existing site
Existing clarifier area provides a large storage/laydown space for future
Lesser environmental impact than Option 4a

Disadvantages

Moderate environmental impact
Facilities on both sides of Woodland Park Road
Proximity of sludge dewatering building and CCT/TWT to landowners
Approx. 9m wasted head between BAC filters and CCT/TWT for all plant flows
Inlet and Outlet pumping required

4.6 Layout Option 5 - New WTP at Manuka Road site, new service reservoir on north side of Woodland Park Road

4.6.1 Layout Options 5a, 5b and 5c

General Description

These options locate a complete new WTP at the less environmentally sensitive Manuka Road site. The proposed PAC storage and dosing facility is located at the inlet area of the existing WTP as PAC would only be used intermittently and once the new WTP is completed, quite infrequently. The new sludge dewatering facilities and CCT/TWT are located with the new WTP. A new admin building is proposed. The DAF tanks have a new upwash water tank and the FTW tank underneath to provide the required hydraulic grade and foundation support. The BAC filter footprint is 14 cells in back to back configuration. The CCT/TWT tanks are located such that they will feed the new service reservoir by gravity flow.

Options 5a and 5b are very similar with the key difference being site access arrangements. Option 5c rearranges the ozone, BAC and CCT/TWT tanks slightly.

The new Service Reservoir would be located north of Woodland Park Road and is the same arrangement for options 5a, 5b and 5c. The optimum TWL for the new service reservoir is 128.0m based on the available hydraulic grade from the WTP. This may possibly be increased to TWL 130.0m once more accurate site survey is available. A service reservoir TWL of 132.0m will require low lift pumping from the CCT/TWT.

Pumping Requirements

Inflow to the plant is pumped 154Ml/day @ 22m (540kW) or 24m (590kW).
Outflows from Treated Water tanks to aquaduct/Titirangi 1&2 via gravity with sufficient available head to accommodate lining and pressurising the aquaduct in future.
Outflows from Treated Water tanks to Manuka Road reservoir via gravity.

Network connections

Inlet pump station connection to aquaduct where it crosses under Woodland Park Road.
Outlet connection to existing aquaduct for supply to Titirangi. Pipeline connection to new Service Reservoir.

Process Unit Levels (TWLs)

Inlet	135.50	137.50
DAF	135.00	137.00
Ozone	133.50	135.50
BAC	133.00	135.00
CCT/TWT	129.50	131.50
Manuka Road reservoir	128.00	130.00

Staging Issues

Muddy Creek overflow pipeline- No impact on timing of works
PAC facility – No impact on timing of works
Sludge facility – needs to be included as part of the new WTP
New Service Reservoir – new CCT/TWT would be on a remote site which is impractical for chemical dosing purposes, The CCT/TWT would need to be deferred and the new service reservoir used for contact time. A temporary pump station with balance tank for pH and pump operation control would

be required. A minimum operational water level in the service reservoir would be required. For simplicity of network operation it would be better to have all flows go to the new service reservoir and then discharge back into the Titirangi aquaduct.
The new WTP would be constructed in a single step with the sludge dewatering and CCT/TWT

Advantages

Reduced environmental impact
Complete new WTP
No impact on existing plant operation
Least impact on adjacent residents
Installation of Muddy Creek and PAC upgrades can proceed immediately and on existing site
Existing WTP site could be released for other uses (excluding the overflow storage lagoon area which is to be retained).

Disadvantages

Sludge upgrade and new CCT/TWT would need to be deferred until the new WTP is constructed
New service reservoir TWL only 128-130m.
All
Approx. 13m wasted head when discharging to Titirangi

This Project Technical Memorandum has been prepared for the benefit of WSL. No liability is accepted by this company or any employee or sub-consultant of this company with respect to its use by any other person.

This disclaimer shall apply notwithstanding that the Project Technical Memorandum may be made available to WSL and other persons for an application for permission or approval or to fulfil a legal requirement.

Attachment 1 – Concept Design Layouts

Appendix J Initial MCA Document

Multi Criteria Analysis Template

Version 9 - 01/10/12

(yellow)	=input required
(grey)	=calculation

Project: Huia WTP Implementation Strategy

Objective / Key Issue for Resolution: Shortlisting of Site Layout options

Must-haves:

	Option 1a	Option 1b	Option 1c	Option 2a	Option 2b	Option 2c	Option 2d	Option 2e	Option 3a	Option 3b	Option 4a	Option 4b	Option 5a	Option 5b	Option 5c	Comment
1. Maintain or achieve Ministry of Health "Aa" grading	go	go	go	go	go	go	go	go	go	go	go	go	go	go	go	
2. 100% compliance with microbiological criteria of latest Drinking Water Standards for New Zealand	go	go	go	go	go	go	go	go	go	go	go	go	go	go	go	
3. Meet future supply capacity and system production capacity	go	go	go	go	go	go	go	go	go	go	go	go	go	go	go	
4. Meet design, performance and standard criteria including, levels of service, reliability and availability, with redundancy of each major process unit set at n-1 (also including any project specific, standard design and performan	go	go	go	go	go	go	go	go	go	go	go	go	go	go	go	
5. Meet other regulatory compliance	go	go	go	go	go	go	go	go	go	go	go	go	go	go	go	
6. Must not increase overall system risk factor	go	go	go	go	go	go	go	go	go	go	go	go	go	go	go	
7. Must comply with Watercare Zero Harm Policy, The Health & Safety in Employment Act 1992 (The Act) and its amendments	go	go	go	go	go	go	go	go	go	go	go	go	go	go	go	

Deal-breakers:

	Option 1a	Option 1b	Option 1c	Option 2a	Option 2b	Option 2c	Option 2d	Option 2e	Option 3a	Option 3b	Option 4a	Option 4b	Option 5a	Option 5b	Option 5c	Comment
1. The solution may not reduce overall risk class but must reduce either consequence or likelihood of risk to health and safety in the Watercare Risk Management Framework	go	go	go	go	go	go	go	go	go	go	go	go	go	go	go	
2. Impossible to attain consent, construct or operate	go	go	go	go	go	go	go	go	go	go	go	go	go	go	go	

Multi-Criteria:

Phase	Criteria			Rating [R]: Lowest weight 0%	25%	50%	75%	100%	Weight (W)
Construction (25%)	Environmental Care	Adverse effect on the Environment	Consider the degree to which the option will impact the environment: effect on native ecology (ecological value in District/Regional plans and/or the ecological significance of the area), effect on heritage features (both cultural and built, e.g. archaeological sites, geological feature, volcanic cone, lava cave, building facade), effect on water (groundwater dewatering & water quality, e.g. discharge of sludge, chemicals, sediments, etc.), effect on land (e.g. earthworks, permeability, etc.), effect on air quality (e.g. smoke, air, dust, gas, noise, etc.) & effect on stakeholders (people / properties affected, potential opposition, conflict with cultural groups, e.g. Iwi).	Low	Low-Med	Med	Med-High	High	7.7%
		Ease of Obtaining Consent	Ease of option consentability (time, cost, reputation, Auckland Plan designation, etc.	Low	Low-Med	Med	Med-High	High	7.7%
		Sustainability	Consider sustainability as a whole, estimated carbon footprint and energy consumption during construction.	Low	Low-Med	Med	Med-High	High	2.6%
	Health, Safety & Well-Being	Ability to Manage Hazards to Staff, Contractors and Public	Identify significant hazards (defined in the Hazard Register & the Act) and notifiable hazards (required to be reported to the Department of Labour) and consider the ability and difficulty to eliminate, minimise, isolate and monitor those. E.g. confined spaces, working at height, etc.	Low	Low-Med	Med	Med-High	High	10.3%
		Ability to Manage Risk to Principals	Consider the ability for the principals to manage the risk exposure to " ensure that, as far as is reasonably practicable, the workplaces, machinery, equipment, and processes under their control are safe and without risk to health".	Low	Low-Med	Med	Med-High	High	10.3%
	Stakeholder Relationships	Adverse Stakeholder Impacts / Availability of Resources	These include internal and external local stakeholders / other utilities (excl. environmental stakeholders but incl. neighbours). Consider impacts, availability of resources, programme & difficulty associated with the option.	Low	Low-Med	Med	Med-High	High	5.1%
		Ease of Property Acquisition / Easement	Consider the estimated number, value & difficulty of land acquisition / easements.	Low	Low-Med	Med	Med-High	High	2.6%
		Community Acceptance / Satisfaction	Consider wider Auckland community and political acceptance / satisfaction of project.	Low	Low-Med	Med	Med-High	High	2.6%
	Customer Service	Supply Security & Impact / Redundancy / Resilience / Risk	Consider the ability of option to reduce system risk and maintain supply during abnormal condition, failure of plant, force majeure & meet required performance criteria. Consider both positive and negative impacts on the supply (e.g. an option may provide additional capacity or storage but be limited for further development).	Low	Low-Med	Med	Med-High	High	12.8%
		Positive Impact on Water Quality	Consider impacts on water quality assuming it currently meets microbiological standards (e.g. an option may reduce discoloured water but reduce pressure).	Low	Low-Med	Med	Med-High	High	2.6%
	Asset Management	Design	Consider interface with existing equipment or infrastructure, ability of option to facilitate implementation and tie-ins, ancillary services, ease of future expansion, upgradability, access, serviceability, continuous operation capability, automation capability, process control, availability of materials, equipment and technology and proven service records.	Low	Low-Med	Med	Med-High	High	12.8%
		Constructability, Ease of Implementation & Commissioning	Ability to construct option within existing site footprint, sequencing/phasing, suitability of construction duration, potential adverse ground conditions, ability to fully commission & integrate with existing plant (not including tie-ins but including electrical, start-up, integration with operation, ease of fall-back and decommissioning). Consider any process that may delay the option implementation.	Low	Low-Med	Med	Med-High	High	12.8%
		Short Term Operability	Consider robustness of plant, equipment, structures and reliability of processes provided to minimise operator input.	Low	Low-Med	Med	Med-High	High	10.3%
	TOTAL Construction Phase								1.0
	RANK Construction Phase								
	Environmental Care	Adverse effect on the Environment	Consider the degree to which the option will impact the environment: effect on native ecology (ecological value in District/Regional plans and/or the ecological significance of the area), effect on heritage features (both cultural and built, e.g. archaeological sites, geological feature, volcanic cone, lava cave, building facade), effect on water (groundwater dewatering & water quality, e.g. discharge of sludge, chemicals, sediments, etc.), effect on land (e.g. earthworks, permeability, etc.), effect on air quality (e.g. smoke, air, dust, gas, noise, etc.) & effect on stakeholders (people / properties affected, potential opposition, conflict with cultural groups, e.g. Iwi).	Low	Low-Med	Med	Med-High	High	9.8%
		Ease of Obtaining Consent	Ease of option consentability (time, cost, reputation, Auckland Plan designation, etc.	Low	Low-Med	Med	Med-High	High	7.3%
		Sustainability	Consider sustainability as a whole, estimated carbon footprint and annual energy consumption.	Low	Low-Med	Med	Med-High	High	4.9%

Criteria	Option 1a R	Option 1a Wx%	Option 1b R	Option 1b Wx%	Option 1c R	Option 1c Wx%	Option 2a R	Option 2a Wx%	Option 2b R	Option 2b Wx%	Option 2c R	Option 2c Wx%	Option 2d R	Option 2d Wx%	Option 2e R	Option 2e Wx%
Adverse effect on the Environment	High	0.08	High	0.08	High	0.08	Low	0.00	Low-Med	0.02	Med	0.04	Med	0.04	Med-High	0.06
Ease of Obtaining Consent	Med-High	0.06	High	0.08	High	0.08	Low	0.00	Low	0.00	Low-Med	0.02	Low-Med	0.02	Med-High	0.06
Sustainability	High	0.03	High	0.03	High	0.03	Low	0.00	Low	0.00	Med	0.01	Med	0.01	High	0.03
Ability to Manage Hazards to Staff, Contractors and Public	Low	0.00	Low	0.00	Low	0.00	Med	0.05	Med	0.05	Med	0.05	Med	0.05	Low-Med	0.03
Ability to Manage Risk to Principals	Low	0.00	Low	0.00	Low-Med	0.03	Med	0.05	Med	0.05	Med	0.05	Med	0.05	Med	0.05
Adverse Stakeholder Impacts / Availability of Resources	Med-High	0.04	High	0.05	Med-High	0.04	Low	0.00	Low-Med	0.01	Med	0.03	Low-Med	0.01	Med-High	0.04
Ease of Property Acquisition / Easement	High	0.03	High	0.03	High	0.03	High	0.03	High	0.03	High	0.03	High	0.03	High	0.03
Community Acceptance / Satisfaction	High	0.03	High	0.03	High	0.03	Med	0.01	Med	0.01	Med	0.01	Med	0.01	High	0.03
Supply Security & Impact / Redundancy / Resilience / Risk	Low-Med	0.03	Low-Med	0.03	Low-Med	0.03	Med	0.06	Low-Med	0.03	Low-Med	0.03	Low-Med	0.03	Low-Med	0.03
Positive Impact on Water Quality	High	0.03	High	0.03	High	0.03	High	0.03	High	0.03	High	0.03	High	0.03	High	0.03
Design	Low-Med	0.03	Low-Med	0.03	Low	0.00	Med	0.06	Med	0.06	Med	0.06	Med	0.06	Low-Med	0.03
Constructability, Ease of Implementation & Commissioning	Low-Med	0.03	Low-Med	0.03	Low	0.00	Med	0.06	Low-Med	0.03	Med	0.06	Med	0.06	Low-Med	0.03
Short Term Operability	Low	0.00	Low	0.00	Low	0.00	Low-Med	0.03	Med	0.05	Low-Med	0.03	Low-Med	0.03	Low-Med	0.03
TOTAL Construction Phase	0.37		0.41		0.35		0.39		0.38		0.45		0.44		0.46	
RANK Construction Phase	14		11		15		12		13		9		10		8	
Adverse effect on the Environment	Med-High	0.07	Med-High	0.07	Med-High	0.07	Med-High	0.07	Med-High	0.07	Med-High	0.07	Med-High	0.07	Med-High	0.07
Ease of Obtaining Consent	High	0.07	High	0.07	High	0.07	High	0.07	High	0.07	High	0.07	High	0.07	High	0.07
Sustainability	High	0.05	High	0.05	High	0.05	Med-High	0.04	Med	0.02	Low	0.00	Low-Med	0.01	High	0.05

Criteria	Option 3a R	Option 3a Wx%	Option 3b R	Option 3b Wx%	Option 4a R	Option 4a Wx%	Option 4b R	Option 4b Wx%	Option 5a R	Option 5a Wx%	Option 5b R	Option 5b Wx%	Option 5c R	Option 5c Wx%	Comment
Adverse effect on the Environment	Low	0.00	Low	0.00	Low	0.00	Med	0.04	Med-High	0.06	Med-High	0.06	Med-High	0.06	
Ease of Obtaining Consent	Low-Med	0.02	Low-Med	0.02	Low-Med	0.02	Med	0.04	Med-High	0.06	Med-High	0.06	Med-High	0.06	
Sustainability	Med	0.01	Med	0.01	Low-Med	0.01	Low-Med	0.01	Med-High	0.02	Med-High	0.02	Med-High	0.02	
Ability to Manage Hazards to Staff, Contractors and Public	Med	0.05	Med	0.05	Med	0.05	Med-High	0.08	Med-High	0.08	Med-High	0.08	Med-High	0.08	
Ability to Manage Risk to Principals	Med	0.05	Med	0.05	Med	0.05	Med	0.05	Med-High	0.08	Med-High	0.08	Med-High	0.08	
Adverse Stakeholder Impacts / Availability of Resources	Low-Med	0.01	Low-Med	0.01	Low-Med	0.01	Med	0.03	Med-High	0.04	High	0.05	Med-High	0.04	
Ease of Property Acquisition / Easement	High	0.03	High	0.03	High	0.03	High	0.03	High	0.03	High	0.03	High	0.03	
Community Acceptance / Satisfaction	Med	0.01	Med	0.01	Med	0.01	Med	0.01	High	0.03	High	0.03	High	0.03	
Supply Security & Impact / Redundancy / Resilience / Risk	Med-High	0.10	Med-High	0.10	Med-High	0.10	Med	0.06	Med-High	0.10	Med-High	0.10	Med-High	0.10	
Positive Impact on Water Quality	High	0.03	High	0.03	High	0.03	High	0.03	High	0.03	High	0.03	High	0.03	
Design	Med	0.06	Med	0.06	Med	0.06	Med	0.06	Med-High	0.10	Med-High	0.10	Med-High	0.10	
Constructability, Ease of Implementation & Commissioning	Med-High	0.10	Med-High	0.10	Med	0.06	Med	0.06	Med-High	0.10	Med-High	0.10	Med-High	0.10	
Short Term Operability	Low-Med	0.03	Low-Med	0.03	Med-High	0.08	Med	0.05	Low	0.00	Low	0.00	Low	0.00	
TOTAL Construction Phase	0.49		0.49		0.51		0.55		0.69		0.71		0.69		
RANK Construction Phase	6		6		5		4		2		1		2		
Adverse effect on the Environment	Med-High	0.07	Med-High	0.07	Med-High	0.07	Med-High	0.07	High	0.10	High	0.10	High	0.10	
Ease of Obtaining Consent	High	0.07	High	0.07	High	0.07	High	0.07	High	0.07	High	0.07	High	0.07	
Sustainability	Med-High	0.04	Med-High	0.04	Med	0.02	Med	0.02	Low	0.00	Low	0.00	Low	0.00	

Operation (75%)	**Health, Safety & Well-Being**	Ability to Manage Hazards to Staff, Contractors and Public	Identify significant hazards (defined in the Hazard Register & the Act) and notifiable hazards (required to be reported to the Department of Labour) and consider the ability and difficulty to eliminate, minimise, isolate and monitor those. E.g. confined spaces, working at height, etc.	Low	Low-Med	Med	Med-High	High	9.8%
		Ability to Manage Risk to Principals	Consider the ability for the principals to manage the risk exposure to " ensure that, as far as is reasonably practicable, the workplaces, machinery, equipment, and processes under their control are safe and without risk to health".	Low	Low-Med	Med	Med-High	High	9.8%
	Stakeholder Relationships	Adverse Stakeholder Impacts / Availability of Resources	These include internal and external local stakeholders / other utilities (excl. environmental stakeholders but incl. neighbours). Consider impacts, availability of resources, programme & difficulty associated with the option.	Low	Low-Med	Med	Med-High	High	4.9%
		Community Acceptance / Satisfaction	Consider wider Auckland community and political acceptance / satisfaction of project.	Low	Low-Med	Med	Med-High	High	4.9%
	Customer Service	Supply Security & Impact / Redundancy / Resilience / Risk	Consider the ability of option to reduce system risk and maintain supply during abnormal condition, failure of plant, force majeure & meet required performance criteria. Consider both positive and negative impacts on the supply (e.g. an option may provide additional capacity or storage but be limited for further development).	Low	Low-Med	Med	Med-High	High	12.2%
		Positive Impact on Water Quality	Consider impacts on water quality assuming it currently meets microbiological standards (e.g. an option may reduce discoloured water but reduce pressure).	Low	Low-Med	Med	Med-High	High	2.4%
	Asset Management	Medium and Long Term Operability	Consider interface with existing equipment or infrastructure, ease of future expansion / upgradability, access, continuous operation capability, automation capability, process control, availability of materials, equipment and technology, and proven service records, robustness of plant, equipment, structures and reliability of processes provided to minimise operator input.	Low	Low-Med	Med	Med-High	High	17.1%
		Medium and Long Term Maintainability	Consider ease & frequency of maintenance / serviceability, availability of materials, equipment and technology, ease of decommissioning, robustness of plant, equipment, structures and reliability of processes provided to minimise maintenance input.	Low	Low-Med	Med	Med-High	High	17.1%
	TOTAL Operation Phase								1.0
	RANK Operation Phase								
	GRAND TOTAL								
	FINAL RANK								

Ability to Manage Hazards to Staff, Contractors and Public	Med-High	0.07	Med-High	0.07	Med-High	0.07	Med-High	0.07	Med-High	0.07	Med-High	0.07	Med-High	0.07	Med-High	0.07
Ability to Manage Risk to Principals	High	0.10	High	0.10	High	0.10	High	0.10	High	0.10	High	0.10	High	0.10	High	0.10
Adverse Stakeholder Impacts / Availability of Resources	High	0.05	High	0.05	High	0.05	High	0.05	High	0.05	High	0.05	High	0.05	High	0.05
Community Acceptance / Satisfaction	High	0.05	High	0.05	High	0.05	High	0.05	High	0.05	High	0.05	High	0.05	High	0.05
Supply Security & Impact / Redundancy / Resilience / Risk	High	0.12	High	0.12	High	0.12	High	0.12	High	0.12	High	0.12	High	0.12	High	0.12
Positive Impact on Water Quality	High	0.02	High	0.02	High	0.02	High	0.02	High	0.02	High	0.02	High	0.02	High	0.02
Medium and Long Term Operability	Med	0.09	Med	0.09	Med	0.09	Med	0.09	Med-High	0.13	Med	0.09	Med	0.09	Med	0.09
Medium and Long Term Maintainability	Med	0.09	Med	0.09	Med	0.09	Med	0.09	Med	0.09	Med	0.09	Med	0.09	Med	0.09
TOTAL Operation Phase	**0.78**		**0.78**		**0.78**		**0.77**		**0.80**		**0.73**		**0.75**		**0.78**	
RANK Operation Phase	**6**		**6**		**6**		**11**		**3**		**14**		**13**		**6**	
GRAND TOTAL	**0.68**		**0.69**		**0.68**		**0.67**		**0.70**		**0.66**		**0.67**		**0.70**	
FINAL RANK	**10**		**9**		**11**		**12**		**8**		**14**		**13**		**7**	

Ability to Manage Hazards to Staff, Contractors and Public	Med-High	0.07	Med-High	0.07	Med	0.05	Med	0.05	Med-High	0.07	Med-High	0.07	Med-High	0.07
Ability to Manage Risk to Principals	High	0.10	High	0.10	High	0.10	High	0.10	High	0.10	High	0.10	High	0.10
Adverse Stakeholder Impacts / Availability of Resources	High	0.05	High	0.05	High	0.05	High	0.05	High	0.05	High	0.05	High	0.05
Community Acceptance / Satisfaction	High	0.05	High	0.05	High	0.05	High	0.05	High	0.05	High	0.05	High	0.05
Supply Security & Impact / Redundancy / Resilience / Risk	High	0.12	High	0.12	High	0.12	High	0.12	High	0.12	High	0.12	High	0.12
Positive Impact on Water Quality	High	0.02	High	0.02	High	0.02	High	0.02	High	0.02	High	0.02	High	0.02
Medium and Long Term Operability	High	0.17	High	0.17	Med-High	0.13	Low-Med	0.04	Med-High	0.13	Med-High	0.13	Med	0.09
Medium and Long Term Maintainability	Med	0.09	Med	0.09	Med	0.09	Med	0.09	Med	0.09	Med	0.09	Med	0.09
TOTAL Operation Phase	**0.86**		**0.86**		**0.78**		**0.69**		**0.80**		**0.80**		**0.76**	
RANK Operation Phase	**1**		**1**		**10**		**15**		**3**		**3**		**12**	
GRAND TOTAL	**0.77**		**0.77**		**0.71**		**0.65**		**0.77**		**0.78**		**0.74**	
FINAL RANK	**3**		**3**		**6**		**15**		**2**		**1**		**5**	

Huia WTP NPC for pumping costs for various site options

Pumpstations	1a	1b	1c	2a	2b (128)	2c	2d	2e	3a	3b	4a	4b	5a (128)	5b (128)	5c (128)	5a (130)	5b (130)	5c (130)
	Pump power for various Layout Options																	
Inlet PS - all flow	0	0	0	350	475	390	390	175	350	350	340	340	540	540	540	590	590	590
Outlet PS - Manuka	475	475	475	225	0	225	430	420	225	225	430	430	0	0	0	0	0	0
Outlet PS - Titirangi	55	55	70			225 Intermediate Pump												

Power cost $/kWhr **0.09**

NPV discount rate % **5.14%** **6.80%**

Year	Average Day demand kL Manuka	Titirangi	Total Huia	Power $/kWhr	1a	1b	1c	2a	2b (128)	2c	2d	2e	3a	3b	4a	4b	5a (128)	5b (128)	5c (128)	5a (130)	5b (130)	5c (130)
					Pumping power costs $/annum																	
2017																						
2018																						
2019																						
2020	11539	76213	87752	0.09	54471	54471	60909	187580	234730	303914	220668	113772	187580	187580	195959	195959	266851	266851	266851	291560	291560	291560
2021	15385	73420	88805	0.0918	63894	63894	70096	194528	237546	307560	232293	123906	194528	194528	207288	207288	270052	270052	270052	295057	295057	295057
2022	19231	70626	89857	0.093636	73317	73317	79282	201476	240362	311205	243918	134039	201476	201476	218616	218616	273253	273253	273253	298554	298554	298554
2023	23077	67833	90910	0.095509	82739	82739	88469	208423	243177	314851	255543	144173	208423	208423	229945	229945	276454	276454	276454	302052	302052	302052
2024	26923	65039	91962	0.097419	92162	92162	97656	215371	245993	318496	267168	154307	215371	215371	241274	241274	279655	279655	279655	305549	305549	305549
2025	30769	62246	93015	0.099367	101584	101584	106842	222319	248808	322142	278792	164441	222319	222319	252602	252602	282856	282856	282856	309046	309046	309046
2026	33846	59288	93134	0.101355	108899	108899	113907	226452	249127	322554	286505	171836	226452	226452	260281	260281	283218	283218	283218	309442	309442	309442
2027	36923	56330	93253	0.103382	116213	116213	120972	230586	249445	322966	294217	179231	230586	230586	267960	267960	283580	283580	283580	309837	309837	309837
2028	40000	53372	93372	0.105449	123528	123528	128036	234719	249763	323378	301929	186626	234719	234719	275639	275639	283942	283942	283942	310232	310232	310232
2029	43077	50414	93491	0.107558	130843	130843	135101	238852	250082	323790	309642	194021	238852	238852	283317	283317	284303	284303	284303	310628	310628	310628
2030	46154	47456	93610	0.109709	138157	138157	142166	242986	250400	324202	317354	201416	242986	242986	290996	290996	284665	284665	284665	311023	311023	311023
2031	46408	47172	93581	0.111904	138750	138750	142735	243250	250321	324100	317906	201989	243250	243250	291556	291556	284576	284576	284576	310925	310925	310925
2032	46663	46888	93551	0.114142	139343	139343	143303	243514	250242	323998	318457	202562	243514	243514	292116	292116	284486	284486	284486	310827	310827	310827
2033	46917	46604	93522	0.116425	139935	139935	143872	243779	250164	323896	319009	203135	243779	243779	292676	292676	284397	284397	284397	310730	310730	310730
2034	47172	46320	93492	0.118753	140528	140528	144441	244043	250085	323794	319560	203707	244043	244043	293235	293235	284307	284307	284307	310632	310632	310632
2035	47426	46036	93463	0.121128	141121	141121	145010	244307	250006	323692	320112	204280	244307	244307	293795	293795	284217	284217	284217	310534	310534	310534
2036	47681	45752	93433	0.123551	141714	141714	145578	244572	249927	323590	320663	204853	244572	244572	294355	294355	284128	284128	284128	310436	310436	310436
2037	47935	45468	93404	0.126022	142306	142306	146147	244836	249848	323488	321215	205426	244836	244836	294915	294915	284038	284038	284038	310338	310338	310338
2038	48190	45185	93374	0.128542	142899	142899	146716	245101	249769	323386	321766	205999	245101	245101	295475	295475	283948	283948	283948	310240	310240	310240
2039	48444	44901	93345	0.131113	143492	143492	147285	245365	249691	323284	322318	206572	245365	245365	296034	296034	283859	283859	283859	310142	310142	310142
2040	48699	44617	93315	0.133735	144085	144085	147853	245629	249612	323182	322869	207144	245629	245629	296594	296594	283769	283769	283769	310044	310044	310044
2041	48953	44333	93286	0.13641	144677	144677	148422	245894	249533	323080	323420	207717	245894	245894	297154	297154	283680	283680	283680	309946	309946	309946
2042	49208	44049	93256	0.139138	145270	145270	148991	246158	249454	322978	323972	208290	246158	246158	297714	297714	283590	283590	283590	309848	309848	309848
2043	49462	43765	93227	0.141921	145863	145863	149560	246422	249375	322876	324523	208863	246422	246422	298273	298273	283500	283500	283500	309750	309750	309750
2044	49717	43481	93197	0.144759	146455	146455	150128	246687	249297	322773	325075	209436	246687	246687	298833	298833	283411	283411	283411	309653	309653	309653
2045	49971	43197	93168	0.147655	147048	147048	150697	246951	249218	322671	325626	210008	246951	246951	299393	299393	283321	283321	283321	309555	309555	309555
2046	50225	42913	93139	0.150608	147641	147641	151266	247215	249139	322569	326178	210581	247215	247215	299953	299953	283232	283232	283232	309457	309457	309457
2047	50480	42629	93109	0.15362	148234	148234	151835	247480	249060	322467	326729	211154	247480	247480	300512	300512	283142	283142	283142	309359	309359	309359
2048	50734	42345	93080	0.156692	148826	148826	152403	247744	248981	322365	327281	211727	247744	247744	301072	301072	283052	283052	283052	309261	309261	309261
2049	50989	42061	93050	0.159826	149419	149419	152972	248008	248902	322263	327832	212300	248008	248008	301632	301632	282963	282963	282963	309163	309163	309163
2050	51243	41777	93021	0.163023	150012	150012	153541	248273	248824	322161	328384	212873	248273	248273	302192	302192	282873	282873	282873	309065	309065	309065
2051	51498	41493	92991	0.166283	150605	150605	154110	248537	248745	322059	328935	213445	248537	248537	302752	302752	282784	282784	282784	308967	308967	308967
2052	51752	41209	92962	0.169609	151197	151197	154678	248801	248666	321957	329487	214018	248801	248801	303311	303311	282694	282694	282694	308869	308869	308869
2053	52007	40926	92932	0.173001	151790	151790	155247	249066	248587	321855	330038	214591	249066	249066	303871	303871	282604	282604	282604	308771	308771	308771
2054	52261	40642	92903	0.176461	152383	152383	155816	249330	248508	321753	330590	215164	249330	249330	304431	304431	282515	282515	282515	308674	308674	308674
2055	52516	40358	92873	0.17999	152976	152976	156385	249594	248430	321651	331141	215737	249594	249594	304991	304991	282425	282425	282425	308576	308576	308576
2056	52770	40074	92844	0.18359	153568	153568	156953	249859	248351	321549	331693	216310	249859	249859	305550	305550	282336	282336	282336	308478	308478	308478
2057	53025	39790	92814	0.187262	154161	154161	157522	250123	248272	321447	332244	216882	250123	250123	306110	306110	282246	282246	282246	308380	308380	308380
2058	53279	39506	92785	0.191007	154754	154754	158091	250387	248193	321345	332796	217455	250387	250387	306670	306670	282156	282156	282156	308282	308282	308282
2059	53534	39222	92755	0.194827	155347	155347	158660	250652	248114	321243	333347	218028	250652	250652	307230	307230	282067	282067	282067	308184	308184	308184
2060	53788	38938	92726	0.198724	155939	155939	159228	250916	248035	321141	333899	218601	250916	250916	307790	307790	281977	281977	281977	308086	308086	308086
NPC 2020-2060	5%				2045146	2045146	2121806	3924164	4191612	5427034	5038474	3104080	3924164	3924164	4597252	4597252	4765201	4765201	4765201	5206423	5206423	5206423
RANK					1	1	3	5	8	18	14	4	5	5	9	9	11	11	11	15	15	15
NPC 2020-2060	7%				1594016	1594016	1657911	3136886	3383088	4380209	4008609	2448691	3136886	3136886	3652495	3652495	3846037	3846037	3846037	4202152	4202152	4202152
RANK					1	1	3	5	8	18	14	4	5	5	9	9	11	11	11	15	15	15

Appendix K Preliminary Load List

HUIA WTP CONCEPT DESIGN

POWER SUPPLY REQUIREMENTS -Site Option 1B

	Load Dependent	Type	No. Duty units	Fixed/VSD	Head	Flow m3/s	Unit kW	Install kW	Motor Eff	VFD/Fixed Eff	Supply KW at MLD 140	KVA at MLD 70	% time operating	Average kW	Comment
Inlet PS															
Main pumps															N/A Option 1B, gravity inflow
Sump pumps															N/A Option 1B
Building services															N/A Option 1B
Misc power															N/A Option 1B
Outlet PS															
Main pumps	y	Centrifugal	4	VSD	21	0.405	111.2	445.0	0.95	0.97	482.9	241.4	50%	222.5	Flowserve split case 400-450-425 985rpm (50% flow to Manuka)
Titirangi Pumps	y	Axial	2	VSD	5	0.810	53.0	106.0	0.95	0.97	115.0	57.5	50%	53.0	Gould AF 18inch or equivalent (50% flow to Titirangi)
Building services	n							20.0	0.95	0.97	21.7	21.7	20%	4.0	Air con for MCC, ventillation, crane, lighting
Misc power	n							10.0	0.95	0.97	10.9	10.9	10%	1.0	
DAF Tanks															
Flocculator drives	n		16	Fixed			1	16.0	0.95	1.00	16.8	16.8	100%	16.0	
DAF recirculation pumps	y	Centrifugal	12	Fixed	60	0.022	17.5	209.8	0.95	1.00	220.9	110.4	67%	140.6	
DAF air compressor	y	Screw	1	Fixed			50	50.0	0.95	1.00	52.6	26.3	40%	20.0	
Float tank pumps	y	Submersible	1	Fixed	6	0.032	2.5	2.5	0.95	1.00	2.7	1.3	50%	1.3	
Float tank mixer	n	Submersible	1	Fixed				2.0	0.95	1.00	2.1	2.1	50%	1.0	
Building services	n							10.0	0.95	1.00	10.5	10.5	20%	2.0	Air con for MCC, ventillation, crane, lighting
Misc power	n							10.0	0.95	0.97	10.9	10.9	10%	1.0	
Ozone															
O2 generators	y	VPSA	1				200	200.0	0.95	1.00	210.5	105.3	50%	100.0	Average dose say 50% of max (ie 1.6mg/L)
O3 generators	y		2				100	200.0	0.95	1.00	210.5	105.3	50%	100.0	Average dose say 50% of max (ie 1.6mg/L)
Sidestream injection pumps	y	Centrifugal	2	Fixed	30	0.018	6.9	13.7	0.95	1.00	14.5	7.2	100%	13.7	
Ozone destructor	n	Thermal	2				5.0	10.0	0.95	1.00	10.5	10.5	100%	10.0	
Building services	n							10.0	0.95	0.97	10.9	10.9	20%	2.0	Air con for MCC, ventillation, crane, lighting
Misc power	n							10.0	0.95	0.97	10.9	10.9	10%	1.0	
BAC															
Backwash pumps	n	Centrifugal	2	Fixed	10	0.482	63.1	126.2	0.95	1.00	132.8	132.8	10%	12.6	Flowserve MVE 400-400-380L 985rpm
Air scour blowers	n	Roots	1	Fixed	10	1.23	161.4	161.4	0.95	1.00	169.9	169.9	5%	8.1	Aerzen GM80
FTW return pumps	n	Submersible	2	VSD	10	0.037	4.9	9.8	0.95	0.97	10.6	10.6	50%	4.9	
Building services	n							10.0	0.95	0.97	10.9	10.9	20%	2.0	Air con for MCC, ventillation, crane, lighting
Misc power	n							10.0	0.95	0.97	10.9	10.9	10%	1.0	
Washwater thickeners															
Thickener feed pumps	y	Submersible	2	Fixed	10	0.056	7.3	14.6	0.95	1.00	15.4	7.7	50%	7.3	
Common supernatent return	y	Submersible	2	Fixed	10	0.054	7.0	14.0	0.95	1.00	14.7	7.4	50%	7.0	Includes sludge thickener supernatent
Thickener drives	y		2	Fixed				2.0	0.95	1.00	2.1	1.1	100%	2.0	
Polymer preparation	n							2.0	0.95	1.00	2.1	2.1	10%	0.2	
Polymer dosing pumps	n	PD						1.0	0.95	1.00	1.1	1.1	100%	1.0	
Sludge dewatering															
Sludge thickener feed pumps	y	PD	2	Fixed	10	0.033	4.3	8.6	0.95	1.00	9.0	4.5	50%	4.3	
Thickener drives	y		2	Fixed				2.0	0.95	1.00	2.1	1.1	100%	2.0	
Sludge press feed pumps	y	PD	2	VSD				20.0	0.95	0.97	21.7	10.9	5%	1.0	
Sludge Presses	y		2					10.0	0.95	1.00	10.5	5.3	20%	2.0	Membrane inflation, compressed air system etc
Building services	n							10.0	0.95	0.97	10.9	10.9	20%	2.0	Air con for MCC, ventillation, crane, lighting
Misc power	n							10.0	0.95	0.97	10.9	10.9	10%	1.0	
Chemical Dosing															
Polymer preparation system	n		3				5	15.0	0.95	1.00	15.8	15.8	10%	1.5	
Polymer dosing pumps	n	PD	3	VSD			0.75	2.3	0.95	0.97	2.4	2.4	100%	2.3	
Coagulant dosing pumps	n	Diaphragm	2	VSD			0.75	1.5	0.95	0.97	1.6	1.6	100%	1.5	
Lime silo and prep system	y		2				15	30.0	0.95	1.00	31.6	15.8	50%	15.0	Alternate duty
Lime dosing pumps	dc	Hose	2	VSD			0.75	1.5	0.95	0.97	1.6	1.6	100%	1.5	
Lime sidestream pumps	dc	Centrifugal	1	Fixed			3	3.0	0.95	1.00	3.2	3.2	100%	3.0	
Hypo dosing pumps	dc	Diaphragm	2	VSD			0.75	1.5	0.95	0.97	1.6	1.6	100%	1.5	
Fluoride dosing pumps	dc	Diaphragm	1	VSD			0.75	0.8	0.95	0.97	0.8	0.8	100%	0.8	

PAC preparation system	y		2				3	6.0	0.95	1.00	6.3	3.2	0%	0.0	Alternate duty
PAC sidestream pumps	y	Centrifugal	2	Fixed	60	0.002	1.6	3.1	0.95	1.00	3.3	1.7	0%	0.0	
Service water pumps	y	Centrifugal		VSD				10.0	0.95	0.97	10.9	5.4	20%	2.0	
Compressed air system	y	Screw	1	Fixed				30.0	0.95	1.00	31.6	15.8	20%	6.0	
Building services	n							10.0	0.95	0.97	10.9	10.9	20%	2.0	Air con for MCC, ventillation, crane, lighting
Misc power	n							10.0	0.95	0.97	10.9	10.9	10%	1.0	
Admin															
Building services	n							40.0	0.95	0.97	43.4	43.4	40%	16.0	Air con, lighting, workshop ventillation
Misc power	n							20.0	0.95	0.97	21.7	21.7	40%	8.0	
External site lighting	n							10.0	0.95	1.00	10.5	10.5	50%	5.0	

Max Power	2058	1324	
Max KVA	2167	1393	
Max Simult Load incl Diversity	1517	975	
Max Single Load	217	217	Only Concerned about startup

Assume

Mains will have no Problem as will install a new dedicated Vector Feeder of 5 MVA Capacity

Install power factor correction to achieve power factor of 0.95

All motors over 55 kw will be started via either soft starters or controlled with VFDS

Start Current for motors under Soft start control will be a maximum of 3.8 times the Full Load Current

Diversity Factor attempts to quantify how many loads will be simultaneously running at full load DF= 0.7

Generator size: Critierion: All loads except the largest one running - then start it Sizing according to sum of all loads less the largest then add 3.8 times the largest

Whence For Generator	2124	1583

HUIA WTP CONCEPT DESIGN

POWER SUPPLY REQUIREMENTS -Site Option 2E

	Load Dependant	Type	No. Duty units	Fixed/VSD	Head	Flow m3/s	Unit kW	Install kW	Motor Eff	VFD/Fixed Eff	Supply KW at MLD 140	KVA at MLD 70	% time operating	Average kW	Comment
Inlet PS															
Main pumps	y	Lineshaft	4	VSD	6	0.41	34.1	136.2	0.95	0.97	147.8	73.9	100%	136.2	
Sump pumps	n	Centrifugal	1	Fixed			2.0	2.0	0.95	0.97	2.2	2.2	1%	0.0	
Building services	n							10	0.95	0.97	10.9	10.9	20%	2.0	Air con for MCC, ventillation, crane, lighting
Misc power	n							10	0.95	0.97	10.9	10.9	10%	1.0	
Outlet PS															
Main pumps	y	Centrifugal	4	VSD	18	0.405	102.2	408.7	0.95	0.97	443.5	221.7	50%	204.3	Flowserve split case 400-450-425 985rpm (50% flow to Manuka)
Titirangi Pumps	y								0.95	0.97	0.0	0.0			N/A Option 2E, gravity supply
Building services	n							20.0	0.95	0.97	21.7	21.7	20%	4.0	Air con for MCC, ventillation, crane, lighting
Misc power	n							10.0	0.95	0.97	10.9	10.9	10%	1.0	
DAF Tanks															
Flocculator drives	n		16	Fixed			1	16.0	0.95	1.00	16.8	16.8	100%	16.0	
DAF recirculation pumps	y	Centrifugal	12	Fixed	60	0.022	18.7	224.8	0.95	1.00	236.6	118.3	67%	150.6	
DAF air compressor	y	Screw	1	Fixed			50	50.0	0.95	1.00	52.6	26.3	40%	20.0	
Float tank pumps	y	Submersible	1	Fixed	6	0.032	2.7	2.7	0.95	1.00	2.9	1.4	50%	1.4	
Float tank mixer	n	Submersible	1	Fixed				2.0	0.95	1.00	2.1	2.1	50%	1.0	
Building services	n							10.0	0.95	1.00	10.5	10.5	20%	2.0	Air con for MCC, ventillation, crane, lighting
Misc power	n							10.0	0.95	0.97	10.9	10.9	10%	1.0	
Ozone															
O2 generators	y	VPSA	1				200	200.0	0.95	1.00	210.5	105.3	50%	100.0	Average dose say 50% of max (ie 1.6mg/L)
O3 generators	y		2				100	200.0	0.95	1.00	210.5	105.3	50%	100.0	Average dose say 50% of max (ie 1.6mg/L)
Sidestream injection pumps	y	Centrifugal	2	Fixed	30	0.018	7.4	14.7	0.95	1.00	15.5	7.7	100%	14.7	
Ozone destructor	n	Thermal	2				5.0	10.0	0.95	1.00	10.5	10.5	100%	10.0	
Building services	n							10.0	0.95	0.97	10.9	10.9	20%	2.0	Air con for MCC, ventillation, crane, lighting
Misc power	n							10.0	0.95	0.97	10.9	10.9	10%	1.0	
BAC															
Backwash pumps	n	Centrifugal	2	Fixed	10	0.482	67.6	135.2	0.95	1.00	142.3	142.3	10%	13.5	Flowserve MVE 400-400-380L 985rpm
Air scour blowers	n	Roots	1	Fixed	10	1.23	160	160.0	0.95	1.00	168.4	168.4	5%	8.0	Aerzen GM80
FTW return pumps	n	Submersible	2	VSD	10	0.037	5.2	10.5	0.95	0.97	11.3	11.3	50%	5.2	
Building services	n							10.0	0.95	0.97	10.9	10.9	20%	2.0	Air con for MCC, ventillation, crane, lighting
Misc power	n							10.0	0.95	0.97	10.9	10.9	10%	1.0	
Washwater thickeners															
Thickener feed pumps	y	Submersible	2	Fixed	10	0.056	7.8	15.7	0.95	1.00	16.5	8.3	50%	7.8	
Common supernatent return	y	Submersible	2	Fixed	10	0.054	7.5	15.0	0.95	1.00	15.8	7.9	50%	7.5	Includes sludge thickener supernatent
Thickener drives	y		2	Fixed				2.0	0.95	1.00	2.1	1.1	100%	2.0	
Polymer preparation	n							2.0	0.95	1.00	2.1	2.1	10%	0.2	
Polymer dosing pumps	n	PD						1.0	0.95	1.00	1.1	1.1	100%	1.0	
Sludge dewatering															
Sludge thickener feed pumps	y	PD	2	Fixed	10	0.033	4.6	9.2	0.95	1.00	9.6	4.8	50%	4.6	
Thickener drives	y		2	Fixed				2.0	0.95	1.00	2.1	1.1	100%	2.0	
Sludge press feed pumps	y	PD	2	VSD				20.0	0.95	0.97	21.7	10.9	5%	1.0	
Sludge Presses	y		2					10.0	0.95	1.00	10.5	5.3	20%	2.0	Membrane inflation, compressed air system etc
Building services	n							10.0	0.95	0.97	10.9	10.9	20%	2.0	Air con for MCC, ventillation, crane, lighting
Misc power	n							10.0	0.95	0.97	10.9	10.9	10%	1.0	
Chemical Dosing															
Polymer preparation system	n		3				5	15.0	0.95	1.00	15.8	15.8	10%	1.5	
Polymer dosing pumps	n	PD	3	VSD			0.75	2.3	0.95	0.97	2.4	2.4	100%	2.3	
Coagulant dosing pumps	n	Diaphragm	2	VSD			0.75	1.5	0.95	0.97	1.6	1.6	100%	1.5	
Lime silo and prep system	y		2				15	30.0	0.95	1.00	31.6	15.8	50%	15.0	Alternate duty
Lime dosing pumps	dc	Hose	2	VSD			0.75	1.5	0.95	0.97	1.6	1.6	100%	1.5	
Lime sidestream pumps	dc	Centrifugal	1	Fixed			3	3.0	0.95	1.00	3.2	3.2	100%	3.0	
Hypo dosing pumps	dc	Diaphragm	2	VSD			0.75	1.5	0.95	0.97	1.6	1.6	100%	1.5	
Fluoride dosing pumps	dc	Diaphragm	1	VSD			0.75	0.8	0.95	0.97	0.8	0.8	100%	0.8	

PAC preparation system	y		2				3	6.0	0.95	1.00	6.3	3.2	0%	0.0	Alternate duty
PAC sidestream pumps	y	Centrifugal	2	Fixed	60	0.002	1.7	3.4	0.95	1.00	3.5	1.8	0%	0.0	
Service water pumps	y	Centrifugal		VSD				10.0	0.95	0.97	10.9	5.4	20%	2.0	
Compressed air system	y	Screw	1	Fixed				30.0	0.95	1.00	31.6	15.8	20%	6.0	
Building services	n							10.0	0.95	0.97	10.9	10.9	20%	2.0	Air con for MCC, ventillation, crane, lighting
Misc power	n							10.0	0.95	0.97	10.9	10.9	10%	1.0	
Admin															
Building services	n							40.0	0.95	0.97	43.4	43.4	40%	16.0	Air con, lighting, workshop ventillation
Misc power	n							20.0	0.95	0.97	21.7	21.7	40%	8.0	
External site lighting	n							10.0	0.95	1.00	10.5	10.5	50%	5.0	
							Max Power				2104	1363			
							Max KVA				2215	1435			
							Max Simult Load incl Diversity				1551	1004			
							Max Single Load				217	217	Only Concerned about startup		

Assume

Mains will have no Problem as will install a new dedicated Vector Feeder of 5 MVA Capacity

Install power factor correction to achieve power factor of 0.95

All motors over 55 kw will be started via either soft starters or controlled with VFDS

Start Current for motors under Soft start control will be a maximum of 3.8 times the Full Load Current

Diversity Factor attempts to quantify how many loads will be simultaneously running at full load DF= 0.7

Generator size: Critierion: All loads except the largest one running - then start it Sizing according to sum of all loads less the largest then add 3.8 times the largest

Whence For Generator	2158	1612

HUIA WTP CONCEPT DESIGN

POWER SUPPLY REQUIREMENTS -Site Option 5D (128mRL Service Reservoir)

	Load Dependant	Type	No. Duty units	Fixed/VSD	Head	Flow m3/s	Unit kW	Install kW	Motor Eff	VFD/Fixed Eff	Supply KW at ML/day 140	KVA at ML/day 70	% time operating	Average kW	Comment
Inlet PS															
Main pumps	y	Lineshaft	4	VSD	21.5	0.41	122.0	488.1	0.95	0.97	529.7	264.8	100%	488.1	
Sump pumps	n	Centrifugal	1	Fixed			2	2.0	0.95	0.97	2.2	2.2	1%	0.0	
Building services	n							10	0.95	0.97	10.9	10.9	20%	2.0	Air con for MCC, ventillation, crane, lighting
Misc power	n							10	0.95	0.97	10.9	10.9	10%	1.0	
Outlet PS															
Main pumps															N/A Option 5, gravity supply
Titirangi Pumps															N/A Option 5, gravity supply
Building services															N/A Option 5
Misc power															N/A Option 5
DAF Tanks															
Flocculator drives	n		16	Fixed			1	16.0	0.95	1.00	16.8	16.8	100%	16.0	
DAF recirculation pumps	y	Centrifugal	12	Fixed	60	0.022	18.7	224.8	0.95	1.00	236.6	118.3	67%	150.6	
DAF air compressor	y	Screw	1	Fixed			50	50.0	0.95	1.00	52.6	26.3	40%	20.0	
Float tank pumps	y	Submersible	1	Fixed	6	0.032	2.7	2.7	0.95	1.00	2.9	1.4	50%	1.4	
Float tank mixer	n	Submersible	1	Fixed				2.0	0.95	1.00	2.1	2.1	50%	1.0	
Building services	n							10.0	0.95	1.00	10.5	10.5	20%	2.0	Air con for MCC, ventillation, crane, lighting
Misc power	n							10.0	0.95	0.97	10.9	10.9	10%	1.0	
Ozone															
O2 generators	y	VPSA	1				200	200.0	0.95	1.00	210.5	105.3	50%	100.0	Average dose say 50% of max (ie 1.6mg/L)
O3 generators	y		2				100	200.0	0.95	1.00	210.5	105.3	50%	100.0	Average dose say 50% of max (ie 1.6mg/L)
Sidestream injection pumps	y	Centrifugal	2	Fixed	30	0.018	7.4	14.7	0.95	1.00	15.5	7.7	100%	14.7	
Ozone destructor	n	Thermal	2				5.0	10.0	0.95	1.00	10.5	10.5	100%	10.0	
Building services	n							10.0	0.95	0.97	10.9	10.9	20%	2.0	Air con for MCC, ventillation, crane, lighting
Misc power	n							10.0	0.95	0.97	10.9	10.9	10%	1.0	
BAC															
Backwash pumps	n	Centrifugal	2	Fixed	10	0.482	67.6	135.2	0.95	1.00	142.3	142.3	10%	13.5	Flowserve MVE 400-400-380L 985rpm
Air scour blowers	n	Roots	1	Fixed	10	1.23	160	160.0	0.95	1.00	168.4	168.4	5%	8.0	Aerzen GM80
FTW return pumps	n	Submersible	2	VSD	10	0.037	5.2	10.5	0.95	0.97	11.3	11.3	50%	5.2	
Building services	n							10.0	0.95	0.97	10.9	10.9	20%	2.0	Air con for MCC, ventillation, crane, lighting
Misc power	n							10.0	0.95	0.97	10.9	10.9	10%	1.0	
Washwater thickeners															
Thickener feed pumps	y	Submersible	2	Fixed	10	0.056	7.8	15.7	0.95	1.00	16.5	8.3	50%	7.8	
Common supernatent return	y	Submersible	2	Fixed	10	0.054	7.5	15.0	0.95	1.00	15.8	7.9	50%	7.5	Includes sludge thickener supernatent
Thickener drives	y		2	Fixed				2.0	0.95	1.00	2.1	1.1	100%	2.0	
Polymer preparation	n							2.0	0.95	1.00	2.1	2.1	10%	0.2	
Polymer dosing pumps	n	PD						1.0	0.95	1.00	1.1	1.1	100%	1.0	
Sludge dewatering															
Sludge thickener feed pumps	y	PD	2	Fixed	10	0.033	4.6	9.2	0.95	1.00	9.6	4.8	50%	4.6	
Thickener drives	y		2	Fixed				2.0	0.95	1.00	2.1	1.1	100%	2.0	
Sludge press feed pumps	y	PD	2	VSD				20.0	0.95	0.97	21.7	10.9	5%	1.0	
Sludge Presses	y		2					10.0	0.95	1.00	10.5	5.3	20%	2.0	Membrane inflation, compressed air system etc
Building services	n							10.0	0.95	0.97	10.9	10.9	20%	2.0	Air con for MCC, ventillation, crane, lighting
Misc power	n							10.0	0.95	0.97	10.9	10.9	10%	1.0	
Chemical Dosing															
Polymer preparation system	n		3				5	15.0	0.95	1.00	15.8	15.8	10%	1.5	
Polymer dosing pumps	n	PD	3	VSD			0.75	2.3	0.95	0.97	2.4	2.4	100%	2.3	
Coagulant dosing pumps	n	Diaphragm	2	VSD			0.75	1.5	0.95	0.97	1.6	1.6	100%	1.5	
Lime silo and prep system	y		2				15	30.0	0.95	1.00	31.6	15.8	50%	15.0	Alternate duty
Lime dosing pumps	dc	Hose	2	VSD			0.75	1.5	0.95	0.97	1.6	1.6	100%	1.5	
Lime sidestream pumps	dc	Centrifugal	1	Fixed			3	3.0	0.95	1.00	3.2	3.2	100%	3.0	
Hypo dosing pumps	dc	Diaphragm	2	VSD			0.75	1.5	0.95	0.97	1.6	1.6	100%	1.5	

Fluoride dosing pumps	dc	Diaphragm	1	VSD			0.75	0.8	0.95	0.97	0.8	0.8	100%	0.8	
PAC preparation system	y		2				3	6.0	0.95	1.00	6.3	3.2	0%	0.0	Alternate duty
PAC sidestream pumps	y	Centrifugal	2	Fixed	60	0.002	1.7	3.4	0.95	1.00	3.5	1.8	0%	0.0	
Service water pumps	y	Centrifugal		VSD				10.0	0.95	0.97	10.9	5.4	20%	2.0	
Compressed air system	y	Screw	1	Fixed				30.0	0.95	1.00	31.6	15.8	20%	6.0	
Building services	n							10.0	0.95	0.97	10.9	10.9	20%	2.0	Air con for MCC, ventillation, crane, lighting
Misc power	n							10.0	0.95	0.97	10.9	10.9	10%	1.0	
Admin															
Building services	n							40.0	0.95	0.97	43.4	43.4	40%	16.0	Air con, lighting, workshop ventillation
Misc power	n							20.0	0.95	0.97	21.7	21.7	40%	8.0	
External site lighting	n							10.0	0.95	1.00	10.5	10.5	50%	5.0	
								Max Power			2010	1300			
								Max KVA			2116	1368			
								Max Simult Load incl Diversity			1481	958			
								Max Single Load			217	217	Only Concerned about startup		

Assume

Mains will have no Problem as will install a new dedicated Vector Feeder of 5 MVA Capacity

Install power factor correction to achieve power factor of 0.95

All motors over 55 kw will be started via either soft starters or controlled with VFDS

Start Current for motors under Soft start control will be a maximum of 3.8 times the Full Load Current

Diversity Factor attempts to quantify how many loads will be simultaneously running at full load DF= 0.7

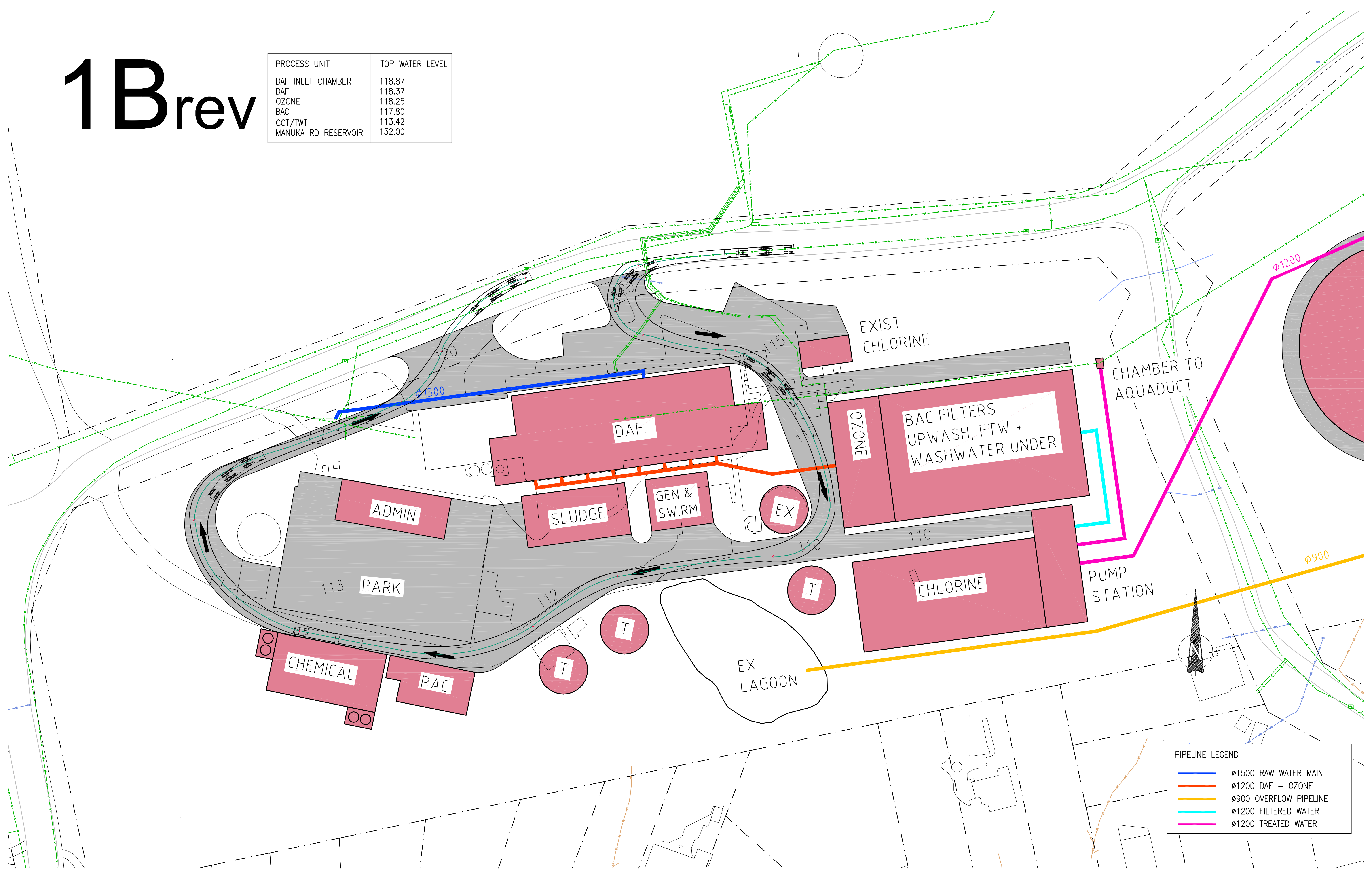
Generator size: Critierion: All loads except the largest one running - then start it Sizing according to sum of all loads less the largest then add 3.8 times the largest

Whence For Generator 2089 1565

Appendix L Shortlisted Options Layouts

1Brev

PROCESS UNIT	TOP WATER LEVEL
DAF INLET CHAMBER	118.87
DAF	118.37
OZONE	118.25
BAC	117.80
CCT/TWT	113.42
MANUKA RD RESERVOIR	132.00



PIPELINE LEGEND

Blue	ø1500 RAW WATER MAIN
Red	ø1200 DAF – OZONE
Orange	ø900 OVERFLOW PIPELINE
Cyan	ø1200 FILTERED WATER
Magenta	ø1200 TREATED WATER

ISSUE	DATE	AMENDMENT	BY	APPD.

	BY	DATE
DESIGNED	C POVEY	01/13
DES. CHECKED		
DRAWN	R MULLIGAN	01/13
DWG. CHECKED		
PROJECT LEADER		
INFRAST'R APP'D		

WSL TO SIGN

WSL TO SIGN

water Care services limited

MWH.

HUIA WTP IMPLEMENTATION STRATEGY

SITE LAYOUT PLAN – OPTION 1B rev.

DRAFT

CAD FILE 80501084-01-001-G014 DATE

ORIGINAL SCALE A1 1 : 500

CONTRACT No.

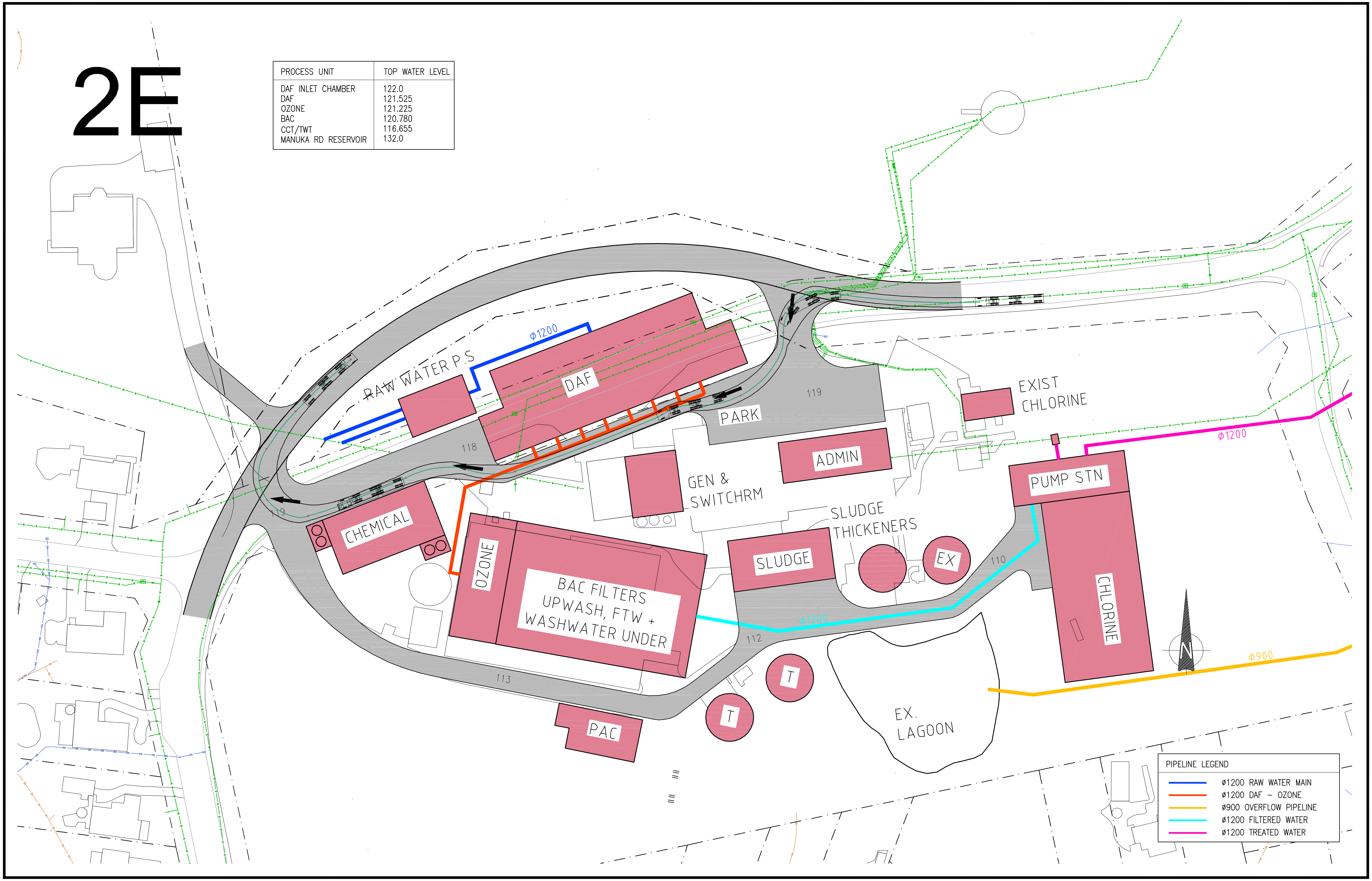
REF. No. 80501084-01-001-G014

ISSUE A

DWG. No.

2E

PROCESS UNIT	TOP WATER LEVEL
DAF INLET CHAMBER	122.0
DAF	121.525
OZONE	121.225
BAC	120.780
CCT/TWT	116.655
MANUKA RD RESERVOIR	132.0



ISSUE	DATE	AMENDMENT	BY	APPD.

DESIGNED	C POVEY	12/12	WSL TO SIGN
DES. CHECKED			
DRAWN	G MURRAY	12/12	WSL TO SIGN
DWG. CHECKED			
PROJECT LEADER			
INFRAST'R APP'D	BY	DATE	

water Care services limited

MWH.

HUIA WTP IMPLEMENTATION STRATEGY

SITE LAYOUT PLAN – OPTION 2E

DRAFT

CAD FILE 80501084-01-001-G025E

ORIGINAL SCALE A1 1 : 500

CONTRACT No.

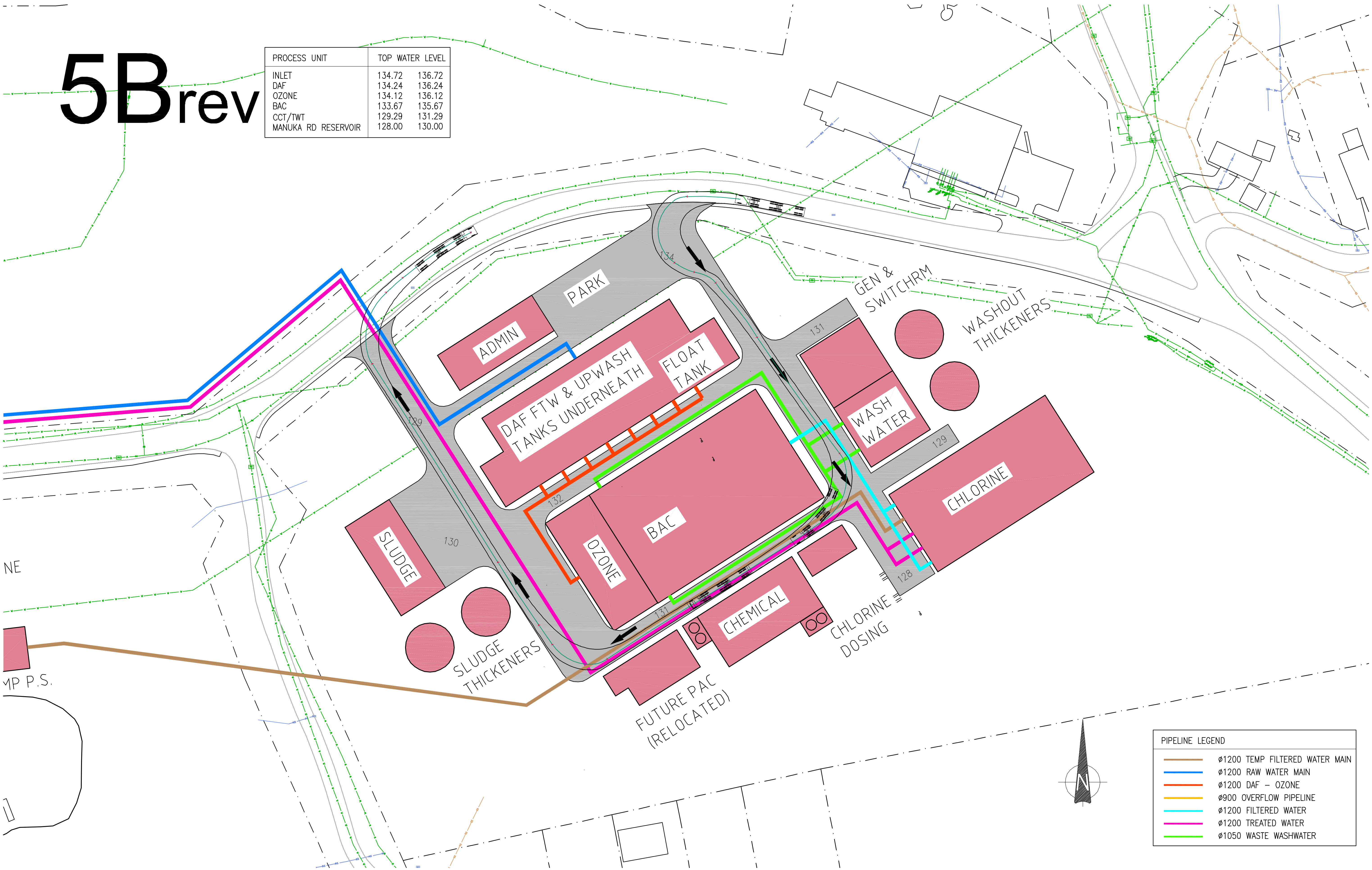
REF. No. 80501084-01-001-G025

ISSUE F

DWG. No.

5Brev

PROCESS UNIT	TOP WATER LEVEL	
INLET	134.72	136.72
DAF	134.24	136.24
OZONE	134.12	136.12
BAC	133.67	135.67
CCT/TWT	129.29	131.29
MANUKA RD RESERVOIR	128.00	130.00



PIPELINE LEGEND

- ø1200 TEMP FILTERED WATER MAIN
- ø1200 RAW WATER MAIN
- ø1200 DAF – OZONE
- ø900 OVERFLOW PIPELINE
- ø1200 FILTERED WATER
- ø1200 TREATED WATER
- ø1050 WASTE WASHWATER

ISSUE	DATE	AMENDMENT	BY	APPD.

	BY	DATE
DESIGNED	C POVEY	12/12
DES. CHECKED		
DRAWN	G MURRAY	12/12
DWG. CHECKED		
PROJECT LEADER		
INFRAST'R APP'D		

WSL TO SIGN

WSL TO SIGN

water Care services limited

MWH.

HUIA WTP IMPLEMENTATION STRATEGY

SITE LAYOUT PLAN – OPTION 5B rev.

DRAFT

CAD FILE 80501084-01-001-G054 DATE

ORIGINAL SCALE A1 1 : 1,000

CONTRACT No.

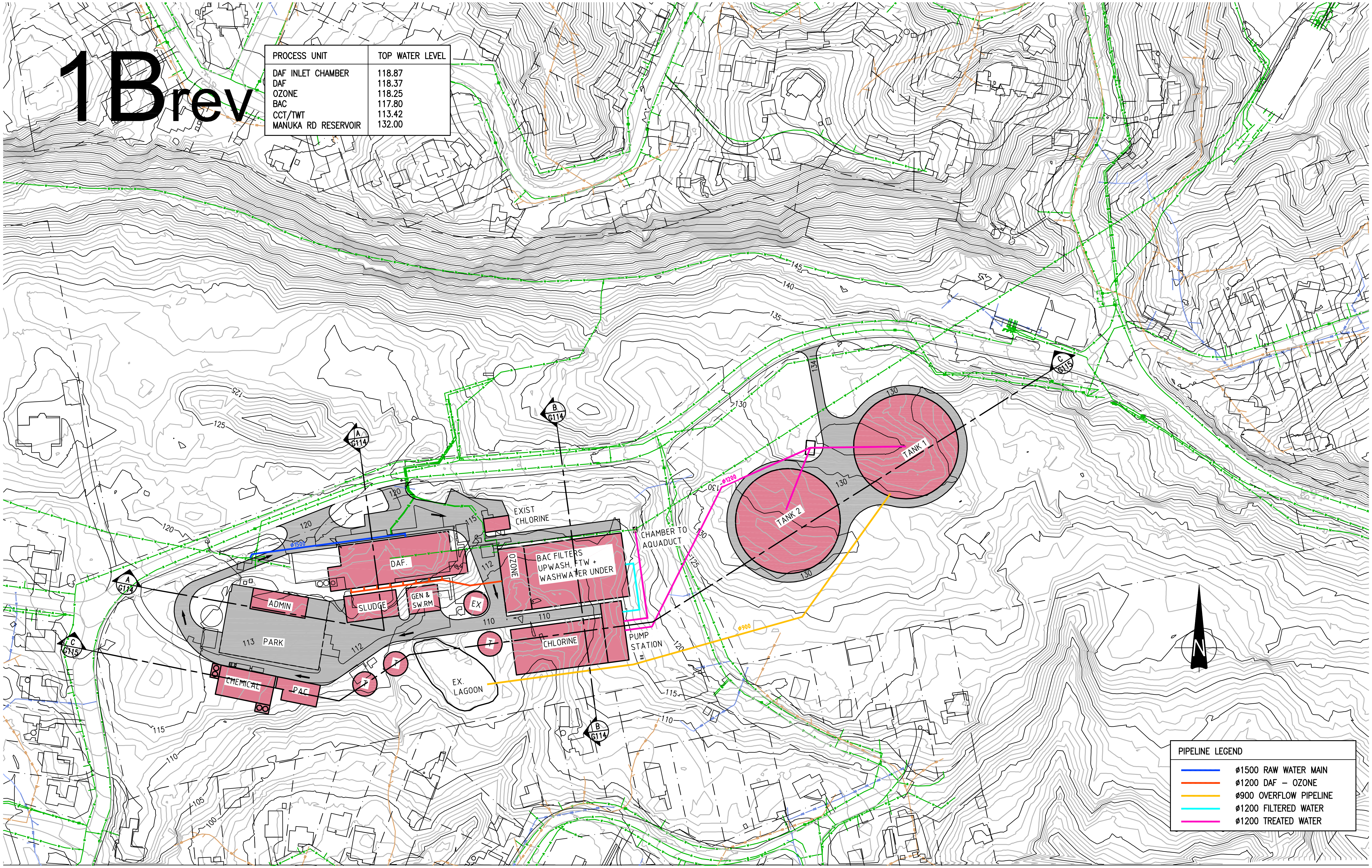
REF. No. 80501084-01-001-G054

ISSUE D

DWG. No.

1Brev

PROCESS UNIT	TOP WATER LEVEL
DAF INLET CHAMBER	118.87
DAF	118.37
OZONE	118.25
BAC	117.80
CCT/TWT	113.42
MANUKA RD RESERVOIR	132.00



ISSUE	DATE	AMENDMENT	BY	APPD.			
					DESIGNED	C POVEY	01/13
					DES. CHECKED		
					DRAWN	R MULLIGAN	01/13
					DWG. CHECKED		
					PROJECT LEADER		
					INFRAST'R APP'D	BY	DATE

WSL TO SIGN

WSL TO SIGN

water Care services limited

MWH.

HUIA WTP IMPLEMENTATION STRATEGY

SITE LAYOUT PLAN – OPTION 1B rev.

DRAFT

CAD FILE 80501084-01-001-G014

ORIGINAL SCALE A1 1 : 1,000

CONTRACT No.

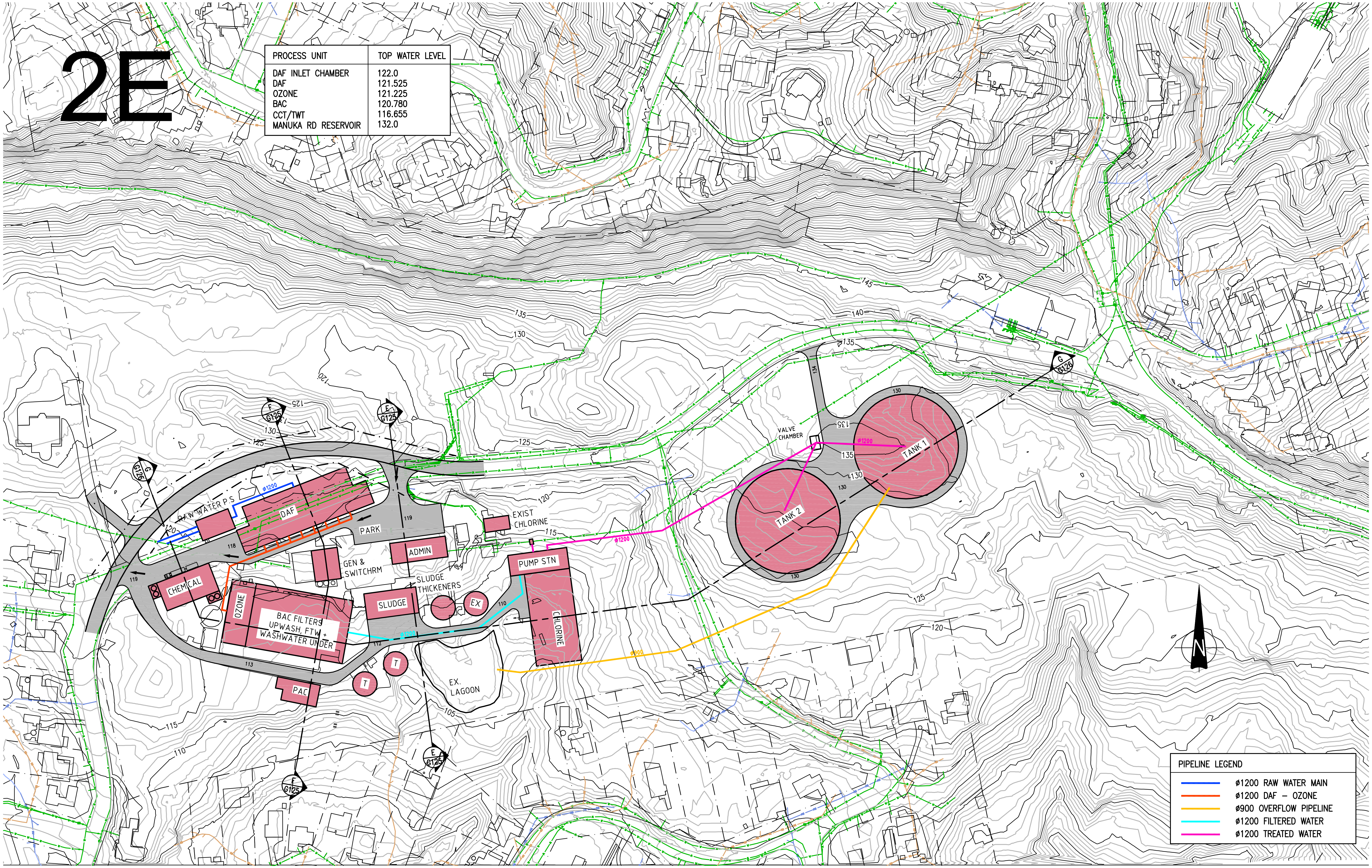
REF. No. 80501084-01-001-G014

ISSUE A

DWG. No.

2E

PROCESS UNIT	TOP WATER LEVEL
DAF INLET CHAMBER	122.0
DAF	121.525
OZONE	121.225
BAC	120.780
CCT/TWT	116.655
MANUKA RD RESERVOIR	132.0



PIPELINE LEGEND

- ø1200 RAW WATER MAIN
- ø1200 DAF – OZONE
- ø900 OVERFLOW PIPELINE
- ø1200 FILTERED WATER
- ø1200 TREATED WATER

ISSUE	DATE	AMENDMENT	BY	APPD.		BY	DATE
					DESIGNED	C POVEY	12/12
					DES. CHECKED		
					DRAWN	G MURRAY	12/12
					DWG. CHECKED		
					PROJECT LEADER		
					INFRAST'R APP'D		

WSL TO SIGN

WSL TO SIGN

watercare services limited

MWH

HUIA WTP IMPLEMENTATION STRATEGY

SITE LAYOUT PLAN – OPTION 2E

DRAFT

CAD FILE 80501084-01-001-G025

ORIGINAL SCALE A1 1 : 1,000

CONTRACT No.

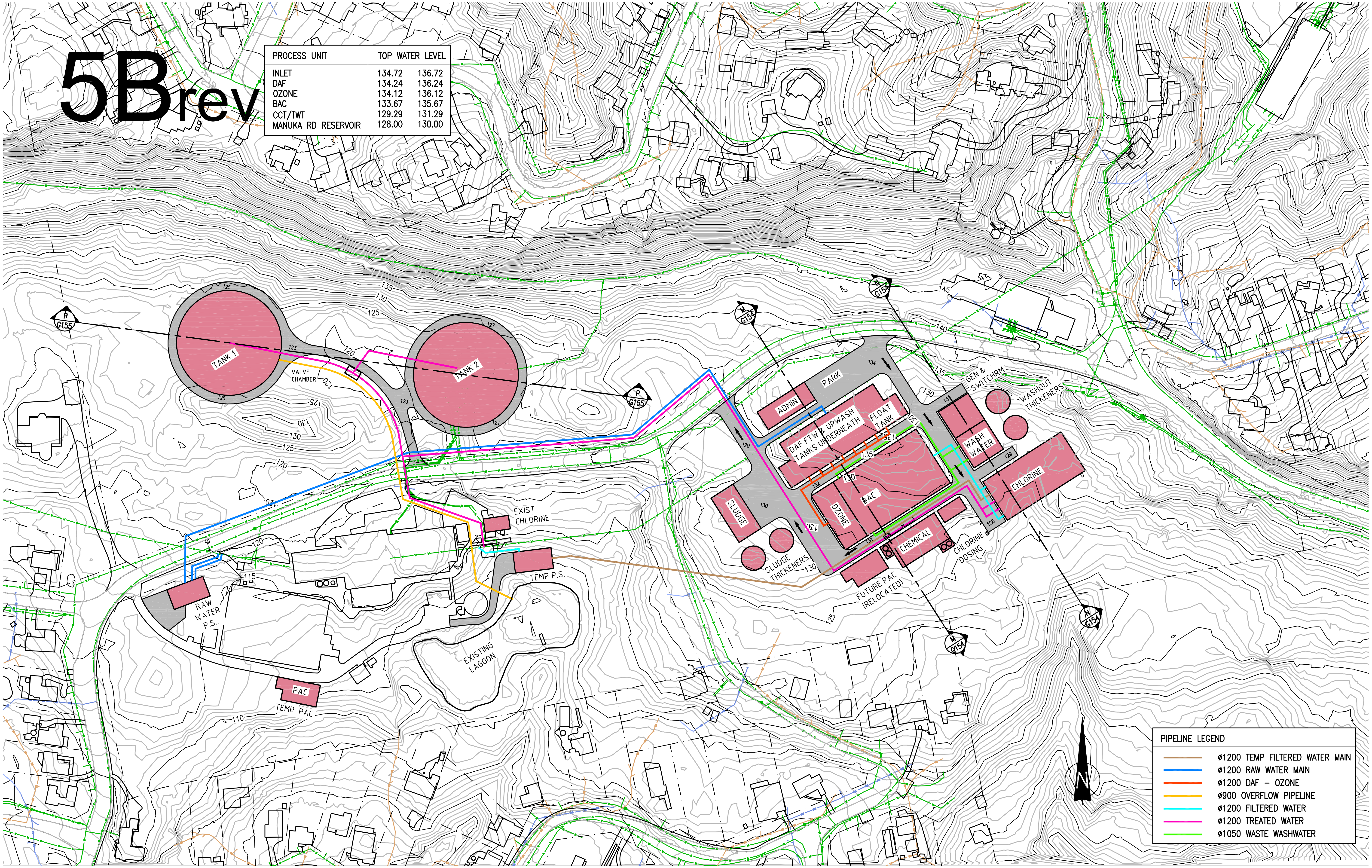
REF. No. 80501084-01-001-G025

ISSUE F

DWG. No.

5Brev

PROCESS UNIT	TOP WATER LEVEL	
INLET	134.72	136.72
DAF	134.24	136.24
OZONE	134.12	136.12
BAC	133.67	135.67
CCT/TWT	129.29	131.29
MANUKA RD RESERVOIR	128.00	130.00



PIPELINE LEGEND

- ø1200 TEMP FILTERED WATER MAIN
- ø1200 RAW WATER MAIN
- ø1200 DAF – OZONE
- ø900 OVERFLOW PIPELINE
- ø1200 FILTERED WATER
- ø1200 TREATED WATER
- ø1050 WASTE WASHWATER

ISSUE	DATE	AMENDMENT	BY	APPD.

	BY	DATE
DESIGNED	C POVEY	12/12
DES. CHECKED		
DRAWN	G MURRAY	12/12
DWG. CHECKED		
PROJECT LEADER		
INFRAST'R APP'D		

WSL TO SIGN

WSL TO SIGN

water Care services limited

MWH.

HUIA WTP IMPLEMENTATION STRATEGY

SITE LAYOUT PLAN – OPTION 5B rev.

DRAFT

CAD FILE 80501084-01-001-G054

ORIGINAL SCALE A1 1 : 1,000

CONTRACT No.

REF. No. 80501084-01-001-G054

ISSUE D

DWG. No.

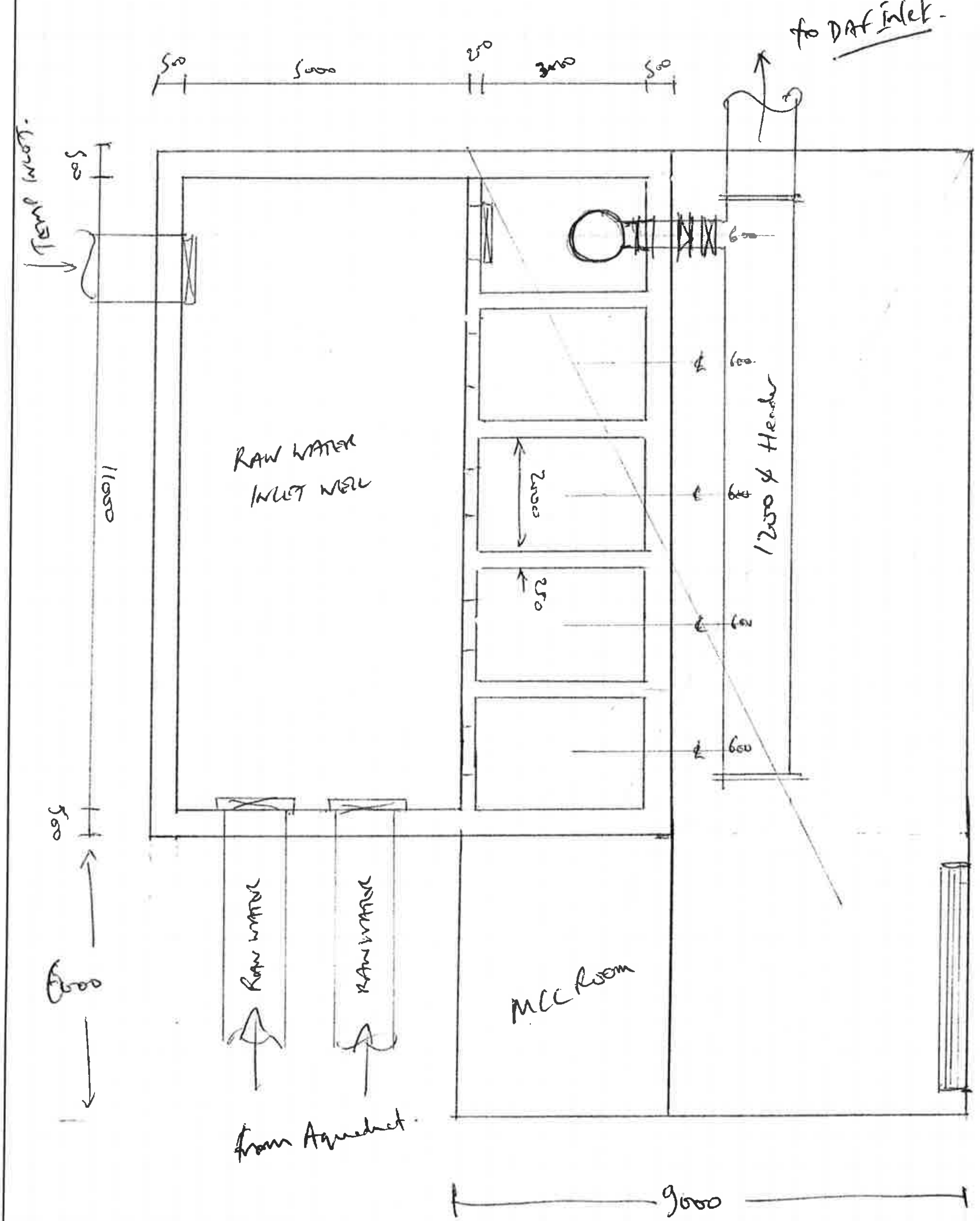
Appendix M Unit Process Drawings

MWH

MWH Australia Pty Ltd
ABN 17 007 820 322

PROJECT Haia WTP	PROJECT No.
DESCRIPTION Raw Water P.S	
PREPARED BY	DATE
CHECKED BY	DATE

PAGE .... OF ....

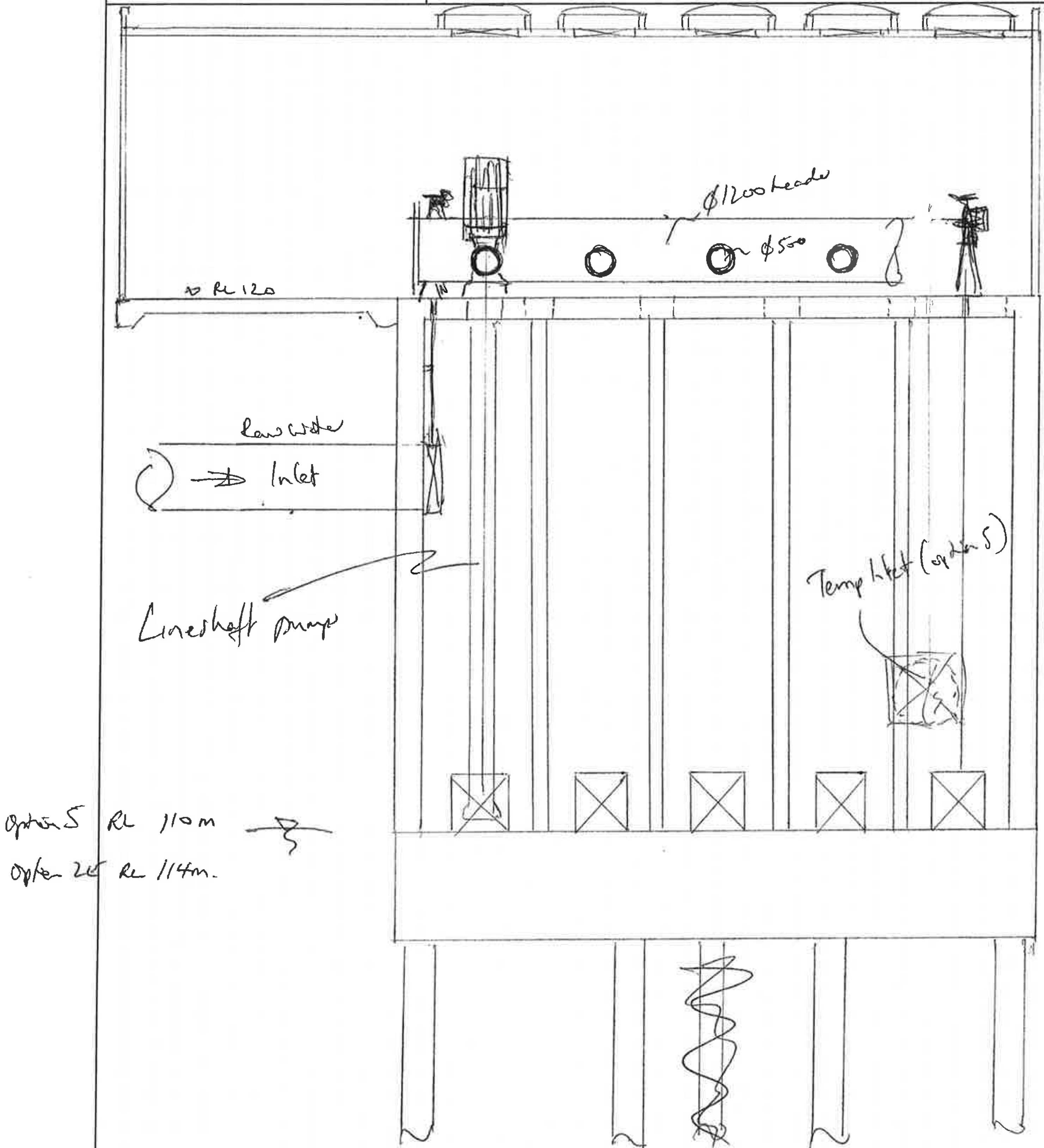


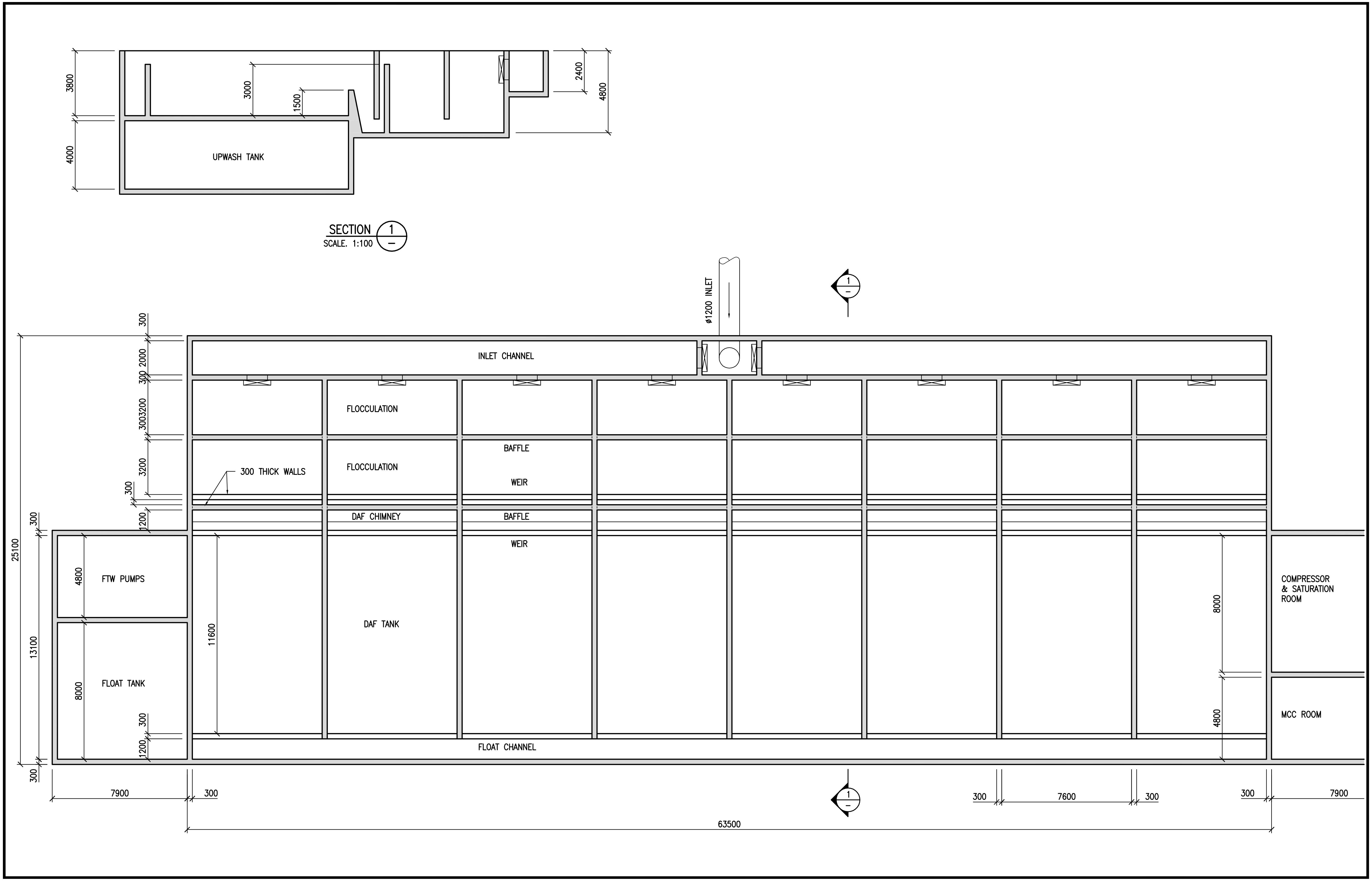
Pumpstation arrangement for line shaft pumps. (Options – well 10m deep total)

MWH

MWH Australia Pty Ltd
ABN 17 007 820 322

PROJECT: HVIA WTP	PROJECT No.
DESCRIPTION: RAW WATER P.S	
PREPARED BY	DATE
PAGE .... OF .... CHECKED BY	DATE





				DESIGNED	C POVEY	11/12	WSL TO SIGN OPERATIONS
				DES. CHECKED			
				DRAWN	G MURRAY	11/12	
				DWG. CHECKED			WSL TO SIGN INFRASTRUCTURE
				PROJECT LEADER			
				INFRAST'R APP'D			
ISSUE	DATE	AMENDMENT	BY	APPD.	BY	DATE	

water Care services limited

MWH.

HUIA WTP IMPLEMENTATION STRATEGY

DAF TANK PLAN – UPPER LEVEL

DRAFT

CAD FILE 80501084-01-001-G070E

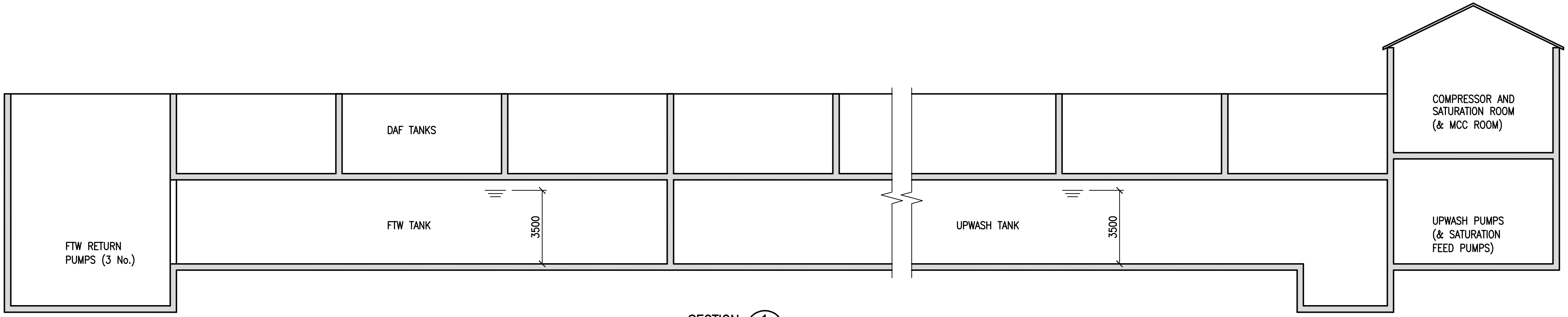
ORIGINAL SCALE A1 AS SHOWN

CONTRACT No.

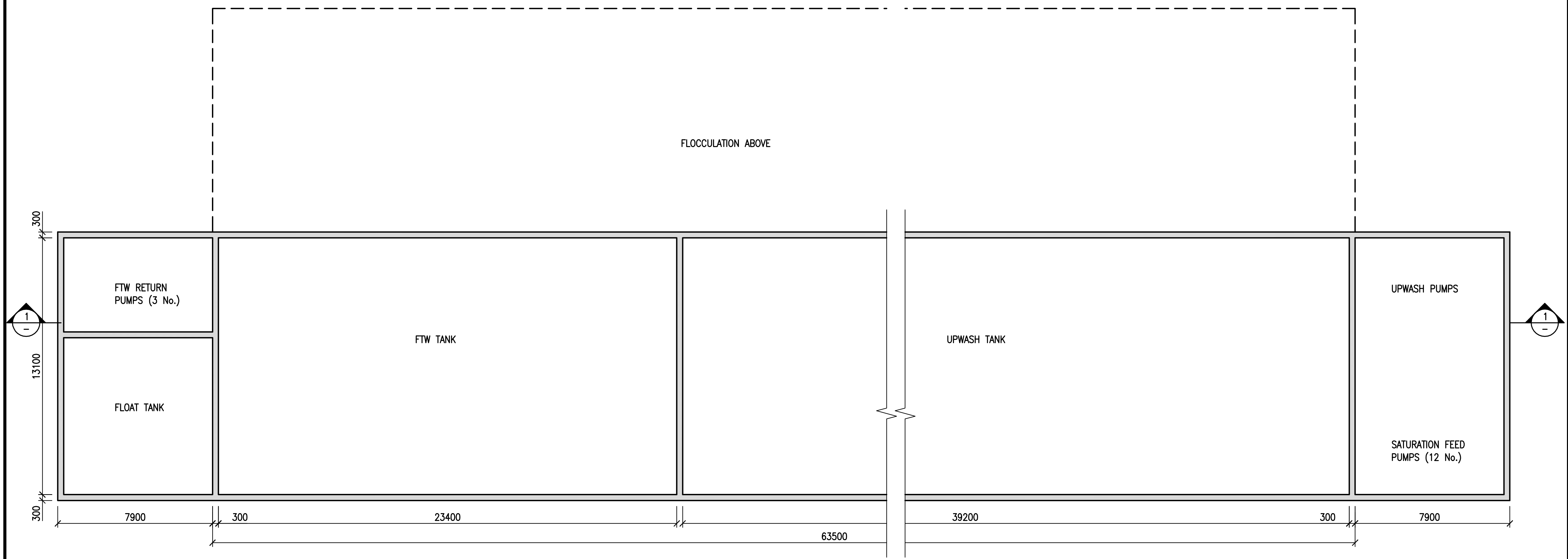
REF. No. 80501084-01-001-G070

ISSUE A

DWG. No.



SECTION 1
SCALE. 1:100



ISSUE	DATE	AMENDMENT	BY	APPD.

	BY	DATE
DESIGNED	C POVEY	11/12
DES. CHECKED		
DRAWN	G MURRAY	11/12
DWG. CHECKED		
PROJECT LEADER		
INFRAST'R APP'D		

WSL TO SIGN
OPERATIONS
WSL TO SIGN
INFRASTRUCTURE

watercare services limited

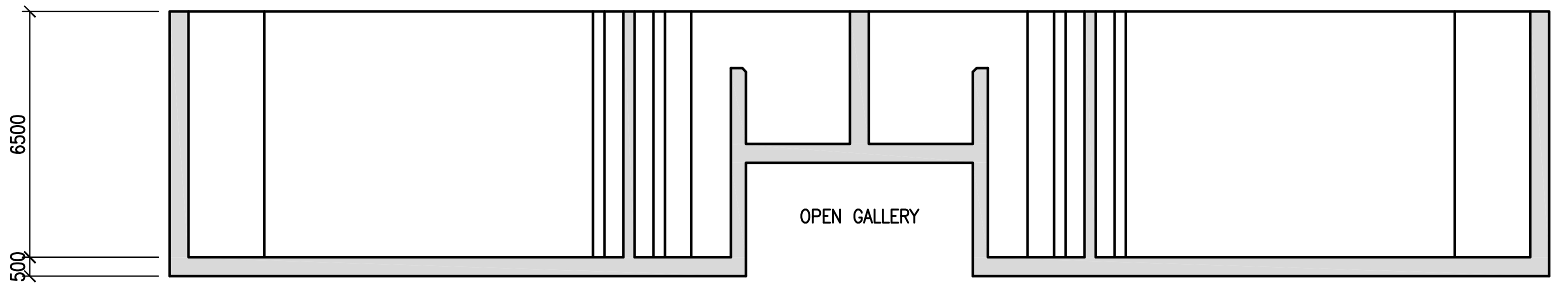
MWH.

HUIA WTP IMPLEMENTATION STRATEGY

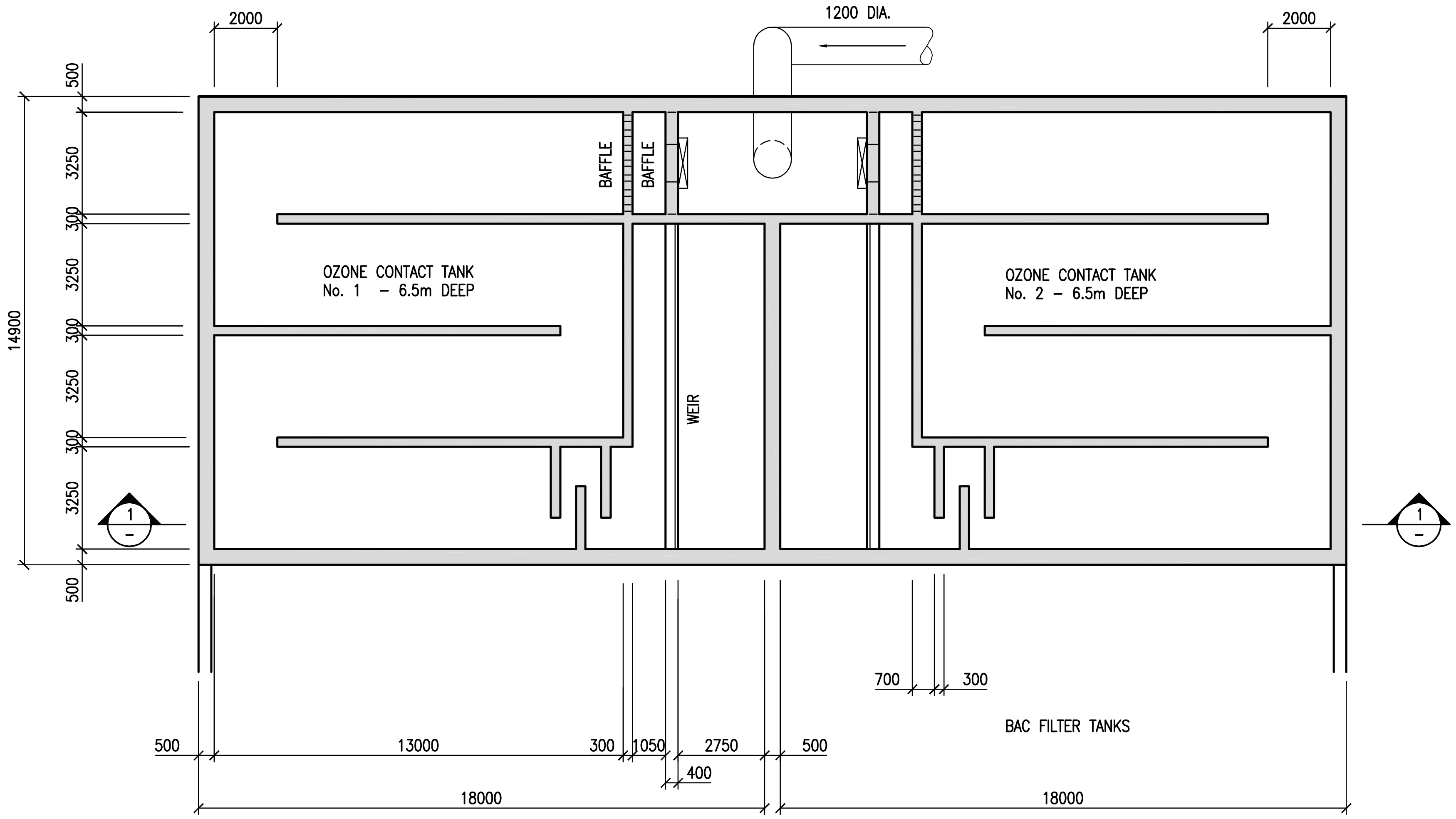
DAF TANK PLAN – LOWER LEVEL

DRAFT

CAD FILE 80501084-01-001-G071 DATE
ORIGINAL SCALE A1 1 : 100
CONTRACT No.
REF. No. 80501084-01-001-G071
ISSUE B
DWG. No.



SECTION 1 / –
SCALE. 1:100



					DESIGNED	C POVEY	11/12	WSL TO SIGN	
					DES. CHECKED			OPERATIONS	
					DRAWN	G MURRAY	11/12		
					DWG. CHECKED			WSL TO SIGN	
					PROJECT LEADER				
					INFRAST'R APP'D			INFRASTRUCTURE	
ISSUE	DATE	AMENDMENT	BY	APPD.		BY	DATE		

watercare services limited

MWH.

HUIA WTP IMPLEMENTATION STRATEGY

OZONE CONTACT TANK PLAN

CAD FILE 80501084-01-001-G072

DATE

ORIGINAL SCALE A1 1 : 100

CONTRACT No.

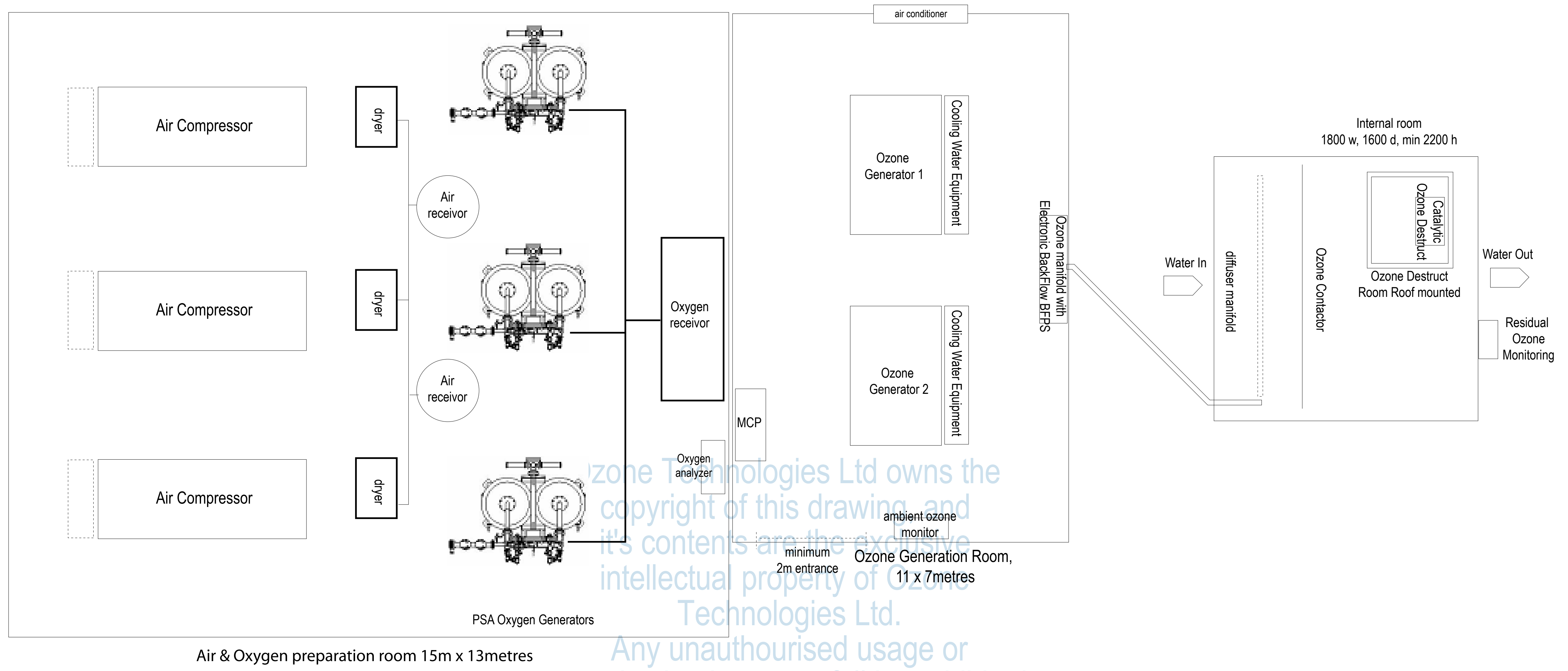
REF. No. 80501084-01-001-G072

ISSUE B

DWG. No.

ozone technologies ltd
22b Turner Place, PO Box 655, Napier
New Zealand
Ph: +64 6 843 2881
Fax: +64 6 843 2441
info@ozonenz.com

Ozone Plant Room Dimensioning Full redundancy Ozone Generators 3 models CFV 10, 15 or 20



Dwg Name	MWH 10-15-20 plant layout redundancy.ai
Design:	D Haselhoff
Date:	28.5.10
Dwg No.	
Scale:	NA

DO NOT SCALE

Approved:

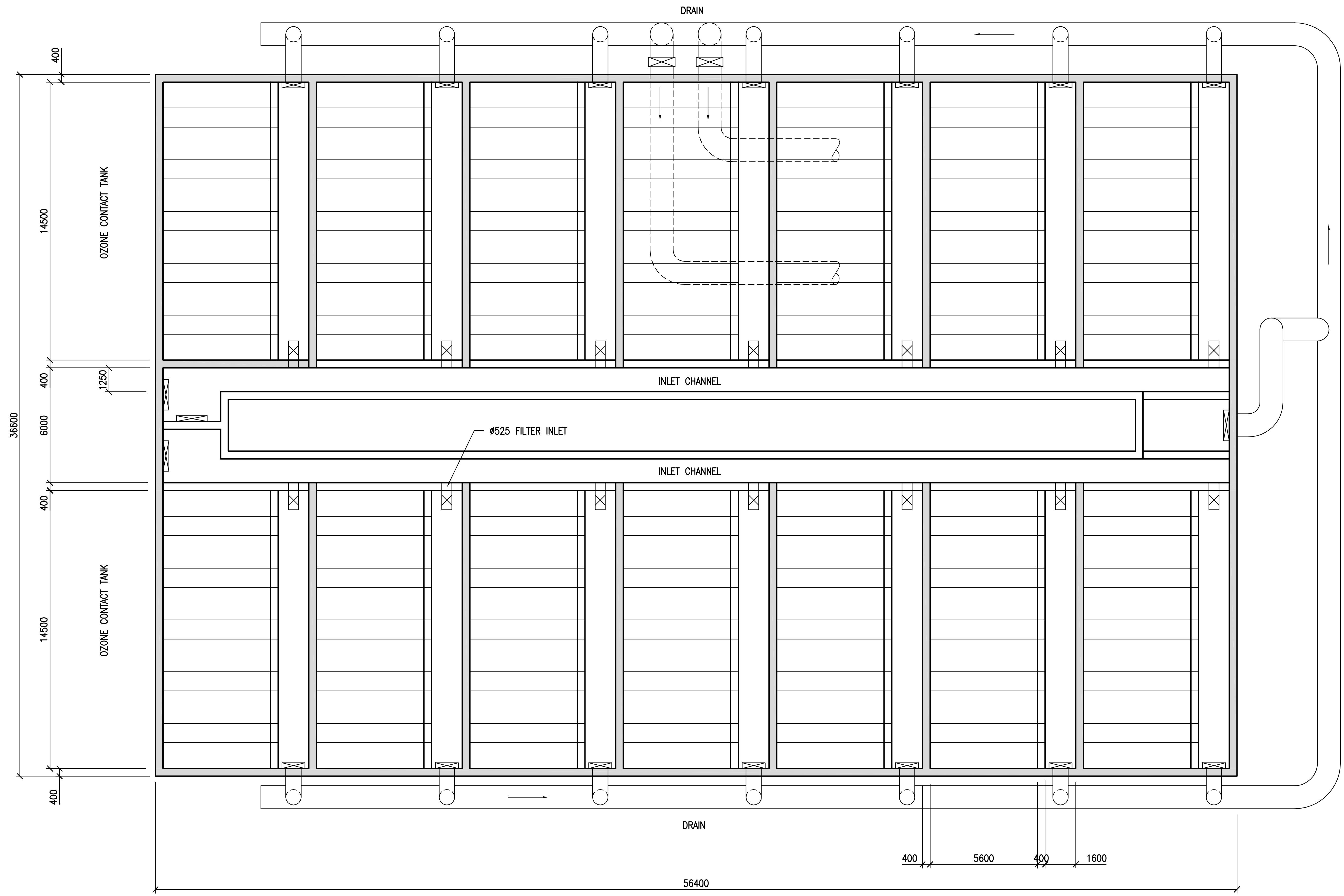
Revision:

Material:

Symbols:

UNLESS OTHERWISE SPECIFIED ALL DIMENSIONS ARE IN MILLIMETRES

D:



					DESIGNED	C POVEY	11/12	WSL TO SIGN
					DES. CHECKED			OPERATIONS
					DRAWN	G MURRAY	11/12	
					DWG. CHECKED			WSL TO SIGN
					PROJECT LEADER			
					INFRAST'R APP'D			INFRASTRUCTURE
ISSUE	DATE	AMENDMENT	BY	APPD.		BY	DATE	

watercare services limited

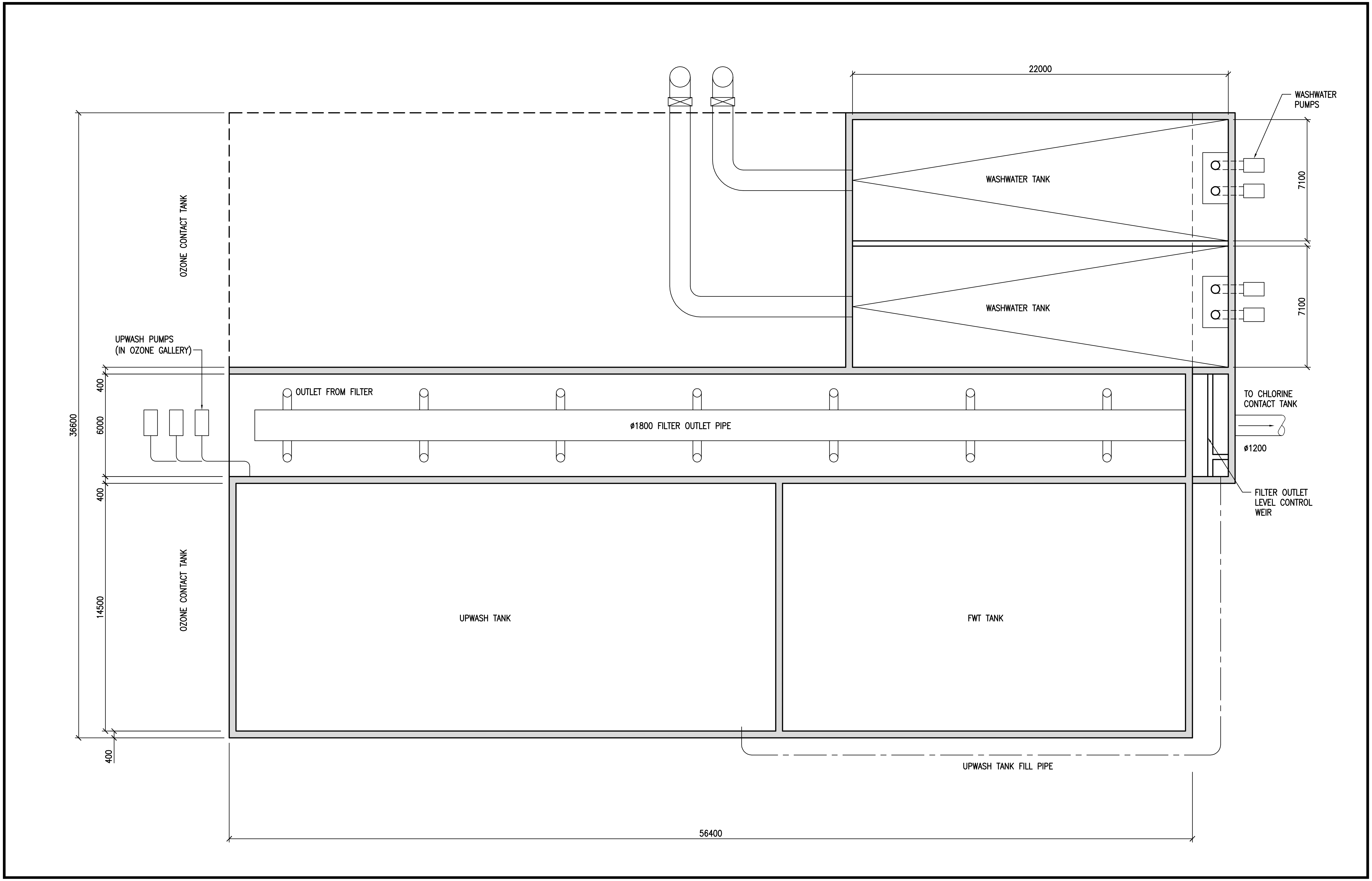
MWH

HUIA WTP IMPLEMENTATION STRATEGY

BAC FILTER TANK PLAN – UPPER LEVEL

DRAFT

CAD FILE 80501084-01-001-G073 DATE	
ORIGINAL SCALE A1 1 : 100	CONTRACT No.
REF. No. 80501084-01-001-G073	ISSUE B
DWG. No.	



ISSUE	DATE	AMENDMENT	BY	APPD.		BY	DATE
					DESIGNED	C POVEY	11/12
					DES. CHECKED		
					DRAWN	G MURRAY	11/12
					DWG. CHECKED		
					PROJECT LEADER		
					INFRAST'R APP'D		

WSL TO SIGN
OPERATIONS
WSL TO SIGN
INFRASTRUCTURE

water Care services limited

MWH

HUIA WTP IMPLEMENTATION STRATEGY

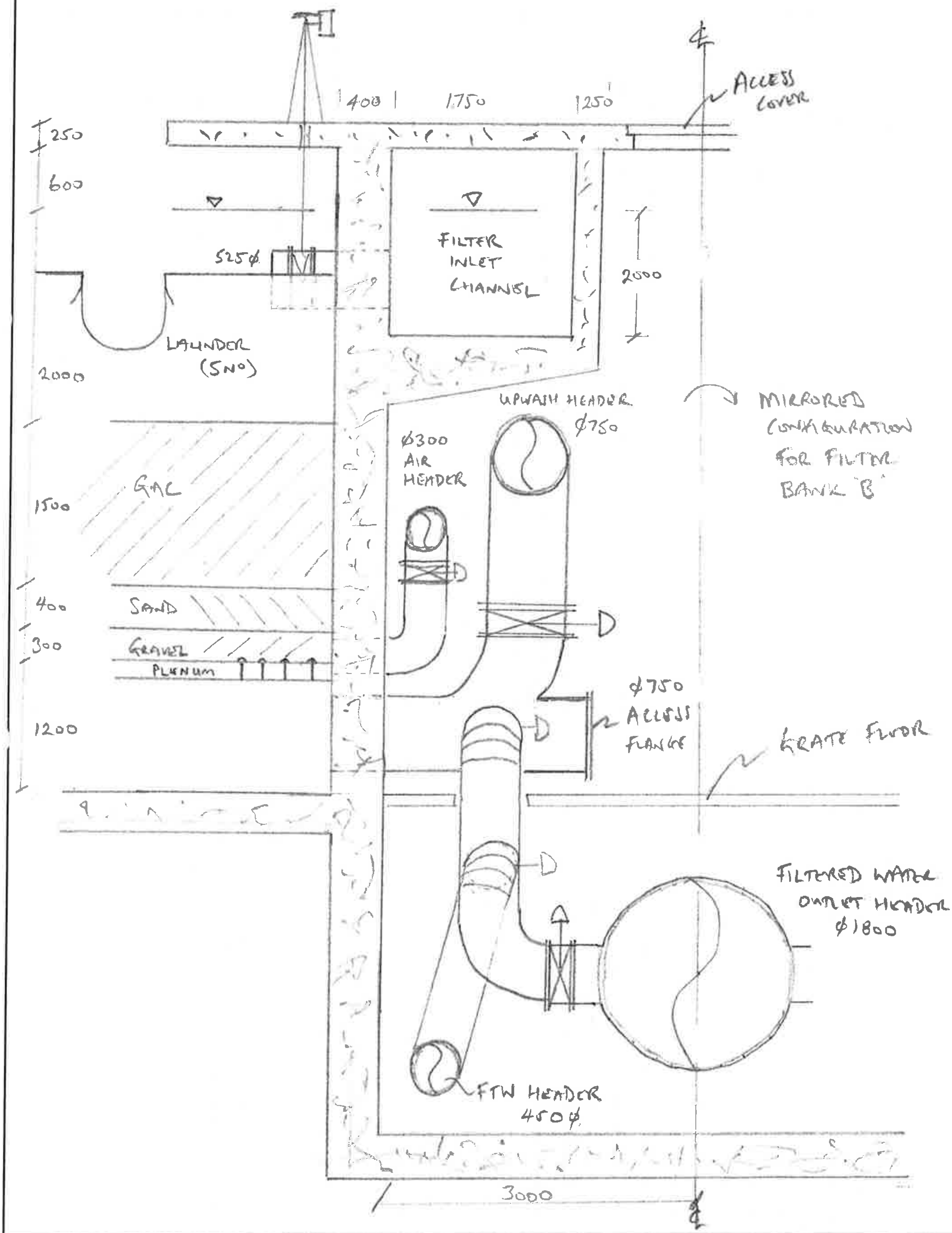
BAC FILTER TANK PLAN – LOWER LEVEL

DRAFT

CAD FILE 80501084-01-001-G074 DATE
ORIGINAL SCALE A1 AS SHOWN
CONTRACT No.
REF. No. 80501084-01-001-G074
ISSUE A
DWG. No.

MWH
BUILDING A BETTER WORLD

PROJECT HUIA WTP PROJECT NO.
DESCRIPTION FILTER GALLERY BANK 'A'
PREPARED BY DATE
CHECKED BY DATE
REF/DWGS SHEET OF



MWH
BUILDING A BETTER WORLD

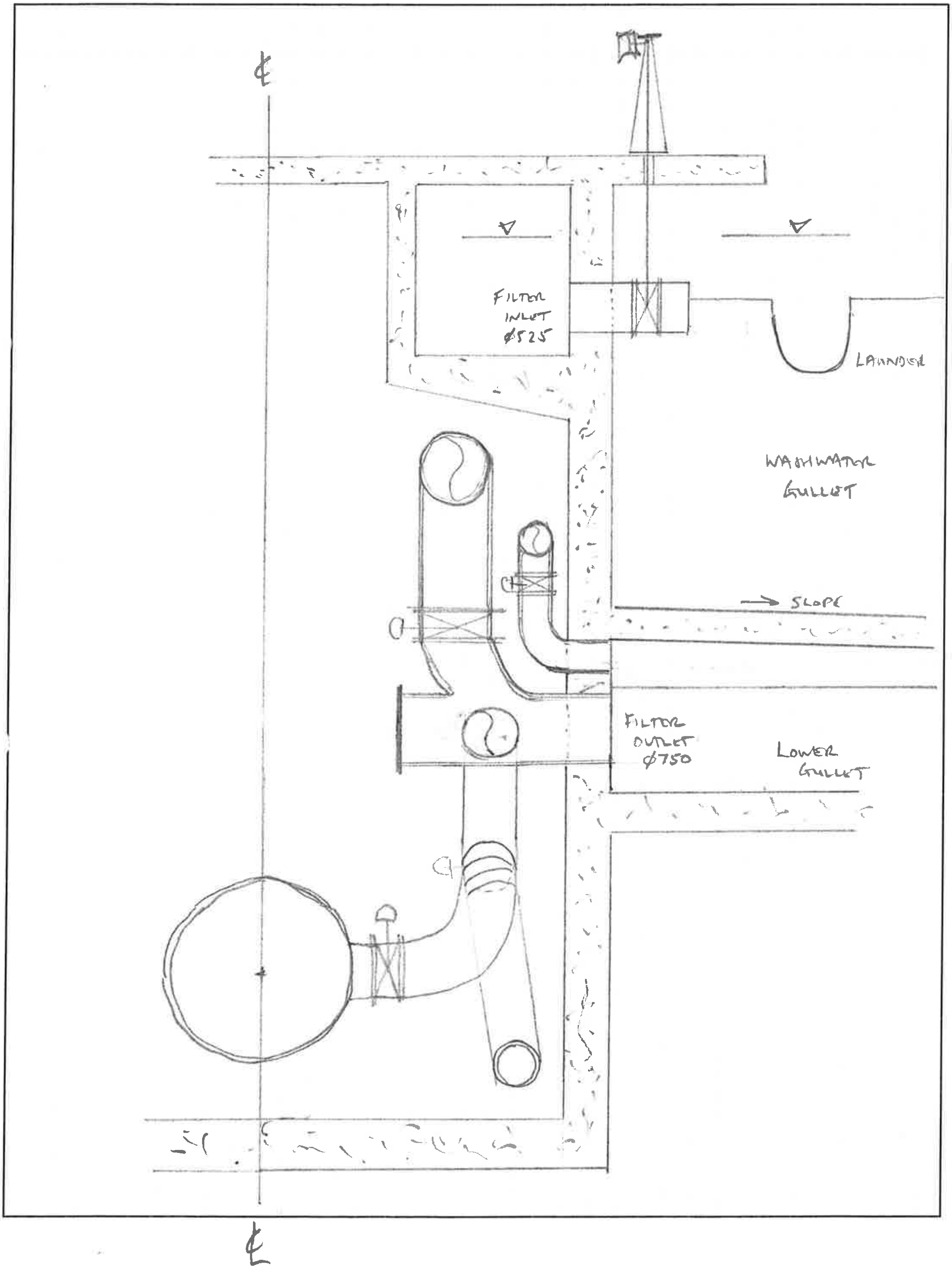
PROJECT HUIA WTP PROJECT NO.

DESCRIPTION FILTER GALLERY - BANK B WASHWATER GULLET

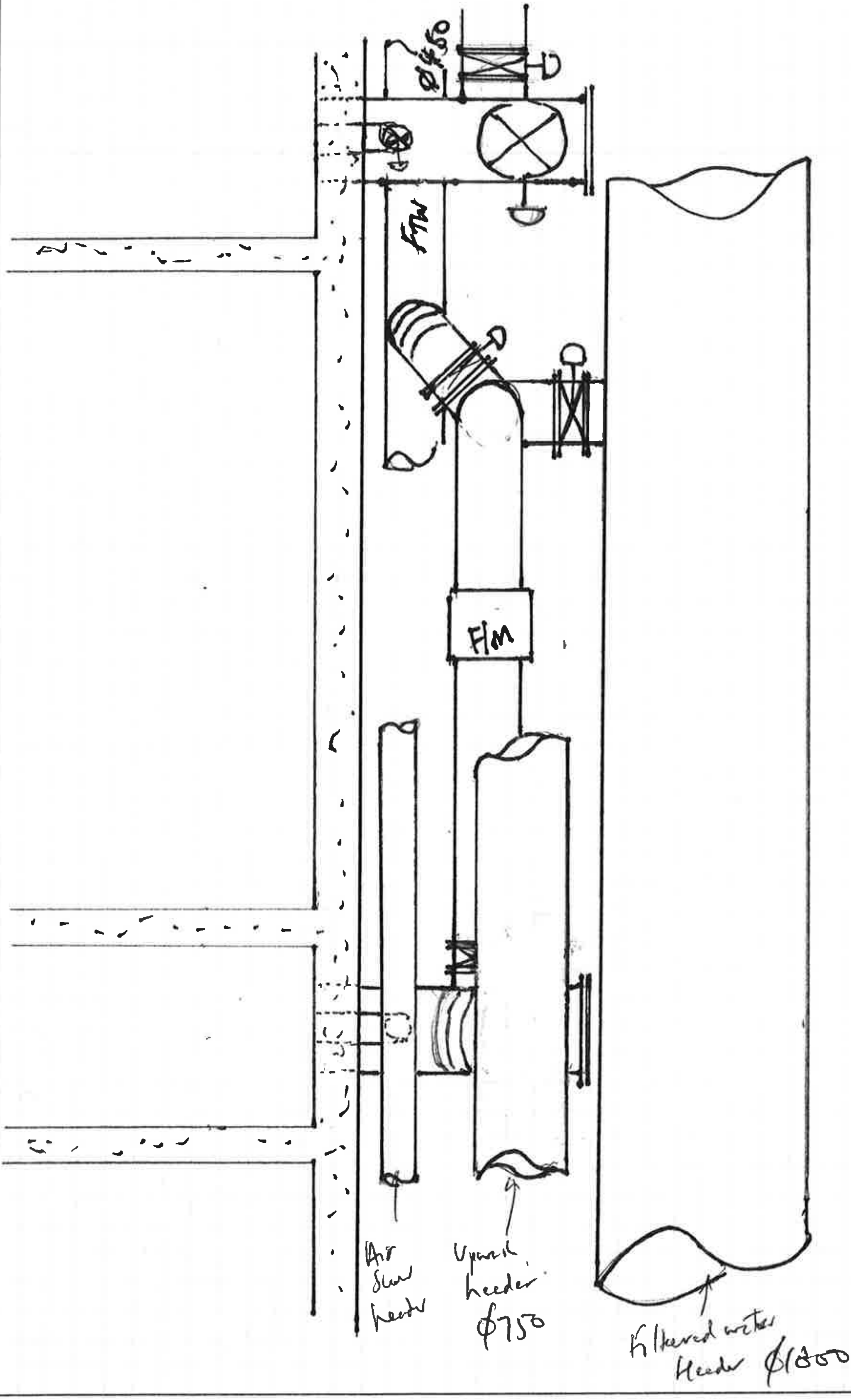
PREPARED BY DATE

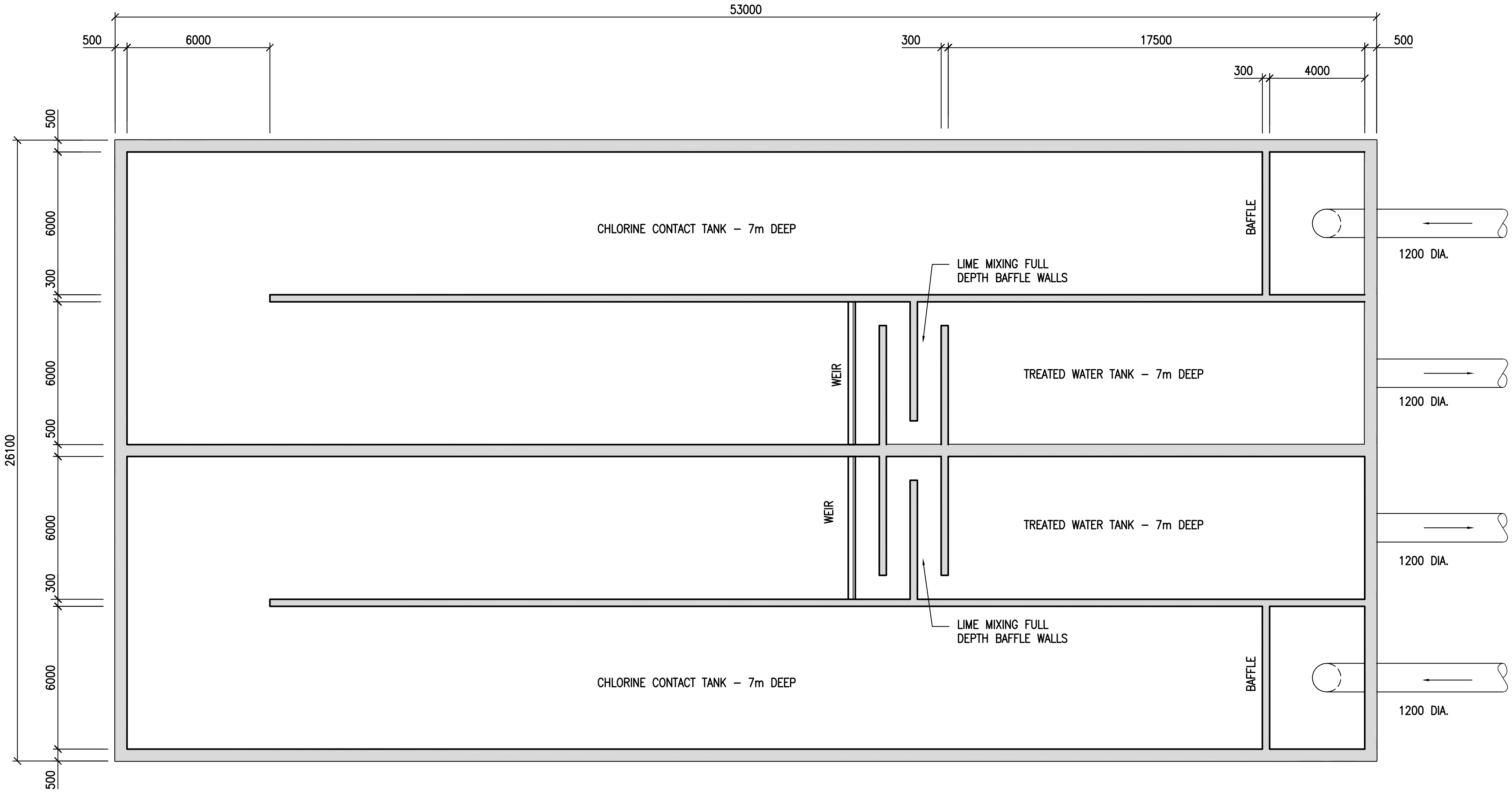
CHECKED BY DATE

REF/DWGS SHEET OF



MWH MWH Australia Pty Ltd ABN 17 007 820 322	PROJECT: HUIA WTP	PROJECT No.
	DESCRIPTION: FILTER GALLERY	
	PREPARED BY	DATE
PAGE .... OF	CHECKED BY	DATE





ISSUE	DATE	AMENDMENT	BY	APPD.

	BY	DATE
DESIGNED	C POVEY	11/12
DES. CHECKED		
DRAWN	G MURRAY	11/12
DWG. CHECKED		
PROJECT LEADER		
INFRAST'R APP'D		

WSL TO SIGN
OPERATIONS
WSL TO SIGN
INFRASTRUCTURE

water Care services limited

MWH.

HUIA WTP IMPLEMENTATION STRATEGY

CHLORINE CONTACT TANK & TREATED WATER TANK PLAN

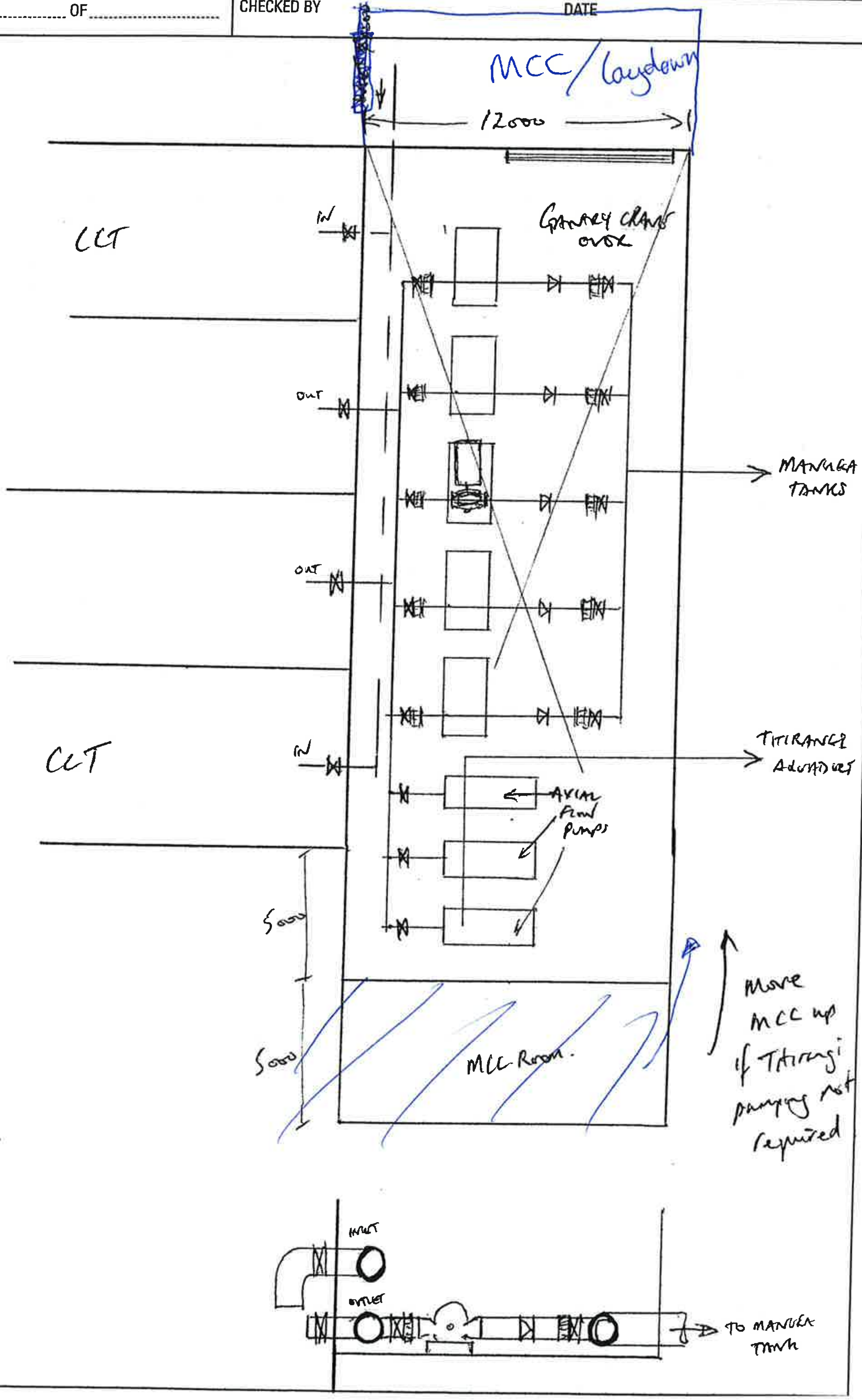
DRAFT

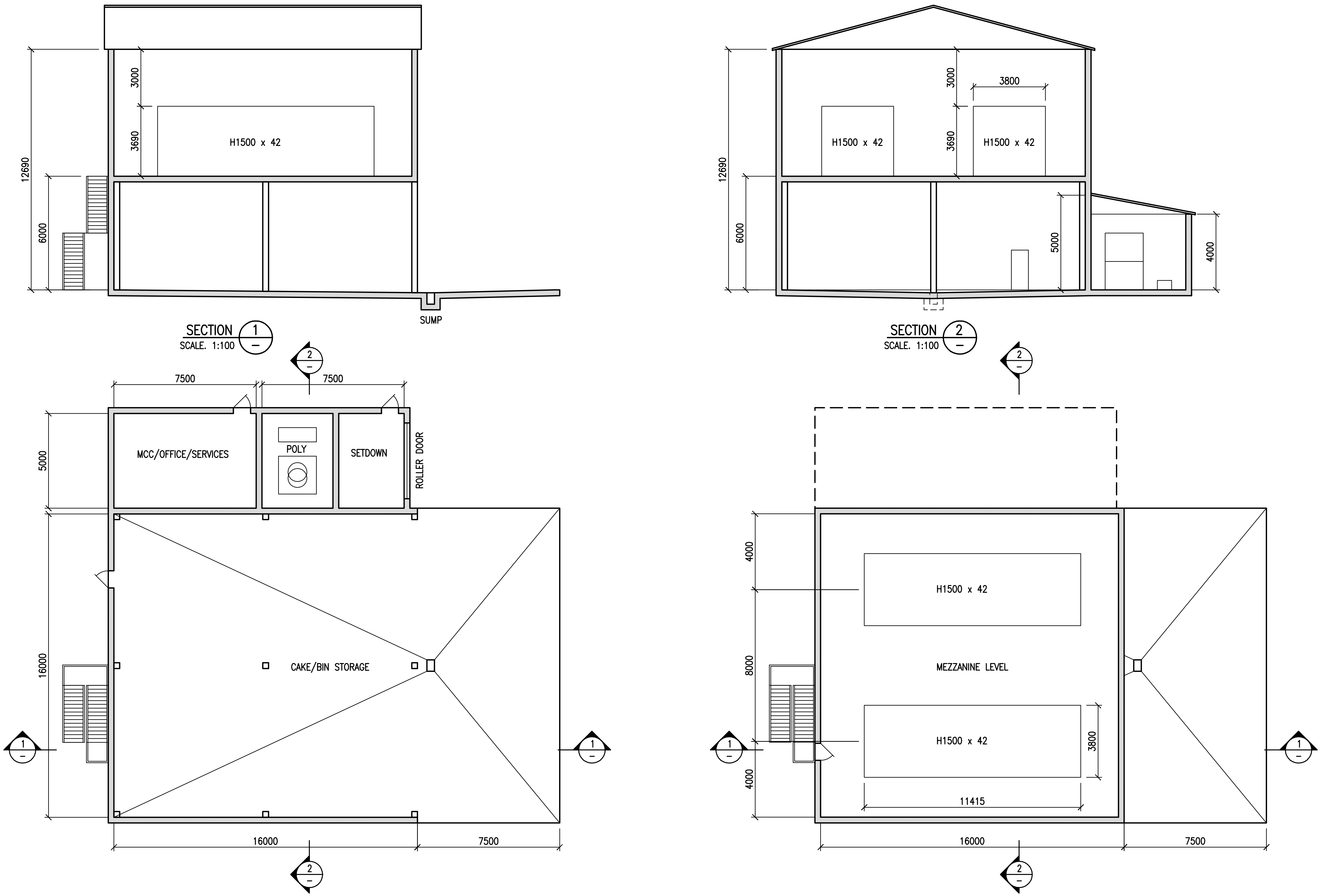
CAD FILE 80501084-01-001-G075E
ORIGINAL SCALE A1 1 : 100
CONTRACT No.
REF. No. 80501084-01-001-G075
ISSUE B
DWG. No.

MWH

MWH Australia Pty Ltd
ABN 17 007 820 322

PROJECT: HUIA WTP	PROJECT No.
DESCRIPTION: OUTLET P.S	
PREPARED BY	DATE
PAGE .... OF	
CHECKED BY	DATE





ISSUE	DATE	AMENDMENT	BY	APPD.		BY	DATE
					DESIGNED	G GLASGOW	01/13
					DES. CHECKED		
					DRAWN	IR MULLIGAN	01/13
					DWG. CHECKED		
					PROJECT LEADER		
					INFRAST'R APP'D		

WSL TO SIGN
OPERATIONS
WSL TO SIGN
INFRASTRUCTURE

water Care services limited

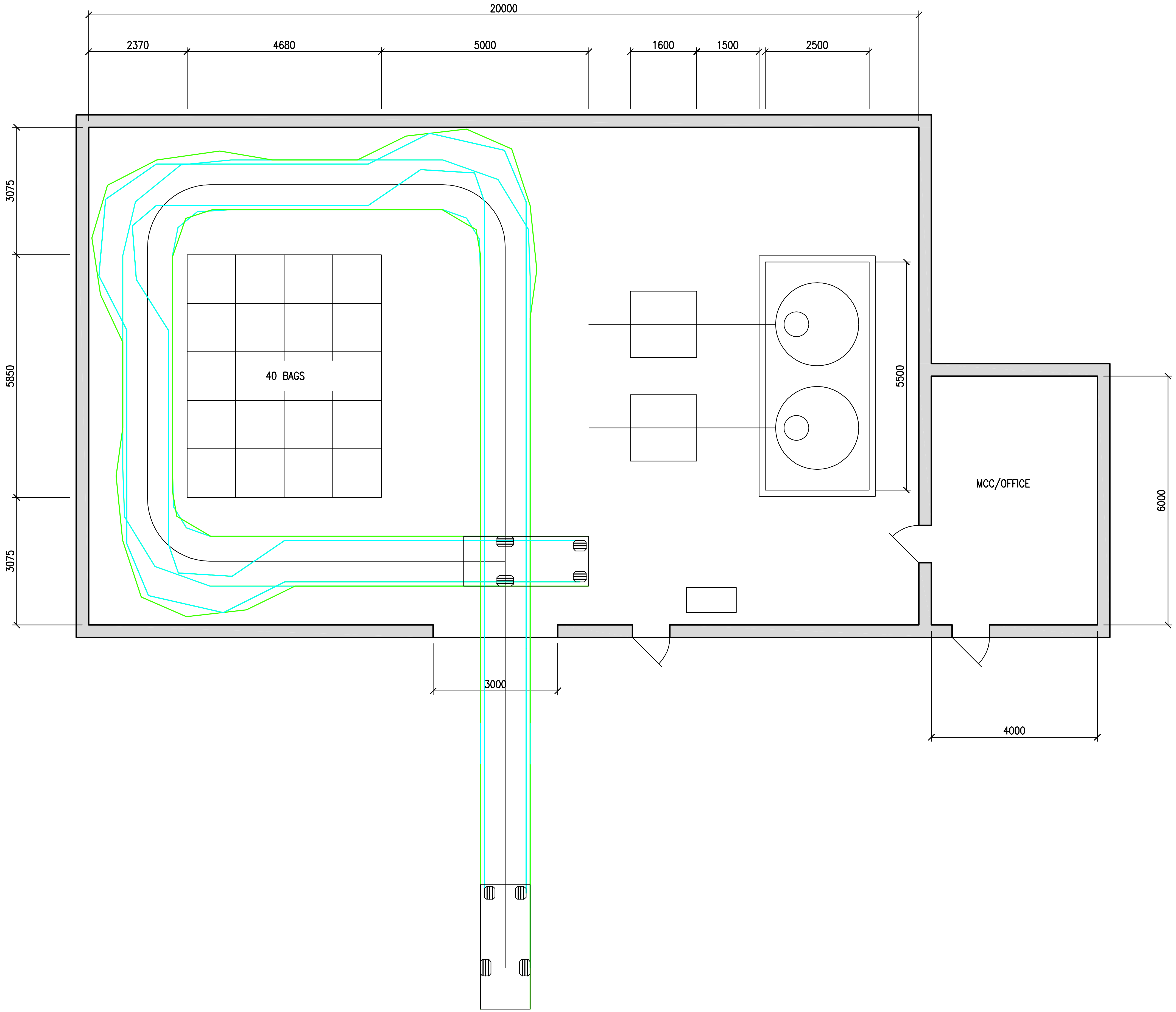
MWH.

HUIA WTP IMPLEMENTATION STRATEGY

SLUDGE DEWATERING BUILDING

DRAFT

CAD FILE 80501084-01-001-G076E
ORIGINAL SCALE A1: AS SHOWN
CONTRACT No.
REF. No. 80501084-01-001-G076
ISSUE A
DWG. No.



ISSUE	DATE	AMENDMENT	BY	APPD.		BY	DATE
					DESIGNED	G GLASGOW	01/13
					DES. CHECKED		
					DRAWN	IR MULLIGAN	01/13
					DWG. CHECKED		
					PROJECT LEADER		
					INFRAST'R APP'D		

WSL TO SIGN
OPERATIONS

WSL TO SIGN
INFRASTRUCTURE

water Care services limited

MWH

HUIA WTP IMPLEMENTATION STRATEGY

PAC BAG STORAGE BUILDING PLAN

DRAFT

CAD FILE 80501084-01-001-G077 DATE

ORIGINAL SCALE A1 1 : 50

CONTRACT No.

REF. No. 80501084-01-001-G077

ISSUE A

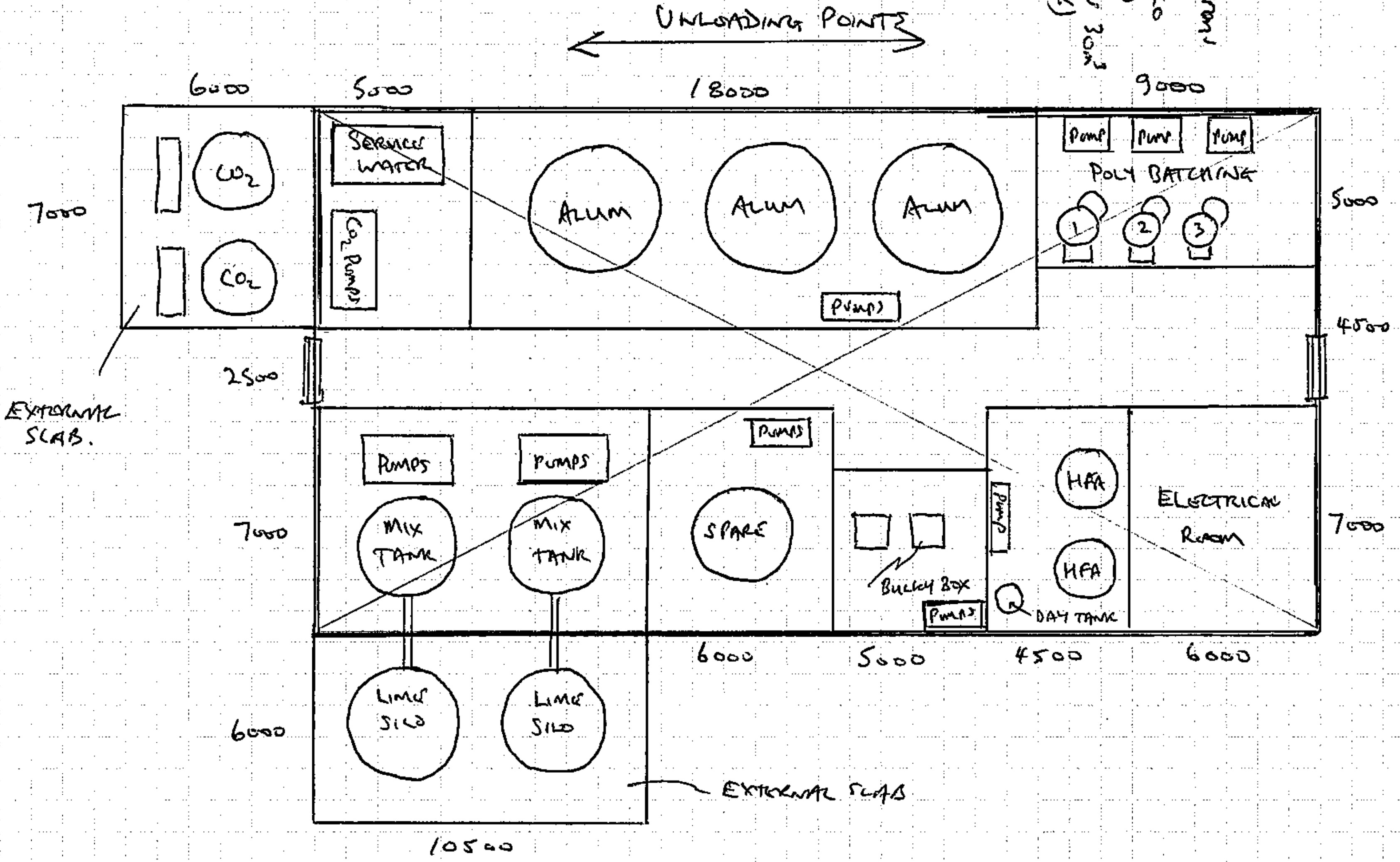
DWG. No.

MWH
BUILDING A BETTER WORLD

PROJECT: HUIA WTP
PROJECT NO.
DESCRIPTION: CHEMICAL STORAGE BUILDING (NO CHLORINE)
PREPARED BY
DATE
CHECKED BY
DATE
REF/DWGS
SHEET OF

TANKS

CO2 2x 50t
POLY 3x PROD SYSTEMS
LIME 2x 45t SILO (12m x 3m dia)
2x MIX TANKS 30m³ (4.5m x 3m dia)
ALUM 3x 60m³ (5m x 4m dia)
HFA 2x 6m³ (3m x 2m dia)
SPARE (NO 4m x 3m dia)

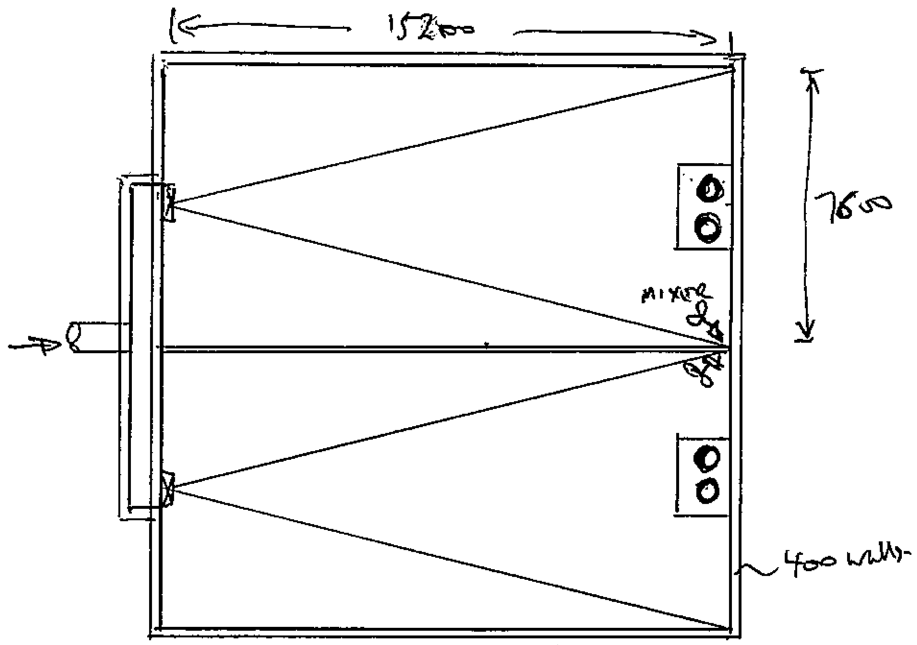


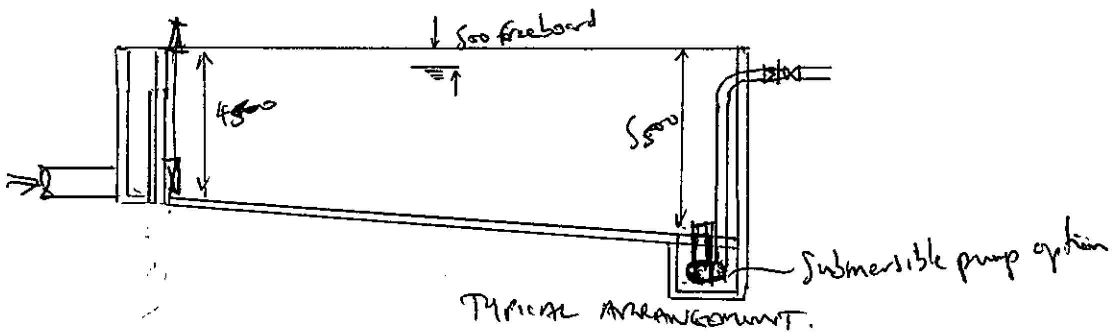
MWH

MWH Australia Pty Ltd
ABN 17 007 820 322

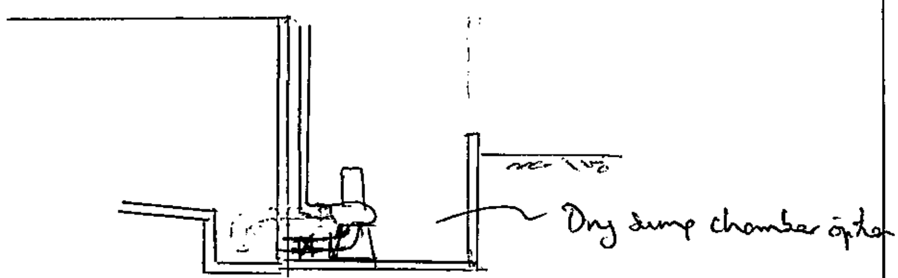
PAGE .... OF ....

PROJECT HUIA WTP	PROJECT No.
DESCRIPTION WASHWATER HOLDING TANK	
PREPARED BY	DATE
CHECKED BY	DATE





TYPICAL ARRANGEMENT.



ALTERNATIVE ARRANGEMENT

Appendix N MCA Document

Huia WTP NPC for pumping costs for various site options

Pumpstations	Pump power for various Layout Options													
	1a	**1b**	1c	2a	2b (128)	2c	2d	**2e**	3a	3b	4a	4b	5a (128)	**5b (128)**
Inlet PS - all flow	0	**0**	0	350	475	390	390	**175**	350	350	340	340	540	**540**
Outlet PS - Manuka	475	**475**	475	225	0	225	430	**420**	225	225	430	430	0	**0**
Outlet PS - Titirangi	55	**55**	70			225 Intermediate Pump								

Power cost $/kWhr **0.09**

NPV discount rate % **5.14%** **6.80%**

Year	Average Day demand kL Manuka	Titirangi	Total Huia	Power $/kWhr	Pumping power costs $/annum 1a	**1b**	1c	2a	2b (128)	2c	2d	**2e**	3a	3b	4a	4b	5a (128)	**5b (128)**
2017																		
2018																		
2019																		
2020	11539	76213	87752	0.09	54471	54471	60909	187580	234730	303914	220668	113772	187580	187580	195959	195959	266851	266851
2021	15385	73420	88805	0.0918	65172	65172	71498	198418	242297	313711	236939	126384	198418	198418	211434	211434	275453	275453
2022	19231	70626	89857	0.093636	76278	76278	82485	209615	250072	323778	253772	139455	209615	209615	227449	227449	284293	284293
2023	23077	67833	90910	0.095509	87803	87803	93884	221181	258062	334122	271184	152998	221181	221181	244019	244019	293375	293375
2024	26923	65039	91962	0.097419	99759	99759	105706	233125	266271	344750	289191	167027	233125	233125	261162	261162	302708	302708
2025	30769	62246	93015	0.099367	112157	112157	117962	245458	274705	355670	307809	181556	245458	245458	278893	278893	312296	312296
2026	33846	59288	93134	0.101355	122638	122638	128278	255022	280557	363248	322651	193515	255022	255022	293119	293119	318949	318949
2027	36923	56330	93253	0.103382	133493	133493	138958	264871	286534	370986	337963	205880	264871	264871	307802	307802	325744	325744
2028	40000	53372	93372	0.105449	144733	144733	150015	275011	292638	378889	353759	218662	275011	275011	322955	322955	332683	332683
2029	43077	50414	93491	0.107558	156369	156369	161458	285451	298871	386959	370051	231873	285451	285451	338591	338591	339769	339769
2030	46154	47456	93610	0.109709	168413	168413	173299	296198	305236	395201	386853	245525	296198	296198	354723	354723	347005	347005
2031	46408	47172	93581	0.111904	172518	172518	177472	302451	311243	402978	395276	251148	302451	302451	362513	362513	353834	353834
2032	46663	46888	93551	0.114142	176720	176720	181743	308835	317368	410908	403881	256897	308835	308835	370474	370474	360797	360797
2033	46917	46604	93522	0.116425	181021	181021	186114	315354	323613	418994	412672	262776	315354	315354	378607	378607	367897	367897
2034	47172	46320	93492	0.118753	185424	185424	190587	322010	329982	427239	421653	268788	322010	322010	386918	386918	375137	375137
2035	47426	46036	93463	0.121128	189930	189930	195164	328806	336475	435647	430828	274934	328806	328806	395410	395410	382519	382519
2036	47681	45752	93433	0.123551	194542	194542	199848	335745	343096	444220	440202	281219	335745	335745	404086	404086	390046	390046
2037	47935	45468	93404	0.126022	199263	199263	204641	342830	349848	452961	449778	287646	342830	342830	412952	412952	397722	397722
2038	48190	45185	93374	0.128542	204095	204095	209546	350064	356732	461875	459561	294217	350064	350064	422010	422010	405548	405548
2039	48444	44901	93345	0.131113	209040	209040	214566	357450	363752	470963	469556	300936	357450	357450	431266	431266	413529	413529
2040	48699	44617	93315	0.133735	214102	214102	219702	364992	370910	480231	479766	307806	364992	364992	440723	440723	421666	421666
2041	48953	44333	93286	0.13641	219282	219282	224958	372693	378209	489681	490198	314830	372693	372693	450386	450386	429964	429964
2042	49208	44049	93256	0.139138	224584	224584	230337	380555	385651	499317	500854	322012	380555	380555	460259	460259	438424	438424
2043	49462	43765	93227	0.141921	230011	230011	235840	388583	393240	509142	511741	329356	388583	388583	470347	470347	447052	447052
2044	49717	43481	93197	0.144759	235564	235564	241472	396780	400978	519161	522863	336864	396780	396780	480654	480654	455849	455849
2045	49971	43197	93168	0.147655	241248	241248	247235	405149	408868	529377	534225	344541	405149	405149	491186	491186	464819	464819
2046	50225	42913	93139	0.150608	247065	247065	253131	413695	416914	539793	545832	352391	413695	413695	501946	501946	473965	473965
2047	50480	42629	93109	0.15362	253018	253018	259164	422420	425117	550415	557690	360416	422420	422420	512941	512941	483291	483291
2048	50734	42345	93080	0.156692	259110	259110	265338	431328	433482	561246	569804	368622	431328	431328	524174	524174	492801	492801
2049	50989	42061	93050	0.159826	265345	265345	271655	440424	442012	572289	582179	377011	440424	440424	535652	535652	502498	502498
2050	51243	41777	93021	0.163023	271726	271726	278118	449712	450710	583550	594822	385589	449712	449712	547379	547379	512386	512386
2051	51498	41493	92991	0.166283	278255	278255	284731	459194	459578	595033	607737	394359	459194	459194	559360	559360	522468	522468
2052	51752	41209	92962	0.169609	284938	284938	291498	468876	468621	606741	620931	403326	468876	468876	571603	571603	532748	532748
2053	52007	40926	92932	0.173001	291776	291776	298421	478762	477842	618680	634410	412494	478762	478762	584111	584111	543231	543231
2054	52261	40642	92903	0.176461	298773	298773	305504	488856	487244	630853	648179	421867	488856	488856	596890	596890	553920	553920
2055	52516	40358	92873	0.17999	305934	305934	312752	499161	496832	643266	662246	431450	499161	499161	609948	609948	564819	564819
2056	52770	40074	92844	0.18359	313262	313262	320167	509684	506607	655923	676616	441247	509684	509684	623289	623289	575933	575933
2057	53025	39790	92814	0.187262	320761	320761	327754	520427	516576	668829	691295	451264	520427	520427	636919	636919	587265	587265
2058	53279	39506	92785	0.191007	328434	328434	335516	531397	526740	681989	706292	461505	531397	531397	650845	650845	598820	598820
2059	53534	39222	92755	0.194827	336286	336286	343458	542597	537104	695408	721611	471975	542597	542597	665074	665074	610602	610602
2060	53788	38938	92726	0.198724	344320	344320	351583	554033	547672	709091	737261	482679	554033	554033	679612	679612	622617	622617
NPC 2020-2060	5.14%				2858495	2858495	2956773	5317222	5610281	7263838	6867812	4275829	5317222	5317222	6277256	6277256	6378004	6378004
RANK					1	1	3	5	8	18	14	4	5	5	9	9	11	11
NPC 2020-2060	6.80%				2151113	2151113	2230306	4100308	4368513	5656075	5271238	3254738	4100308	4100308	4811395	4811395	4966310	4966310
RANK					1	1	3	5	8	18	14	4	5	5	9	9	11	11
			Difference from 1B									**$1,417,334**						**$3,519,509**

Multi Criteria Analysis Template

Version 9 - 01/10/12

=input required

=calculation

Project: Huia WTP Implementation Strategy

Objective / Key Issue for Resolution: Selection of Preferred Layout

20121001 Template MCA V9.xlsx

	Option 1B	Option 2E	Option 5B	Comment
	New treatment plant entirely on existing WTP site. New Service Reservoir on Manuka Road site.	**Existing WTP site extended to north and section of Woodlands Park Road realigned. New Service Reservoir on Manuka Road site.**	**New treatment plant on Manuka Road site. New Service Reservoir located north of Woodlands Park Road.**	
Must-haves:				
1. Maintain or achieve Ministry of Health "Aa" grading	go	go	go	
2. 100% compliance with microbiological criteria of latest Drinking Water Standards for New Zealand	go	go	go	
3. Meet future supply capacity and system production capacity	go	go	go	
4. Meet design, performance and standard criteria including, levels of service, reliability and availability, with redundancy of each major process unit set at n-1 (also including any project specific, standard design and perform	go	go	go	
5. Meet other regulatory compliance	go	go	go	
6. Must not increase overall system risk factor	go	go	go	
7. Must comply with Watercare Zero Harm Policy, The Health & Safety in Employment Act 1992 (The Act) and its amendments	go	go	go	
Deal-breakers:				
1. The solution may not reduce overall risk class but must reduce either consequence or likelihood of risk to health and safety in the Watercare Risk Management Framework	go	go	go	
2. Impossible to attain consent, construct or operate	go	go	go	

Multi-Criteria:

Phase	Criteria			Rating [R]: Lowest weight 0%	25%	50%	75%	100%	Weight (W)	Option 1B R	Option 1B Wx%	Option 2E R	Option 2E Wx%	Option 5B R	Option 5B Wx%	Comment
Construction (25%)	Environmental Care	Adverse effect on the Environment	Consider the degree to which the option will impact the environment: effect on native ecology (ecological value in District/Regional plans and/or the ecological significance of the area), effect on heritage features (both cultural and built, e.g. archaeological sites, geological feature, volcanic cone, lava cave, building facade), effect on water (groundwater dewatering & water quality, e.g. discharge of sludge, chemicals, sediments, etc.), effect on land (e.g. earthworks, permeability, etc.), effect on air quality (e.g. smoke, air, dust, gas, noise, etc.) & effect on stakeholders (people / properties affected, potential opposition, conflict with cultural groups, e.g. Iwi).	Low	Low-Med	Med	Med-High	High	7.7%	Med-High	0.06	Low-Med	0.02	Med	0.04	Option 1B has no impact on the land parcel to the north of Woodland Park Road
		Ease of Obtaining Consent	Ease of option consentability (time, cost, reputation, Auckland Plan designation, etc.	Low	Low-Med	Med	Med-High	High	7.7%	High	0.08	Low-Med	0.02	Med	0.04	Option 1B maximises use of the existing site, option 2E requires some relocation of Woodland Park Road whilst Option 5B requires reservoir construction on north side of Woodland Park Road
		Sustainability	Consider sustainability as a whole, estimated carbon footprint and energy consumption during construction.	Low	Low-Med	Med	Med-High	High	2.6%	Med	0.01	Med	0.01	Med	0.01	No appreciable difference between options
	Health, Safety & Well-Being	Ability to Manage Hazards to Staff, Contractors and Public	Identify significant hazards (defined in the Hazard Register & the Act) and notifiable hazards (required to be reported to the Department of Labour) and consider the ability and difficulty to eliminate, minimise, isolate and monitor those. E.g. confined spaces, working at height, etc.	Low	Low-Med	Med	Med-High	High	10.3%	Low	0.00	Low-Med	0.03	High	0.10	Option 1B will be a very constrained site with progressive demolition and construiction around live assets, excavation work close to existing road and traffic control will be an issue. Contractor facilities likely to be required on northy side of Woodland Park Road due to space constraints. Option 2E has similar issues but to lesser extent.
		Ability to Manage Risk to Principals	Consider the ability for the principals to manage the risk exposure to " ensure that, as far as is reasonably practicable, the workplaces, machinery, equipment, and processes under their control are safe and without risk to health".	Low	Low-Med	Med	Med-High	High	10.3%	Low	0.00	Med	0.05	Med-High	0.08	Working within operating facilities and constrained sites is inherently more dangerous and risky.
	Stakeholder Relationships	Adverse Stakeholder Impacts / Availability of Resources	These include internal and external local stakeholders / other utilities (excl. environmental stakeholders but incl. neighbours). Consider impacts, availability of resources, programme & difficulty associated with the option.	Low	Low-Med	Med	Med-High	High	5.1%	Low-Med	0.01	Low-Med	0.01	Med	0.03	Option 1B requires substantial excavations and long construction duration will create the most impact on stakeholders. Option 5B being on greenfield site and more remote from adjacent landowners will have the least impact.
		Ease of Property Acquisition / Easement	Consider the estimated number, value & difficulty of land acquisition / easements.	Low	Low-Med	Med	Med-High	High	2.6%	High	0.03	Med	0.01	High	0.03	WSL owns all existing land parcels. Relocation of Woodland Park Road for Option 2E will require aquistion of the old road.
		Community Acceptance / Satisfaction	Consider wider Auckland community and political acceptance / satisfaction of project.	Low	Low-Med	Med	Med-High	High	2.6%	High	0.03	High	0.03	High	0.03	No appreciable difference between options
	Customer Service	Supply Security & Impact / Redundancy / Resilience / Risk	Consider the ability of option to reduce system risk and maintain supply during abnormal condition, failure of plant, force majeure & meet required performance criteria. Consider both positive and negative impacts on the supply (e.g. an option may provide additional capacity or storage but be limited for further development).	Low	Low-Med	Med	Med-High	High	12.8%	Low-Med	0.03	Low-Med	0.03	Med-High	0.10	Working within the existing plant will require increase numbers of shutdowns and risk of supply interruptions. Construction sequencing has been adopted to minimise this but still a greater risk on customer service than for a greenfield construction under Option 5B
		Positive Impact on Water Quality	Consider impacts on water quality assuming it currently meets microbiological standards (e.g. an option may reduce discoloured water but reduce pressure).	Low	Low-Med	Med	Med-High	High	2.6%	Med	0.01	Med	0.01	Med	0.01	No appreciable difference between options
	Asset Management	Design	Consider interface with existing equipment or infrastructure, ability of option to facilitate implementation and tie-ins, ancillary services, ease of future expansion, upgradability, access, serviceability, continuous operation capability, automation capability, process control, availability of materials, equipment and technology and proven service records.	Low	Low-Med	Med	Med-High	High	12.8%	Med	0.06	Med	0.06	Med-High	0.10	As a greenfield development Option 5B has the least constrints on the design of a new WTP and does not require temporary works or connections or retention of some components of the existing facility.
		Constructability, Ease of Implementation & Commissioning	Ability to construct option within existing site footprint, sequencing/phasing, suitability of construction duration, potential adverse ground conditions, ability to fully commission & integrate with existing plant (not including tie-ins but including electrical, start-up, integration with operation, ease of fall-back and decommissioning). Consider any process that may delay the option implementation.	Low	Low-Med	Med	Med-High	High	12.8%	Low	0.00	Med	0.06	High	0.13	As a greenfield development Option 5B has the least constrints on the design of a new WTP and does not require temporary works or connections or retention of some components of the existing facility. Relocation of the road under Option 2E provides additional working space to facilitate the progressive construction of works
		Short Term Operability	Consider robustness of plant, equipment, structures and reliability of processes provided to minimise operator input.	Low	Low-Med	Med	Med-High	High	10.3%	Low-Med	0.03	Med	0.05	Low	0.00	Working within the existing plant over an extended construction period will impact short term operations in Option 1B and Option 2E albeit to a lesser extent. Option 5B does not facilitate the early construction of the sludge dewatering facility
	TOTAL Construction Phase								1.0	0.35		0.41		0.68		
	RANK Construction Phase									3		2		1		

Operation (75%)	**Environmental Care**	Adverse effect on the Environment	Consider the degree to which the option will impact the environment: effect on native ecology (ecological value in District/Regional plans and/or the ecological significance of the area), effect on heritage features (both cultural and built, e.g. archaeological sites, geological feature, volcanic cone, lava cave, building facade), effect on water (groundwater dewatering & water quality, e.g. discharge of sludge, chemicals, sediments, etc.), effect on land (e.g. earthworks, permeability, etc.), effect on air quality (e.g. smoke, air, dust, gas, noise, etc.) & effect on stakeholders (people / properties affected, potential opposition, conflict with cultural groups, e.g. Iwi).	Low	Low-Med	Med	Med-High	High	9.8%	Med-High	0.07	Med-High	0.07	Med-High	0.07	Optiosn 1B and 2E will leave the land parcel to the north of Woodland Park Road clear. Option 5B will enable the majority of the existing WTP site to be rehabilitated.
		Ease of Obtaining Consent	Ease of option consentability (time, cost, reputation, Auckland Plan designation, etc.	Low	Low-Med	Med	Med-High	High	7.3%	Med	0.04	Med	0.04	Med	0.04	No appreciable difference between options
		Sustainability	Consider sustainability as a whole, estimated carbon footprint and annual energy consumption.	Low	Low-Med	Med	Med-High	High	4.9%	Med	0.02	Med	0.02	Low	0.00	Option 1B has the lowest power usage
	Health, Safety & Well-Being	Ability to Manage Hazards to Staff, Contractors and Public	Identify significant hazards (defined in the Hazard Register & the Act) and notifiable hazards (required to be reported to the Department of Labour) and consider the ability and difficulty to eliminate, minimise, isolate and monitor those. E.g. confined spaces, working at height, etc.	Low	Low-Med	Med	Med-High	High	9.8%	Med	0.05	Med-High	0.07	Med-High	0.07	No appreciable difference between options
		Ability to Manage Risk to Principals	Consider the ability for the principals to manage the risk exposure to " ensure that, as far as is reasonably practicable, the workplaces, machinery, equipment, and processes under their control are safe and without risk to health".	Low	Low-Med	Med	Med-High	High	9.8%	High	0.10	High	0.10	High	0.10	No appreciable difference between options
	Stakeholder Relationships	Adverse Stakeholder Impacts / Availability of Resources	These include internal and external local stakeholders / other utilities (excl. environmental stakeholders but incl. neighbours). Consider impacts, availability of resources, programme & difficulty associated with the option.	Low	Low-Med	Med	Med-High	High	4.9%	Med	0.02	Med-High	0.04	Med-High	0.04	No appreciable difference between options
		Community Acceptance / Satisfaction	Consider wider Auckland community and political acceptance / satisfaction of project.	Low	Low-Med	Med	Med-High	High	4.9%	High	0.05	High	0.05	High	0.05	No appreciable difference between options
	Customer Service	Supply Security & Impact / Redundancy / Resilience / Risk	Consider the ability of option to reduce system risk and maintain supply during abnormal condition, failure of plant, force majeure & meet required performance criteria. Consider both positive and negative impacts on the supply (e.g. an option may provide additional capacity or storage but be limited for further development).	Low	Low-Med	Med	Med-High	High	12.2%	High	0.12	High	0.12	High	0.12	No appreciable difference between options
		Positive Impact on Water Quality	Consider impacts on water quality assuming it currently meets microbiological standards (e.g. an option may reduce discoloured water but reduce pressure).	Low	Low-Med	Med	Med-High	High	2.4%	High	0.02	High	0.02	High	0.02	No appreciable difference between options
	Asset Management	Medium and Long Term Operability	Consider interface with existing equipment or infrastructure, ease of future expansion / upgradability, access, continuous operation capability, automation capability, process control, availability of materials, equipment and technology, and proven service records, robustness of plant, equipment, structures and reliability of processes provided to minimise operator input.	Low	Low-Med	Med	Med-High	High	17.1%	Med	0.09	Med	0.09	Med-High	0.13	As a completely new plant Option 5B layout is the most regular and will afford ease of operation and maintenance. Option 1B access around process units is quite limited
		Medium and Long Term Maintainability	Consider ease & frequency of maintenance / serviceability, availability of materials, equipment and technology, ease of decommissioning, robustness of plant, equipment, structures and reliability of processes provided to minimise maintenance input.	Low	Low-Med	Med	Med-High	High	17.1%	Med	0.09	Med	0.09	Med-High	0.13	As a completely new plant Option 5B layout is the most regular and will afford ease of operation and maintenance. Option 1B access around process units is quite limited
	TOTAL Operation Phase								**1.0**	**0.67**		**0.71**		**0.77**		
	RANK Operation Phase									**3**		**2**		**1**		
	GRAND TOTAL									**0.59**		**0.63**		**0.75**		
	FINAL RANK									**3**		**2**		**1**		

Appendix O Cost Estimate

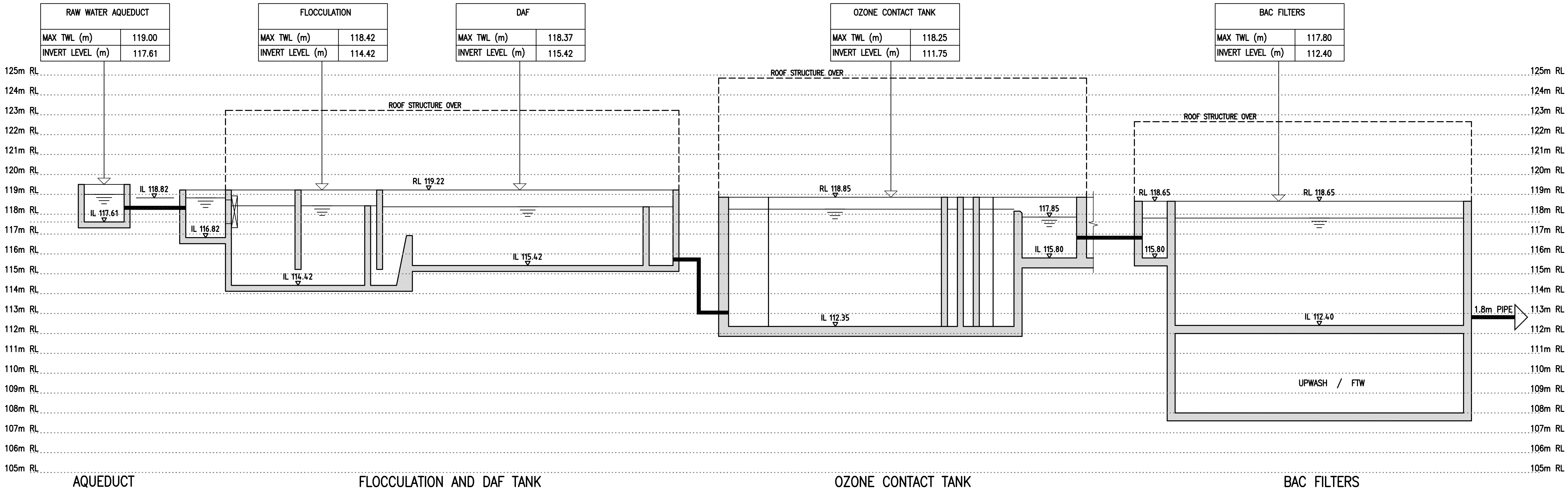
HUIA WTP - ORDER OF MAGNITUDE COST ESTIMATE

Excludes Sludge dewatering facility, PAC facility, Muddy Ck Pipeline and new reservoir

Item	**Option 1B**	**Option 2E**	**Option 5B**	**Comment**
Raw Water PS		$ 4,000,000	$ 5,000,000	Option 5B PS is higher head
DAF	$ 8,800,000	$ 8,400,000	$ 8,000,000	Option 1B more constrained allow extra 10%, Option 2E extra 5%
Ozone	$ 11,000,000	$ 10,000,000	$ 10,000,000	Option 1B more constrained allow extra 10%
BAC	$ 17,600,000	$ 16,000,000	$ 16,000,000	Option 1B more constrained allow extra 10%
CCT/TWT	$ 5,000,000	$ 5,000,000	$ 5,000,000	
Outlet PS	$ 4,000,000	$ 3,000,000		Option 1B requires pumping to Titirangi also
Temporary outlet PS			$ 3,000,000	Pumpstation and small TWT
FTW tank	$ 750,000	$ 750,000	$ 750,000	Includes return pumping
Upwash tank	$ 1,000,000	$ 1,000,000	$ 1,000,000	
Washwater balance tanks	$ 1,250,000	$ 1,250,000	$ 1,500,000	Includes transfer pumping, separate tanks for Option 5B more expensive
Washwater Thickeners	$ 650,000	$ 650,000	$ 1,200,000	1 no. Thickener Options 1B and 2E, 2No. Option 5B
Effluent return PS	$ 250,000	$ 250,000	$ 250,000	
Overflow lagoon mods	$ 100,000	$ 100,000		
Power supply and Generators	$ 5,000,000	$ 5,000,000	$ 6,000,000	Assumes new generator is required for the Option 5B temporary TW PS
Chemical Systems	$ 5,000,000	$ 5,000,000	$ 7,000,000	Option 1B and 2E use existing chlorination facility
Site piping	$ 4,000,000	$ 4,000,000	$ 6,000,000	Option 5B has approx 1000m of additional 1200mm pipeline
Temporary piping & connections	$ 500,000	$ 250,000		Option 1B Clarifiers to new BAC, Option 2E DAF to existing filters
Woodland Park Road relocation		$ 500,000		
Site works	$ 4,000,000	$ 3,000,000	$ 2,000,000	Includes excavation, road and drainage, retaining walls
Admin and workshop	$ 4,000,000	$ 3,000,000	$ 3,000,000	Option 1B requires temporary control room and admin facilities
SCADA	$ 2,000,000	$ 2,000,000	$ 2,000,000	
Demolition	$ 3,000,000	$ 3,000,000	$ 1,000,000	Option 1B and 2E require progressive demolition within a working plant
Site mobilisation/demob	$ 2,000,000	$ 2,000,000	$ 2,000,000	Includes site facilities
Construction Site staff	$ 6,400,000	$ 5,600,000	$ 3,200,000	Option 1A estimated construction 4 years, Option 2E 3.5 years, Option 5B 2 years
Manuals and Commissioning	$ 500,000	$ 500,000	$ 500,000	
Spares and tools	$ 500,000	$ 500,000	$ 500,000	
Defects management	$ 500,000	$ 500,000	$ 500,000	
Site security/ traffic management	$ 1,000,000	$ 1,000,000	$ 500,000	Options 1B and 2E managing existing site and longer construction
Transportation	$ 720,000	$ 720,000	$ 540,000	Site vehicles, etc longer duration for Options 1B and 2E
Misc site costs	$ 4,000,000	$ 3,500,000	$ 2,000,000	Longer duration for Options 1B and 2E
Sludge Thickeners				Not in WTP upgrade scope
Sludge Holding tanks				Not in WTP upgrade scope
Sludge dewatering facility				Not in WTP upgrade scope
Muddy Creek overflow pipeline				Not in WTP upgrade scope
PAC facility				Not in WTP upgrade scope
Sub-total	**$ 93,520,000**	**$ 90,470,000**	**$ 88,440,000**	
Contractors O&P	$ 11,222,400	$ 10,856,400	$ 10,612,800	12%
Design & approvals	$ 9,352,000	$ 9,047,000	$ 8,844,000	10%
Contract Management/QA/Safety	$ 2,805,600	$ 2,714,100	$ 2,653,200	3%
Sub-total	**$ 116,900,000**	**$ 113,087,500**	**$ 110,550,000**	
Contingency	$ 23,380,000	$ 22,617,500	$ 22,110,000	20%
TOTAL	**$ 140,280,000**	**$ 135,705,000**	**$ 132,660,000**	

Appendix P Shortlisted Cross Sections and Hydraulic Profiles

NOTES
1. ALL DETAILS HAVE BEEN TAKEN FROM DRAWINGS PROVIDED BY WATERCARE SERVICES LTD.
2. HYDRAULIC LEVELS HAVE BEEN CALCULATED USING A MAXIMUM FLOW OF 140 MLD.



ISSUE	DATE	AMENDMENT	BY	APPD.			
					DESIGNED	C POVEY	01/13
					DES. CHECKED		
					DRAWN	IR MULLIGAN	01/13
					DWG. CHECKED		
					PROJECT LEADER		
					INFRAST'R APP'D		
						BY	DATE

WSL TO SIGN
OPERATIONS
WSL TO SIGN
INFRASTRUCTURE

water Care services limited

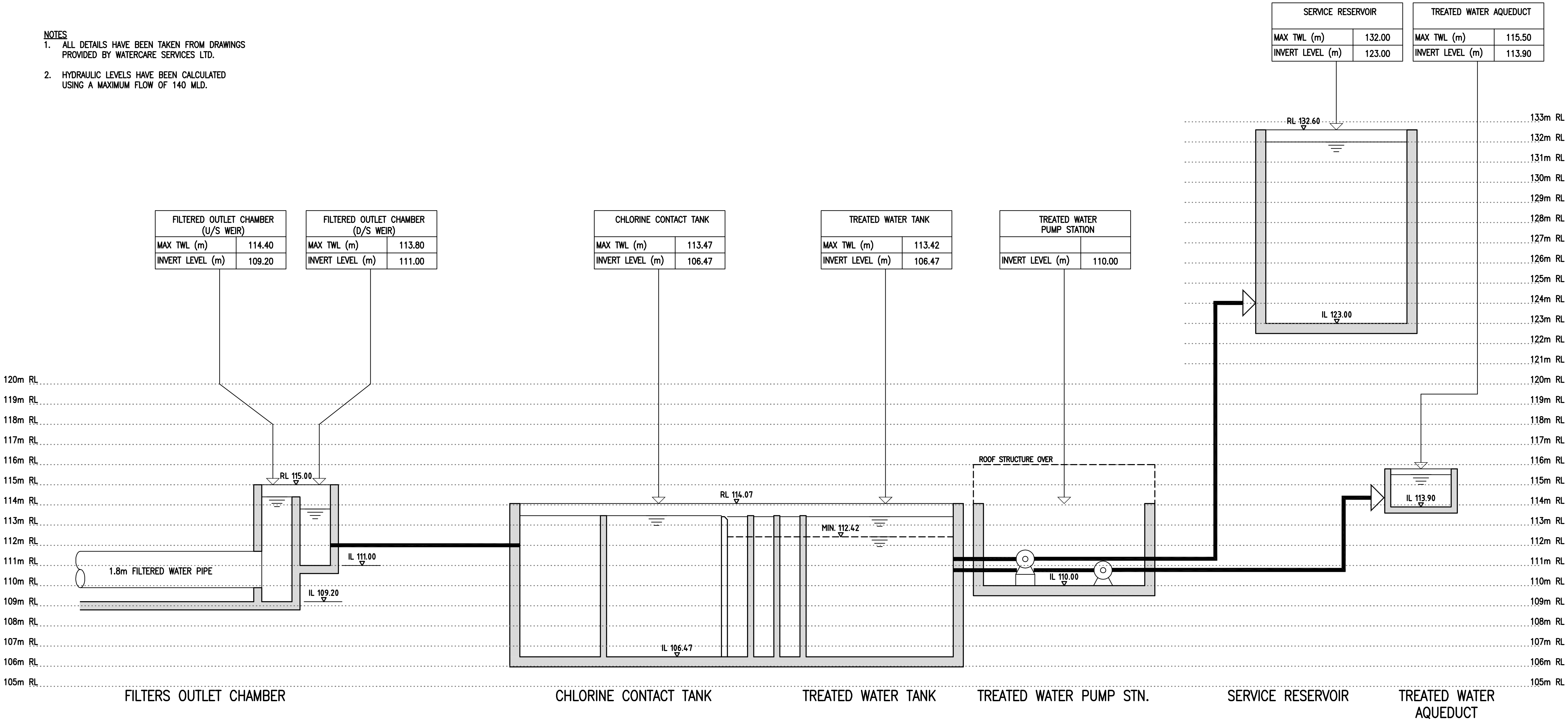
MWH.

HUIA WTP IMPLEMENTATION STRATEGY
OPTION 1B
HYDRAULIC PROFILE (CONCEPTUAL) – SHEET 1

DRAFT

CAD FILE 80501084-01-001-G060
ORIGINAL SCALE A1 NTS
CONTRACT No.
REF. No. 80501084-01-001-G060
ISSUE A
DWG. No.

NOTES
1. ALL DETAILS HAVE BEEN TAKEN FROM DRAWINGS PROVIDED BY WATERCARE SERVICES LTD.
2. HYDRAULIC LEVELS HAVE BEEN CALCULATED USING A MAXIMUM FLOW OF 140 MLD.



ISSUE	DATE	AMENDMENT	BY	APPD.		BY	DATE
					DESIGNED	C POVEY	01/13
					DES. CHECKED		
					DRAWN	IR MULLIGAN	01/13
					DWG. CHECKED		
					PROJECT LEADER		
					INFRAST'R APP'D		

WSL TO SIGN
OPERATIONS

WSL TO SIGN
INFRASTRUCTURE

water Care services limited

MWH.

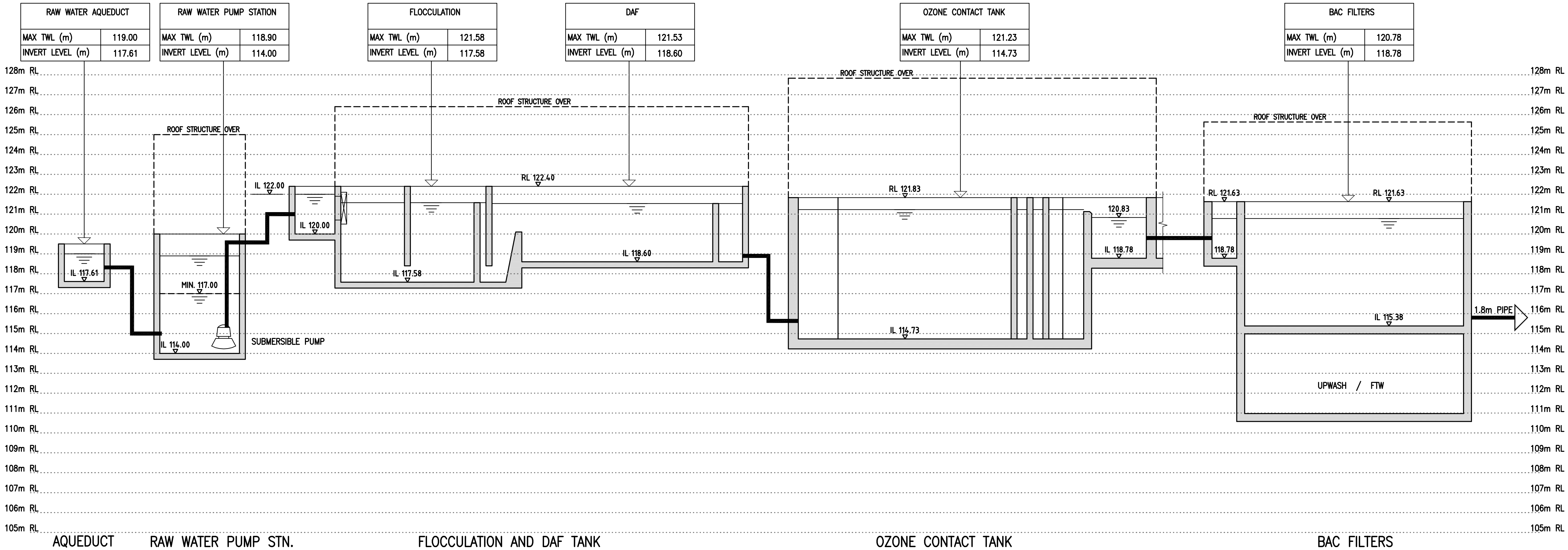
HUIA WTP IMPLEMENTATION STRATEGY
OPTION 1B
HYDRAULIC PROFILE (CONCEPTUAL) – SHEET 2

DRAFT

CAD FILE 80501084-01-001-G061 DATE
ORIGINAL SCALE A1 AS SHOWN
CONTRACT No.
REF. No. 80501084-01-001-G061
ISSUE A
DWG. No.

NOTES
1. ALL DETAILS HAVE BEEN TAKEN FROM DRAWINGS PROVIDED BY WATERCARE SERVICES LTD.

2. HYDRAULIC LEVELS HAVE BEEN CALCULATED USING A MAXIMUM FLOW OF 140 MLD.



ISSUE	DATE	AMENDMENT	BY	APPD.

DESIGNED	C POVEY	01/13	
DES. CHECKED			
DRAWN	IR MULLIGAN	01/13	
DWG. CHECKED			
PROJECT LEADER			
INFRAST'R APP'D			
	BY	DATE	

WSL TO SIGN
OPERATIONS
WSL TO SIGN
INFRASTRUCTURE

water Care services limited

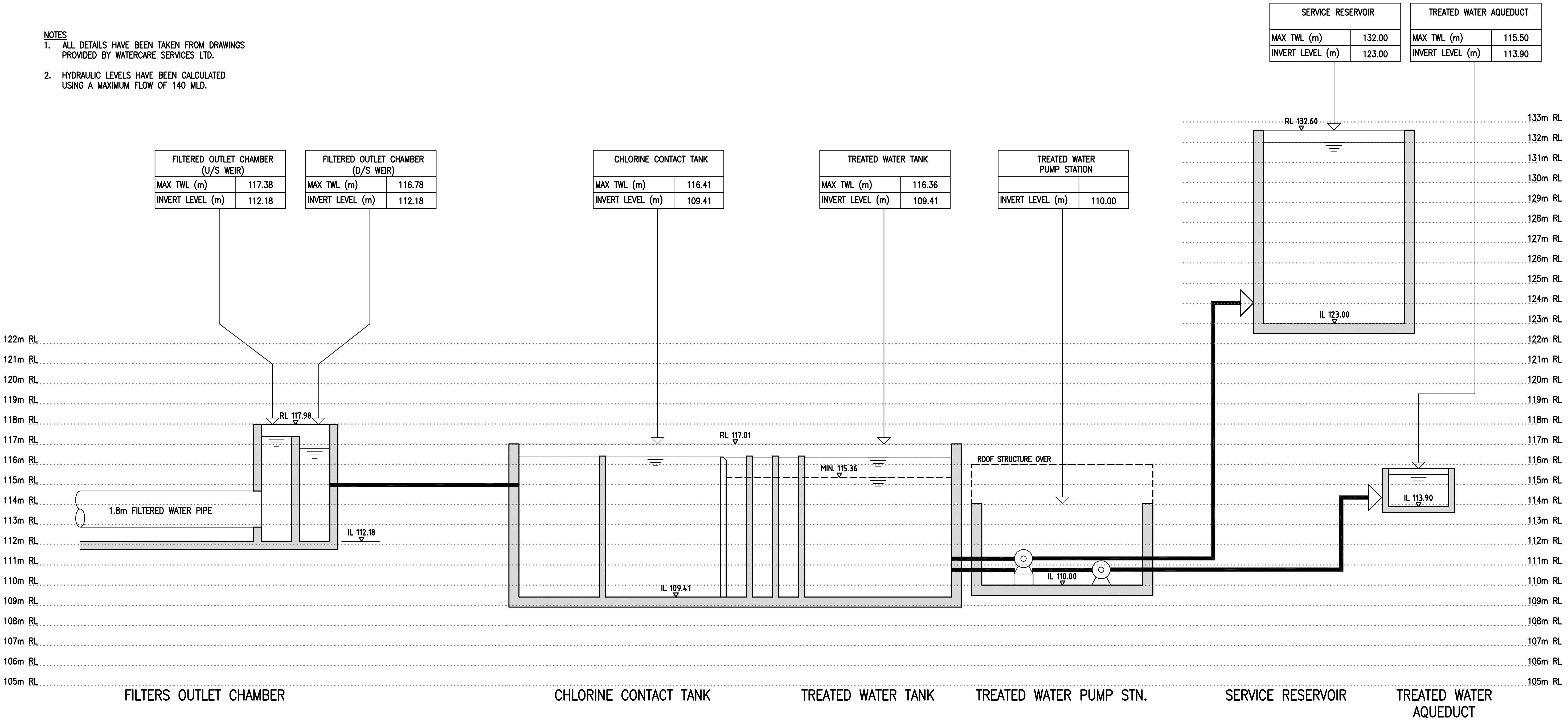
MWH.

HUIA WTP IMPLEMENTATION STRATEGY
OPTION 2E
HYDRAULIC PROFILE (CONCEPTUAL) – SHEET 1

DRAFT

CAD FILE 80501084-01-001-G063 DATE
ORIGINAL SCALE A1 AS SHOWN
CONTRACT No.
REF. No. 80501084-01-001-G063
ISSUE A
DWG. No.

NOTES
1. ALL DETAILS HAVE BEEN TAKEN FROM DRAWINGS PROVIDED BY WATERCARE SERVICES LTD.
2. HYDRAULIC LEVELS HAVE BEEN CALCULATED USING A MAXIMUM FLOW OF 140 MLD.



ISSUE	DATE	AMENDMENT	BY	APPD.

DESIGNED	C POVEY	01/13
DES. CHECKED		
DRAWN	IR MULLIGAN	01/13
DWG. CHECKED		
PROJECT LEADER		
INFRAST'R APP'D		
	BY	DATE

WSL TO SIGN
OPERATIONS
WSL TO SIGN
INFRASTRUCTURE

water Care services limited

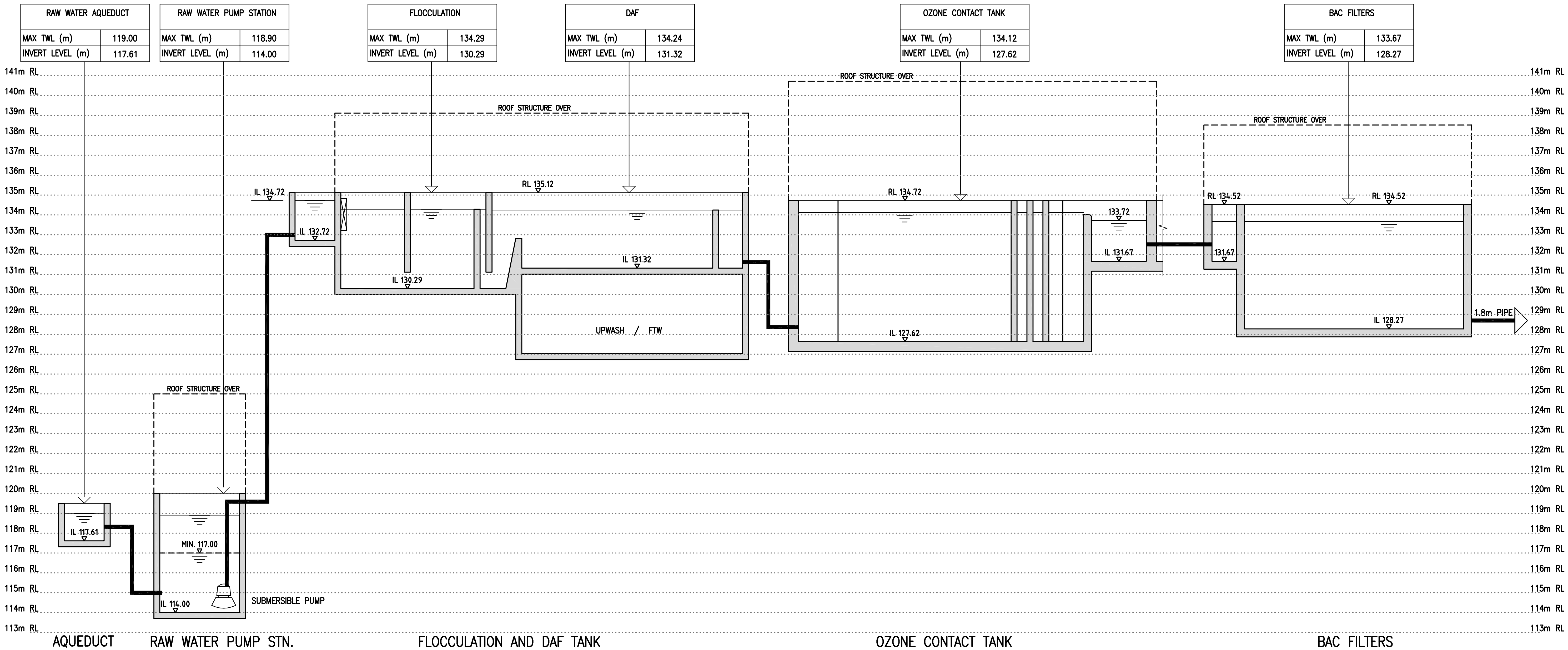
MWH.

HUIA WTP IMPLEMENTATION STRATEGY
OPTION 2E
HYDRAULIC PROFILE (CONCEPTUAL) – SHEET 2

DRAFT

CAD FILE 80501084-01-001-G064
ORIGINAL SCALE A1 AS SHOWN
CONTRACT No.
REF. No. 80501084-01-001-G064
ISSUE A
DWG. No.

NOTES
1. ALL DETAILS HAVE BEEN TAKEN FROM DRAWINGS PROVIDED BY WATERCARE SERVICES LTD.
2. HYDRAULIC LEVELS HAVE BEEN CALCULATED USING A MAXIMUM FLOW OF 140 MLD.



ISSUE	DATE	AMENDMENT	BY	APPD.		BY	DATE
					DESIGNED	C POVEY	01/13
					DES. CHECKED		
					DRAWN	IR MULLIGAN	01/13
					DWG. CHECKED		
					PROJECT LEADER		
					INFRAST'R APP'D		

WSL TO SIGN
OPERATIONS
WSL TO SIGN
INFRASTRUCTURE

water Care services limited

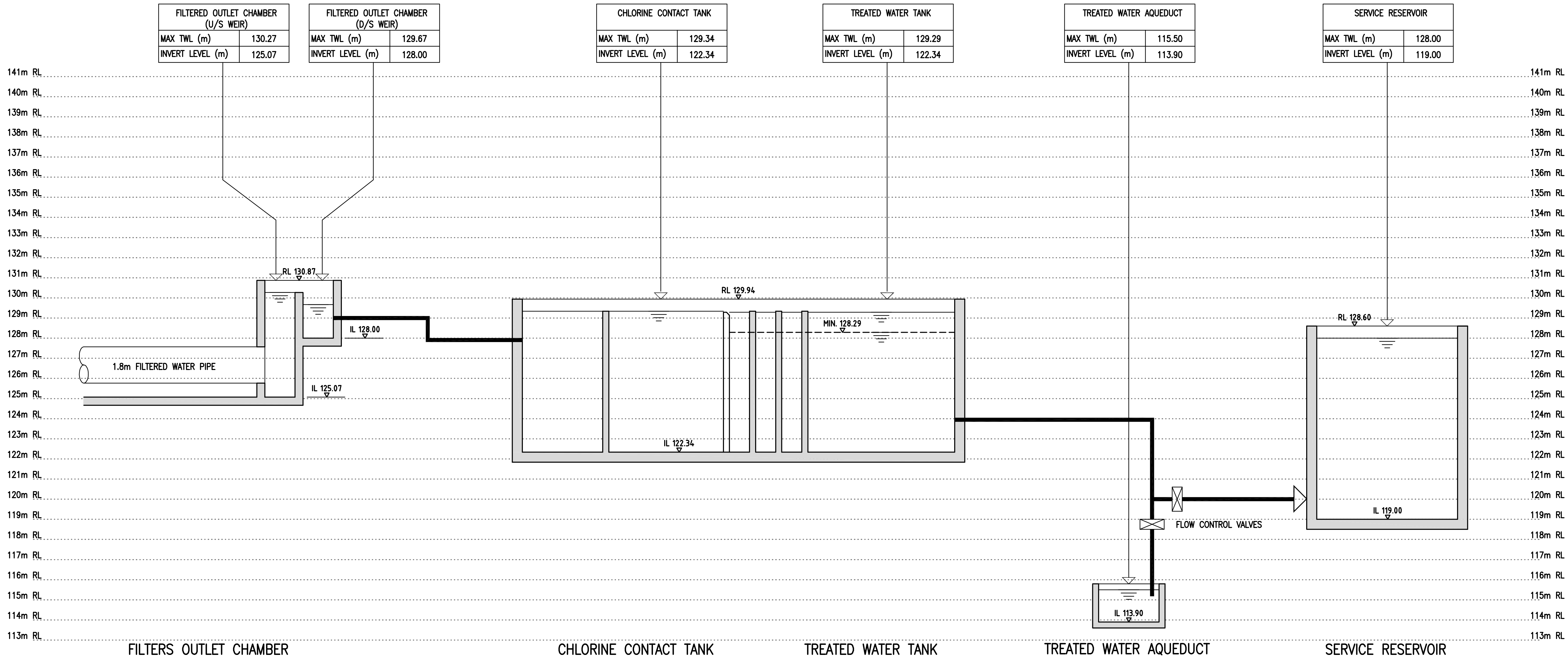
MWH.

HUIA WTP IMPLEMENTATION STRATEGY
OPTION 5B
HYDRAULIC PROFILE (CONCEPTUAL) – SHEET 1

DRAFT

CAD FILE 80501084-01-001-G066
ORIGINAL SCALE A1 AS SHOWN
CONTRACT No.
REF. No. 80501084-01-001-G066
ISSUE A
DWG. No.

NOTES
1. ALL DETAILS HAVE BEEN TAKEN FROM DRAWINGS PROVIDED BY WATERCARE SERVICES LTD.
2. HYDRAULIC LEVELS HAVE BEEN CALCULATED USING A MAXIMUM FLOW OF 140 MLD.



ISSUE	DATE	AMENDMENT	BY	APPD.		BY	DATE
					DESIGNED	C POVEY	01/13
					DES. CHECKED		
					DRAWN	IR MULLIGAN	01/13
					DWG. CHECKED		
					PROJECT LEADER		
					INFRAST'R APP'D		

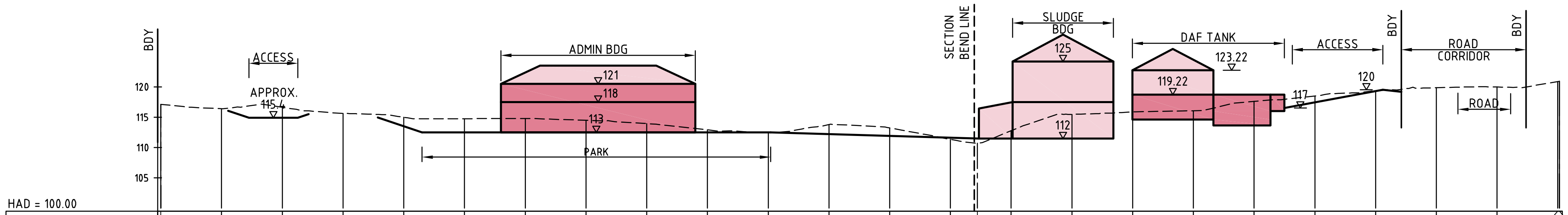
WSL TO SIGN
OPERATIONS
WSL TO SIGN
INFRASTRUCTURE

water Care services limited

MWH.

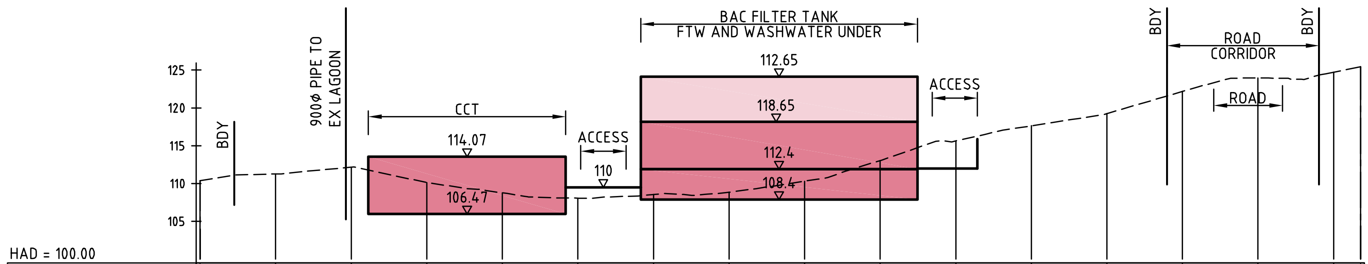
HUIA WTP IMPLEMENTATION STRATEGY
OPTION 5B
HYDRAULIC PROFILE (CONCEPTUAL) – SHEET 2

CAD FILE 80501084-01-001-G067 DATE
ORIGINAL SCALE A1 AS SHOWN
CONTRACT No.
REF. No. 80501084-01-001-G067
ISSUE A
DWG. No.



EXISTING GROUND LEVEL	117.10	116.39	116.64	115.64	114.99	114.75	114.79	114.8	113.94	112.90	112.48	113.77	113.23	111.33	110.70	112.77	115.48	115.87	116.07	117.60	118.47	119.29	119.85	119.98	120.87	120.92
CHAINAGE	0.00	10.00	20.00	30.00	40.00	50.00	60.00	70.00	80.00	90.00	100.00	110.00	120.00	130.00	134.42	140.00	150.00	160.00	170.00	180.00	190.00	200.00	210.00	220.00	230.00	230.26

LONGSECTION - SECTION A-A
SCALES: HOR 1:500 VERT 1:500



EXISTING GROUND LEVEL	110.39	111.26	112.17	110.13	108.77	108.07	108.55	108.84	110.31	113.03	115.63	117.64	119.25	122.18	123.96	124.71	125.46
CHAINAGE	0.00	10.00	20.00	30.00	40.00	50.00	60.00	70.00	80.00	90.00	100.00	110.00	120.00	130.00	140.00	150.00	153.56

LONGSECTION - SECTION B-B
SCALES: HOR 1:500 VERT 1:500

ISSUE	DATE	AMENDMENT	BY	APPD.

DESIGNED	J PEVERIL	01/13
DES. CHECKED		
DRAWN	B TIMBLICK	01/13
DWG. CHECKED		
PROJECT LEADER		
INFRAST'R APP'D		
	BY	DATE

WSL TO SIGN
OPERATIONS
WSL TO SIGN
INFRASTRUCTURE

water Care services limited

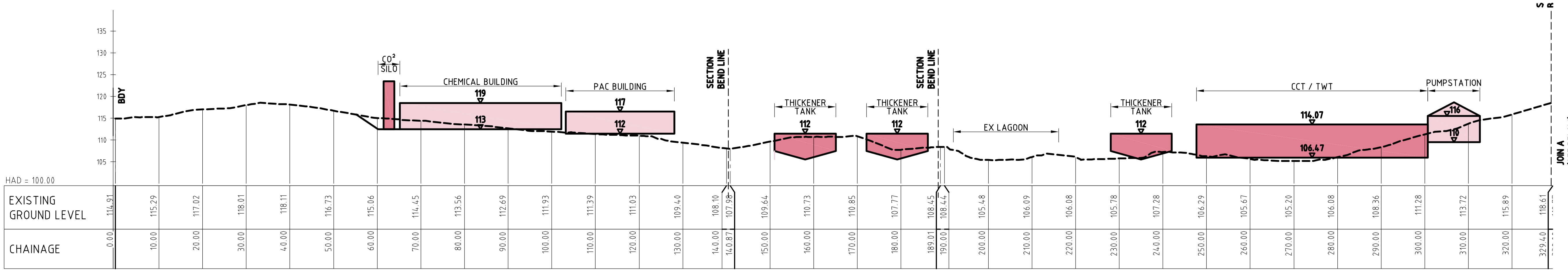
MWH.

HUIA WTP IMPLEMENTATION STRATEGY

OPTION 1B rev – SITE CIVIL SECTIONS – SHEET 1

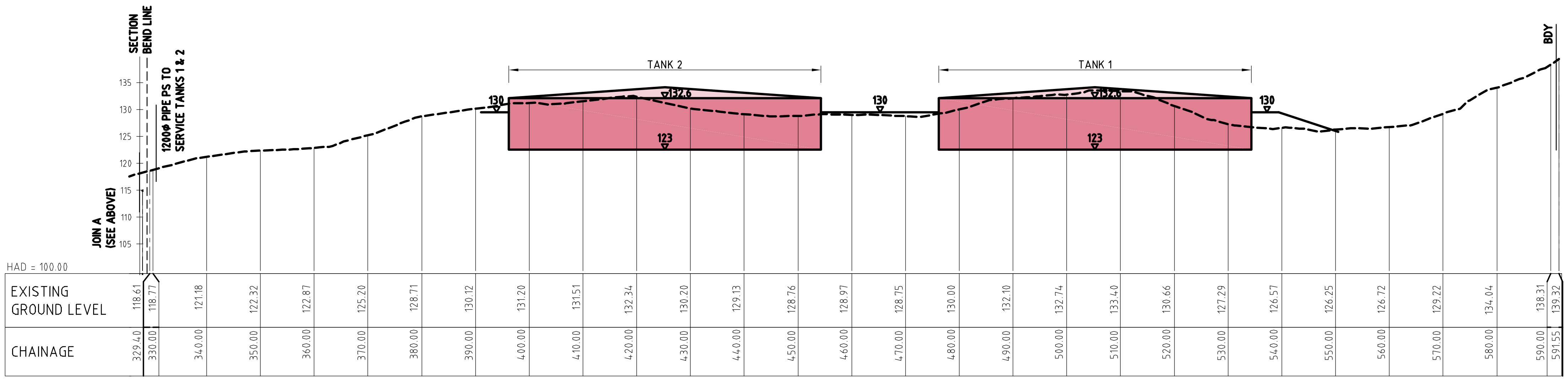
DRAFT

CAD FILE 80501084-01-001-G114 DATE
ORIGINAL SCALE A1 1 : 500
CONTRACT No.
REF. No. 80501084-01-001-G114
ISSUE A
DWG. No.



LONGSECTION - SECTION C-C PART 1

SCALES: HOR 1:500 VERT 1:500



LONGSECTION - SECTION C-C PART 2

SCALES: HOR 1:500 VERT 1:500

ISSUE	DATE	AMENDMENT	BY	APPD.

	BY	DATE
DESIGNED	J PEVERIL	01/13
DES. CHECKED		
DRAWN	B TIMBLICK	01/13
DWG. CHECKED		
PROJECT LEADER		
INFRAST'R APP'D		

WSL TO SIGN
OPERATIONS
WSL TO SIGN
INFRASTRUCTURE

water Care services limited

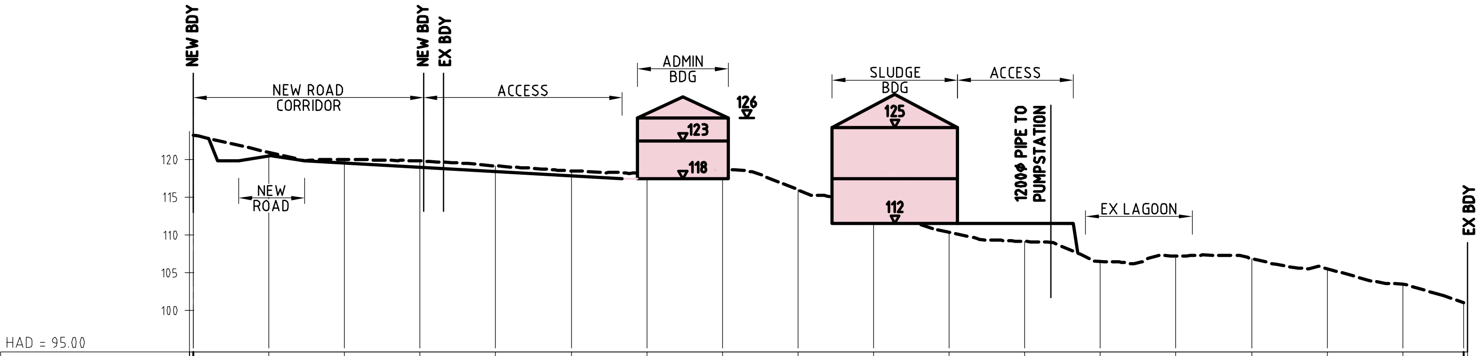
MWH.

HUIA WTP IMPLEMENTATION STRATEGY

OPTION 1B rev – SITE CIVIL SECTIONS – SHEET 2

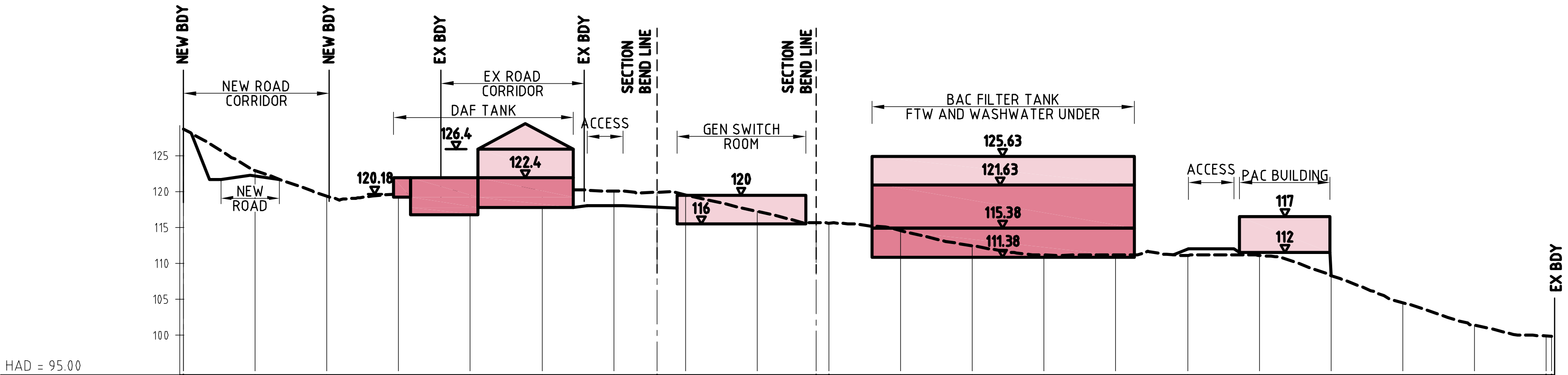
DRAFT

CAD FILE 80501084-01-001-G DATE
ORIGINAL SCALE A1 1 : 500
CONTRACT No.
REF. No. 80501084-01-001-G115
ISSUE A
DWG. No.



EXISTING GROUND LEVEL	123.24	120.95	120.03	119.82	119.15	118.49	118.29	118.70	116.00	113.68	110.36	109.16	106.53	107.22	106.91	105.56	103.54	101.05
CHAINAGE	0.00	10.00	20.00	30.00	40.00	50.00	60.00	70.00	80.00	90.00	100.00	110.00	120.00	130.00	140.00	150.00	160.00	168.03

LONGSECTION - SECTION E-E
SCALES: HOR 1:500 VERT 1:500



EXISTING GROUND LEVEL	128.72	122.94	119.40	119.64	120.46	120.43	120.05	119.91	119.54	117.24	115.66	115.62	114.57	112.45	111.17	111.19	111.12	111.10	108.32	104.50	101.38	99.88	99.83
CHAINAGE	0.00	10.00	20.00	30.00	40.00	50.00	60.00	66.03	70.00	80.00	88.26	90.00	100.00	110.00	120.00	130.00	140.00	150.00	160.00	170.00	180.00	190.00	190.71

LONGSECTION - SECTION F-F
SCALES: HOR 1:500 VERT 1:500

ISSUE	DATE	AMENDMENT	BY	APPD.

DESIGNED	J PEVERIL	01/13
DES. CHECKED		
DRAWN	B TIMBLICK	01/13
DWG. CHECKED		
PROJECT LEADER		
INFRAST'R APP'D		
	BY	DATE

WSL TO SIGN
OPERATIONS
WSL TO SIGN
INFRASTRUCTURE

water Care services limited

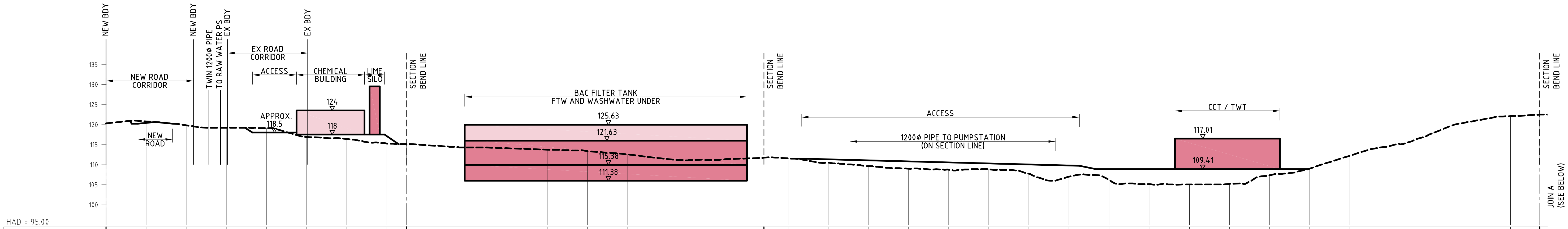
MWH.

HUIA WTP IMPLEMENTATION STRATEGY

OPTION 2E - SITE CIVIL SECTIONS - SHEET 1

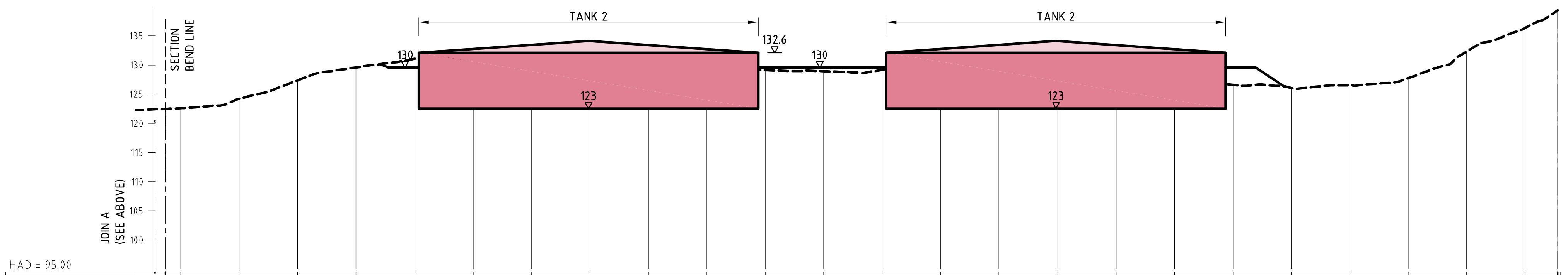
DRAFT

CAD FILE 80501084-01-001-G125 DATE
ORIGINAL SCALE A1 AS SHOWN
CONTRACT No.
REF. No. 80501084-01-001-G125
ISSUE A
DWG. No.



CHAINAGE	EXISTING GROUND LEVEL
0.00	120.35
10.00	120.83
20.00	119.81
30.00	119.18
40.00	119.15
50.00	116.91
60.00	116.42
70.00	115.30
74.84	115.17
80.00	114.88
90.00	114.32
100.00	114.10
110.00	113.77
120.00	113.38
130.00	112.53
140.00	111.44
150.00	111.18
160.00	111.60
163.94	111.74
170.00	111.59
180.00	110.51
190.00	109.67
200.00	109.01
210.00	108.73
220.00	108.84
230.00	107.77
240.00	107.01
250.00	106.20
260.00	105.18
270.00	105.08
280.00	105.21
290.00	107.38
300.00	109.05
310.00	112.26
320.00	114.68
330.00	117.60
340.00	120.72
350.00	122.12
357.33	122.47
360.00	122.58

LONGSECTION - SECTION G-G PART 1
SCALES: HOR 1:500 VERT 1:500



CHAINAGE	EXISTING GROUND LEVEL
357.33	122.47
360.00	122.58
370.00	124.19
380.00	127.36
390.00	129.56
400.00	131.03
410.00	131.06
420.00	132.22
430.00	131.04
440.00	129.55
450.00	128.73
460.00	129.09
470.00	128.91
480.00	129.14
490.00	131.75
500.00	132.57
510.00	133.48
520.00	132.26
530.00	128.29
540.00	126.58
550.00	126.02
560.00	126.45
570.00	127.73
580.00	132.28
590.00	136.35
595.57	139.32

LONGSECTION - SECTION G-G PART 2
SCALES: HOR 1:500 VERT 1:500

ISSUE	DATE	AMENDMENT	BY	APPD.

DESIGNED	J PEVERIL	01/13	
DES. CHECKED			
DRAWN	B TIMBLICK	01/13	
DWG. CHECKED			
PROJECT LEADER			
INFRAST'R APP'D			
	BY	DATE	

WSL TO SIGN
OPERATIONS
WSL TO SIGN
INFRASTRUCTURE

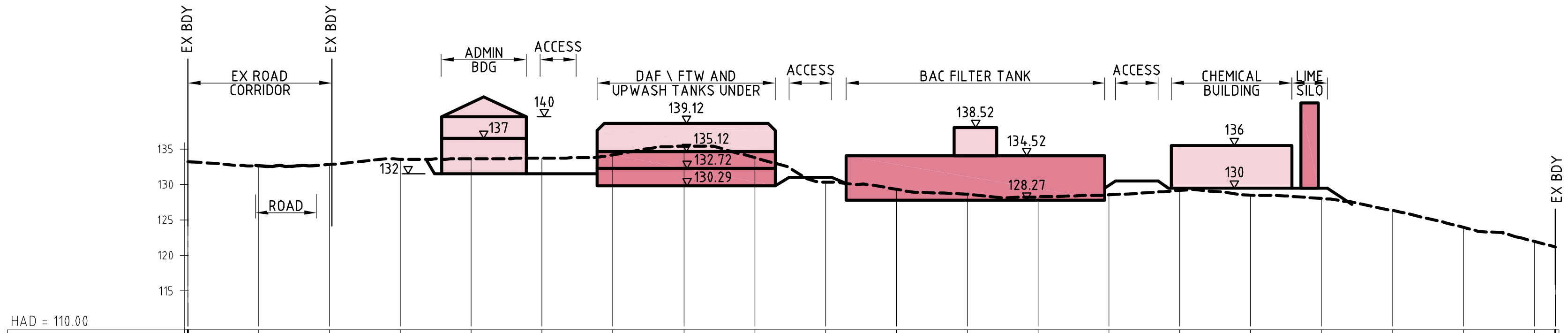
water Care services limited

MWH.

HUIA WTP IMPLEMENTATION STRATEGY

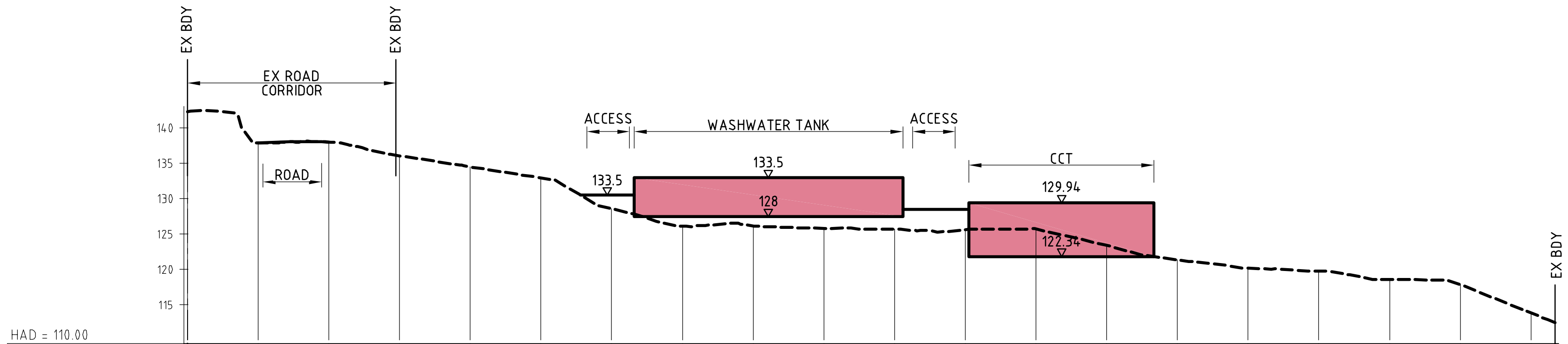
OPTION 2E - SITE CIVIL SECTIONS - SHEET 2

CAD FILE 80501084-01-001-G126 DATE
ORIGINAL SCALE A1 AS SHOWN
CONTRACT No.
REF. No. 80501084-01-001-G126
ISSUE A
DWG. No.



EXISTING GROUND LEVEL	133.20	132.59	132.81	133.55	133.61	133.67	134.19	135.36	133.77	130.33	129.31	128.59	128.24	128.51	129.16	128.49	127.99	126.31	123.96	121.94	121.17
CHAINAGE	0.00	10.00	20.00	30.00	40.00	50.00	60.00	70.00	80.00	90.00	100.00	110.00	120.00	130.00	140.00	150.00	160.00	170.00	180.00	190.00	192.97

LONGSECTION - SECTION M-M
SCALES: HOR 1:500 VERT 1:500



EXISTING GROUND LEVEL	142.30	137.89	138.00	136.06	134.49	132.94	128.58	126.15	126.13	125.81	125.67	125.61	125.72	123.41	121.37	120.17	119.77	118.58	117.83	113.84	112.46
CHAINAGE	0.00	10.00	20.00	30.00	40.00	50.00	60.00	70.00	80.00	90.00	100.00	110.00	120.00	130.00	140.00	150.00	160.00	170.00	180.00	190.00	193.43

LONGSECTION - SECTION N-N
SCALES: HOR 1:500 VERT 1:500

ISSUE | DATE | AMENDMENT | BY | APPD.

DESIGNED J PEVERIL 01/13
DES. CHECKED
DRAWN B TIMBLICK 01/13
DWG. CHECKED
PROJECT LEADER
INFRAST'R APP'D
BY DATE

WSL TO SIGN
OPERATIONS
WSL TO SIGN
INFRASTRUCTURE

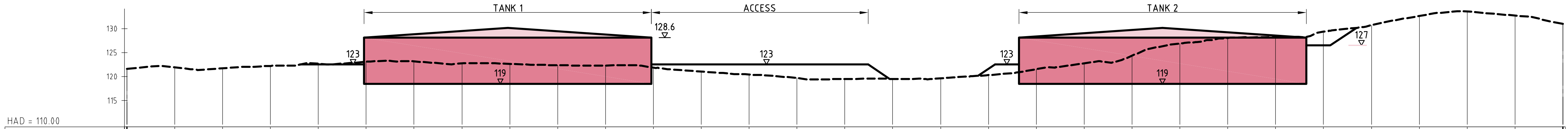
water Care services limited

MWH.

HUIA WTP IMPLEMENTATION STRATEGY

OPTION 5B rev - SITE CIVIL SECTIONS - SHEET 1

CAD FILE 80501084-01-001-G154 DATE
ORIGINAL SCALE A1 AS SHOWN
CONTRACT No.
REF. No. 80501084-01-001-G154
ISSUE A
DWG. No.



EXISTING GROUND LEVEL	121.62	121.90	121.70	122.22	122.66	123.07	123.14	122.75	122.63	122.36	122.31	121.82	121.03	120.39	119.71	119.47
CHAINAGE	0.00	10.00	20.00	30.00	40.00	50.00	60.00	70.00	80.00	90.00	100.00	110.00	120.00	130.00	140.00	150.00

EXISTING GROUND LEVEL	119.50	119.63	120.29	121.53	122.76	124.35	126.88	128.04	128.26	129.35	130.68	132.64	133.56	132.72	131.02
CHAINAGE	160.00	170.00	180.00	190.00	200.00	210.00	220.00	230.00	240.00	250.00	260.00	270.00	280.00	290.00	300.00

LONGSECTION - SECTION P-P
SCALES: HOR 1:500 VERT 1:500

ISSUE	DATE	AMENDMENT	BY	APPD.

DESIGNED	J PEVERIL	01/13
DES. CHECKED		
DRAWN	B TIMBLICK	01/13
DWG. CHECKED		
PROJECT LEADER		
INFRAST'R APP'D		
	BY	DATE

WSL TO SIGN
OPERATIONS
WSL TO SIGN
INFRASTRUCTURE

water Care services limited

MWH.

HUIA WTP IMPLEMENTATION STRATEGY

OPTION 5B rev - SITE CIVIL SECTIONS - SHEET 2

DRAFT

CAD FILE 80501084-01-001-G155 DATE
ORIGINAL SCALE A1 AS SHOWN
CONTRACT No.
REF. No. 80501084-01-001-G155
ISSUE A
DWG. No.

Huia WTP Upgrade - HGL levels

	HGL Levels			Structure floor level			Structure Top level			Roof level			Comment
	Option 1B	Option 2E	Option 5B	Option 1B	Option 2E	Option 5B	Option 1B	Option 2E	Option 5B	Option 1B	Option 2E	Option 5B	
Raw Water Aquaduct - max	119.00	119.00	119.00	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	
Raw Water PS Inlet well - max	N/A	118.90	118.90	N/A	114.00	114.00	N/A	120.00	120.00	N/A	125.00	125.00	
Raw Water PS Inlet well - min	N/A	117.00	117.00	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	
DAF Inlet Mixing Structure	118.87	Pipe mix	Pipe mix	115.87	N/A	N/A	119.87	N/A	N/A	N/A	N/A	N/A	Grated cover
DAF Inlet Channel	118.82	122.00	134.72	116.82	120.00	132.72	119.22	122.40	135.12	N/A	N/A	N/A	
DAF Flocculation tank	118.42	121.58	134.29	114.42	117.58	130.29	119.22	122.40	135.12	123.22	126.40	139.12	Building over floc optional
DAF Flotation tank	118.37	121.53	134.24	115.42	118.60	131.32	119.22	122.40	135.12	123.22	126.40	139.12	
Ozone Tank	118.25	121.23	134.12	111.75	114.73	127.62	118.85	121.83	134.72	124.85	127.83	140.72	Ozone building over tank
Ozone Tank outlet weir - d/s	117.85	120.83	133.72	115.80	118.78	131.67	118.85	121.83	134.72	124.85	127.83	140.72	
BAC inlet channel	117.80	120.78	133.67	115.80	118.78	131.67	118.65	121.63	134.52	122.65	125.63	138.52	
BAC Filter	117.80	120.78	133.67	112.40	115.38	128.27	118.65	121.63	134.52	122.65	125.63	138.52	Roof over filter gallery
BAC Filter outlet weir box - u/s	114.40	117.38	130.27	109.20	112.18	125.07	115.00	117.98	130.87	N/A	N/A	N/A	Grated cover
BAC Filter outlet weir box - d/s	113.80	116.78	129.67	111.00	112.18	128.00	115.00	117.98	130.87	N/A	N/A	N/A	Grated cover
CCT	113.47	116.41	129.34	106.47	109.41	122.34	114.07	110.01	129.94	114.07	110.01	129.94	Slab roof
TWT - max	113.42	116.36	129.29	106.47	109.41	122.34	114.07	110.01	129.94	114.07	110.01	129.94	Slab roof
TWT - min	112.42	115.36	128.29	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	Slab roof
Service Reservoir	132.00	132.00	128.00	123.00	123.00	119.00	132.60	132.60	128.60	132.60	132.60	128.60	Roof level at tank edge
FTW Tank	Under BAC tank		Under DAF	Under BAC tank		Under DAF	Under BAC tank		Under DAF	Under BAC tank		Under DAF	
Waste washwater tank	Under BAC tank		133.00	Under BAC tank		128.00	Under BAC tank		133.50	N/A	N/A	N/A	
Washwater thickener	Match exist		130.00	Match exist		127.00	Match exist		130.60	N/A	N/A	N/A	
Sludge Thickener	Match exist		132.00	Match exist		129.00	Match exist		132.60	N/A	N/A	N/A	Match washwater thickener
Outlet PS building	N/A	N/A	N/A	110.00	110.00	N/A	N/A	N/A	N/A	116.00	116.00	N/A	Assume 6m building
Generator building	N/A	N/A	N/A	111.00	116.00	131.00	N/A	N/A	N/A	115.00	120.00	135.00	Assume 4m building
Admin Building	N/A	N/A	N/A	113.00	118.00	132.00	N/A	N/A	N/A	121.00	126.00	140.00	Assume 8m 2 storey building
Sludge Building	N/A	N/A	N/A	112.00	112.00	130.00	N/A	N/A	N/A	125.00	125.00	143.00	Assume 13m 2 storey building
PAC Building	N/A	N/A	N/A	112.00	112.00	130.00	N/A	N/A	N/A	117.00	117.00	135.00	Assume 5m building
Chemical Building	N/A	N/A	N/A	113.00	118.00	130.00	N/A	N/A	N/A	119.00	124.00	136.00	Assume 6m building

Appendix Q Preliminary Geotechnical Appraisal Report

Huia Water Treatment Plant Upgrade
Preliminary Geotechnical Appraisal Report

Prepared for Watercare Services Ltd

January 2013

This document has been prepared for the benefit of Watercare Services Ltd. No liability is accepted by this company or any employee or sub-consultant of this company with respect to its use by any other person.

This disclaimer shall apply notwithstanding that the report may be made available to Auckland Council and other persons for an application for permission or approval to fulfil a legal requirement.

QUALITY STATEMENT

PROJECT MANAGER	PROJECT TECHNICAL LEAD
Amy Clore	Amy Clore

PREPARED BY		
Ilai Waqa	[signature]	24/01/13
CHECKED BY		
Kevin O'Rourke	K. O'Rourke	24/01/13
REVIEWED BY		
Andrew Irvine	[signature]	24/01/13
APPROVED FOR ISSUE BY		
Amy Clore	……………………………………………	……/……/……

AUCKLAND LEVEL 3
Level 3 Building C Millennium Centre, 600 Great South Road, Greenlane, Auckland 1051
PO Box 12-941, Penrose, Auckland 1642
TEL +64 9 580 4500, FAX +64 9 580 7600

REVISION SCHEDULE

Rev No	Date	Description	Signature or Typed Name (documentation on file).			
			Prepared by	Checked by	Reviewed by	Approved by
1	24/01/13	Draft for Client	IW	KOR	AI	AC

CONTENTS

1 Introduction 1
2 Scope of Report 2
3 Existing Information 2
4 Site Description 2
5 Proposed Works 3
6 Regional Geology 4
6.1 Seismicity 4
7 Geotechnical Issues 4
7.1 Slope Instability 4
7.2 Foundation Conditions 5
7.3 Settlement 5
7.4 Access Road Realignment 5
7.5 Groundwater 5
7.6 Pipeline Route 6
7.7 Service Check 6
7.8 Site Access 6
8 Site Investigation Methodology 6
8.1 Field Investigation and Testing 6
8.2 Laboratory Testing Methodology 7
9 Conclusions 8
Limitations 9
References 10

LIST OF FIGURES

Figure 1 Proposed Site Location 1

APPENDICES

Appendix A Proposed Geotechnical Investigation Plans
Appendix B Testing Schedule
Appendix C Overall Layout Options

1 Introduction

MWH New Zealand Ltd (MWH) has been engaged by Watercare Services Ltd (WSL) to prepare a Preliminary Geotechnical Appraisal Report (PGAR) as part of the Huia Implementation Strategy Studies into the proposed treatment process upgrade at the Huia Water Treatment Plant (WTP), Auckland, at the location indicated on Figure 1. The Huia WTP has an operating capacity of approximately 126 ML/day. It is a conventional water treatment plant which is fed from the four lakes located in the Waitakere ranges namely; Upper Nihotupu, Lower Nihotupu, Upper Huia and Lower Huia. The Huia WTP normally supplies water to west Auckland and approximately one third of the supply to North Shore, Orewa and Whangaparoa.

This PGAR has been prepared as part of the concept design stage of the project. The purpose of this report is to:

- identify gaps in the existing information
- discuss geotechnical issues/risks that are associated with the proposed upgrade works
- recommend field and laboratory testing schedules to characterise the materials encountered at the site and obtain geotechnical information to be used in the design of the various components of the proposed upgrade.

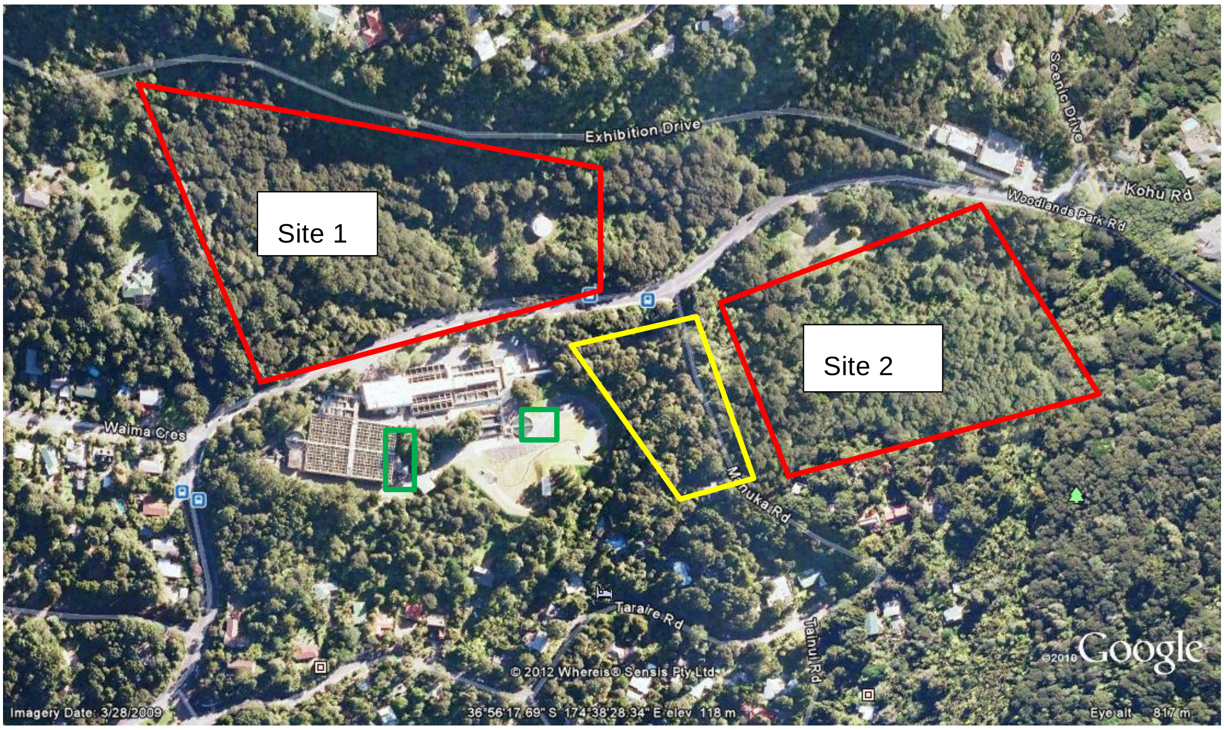


Figure 1 Proposed Site Location

- **the approximate area of this study outlined in red**
- **approximate area studied by GHD Ltd in 2002 outlined in green**
- **the area on eastern side of the existing WTP that will be used for the proposed upgrade works is outlined in yellow**

2 Scope of Report

The Scope of this PGAR is to outline any potential geotechnical issues that could affect the proposed upgrade works at the Huia Water Treatment Plant and to identify what geotechnical site investigation and testing will be required to support future design activities. The PGAR consists of the following:

- Desk study and review of geological maps and existing reports
- Field Reconnaissance
- Identification of likely geotechnical issues
- Preparation of a schedule of recommended field and laboratory testing to be done as part of future geotechnical investigations.

3 Existing Information

A Geotechnical Risk Assessment Report on the Huia Filter Station dated September 2002 was compiled by GHD Ltd (see Figure 1). The objective of the report was to review existing ground investigation data at the treatment plant, provide a preliminary assessment of the geotechnical issues related to the proposed upgrade works and recommend additional geotechnical investigation for the design of additional structures proposed for the 2002 upgrade.

Beca Ltd carried out subsurface investigations at the eastern end of the existing Huia WTP as this area was proposed as a possible additional storage site. The investigations indicate that soils of the weathered Cornwallis Formation are present at the site with varying thicknesses from 7.5 – 19.0 m. These are underlain by highly weathered interbedded Sandstone and Siltstone with fresh rock encountered at depths between 14.0 and 31.0 m below ground level.

The Beca report reveals the presence of several sheared and slickensided surfaces within the weathered rock at depths of 12.0 to 14.0 m in the boreholes and within the test pits at depths of approximately 1.5 to 2.0 m below ground surface. Large scale, deep seated instabilities as well as shallow instability features were found at the eastern end of the Huia WTP site and Beca concluded that the instability features observed at the existing Huia WTP are likely to be present at the Manuka Road site.

Preliminary drawings obtained from WSL showed the various layout options for the proposed water treatment plant upgrade. These options are briefly described in Section 5.

In addition, information on the elements of the work was obtained from discussion notes on the Concept Design Summary Report for the Manuka Road Reservoir and this includes construction of the reservoir, treated water tanks, treated water pump stations and connecting pipelines.

General descriptions and characteristics of rock and soil materials likely to be encountered at the project site were obtained from the 1:250,000 Geology of the Auckland Urban Area, Map 3, dated 2001.

4 Site Description

The following areas, which are the sites for the construction of the proposed treatment process upgrade structures were visited during field reconnaissance:

- Site located immediately to the north of the existing Huia WTP and Woodlands Park Road. The slope of the ground in this area varies from gentle to very steep. This site is characterised by a northwest – southeast elongated mound through the middle of the site and is bounded at its northern end by an approximately 50 m high cliff. An approximately 40 m wide valley with gentle sloping ground is located between the base of the cliff and the mound and runs parallel to it in a northwest – south-easterly direction. Localised areas of soft, saturated ground were observed on the valley floor. Two ephemeral streams were located within the site and ponded water was observed in both streams with soft, damp ground within the immediate vicinity.

- Most of the area is densely vegetated with thick native bush and trees with a lightly grassed area on the south-eastern end of the valley near the entrance to the property.
- The second site (Manuka Road site) is located adjacent to the intersection between Manuka Road and Woodlands Park Road and downslope from the Nihotupu Filter Station. A large section of the site is occupied by two mounds which are elongated in a northwest-southeast direction. Slope angles within the site vary from flat at the top of the mounds, to steep on the flanking slopes. Soft, damp ground was observed on the flat area between the two mounds.
- The site is densely vegetated with native bush and trees with a Kauri tree located near the south-eastern boundary of the property. Part of the north eastern mound adjacent to Woodlands Park Road used to be the site of the WSL caretaker's house. This has since been demolished leaving a flat, lightly grassed area approximately 50 m long by 60 m wide. The treated water tunnel from the Huia WTP runs along the northern end of the site.

5 Proposed Works

The proposed works to be carried out at the site are part of the future treatment process upgrade to the water treatment plant. The various options for the proposed works are included in Appendix C.

Option 1

Option 1 comprises developing the existing Huia WTP in at least two stages. The construction of the treated water tanks, treated water pumping station and Manuka Road Reservoir No. 1 would be carried out in the first stage. The Dissolved Air Flotation (DAF) units, flocculation tanks, ozone contact tanks, filter backwash balance tanks and BAC units would be carried out at a later stage. Option 1 would require the use of the proposed Manuka Road Reservoir No. 1 as the chlorine contact tank until the dedicated chlorine tank is constructed

Option 2

Option 2 includes developing a new site adjacent to the Huia WTP and located to the north of Woodlands Park Road. The construction of the treated water tanks, treated water pumping station and Manuka Road Reservoir No. 1 would be carried out in the first stage. The remainder of the upgrade as mentioned in Option 1 above will be included in a later stage.

This option would also require the use of Manuka Road Reservoir No. 1 as the chlorine contact tank until the dedicated chlorine contact tank is constructed in a later stage. Additionally, this option requires the relocation of Woodlands Park Road further to the North adjacent to the base of the slope beneath Scenic Drive.

Option 3

This option is similar to Option 2 in that it will include developing the site to the north of the existing Huia WTP. Option 3 would not include relocating Woodlands Park Road but have two access roads off the existing alignment. The site layout with the location of the various structures (DAF units, BAC units, chlorine contact tanks, ozone tanks and pumping stations) differs from Option 2.

Option 4

Option 4 is similar to Option 3 with the change in the layout of the site and location of the proposed structures. As is the case in Options 1 to 3, this option will include construction of the Manuka Road Reservoir on the eastern ridge with the access off Woodlands Park Road. Provision for Reservoir No. 2 on the western ridge closer to Manuka Road is also included in options 3 and 4.

Option 5

This option includes constructing the two proposed reservoirs on the site to the north of the existing Huia WTP. The remainder of the proposed structure is located on the Manuka Road site with an access road off Manuka Road and another off Woodlands Park Road.

6 Regional Geology

The site geology is indicated on the IGNS 1:250,000 Geological Map of the Auckland Area, Map 3, dated 2001 to be East Coast Bays Formation (ECBF) and Cornwallis Formation (CF) which are part of the Waitemata Group and Nihotupu Formation (NF) of the Waitakere Group deposited in the Early Miocene.

ECBF is described as characteristic alternating, decimetre bedded, graded sandstone and laminated mudstones. The lower part of ECBF has little volcanic detritus and is dominated by argillaceous rock fragments. The upper part is dominated by mixed volcanic rich and volcanic poor turbidites in the west. Locally, there is up to 10 m of massive to laminated mudstone at the base. ECBF rocks weather to a very soft to soft, greyish white to orange-brown clay, which grades into fresh rock at depths as much as 10 m.

CF rocks comprise thick, graded turbidite sandstone, with typical thicknesses of 0.5 – 3.0 m and interbedded with laminated siltstone and fine grained sandstone. The siltstone and fine sandstone are typically 0.05 – 0.2 m thick and overlies ECBF rocks in west Auckland. The contact between CF and ECBF rocks represent an unconformity. The sandstone within CF are coarser grained than those present in ECBF.

NF rocks which mainly occur on the high ground within the vicinity of the site are made up thin to thickly bedded turbidites. The formation also contains reworked tuffacious and pumiceous materials, tuff breccia debris flows, and slide and slump units.

6.1 Seismicity

The Auckland area is considered to be one of the lowest earthquake activity regions of New Zealand (IGNS, 2001 “Geology of the Auckland Area”). Most earthquakes recorded in the region are less than Richter Magnitude 4 (M4) and not widely felt nor do they result in significant property damage or loss of life. Over the last 150 years there appear to be only two earthquakes recorded with magnitudes in excess of M5. On average the Auckland region may expect to experience Modified Mercalli Shaking Intensity of MM7 or greater every 650 years.

The main active faults indicated on the NZGS New Zealand Active Faults Database are the Wairoa Faults (North and South) located in the Hunua Ranges. This is an active normal fault dipping 60 to 70 degrees to the west with an apparent vertical slip rate of 0.1mm per year. There is no known recurrence interval at this fault.

7 Geotechnical Issues

7.1 Slope Instability

The slope of the ground within the two sites being considered for the proposed development varies from gentle to steep. The two areas are characterised by elongated lobes which are oriented in a north-westerly – south-easterly direction. These lobes are located at the base of a 50 m high cliff and have been interpreted by Beca as being part of a large scale landslide that underlies the southern side of the Scenic Drive cliff. The large scale landslide is likely to be inactive as no evidence of recent movement was observed during the site visit. Small scale instability features characterised by slickensided surfaces observed in the boreholes and test pits are likely to be localised features and can be reactivated if toe support is removed or water is introduced to the ground. The proposed detailed geotechnical investigations will be aimed at confirming the areas of potentially unstable ground.

Development adjacent to the base of the cliff is likely to be affected by rockfall hazards as loose boulders of Sandstone were observed on the face of the cliff. Option 2 is proposing to relocate Woodlands Park Road to the northern side of the proposed development area. This proposed road location is sited at the base of the cliff where the road will be at risk from rockfall hazards. This risk will need to be considered in evaluating the feasibility of this option.

The stability of proposed cut and fill batters will have to be considered during the design stage. The proposed field investigation and laboratory testing program will be designed to provide engineering parameters for the design of stable cut and fill batters, retaining structures and stability analysis of natural slopes.

7.2 Foundation Conditions

Most of the proposed structures are likely to be founded on the near surface, weathered Cornwallis Formation soils and weathered sandstone and siltstone rocks. The bearing capacity of the foundation soils at each of the sites will be assessed against the design loads applied by the structure. Investigation holes will be sited at the approximate locations of the structures to characterise the foundation soils. A recommendation on suitable foundation types will need to be made after considering the properties of the materials at the site, likely design loads and groundwater conditions.

It is likely that adequate bearing conditions for the reservoirs will be encountered at the proposed locations on Manuka Road.

Concept design drawings (Appendix C) indicated that development of the site to the north of the existing Huia WTP will also be carried out on the flat ground within the valley floor. Areas of soft, damp ground observed during the site visit in this area will be investigated to confirm the presence or otherwise of any organic clays and peat. A pocket of organic clay and peat was encountered in one of the boreholes at the Huia WTP site.

7.3 Settlement

The soils observed in exposures during the site visit are mostly of a cohesionless, sandy nature; however layers of clay are likely to be encountered within the two sites. The final levels of the proposed structure and any associated excavation have not been established. It is likely that the foundation levels for the reservoirs on Manuka Road will require excavation to the weathered sandy soils and sandstone. Any settlement associated with these materials is likely to be short term and most of the settlements are likely to occur during the construction stage.

Any clay or organic material encountered during the investigation particularly on the site to the north of the existing Huia WTP will be tested to obtain parameters for settlement analysis.

7.4 Access Road Realignment

Ground conditions along the proposed realignment route will need to be investigated to ensure that the soils at the sites are capable of providing the required subgrade strength for the new pavement. Geotechnical properties of these soils are also required if the subgrade needed to be modified to provide the required strength.

7.5 Groundwater

Areas of damp ground were observed on the flat lying areas at the base of the elevated ground and two ephemeral streams with ponded water were observed within the site to the north of the existing Huia WTP.

Groundwater information will be obtained during the investigation and piezometers will be installed in selected boreholes for monitoring of variation in groundwater conditions at the site.

Variation in groundwater levels is likely to affect localised, shallower instability features within the two sites.

7.6 Pipeline Route

Weathered Cornwallis Formation soils and rocks are likely to be encountered along the proposed pipeline route that links the existing Huia WTP to the proposed reservoir at the Manuka Road site. The strength of this material in relation to excavation effort and trench wall stability will have to be investigated as part of the detailed geotechnical investigation stage.

7.7 Service Check

A full service check and markout is recommended prior to any site investigations commencing. The locations of the treated water tunnel and buried pipelines are to be expected within the site especially in areas adjacent to Woodlands Park Road.

7.8 Site Access

Approvals for site access for site investigations will need to be undertaken at respective locations shown on the attached Proposed Geotechnical Investigation Plans (Appendix A). As the site is densely vegetated, the formation of access to test locations, its associated costs and environmental effects will have to be considered before commencing the investigation. Access agreements for these locations will be organised with WSL. The locations of individual test positions will need to be reassessed prior to commencement of site investigation works.

8 Site Investigation Methodology

8.1 Field Investigation and Testing

The proposed site investigations are based on the existing information on the proposed locations of the various structures as shown on the concept plans and should be reviewed if there are changes to these proposed locations. Areas excluded from the investigation plans presented below include all areas currently occupied by existing structures. These include proposed flocculation and DAF tanks and administration building locations.

We are proposing that the geotechnical site investigation is carried out in 2 stages, to facilitate a more focussed ground investigation program as the project is currently in the concept stage and the location of the structures proposed for the site to the north of the existing Huia WTP is yet to be finalised. With current available information and previous studies carried out on the proposed upgrade works, it is likely that the proposed reservoir(s) will be constructed at the Manuka Road site as indicated in four of the five layout options.

Phase 1 of the ground investigation works will concentrate on the Manuka Road site (proposed reservoir site) and all work proposed in Stage 1 and 2 of Option 1 and Stage 1 of Option 2. All the works proposed in these stages are located within the existing WTP and are sited on the only available space at the eastern end of the WTP (see Figure 1). The only investigation that is being proposed for the site to the north of the WTP that will be included in Phase 1 include two boreholes at the proposed filter wash tank site adjacent to the existing filter wash tank.

Ground investigation works included in Phase 2 will be focussed on the upgrade works proposed for the site to the north of the existing Huia WTP. These included investigation works at the locations of the proposed structures and along the new Woodlands Park Road alignment. We are considering two options for the Phase 2 ground investigation works:

i. Conduct widely spaced preliminary investigation to cover the whole area in conjunction with Phase 1 investigation works to obtain information on ground conditions at the site. More detailed investigation will be carried out later as a preferred layout and the locations of the structures are confirmed.

ii. Defer Phase 2 investigation works until the preferred layout option and the locations of the proposed structures are confirmed.

The site investigations to be included in both phases of the investigation are indicated on the attached Proposed Geotechnical Investigation Plans for Phase 1 and Phase 2 (Appendix A) and attached in the Testing Schedule (Appendix B).

Phase 1 Ground Investigation

- 18 x Boreholes using rotary coring techniques
- 7 x Test Pit Excavations with hand held shear vane testing

Boreholes have been recommended at the proposed locations of the two reservoirs (Manuka Road), chlorine tanks, treated water tanks, pump station and BAC units (eastern end of existing Huia WTP) to assess foundation conditions and the stability of the ground. Insitu samples will be taken from these cores and subject to further analysis in the laboratory.

Test Pits will be undertaken for field logging and insitu strength testing and to provide information on depth to bedrock and temporary wall stability of trenches along the pipeline route from the proposed reservoir site to the existing WTP. The test pits will also provide samples for laboratory testing as it is likely that insitu materials obtained from proposed excavations will be used as fill.

Phase 2 Ground Investigation

- 14 x Boreholes using rotary coring techniques
- 5 x Test Pit Excavations with hand held shear vane testing
- 5 Dynamic Cone Penetrometer Tests (Scalas) along the proposed relocated Woodlands Park Road alignment.

The 14 boreholes are located over the proposed development area as outlined in Layout Options 2–4. They are proposed to provide information on foundation conditions and stability of any cut and fill slopes.

The test pits are located along the proposed relocated Woodlands Park Road alignment. The test pits will also provide samples for laboratory testing to obtain parameters for pavement design and batter stability.

8.2 Laboratory Testing Methodology

Samples obtained from the site investigations will be tested by an IANZ accredited laboratory. The following laboratory tests scheduled to be undertaken:

- Water Content
- Atterberg Limits
- Particle Size Distribution tests (PSD)
- New Zealand Standard Compaction tests
- Soaked CBR Tests (natural) Standard Compaction
- Soaked CBR Tests (natural) with lime or cement modification
- One Dimensional Consolidation Test
- Triaxial Testing of Soil

- Unconfined Compression Test (UCS) of Rock

Atterberg limits, water content and particle size distribution will be undertaken on representative samples across the site for classification of subsoils. These will be incorporated into ground models for cut and fill designs and will determine how subsoils are likely to behave under variable conditions. The soaked CBR testing is included as a provisional item as this is proposed to be undertaken for the relocation of Woodlands Park Road. Consolidation testing is also included as a provisional item for clay samples if encountered during the investigation. This information is relevant to the assessment of settlement of the foundation soils beneath the structures. Triaxial tests and UCS will be carried out to obtain soil parameters for the design of cut and fill slopes as well as obtaining information on the bearing capacity of the soils.

9 Conclusions

The proposed upgrade works to water treatment at the Huia site consists of the construction of a new 25,000 m^3 reservoir with a provision for a second one at a later stage, treated water tanks with pumping stations, DAF units, flocculation tanks, ozone contact tank, filter backwash balance tanks and BAC units. There are currently five options being considered for the layout of the various structures outlined above with construction to be carried out in stages. Two sites are currently being considered for the proposed development and these include the Manuka Road site and a site located to the north of the existing Huia WTP. Both sites are owned by WSL.

The desk study has identified the site geology to consist of East Coast Bays Formation (ECBF) and Cornwallis Formation (CF) which are part of the Waitemata Group and Nihotupu Formation (NF) of the Waitakere Group deposited in the Early Miocene. This Auckland site is considered to have low seismicity.

We anticipate the geotechnical issues to be predominantly defined by the bearing conditions of the near surface soils that will form the founding layer for the various proposed structures. Soil types, strengths, degree of variability (vertically and horizontally), degree of weathering and groundwater conditions will influence the type of foundation and the choice of construction methodology for the foundation components of the proposed structures. In addition, the stability of natural ground as well as cut and fill slopes will need to be assessed to ensure that the risks to the proposed structures are understood. Slope stability is a significant issue that needs to be considered at the two sites due to the presence of large scale, deep seated slope failures and shallower instabilities as reported in previous geotechnical investigations carried out at the existing Huia WTP site.

Additional geotechnical concerns identified during this preliminary assessment stage include potential settlement of clay layers if encountered at the site, ground conditions and wall stability along the proposed pipeline route that will connect the existing Huia WTP to the proposed reservoir on Manuka Road and the effects of groundwater on the stability of existing slopes as well as on bearing conditions of soils encountered at the site.

The proposed investigation and testing methodology will consist of boreholes and test pits for field logging and sampling, along with laboratory testing to classify site soils and to enable assessment of any possible geotechnical issues related to the properties of the soils. It is proposed that the geotechnical investigation be carried out in two stages to ensure that the investigation are focussed on the type and confirmed locations of the proposed structures. Phase 1 of the investigation is proposed to be carried out at the Manuka Road site and on the eastern end of the existing Huia WTP while investigation works on the site to the north of the existing Huia WTP is proposed to be carried out in a later stage once a preferred layout option is confirmed.

Soil parameters needed for the design of cut and fill slopes, foundation for the proposed structures and any proposed pavement construction will be obtained from the field investigations and the laboratory testing program.

Limitations

This report has been prepared for Watercare Services Ltd in accordance with the generally accepted practices and standards in use at the time it was prepared. MWH accepts no liability to any third party who relies on this report.

The information contained in this report is accurate to the best of our knowledge at the time of issue. MWH NZ has made no independent verification of this information beyond the agreed scope set out in the report.

The interpretations as to the likely subsurface conditions contained in this report are based on existing site information inferred from geological maps, existing reports and the result of a site visit as described in this report. No subsurface investigations have been undertaken by MWH NZ Ltd at this stage. The type, spacing and frequency of the proposed investigations, sampling, and testing of materials were selected to meet the technical, financial and time requirements agreed by the client.

Actual ground conditions encountered may vary from the predicted subsurface conditions. For example, subsurface groundwater conditions often change seasonally and over time. No warranty is expressed or implied that the actual conditions encountered will conform exactly to the conditions described herein.

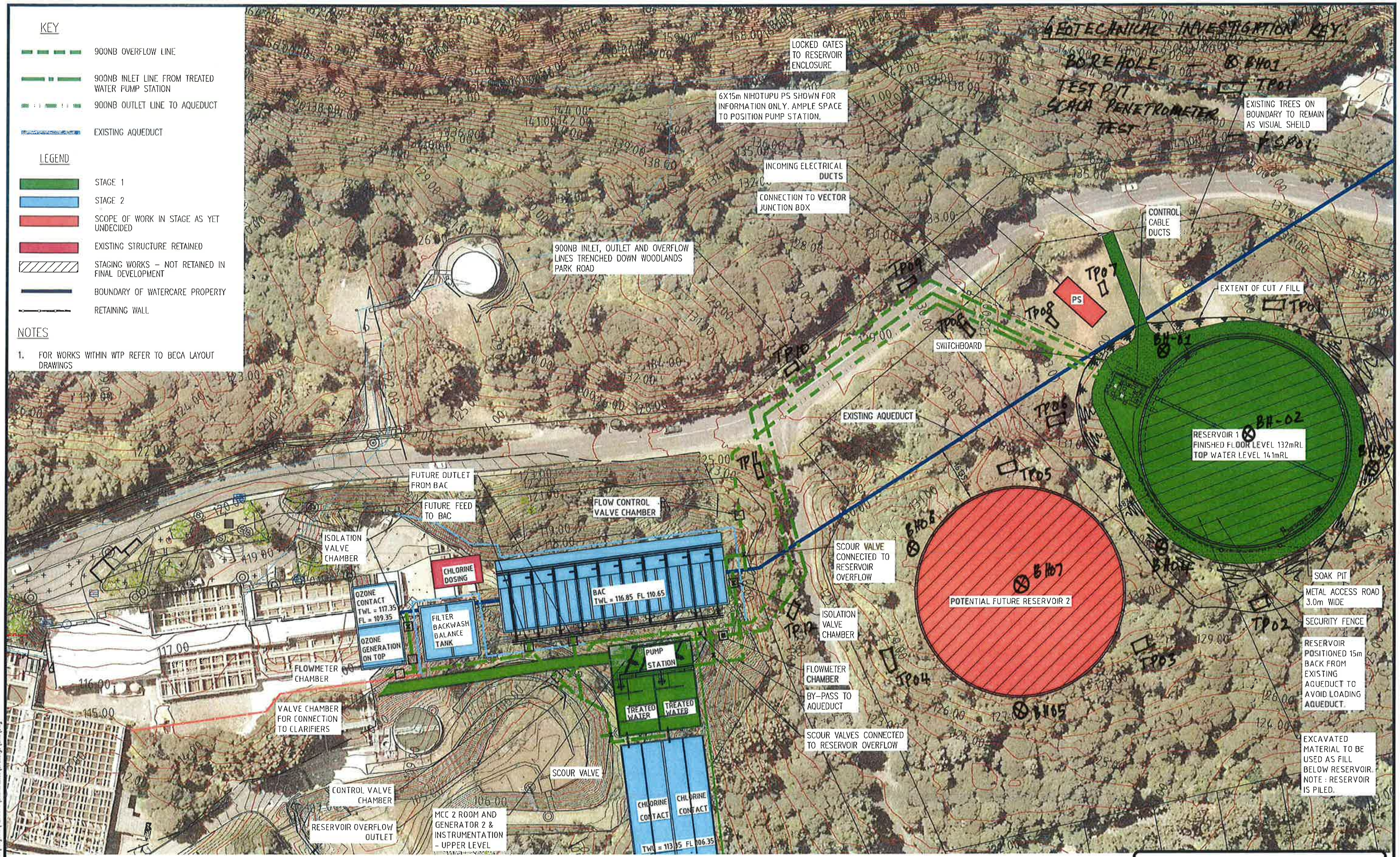
Where conditions encountered at the site differ from those inferred in this report MWH NZ should be notified of such changes, and should be given an opportunity to review the report recommendations made in this report in light of any further information.

This report does not purport to describe all the site characteristics and properties. Subsurface conditions and testing relevant to construction works must be undertaken and assessed by any contractors as necessary for their own purposes.

References

- Edbrooke, S.W. (compiler) (2001). "Geology of the Auckland Area", Institute of Geological and Nuclear Sciences 1:250,000 geological map 3
- GNS "New Zealand Active Faults Database"
- GHD Ltd (September 2002) 'Report on Geotechnical Risk Assessment, Huia Filter Station'
- Beca Ltd (August 2007) 'Report on Titirangi 3 Reservoir Studies'
- SKM Ltd (January 2011) 'Manuka Road Reservoir Concept Design Summary Report'

Appendix A Proposed Geotechnical Investigation Plans



DATUM NOTE
THIS SURVEY IS IN TERMS OF NEW ZEALAND TRANSVERSE MERCATOR (NZTM). ELEVATIONS ARE IN TERMS OF LAND & SURVEY MEAN SEA LEVEL DATUM (AUCKLAND 1946).

PLAN
1:500(A1)

PRELIMINARY

Plot Date: 24-Dec-10 11:46 a.m.
File path: I:\AENVW\Projects\AE03879\Deliverables\Drawings\Civil\Dwg

SKM Project No. AE03879

ISSUE	DATE	AMENDMENT	BY	APPD.
1	05/10	CONCEPT DESIGN	PJG	NML

DESIGNED	NML	
DES. CHECKED	NML	
DRAWN	PJG	
DWG. CHECKED	NML	
REV'D P.MGR	NML	
APP'D P.DIR	DK	
	BY	DATE

OPERATIONS

ASSET MANAGEMENT

SKM
Sinclair Knight Merz
Carlaw Park Commercial
12-16 Nicholls Lane, Parnell, Auckland
NEW ZEALAND
Tel +64 9 928 8000
Fax +64 9 928 8001
www.skmconsulting.com

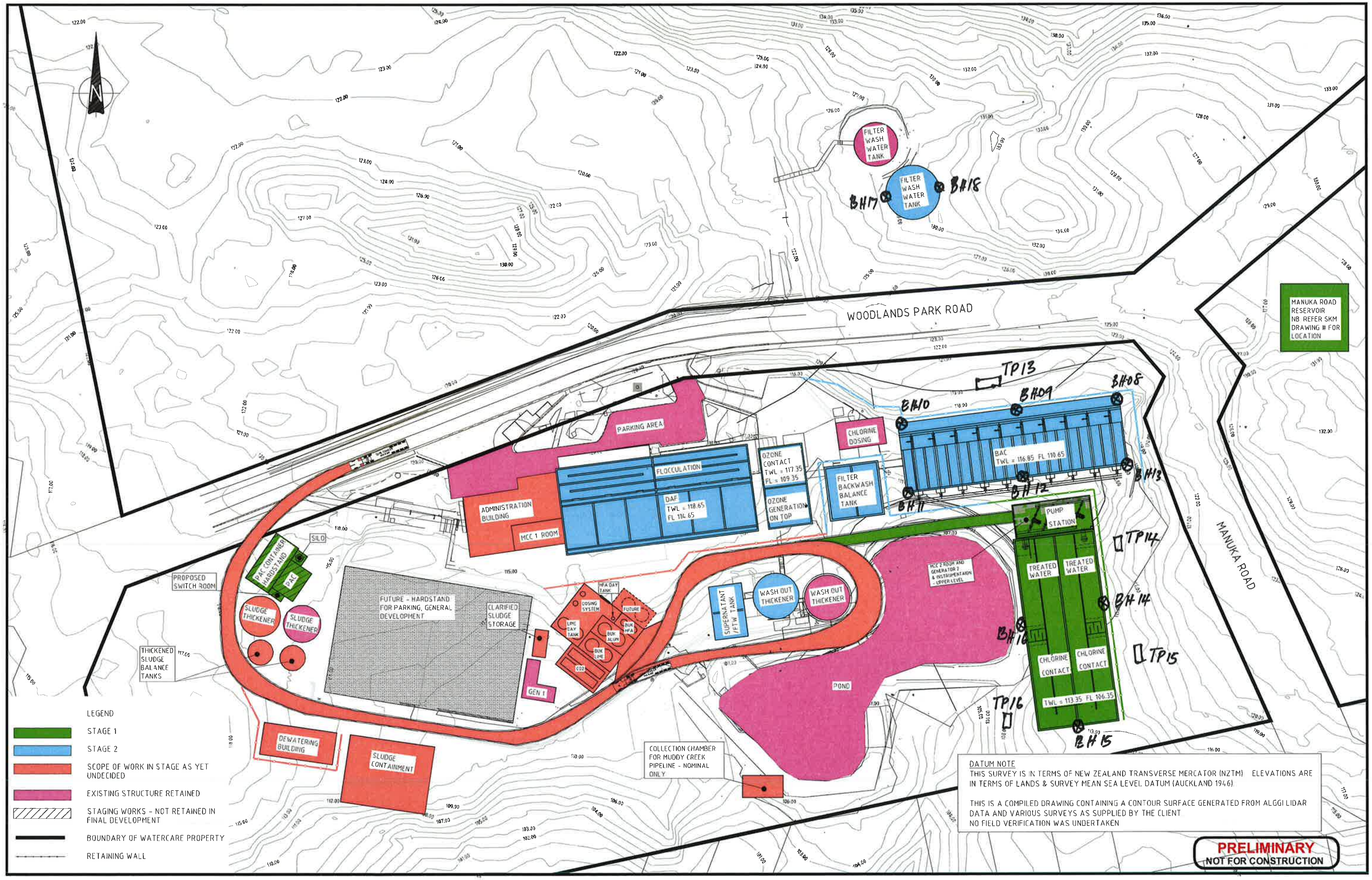
water Care services limited

MANUKA ROAD RESERVOIR PHASE 1.
TREATED WATER PUMPING STATION AND RESERVOIR
OVERALL LAYOUT – OPTION 1 [PROPOSED GEOTECHNICAL INVESTIGATION PLAN]

CAD FILE AE03879-SKM-002
DATE 16-Jun-10

ORIGINAL SCALE A1	CONTRACT No.
AS SHOWN	–

DRAWING No.		ISSUE
AE03879	.002	1



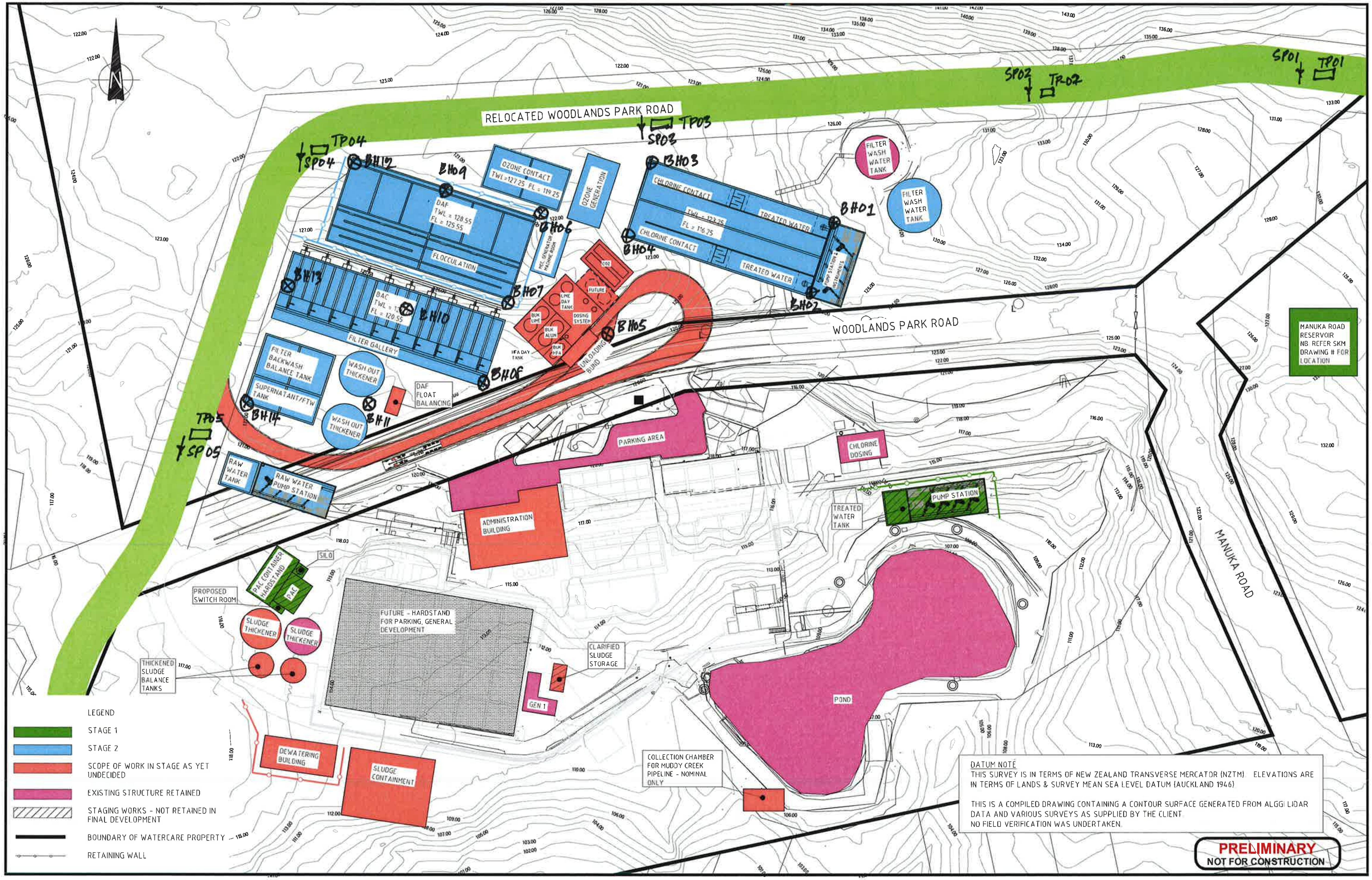
ISSUE	DATE	AMENDMENT	BY	APPD.
E	14.6.10	ISSUED FOR LAYOUT DECISION	HH	AMP
D	21.05.10	GENERAL UPDATE - ISSUED FOR LAYOUT OPTIONS REVIEW	HH	AMP
C	17.5.10	REVISED FOR FACILITY COSTING		
B	7.5.10	REVISED FOR WSL, OPS REVIEW		
A		ISSUED FOR INFORMATION		

	BY	DATE
DESIGNED		
DES. CHECKED		
DRAWN		
DWG. CHECKED		
PROJECT LEADER		
A.M. APPROVED		

water Care services limited

Huia TREATMENT PLANT
LAYOUT PLAN — PROPOSED GEOTECHNICAL INVESTIGATION PLAN. [PHASE 1]
OPTION 1

CAD FILE 6516050-CK-002A DATE 14-6-2010
ORIGINAL SCALE A1 1:500
CONTRACT No. -
DRAWING No. Dwg No .0XX
ISSUE E



ISSUE	DATE	AMENDMENT	BY	APPD.		BY	DATE
E	14.6.10	ISSUED FOR LAYOUT DECISION	HH	AMP	DESIGNED		
D	21.05.10	GENERAL UPDATE - ISSUED FOR LAYOUT OPTIONS REVIEW	HH	AMP	DES. CHECKED		
C	17.5.10	REVISED FOR FACILITY COSTING			DRAWN		
B	7.5.10	REVISED FOR WSL, OPS REVIEW			DWG. CHECKED		
A		ISSUED FOR INFORMATION			PROJECT LEADER		
					A.M. APPROVED		

watercare services limited

Huia TREATMENT PLANT
LAYOUT PLAN - PROPOSED GEOTECHNICAL INVESTIGATION PLAN. [PHASE 2]
OPTION 2

CAD FILE 6516050-CK-003 DATE 14-6-2010
ORIGINAL SCALE A1 1:500
CONTRACT No. -
DRAWING No. Dwg No .0XX
ISSUE E

Appendix B Testing Schedule

Project: **Huia WTP Implementation Strategy [Phase 1]**

Item	Description	Unit	Quantity
E			
E.2	*Geotechnical Testing and Assessment*		
E.2.1	TMP, RON and Utility Consent applications, private access docmentation	L.S.	100%
E.2.2	*Geotechnical Data Collection*		
E.2.2.1	Water content laboratory testing	ea	10
E.2.2.2	CBR testing (Provisional Quantity)	ea	3
E.2.2.3	Extra over for modified CBR testing (Provisional Quantity)	ea	3
E.2.2.4	Investigation test pit excavations – 4m max. depth	ea	17
E.2.2.5	NZ standard compaction test	ea	2
E.2.2.6	Atterberg limits testing	ea	5
E.2.2.7	Grading tests	ea	5
E.2.2.8	Grading (fine soils) tests	ea	5
E.2.2.9	Consolidation testing (Provisional Quantity)	ea	2
E.2.2.10	Triaxial testing – 3 samples	ea	2
E.2.2.11	Unconfined compression testing	ea	2
E.2.2.12	Standard Penetration Test: borehole, solid or hollow nosed Raymond	ea	252
E.2.2.13	Vane shear strength on core samples - 20 m max depth (Provisional Quantity)	ea	20
E.2.2.14	Standard Piezometer (borehole, up to 2 per hole)	ea	7
E.2.2.15	Borehole drilling rig establishment/ de-establishment	L.S.	100%
E.2.2.16	Drill rig set-up at borehole locations	ea	18
E.2.2.17	Core drilling & recovery: soil – 20m max. depth	m	360
E.2.2.18	Thin Walled Tube Sampling	m	3
E.2.2.19	Extra over core drilling and recovery: soil – 20 to 40m depth (Provisional Quantity)	m	50
E.2.2.20	Dutch cone Penetrometer (CPT) rig establishment/de-establishment	L.S.	100%
E.2.2.21	CPT set-up at test locations (Provisional Quantity)	ea	10
E.2.2.22	CPT test – 20m max. depth (Provisional Quantity)	m	200
E.2.2.23	Extra over for coring in rock (Provisional Quantity)	m	40
E.2.2.24	Storage of cores until acceptance of Factual Report (3 months after submission of Geotechnical Report)	L.S.	100%
E.2.2.25	Provisional Sum for maintenance of erosion and sediment control and plantings until vegetation is re-established	PS	100%
E2.2.26	Fieldwork supervision, core logging, sample collection, shear vane tests (5 weeks)	L.S.	100%

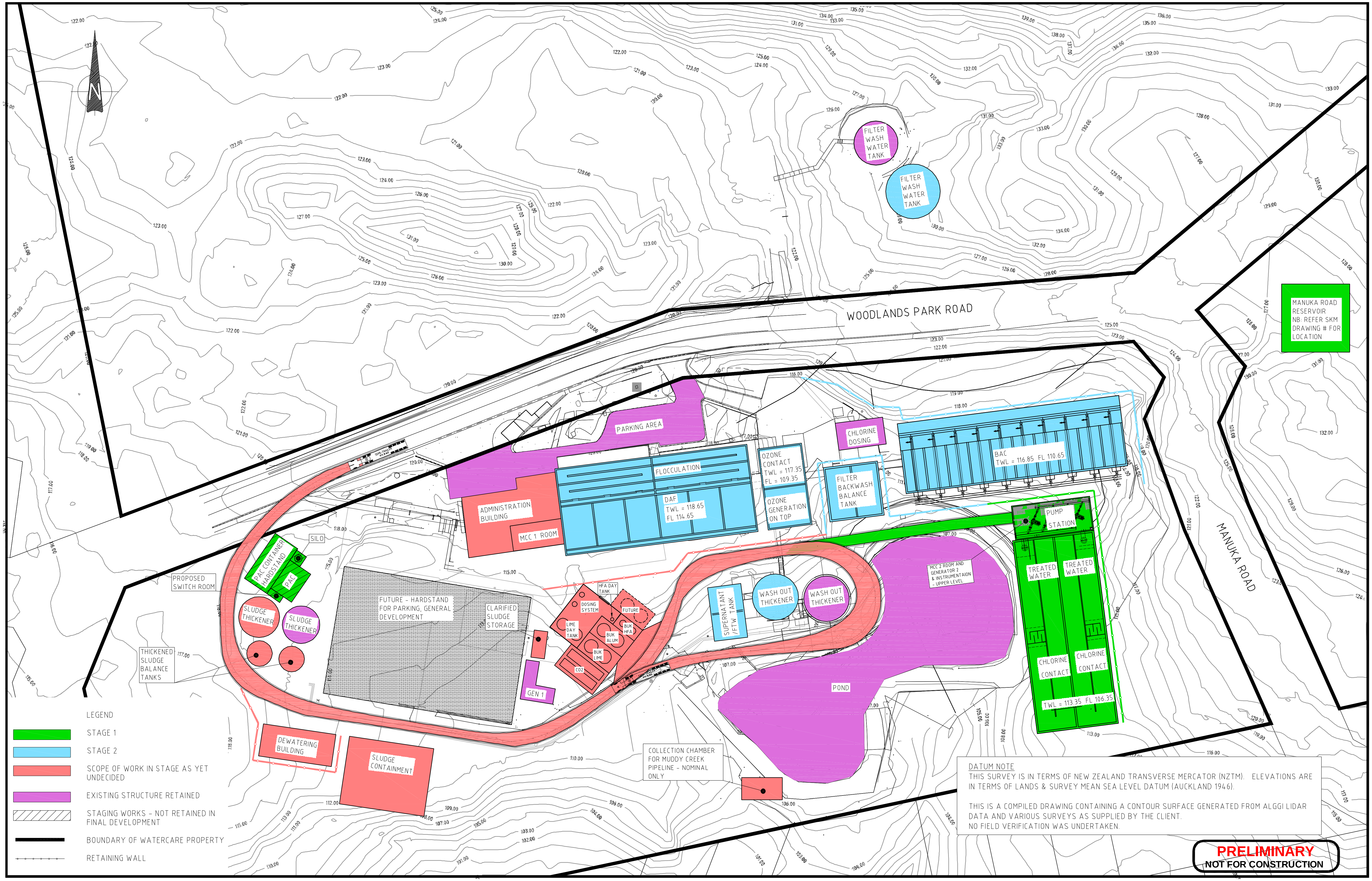
E.2.3	Geotechnical Factual and Interpretive Reports	L.S.	100%
	Total		

Project: **Huia WTP Implementation Strategy [Phase 2]**

Item	Description	Unit	Quantity
E			
E.2	*Geotechnical Testing and Assessment*		
E.2.1	TMP, RON and Utility Consent applications, private access docmentation	L.S.	100%
E.2.2	*Geotechnical Data Collection*		
E.2.2.1	Water content laboratory testing	ea	10
E.2.2.2	CBR testing (Provisional Quantity)	ea	3
E.2.2.3	Extra over for modified CBR testing (Provisional Quantity)	ea	3
E.2.2.4	Investigation test pit excavations – 4m max. depth	ea	5
E.2.2.5	NZ standard compaction test	ea	2
E.2.2.6	Atterberg limits testing	ea	5
E.2.2.7	Grading tests	ea	5
E.2.2.8	Grading (fine soils) tests	ea	5
E.2.2.9	Consolidation testing (Provisional Quantity)	ea	2
E.2.2.10	Triaxial testing – 3 samples	ea	2
E.2.2.11	Unconfined compression testing	ea	2
E.2.2.12	Standard Penetration Test: borehole, solid or hollow nosed Raymond	ea	196
E.2.2.13	Vane shear strength on core samples - 20 m max depth (Provisional Quantity)	ea	20
E.2.2.14	Standard Piezometer (borehole, up to 2 per hole)	ea	7
E.2.2.15	Borehole drilling rig establishment/ de-establishment	L.S.	100%
E.2.2.16	Drill rig set-up at borehole locations	ea	14
E.2.2.17	Core drilling & recovery: soil – 20m max. depth	m	280
E.2.2.18	Thin Walled Tube Sampling	m	3
E.2.2.19	Extra over core drilling and recovery: soil – 20 to 40m depth (Provisional Quantity)	m	50
E.2.2.20	Dutch cone Penetrometer (CPT) rig establishment/de-establishment (Provisional Quantity)	L.S.	100%
E.2.2.21	CPT set-up at test locations (Provisional Quantity)	ea	10
E.2.2.22	CPT test – 20m max. depth (Provisional Quantity)	m	200
E.2.2.23	Extra over for coring in rock (Provisional Quantity)	m	40
E.2.2.24	Storage of cores until acceptance of Factual Report (3 months after submission of Geotechnical Report)	L.S.	100%
E.2.2.25	Provisional Sum for maintenance of erosion and sediment control and plantings until vegetation is re-established	PS	100%

E2.2.26	Fieldwork supervision, core logging, sample collection, shear vane tests (5 weeks)	L.S.	100%
E.2.3	Geotechnical Factual and Interpretive Reports	L.S.	100%
	Total		

Appendix C Overall Layout Options



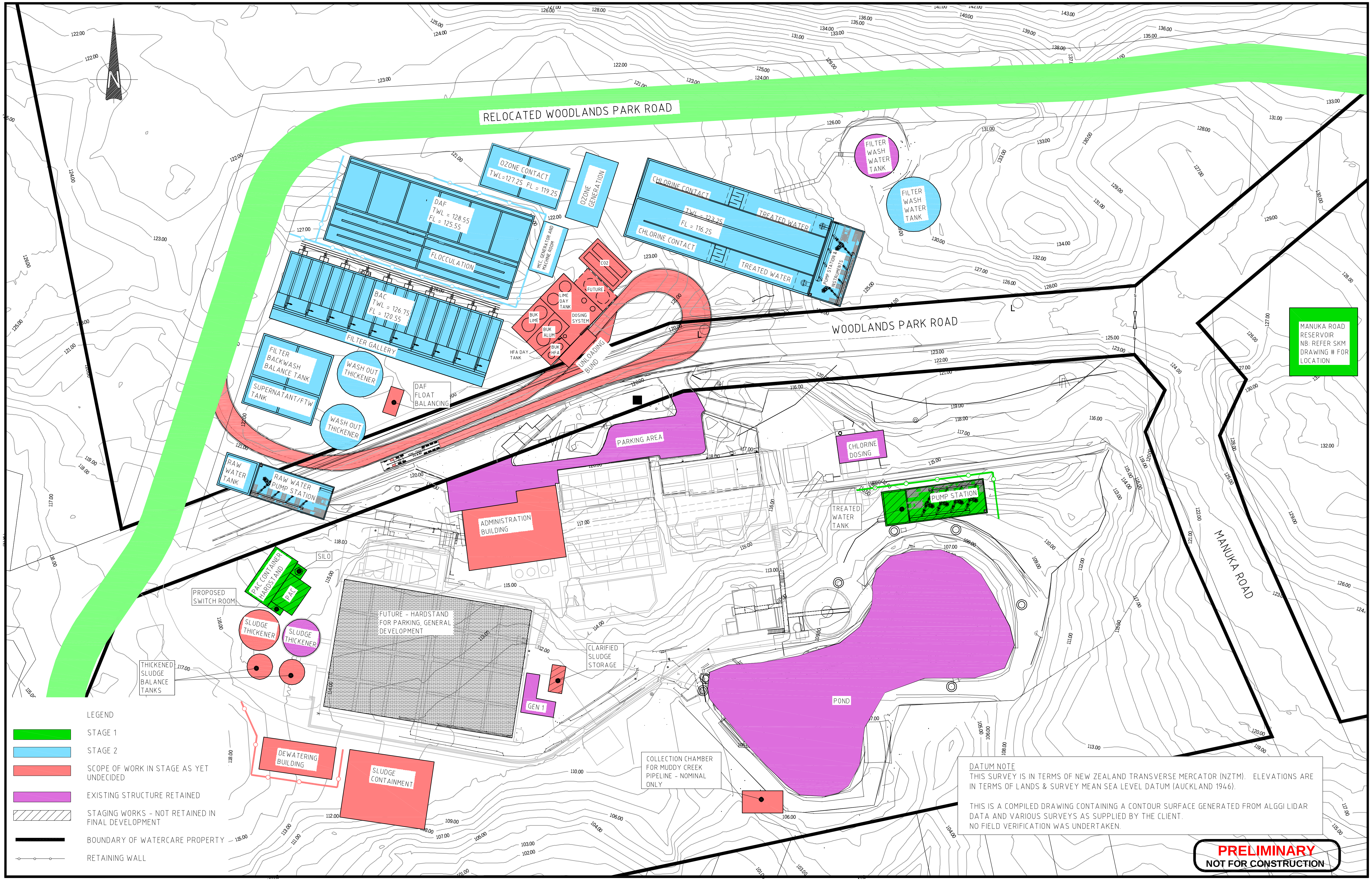
ISSUE	DATE	AMENDMENT	BY	APPD.
E	14.6.10	ISSUED FOR LAYOUT DECISION	HH	AMP
D	21.05.10	GENERAL UPDATE - ISSUED FOR LAYOUT OPTIONS REVIEW	HH	AMP
C	17.5.10	REVISED FOR FACILITY COSTING		
B	7.5.10	REVISED FOR WSL, OPS REVIEW		
A		ISSUED FOR INFORMATION		

	BY	DATE
DESIGNED		
DES. CHECKED		
DRAWN		
DWG. CHECKED		
PROJECT LEADER		
A.M. APPROVED		

water Care services limited

Huia TREATMENT PLANT
LAYOUT PLAN
OPTION 1

CAD FILE 6516050-CK-002A DATE 14-6-2010
ORIGINAL SCALE A1 1:500
CONTRACT No. -
DRAWING No. Dwg No .0XX
ISSUE E



ISSUE	DATE	AMENDMENT	BY	APPD.
E	14.6.10	ISSUED FOR LAYOUT DECISION	HH	AMP
D	21.05.10	GENERAL UPDATE - ISSUED FOR LAYOUT OPTIONS REVIEW	HH	AMP
C	17.5.10	REVISED FOR FACILITY COSTING		
B	7.5.10	REVISED FOR WSL, OPS REVIEW		
A		ISSUED FOR INFORMATION		

	BY	DATE
DESIGNED		
DES. CHECKED		
DRAWN		
DWG. CHECKED		
PROJECT LEADER		
A.M. APPROVED		

water Care services limited

Huia TREATMENT PLANT
LAYOUT PLAN
OPTION 2

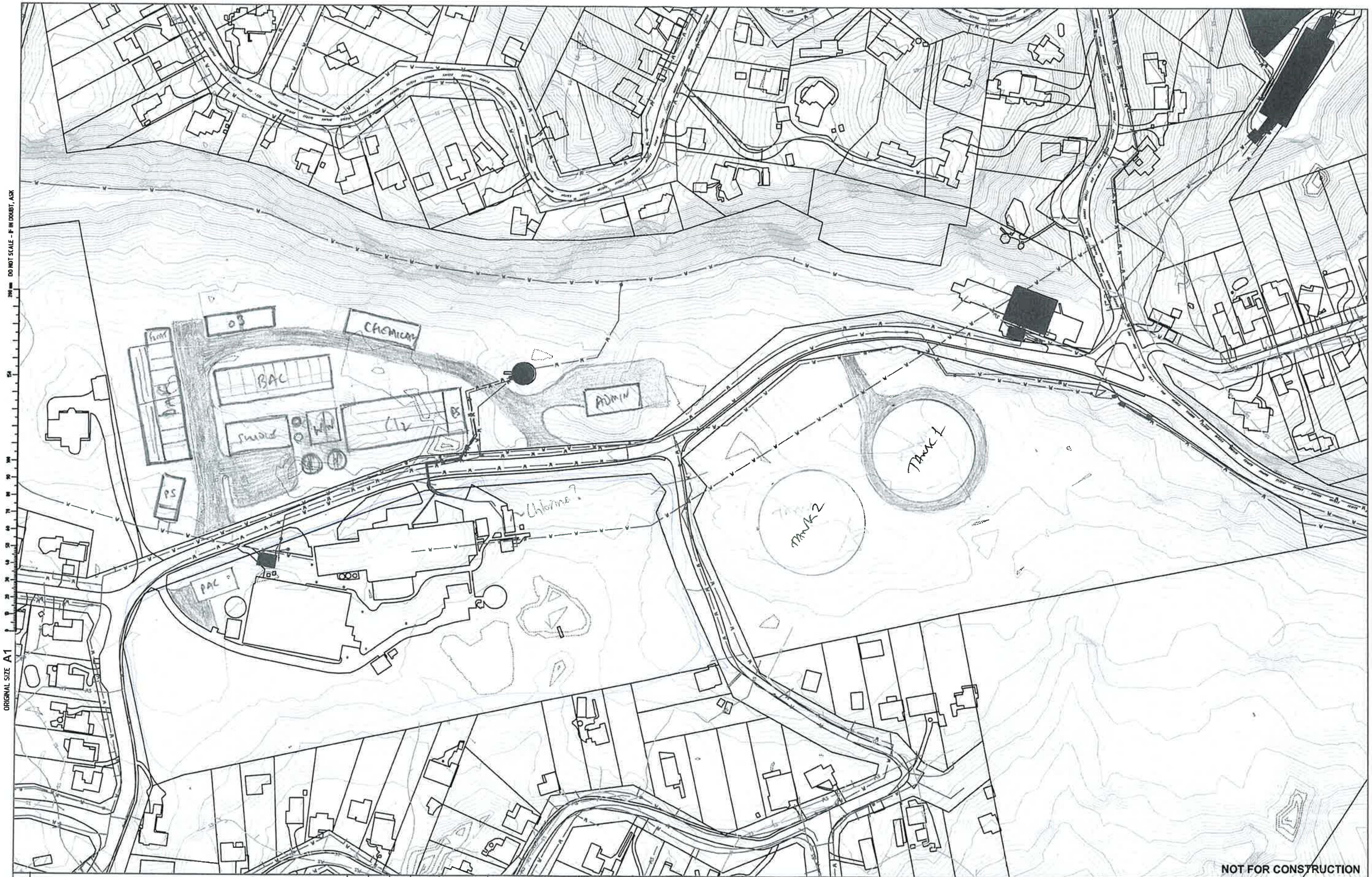
CAD FILE 6516050-CK-003 DATE 14-6-2010

ORIGINAL SCALE A1: 1:500

CONTRACT No.: –

DRAWING No.: Dwg No .0XX

ISSUE: E



ORIGINAL SIZE A1

DO NOT SCALE - IF IN DOUBT, ASK

NOT FOR CONSTRUCTION

REV	REVISIONS	DRN	CHK	APP	DATE

NOT APPROVED

MWH.

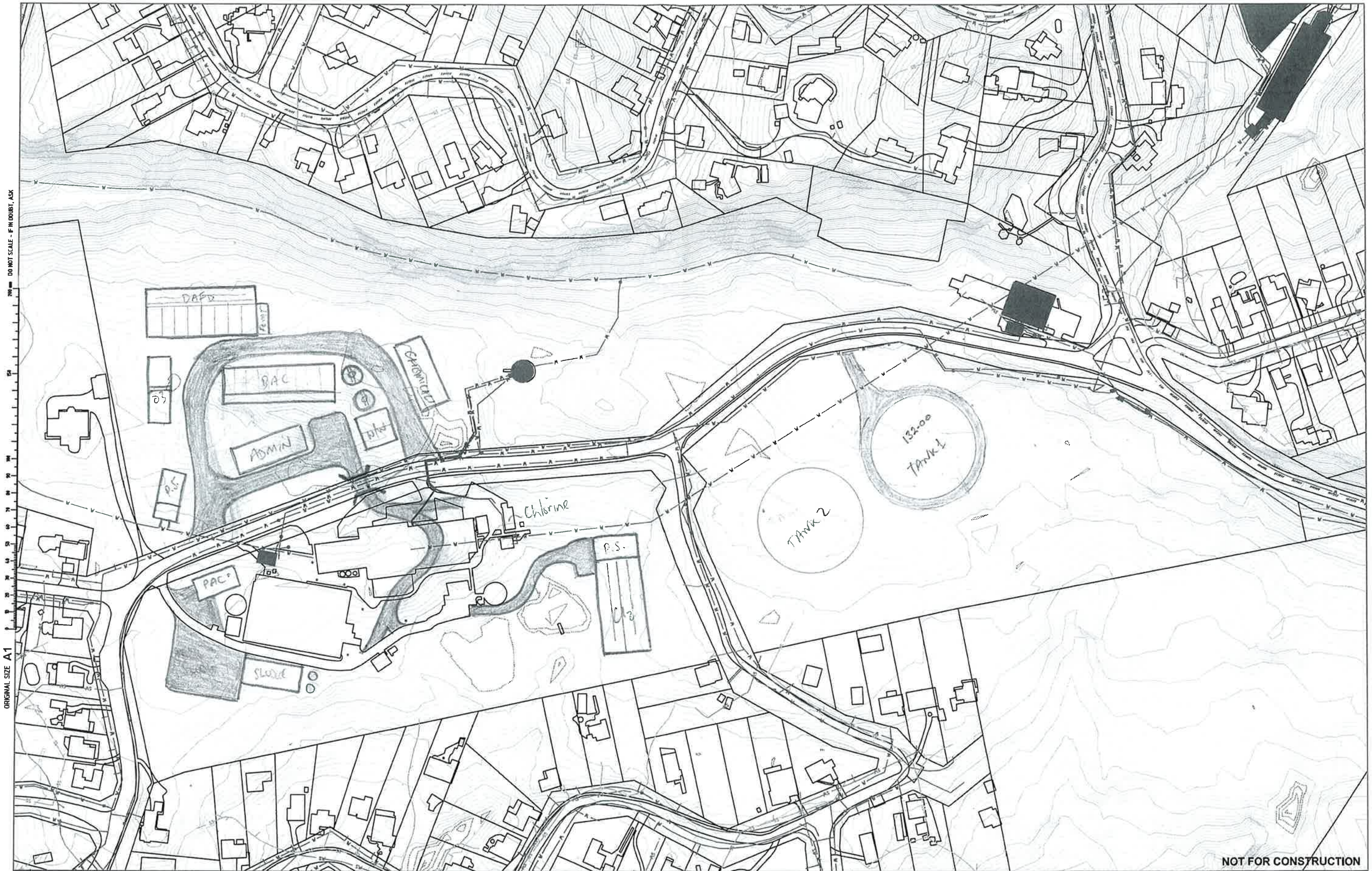
HUIA TREATMENT PLANT

LAYOUT PLAN OPTION 3

WORKING PLOT

C. Povey 24.10.12

Rev. A



NOT FOR CONSTRUCTION

REV	REVISIONS	DRN	CHK	APP	DATE

NOT APPROVED

MWH

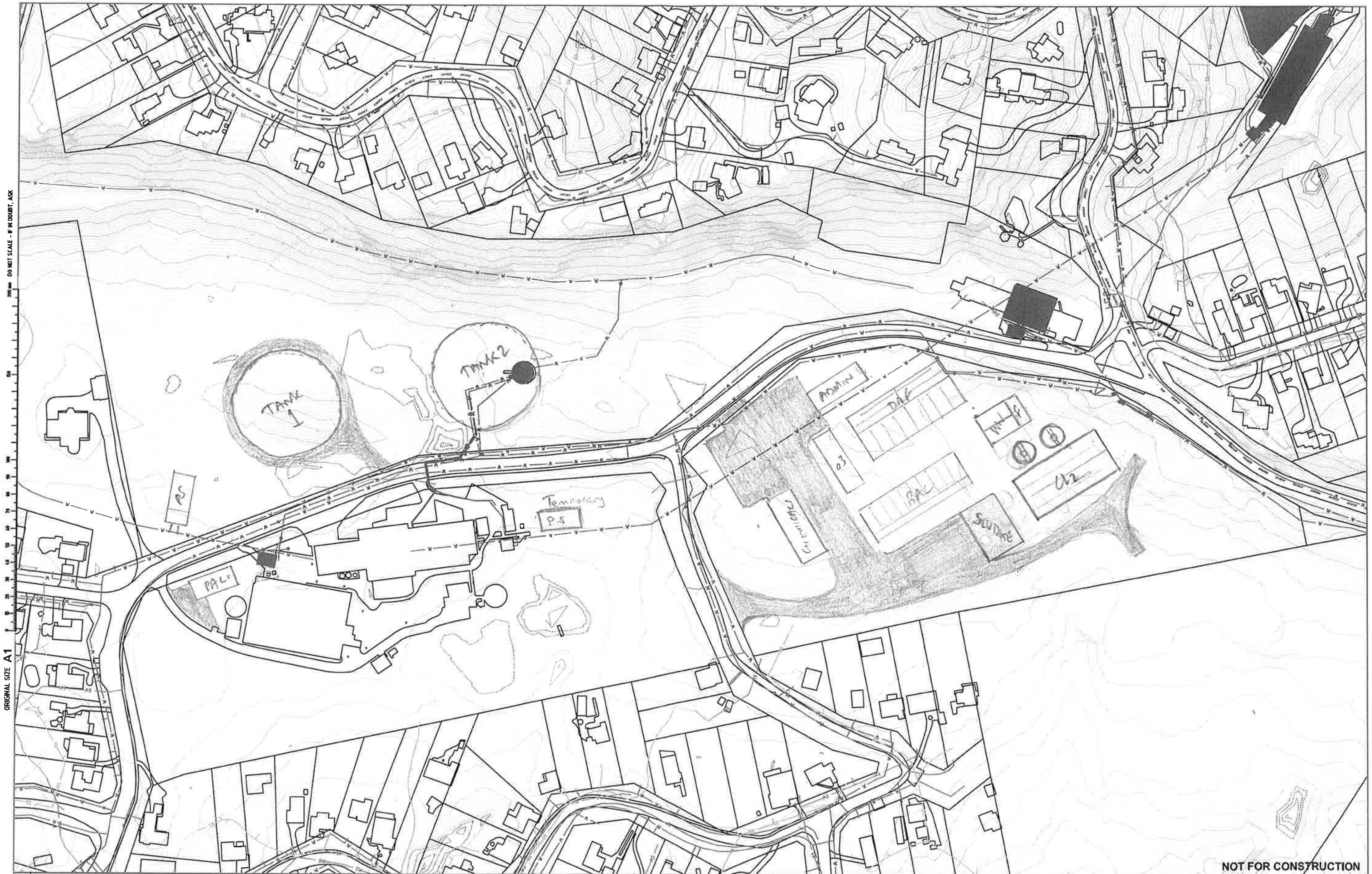
HUIA TREATMENT PLANT

LAYOUT PLAN OPTION 4

WORKING PLOT

C. POVEY 24 10 12

Rev. A



ORIGINAL SIZE A1

DO NOT SCALE - IF IN DOUBT, ASK

NOT FOR CONSTRUCTION

REV	REVISIONS	DRN	CHK	APP	DATE

NOT APPROVED

MWH

Client

HUIA TREATMENT PLANT

LAYOUT PLAN OPTION 5

Status Stamp: WORKING PLOT

Date Stamp: C. Povey 24/10/12

Scale

Drawing No. - - -

Rev. A

Appendix R Risk Assessment

Project (design) Development Risk Register Summary

WSL Project development risk register version 1.0

Overview

Project title:	Huia WTP Upgrade Implementation Strat
Project planning manager:	Maria Dalouche
Current date:	15 October 2013
Date of last complete review:	

Project Drivers

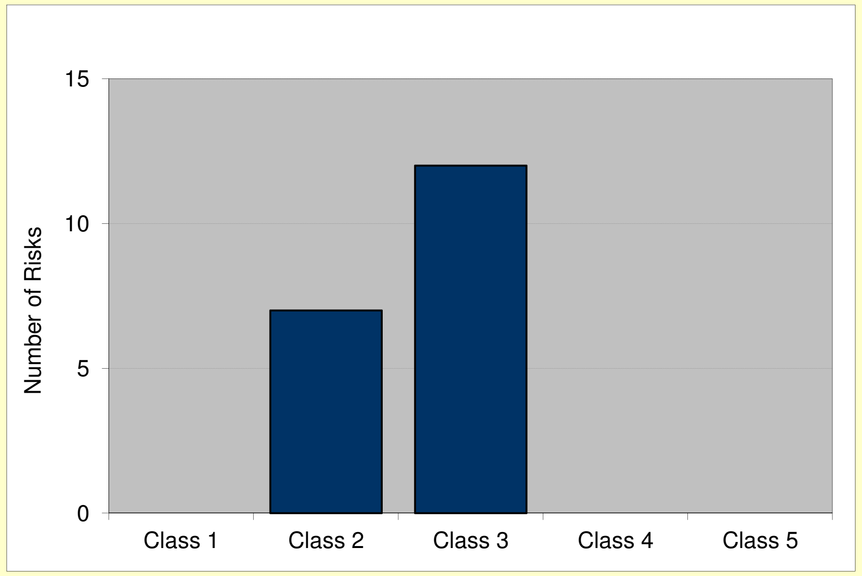
- ☑ Legislation or contractual requirements
- ☑ Growth
- ☑ Service reliability
- ☐ Improving business efficiency

Project Objectives

Project budget:	$132,000,000	
Target completion date:	1 December 2021	2969 days

Project Risk Profile

Class 1	0
Class 2	7
Class 3	12
Class 4	0
Class 5	0
Total	19



Commentary on project risks

Project (design) Development Risk Register Summary

WSL Project development risk register version 1.0

Project Functional Objective:

This section of the risk register is used to record a description of the project deliverable; that is, the customers expectation of what will be delivered at the completion of the project. The description should start with an overview of the 'business need' that the project has been established to address.

Critical success factors may be listed as part of the description of the Projects Functional Objective.

Upgrade of Huia WTP is required to increase capacity to meet future demand and for security of supply to the Auckland region.

MWH has been engaged by Watercare Services Limited (Watercare) to develop an implementation strategy and overall concept layout plan for the Huia Water Treatment Plant (WTP). The concept plan incorporates several existing concept designs for immediate upgrades to the WTP, and supply network, together with the future process design for upgrading the WTP process for the treatment of water from the Upper and Lower Nihotupu and Huia reservoirs. This concept plan will enable Watercare to proceed with the development of the immediate WTP and network upgrades without compromising the long term development requirements of the WTP site.

Design life for performance requirements:

Critical Performance Requirements from Deliverable:

The purpose of the first stage of this two stage investigation is to produce an accurate optimised plan of the future site layout for upgrades to the existing Huia water treatment plant (WTP) incorporating, but not constrained by, the four existing concept locations. This must ensure the compatibility of staged upgrades with the final plant and transmission configuration. The final layout must be an optimised solution balancing costs, risks, construction, hydraulic and operational constraints associated with the site.

Project (design) Development Risk Register

Huia WTP Upgrade Implementation Strategy

Risk Number	Risk Description (i.e., "major consequences caused by…? ")	Potential causal factors	Risk Categorisation		Risk Controls	Active Risk?	Risk Class	Comments
			Threat (specify in column K)	Project Stage (specify in column L)	Identified with responsibility assigned?			
1	OHS risks during construction	H&S risks to construction personnel, Watercare staff and the public - to be identified and managed during design development and construction planning / implementation	Health & safety	Construction	Yes	Yes	Class 3	
2	OHS risks during operation	H&S risks to operators, public - to be identified and managed under WSL H&S Policy	Health & safety	Asset operational life	Yes	Yes	Class 3	
3	Failure to obtain consents causes delay or re-work	Consenting difficulties, protraction. Objections from local residents, interest groups	Consenting	Consenting	Yes	Yes	Class 3	
4	Unforeseen ground conditions or slope stability issues cause delay or re-work	Insufficient geotechnical investigations or issue not identified	Geotechnical uncertainties	Preliminary design	Yes	Yes	Class 3	
5	Unforeseen relocation/diversion of local services	Lack of as-built data or diligence during design development	Other	Preliminary design	Yes	Yes	Class 2	
6	Public nuisance during construction (road works, construction traffic, noise, dust, etc) causes delay or need for management	Construction methodology, inadequate PR, insufficient planning and management	Other	Construction	Yes	Yes	Class 2	
7	Proposed staging not fundable - impacts on strategy causing re-work, delay	Internal funding issues, prioritisation	Other	Approval of budget / project	Yes	Yes	Class 2	
8	Procurement of plant, material and specialist equipment	Lack of planning, fabrication / delivery delay	Procurement	Construction	Yes	Yes	Class 2	
9	Changes to predicted water supply demand necessitates acceleration of Upgrade programme.	Rapid growth, failure of other assets, unforeseeable event	Other	Approval of budget / project	Yes	Yes	Class 2	
10	Proposed TWL at new reservoir/s insufficient for future network needs	Lack of planning, changes to demand, failure of other assets	Other	Preliminary design	Yes	Yes	Class 3	
11	Temporarily unable to gain full MoH Public Health Grading due to use of new service reservoir as TWT	MoH determine that Public Health Grading for new WTP is temporarily reduced due to water effectively being pumped from the network into the 'treatment plant' (reservoir) in the scenario that the new reservoir has to be filled from the network (Huia WTP down).	Other	Asset operational life	Yes	Yes	Class 2	
12	WTP footprint / treatment process units required are larger than planned causing re-work, delay	Design change, insufficient factors of safety at concept stage	Other	Preliminary design	Yes	Yes	Class 3	
13	Unplanned disruption to supply network during construction	Construction incident, commissioning incident, lack of planning	Other	Construction	Yes	Yes	Class 3	
14	Process Design – selected water treatment processes do not meet target water quality criteria for long term.	Design parameters for individual process units are inappropriate	Design error	Preliminary design	Yes	Yes	Class 3	
15	Supply capacity – unable to deliver 140Ml/day future max design flow.	Raw water aqueduct inadequate capacity	Other	Preliminary design	Yes	Yes	Class 2	
16	Chemical spills cause damage, harm, interruption to supply	Chlorine gas leaks, liquid chemical spills during unloading or tank failure	Other	Preliminary design	Yes	Yes	Class 3	
17	Treated water contamination causes disruption to supply, public health issue	Groundwater inflows into below ground reservoirs or gravity aqueduct to Titirangi	Other	Preliminary design	Yes	Yes	Class 3	
18	Unplanned discharge causes environmental or PR issue	Offsite discharge of contaminated water during construction or operation	Other	Preliminary design	Yes	Yes	Class 3	
19	Site topography differs from initial data causing re-work, delay	Ground levels significantly different to those shown by LiDAR survey and preliminary topographic survey work	Other	Preliminary design	Yes	Yes	Class 3	

Delegation & Monitoring of Risk Controls

Huia WTP Upgrade Implementation Strategy

Risk Number	Risk Description (i.e., "major consequences caused by…? ")	Active Risk?	Risk Class	Contractual Risk Transfer	Risk Controls: ACTIONS TO BE UNDERTAKEN to mitigate risk	Risk Controls: Responsibility	Commentary
1	OHS risks during construction	Yes	Class 3	Risk shared with the contractor	H&S risks to be identified and managed during design development and construction planning / implementation	All parties	
2	OHS risks during operation	Yes	Class 3	Risk is entirely Watercare's	H&S risks to be identified and managed under WSL H&S Policy	WSL	
3	Failure to obtain consents causes delay or re-work	Yes	Class 3	Risk shared with the consultant	Early consultation with stakeholders, understand timeframe for consenting process and include in programming	WSL	
4	Unforeseen ground conditions or slope stability issues cause delay or re-work	Yes	Class 3	Risk shared with the consultant	Undertake adequate geotechnical investigation in relevant areas prior to prelim/detailed design	WSL	
5	Unforeseen relocation/diversion of local services	Yes	Class 2	Risk shared with the consultant	Undertake adequate investigation in relevant areas prior to prelim/detailed design, undertake due diligence (pot-holing, standovers, etc)	Consultant / contractor	
6	Public nuisance during construction (road works, construction traffic, noise, dust, etc) causes delay or need for management	Yes	Class 2	Risk shared with the contractor	Good planning, consultation and management	WSL / contractor	
7	Proposed staging not fundable - impacts on strategy causing re-work, delay	Yes	Class 2	Risk is entirely Watercare's	Watercare internal funding processes	WSL	
8	Procurement of plant, material and specialist equipment	Yes	Class 2	Risk shared with the contractor	Awareness of procurement timeframes, early procurement where possible, float in construction programme	WSL / contractor	
9	Changes to predicted water supply demand necessitates acceleration of Upgrade programme.	Yes	Class 2	Risk is entirely Watercare's	Regular demand review	WSL	
10	Proposed TWL at new reservoir/s insufficient for future network needs	Yes	Class 3	Risk is entirely Watercare's	Investigation to confirm adequacy of proposed reservoir TWL, back-up options	WSL / consultant	
11	Temporarily unable to gain full MoH Public Health Grading due to use of new service reservoir as TWT	Yes	Class 2	Risk is entirely Watercare's	Early consultation - may be a means of avoiding impact on Grading as process is temporary and scenario very infrequent / unlikely. In any case, this is the same situation as stands for the existing plant, so any temporary loss of Grading will not cause an overall reduction of Grading at Huia.	WSL	
12	WTP footprint / treatment process units required are larger than planned causing re-work, delay	Yes	Class 3	Risk shared with the consultant	Sizing used in concept layouts is conservative, efficiency options during design development	WSL / consultant	
13	Unplanned disruption to supply network during construction	Yes	Class 3	Risk shared with the contractor	Good planning, due dillegence, good procedures and site management	WSL / contractor	
14	Process Design – selected water treatment processes do not meet target water quality criteria for long term.	Yes	Class 3		Pilot testing of adopted process	WSL	
15	Supply capacity – unable to deliver 140Ml/day future max design flow.	Yes	Class 2		Confirm aquaduct hydraulics and condition and catchment yields	WSL	
16	Chemical spills cause damage, harm, interruption to supply	Yes	Class 3		Emergency response plans, full bunding of chemical tanks to contain spills, evaluate need for caustic soda quench system for chlorine gas leaks	WSL / consultant	
17	Treated water contamination causes disruption to supply, public health issue	Yes	Class 3		Water quality testing, asset inspections, new reservoir constructed using water retaining structures codes	WSL / consultant	
18	Unplanned discharge causes environmental or PR issue	Yes	Class 3		Management plans, detention storage, water quality testing	All parties	
19	Site topography differs from initial data causing re-work, delay	Yes	Class 3		Complete detailed survey of the sites for the new WTP and service reservoirs	WSL	

Appendix S Cashflow

Cashflow - Option 5B - Match AMP Spend

			-2	-1	0	1	2	3	4	
Design / consenting	3 years									
Construction	2 years		2017	2018	2019	2020	2021	2022	2023	
Commissioning	0.5 years									
		AMP Spend	19.8	9.9	12.52	35.21	34.77	19.29	6.54	
										check
		Est Spend	$ 1,768,800	$ 2,653,200	$ 4,422,000	$ 59,458,000	$ 60,858,000	$ 3,500,000	$ -	*$ 132,660,000*

Item	**Est Cost**	**Year**	2017	2018	2019	2020	2021	2022	2023	check
Raw Water PS	$ 5,000,000	2					$ 5,000,000			*$ 5,000,000*
DAF	$ 8,000,000	1,2				$ 3,200,000	$ 4,800,000			*$ 8,000,000*
Ozone	$ 10,000,000	1,2				$ 4,000,000	$ 6,000,000			*$ 10,000,000*
BAC	$ 16,000,000	1,2				$ 6,400,000	$ 9,600,000			*$ 16,000,000*
CCT/TWT	$ 5,000,000	1				$ 5,000,000				*$ 5,000,000*
Temporary outlet PS	$ 3,000,000	1				$ 3,000,000				*$ 3,000,000*
FTW tank	$ 750,000	1				$ 750,000				*$ 750,000*
Upwash tank	$ 1,000,000	1				$ 1,000,000				*$ 1,000,000*
Washwater balance tanks	$ 1,500,000	2					$ 1,500,000			*$ 1,500,000*
Washwater Thickeners	$ 1,200,000	2					$ 1,200,000			*$ 1,200,000*
Effluent return PS	$ 250,000	2					$ 250,000			*$ 250,000*
Power supply and Generators	$ 6,000,000	1				$ 6,000,000				*$ 6,000,000*
Chemical Systems	$ 7,000,000	1,2				$ 3,500,000	$ 3,500,000			*$ 7,000,000*
Site piping	$ 6,000,000	1,2				$ 3,000,000	$ 3,000,000			*$ 6,000,000*
Site works	$ 2,000,000	1,2				$ 1,000,000	$ 1,000,000			*$ 2,000,000*
Admin and workshop	$ 3,000,000	2					$ 3,000,000			*$ 3,000,000*
SCADA	$ 2,000,000	1,2				$ 1,000,000	$ 1,000,000			*$ 2,000,000*
Demolition	$ 1,000,000	3						$ 1,000,000		*$ 1,000,000*
Site mobilisation/demob	$ 2,000,000	1,2				$ 1,500,000	$ 500,000			*$ 2,000,000*
Construction Site staff	$ 3,200,000	1,2				$ 1,600,000	$ 1,600,000			*$ 3,200,000*
Manuals and Commissioning	$ 500,000	3						$ 500,000		*$ 500,000*
Spares and tools	$ 500,000	3						$ 500,000		*$ 500,000*
Defects management	$ 500,000	3						$ 500,000		*$ 500,000*
Site security/ traffic management	$ 500,000	1,2				$ 250,000	$ 250,000			*$ 500,000*
Transportation	$ 540,000	1,2				$ 270,000	$ 270,000			*$ 540,000*
Misc site costs	$ 2,000,000	1,2				$ 1,000,000	$ 1,000,000			*$ 2,000,000*
Sub-total	**$ 88,440,000**					**$ 42,470,000**	**$ 43,470,000**	**$ 2,500,000**		
Contractors O&P	$ 10,612,800	1,2,3				$ 5,096,400	$ 5,216,400	$ 300,000		*$ 10,612,800*
Design & approvals	$ 8,844,000	-2,-1,0	$ 1,768,800	$ 2,653,200	$ 4,422,000					*$ 7,075,200*
Contract Management/QA/Safety	$ 2,653,200	1,2,3				$ 1,274,100	$ 1,304,100	$ 75,000		*$ 2,653,200*
Sub-total	**$ 110,550,000**									*$ -*
Contingency	$ 22,110,000	1,2,3				$ 10,617,500	$ 10,867,500	$ 625,000		*$ 22,110,000*
TOTAL	**$ 132,660,000**					**$ 59,458,000**	**$ 60,858,000**	**$ 3,500,000**		

<u>Cashflow - Option 5B - Early Start</u>

Design / consenting	3 years		-2	-1	0	1	2	3	
Construction	2 years		2014	2015	2016	2017	2018	2019	
Commissioning	0.5 years								
		AMP Spend				19.8	9.9	12.52	
									check
		Est Spend	$ 1,768,800	$ 2,653,200	$ 4,422,000	$ 59,458,000	$ 60,858,000	$ 3,500,000	*$ 132,660,000*

Item	**Est Cost**	**Year**	2014	2015	2016	2017	2018	2019	check
Raw Water PS	$ 5,000,000	2					$ 5,000,000		*$ 5,000,000*
DAF	$ 8,000,000	1,2				$ 3,200,000	$ 4,800,000		*$ 8,000,000*
Ozone	$ 10,000,000	1,2				$ 4,000,000	$ 6,000,000		*$ 10,000,000*
BAC	$ 16,000,000	1,2				$ 6,400,000	$ 9,600,000		*$ 16,000,000*
CCT/TWT	$ 5,000,000	1				$ 5,000,000			*$ 5,000,000*
Temporary outlet PS	$ 3,000,000	1				$ 3,000,000			*$ 3,000,000*
FTW tank	$ 750,000	1				$ 750,000			*$ 750,000*
Upwash tank	$ 1,000,000	1				$ 1,000,000			*$ 1,000,000*
Washwater balance tanks	$ 1,500,000	2					$ 1,500,000		*$ 1,500,000*
Washwater Thickeners	$ 1,200,000	2					$ 1,200,000		*$ 1,200,000*
Effluent return PS	$ 250,000	2					$ 250,000		*$ 250,000*
Power supply and Generators	$ 6,000,000	1				$ 6,000,000			*$ 6,000,000*
Chemical Systems	$ 7,000,000	1,2				$ 3,500,000	$ 3,500,000		*$ 7,000,000*
Site piping	$ 6,000,000	1,2				$ 3,000,000	$ 3,000,000		*$ 6,000,000*
Site works	$ 2,000,000	1,2				$ 1,000,000	$ 1,000,000		*$ 2,000,000*
Admin and workshop	$ 3,000,000	2					$ 3,000,000		*$ 3,000,000*
SCADA	$ 2,000,000	1,2				$ 1,000,000	$ 1,000,000		*$ 2,000,000*
Demolition	$ 1,000,000	3						$ 1,000,000	*$ 1,000,000*
Site mobilisation/demob	$ 2,000,000	1,2				$ 1,500,000	$ 500,000		*$ 2,000,000*
Construction Site staff	$ 3,200,000	1,2				$ 1,600,000	$ 1,600,000		*$ 3,200,000*
Manuals and Commissioning	$ 500,000	3						$ 500,000	*$ 500,000*
Spares and tools	$ 500,000	3						$ 500,000	*$ 500,000*
Defects management	$ 500,000	3						$ 500,000	*$ 500,000*
Site security/ traffic management	$ 500,000	1,2				$ 250,000	$ 250,000		*$ 500,000*
Transportation	$ 540,000	1,2				$ 270,000	$ 270,000		*$ 540,000*
Misc site costs	$ 2,000,000	1,2				$ 1,000,000	$ 1,000,000		*$ 2,000,000*
Sub-total	**$ 88,440,000**					**$ 42,470,000**	**$ 43,470,000**	**$ 2,500,000**	
Contractors O&P	$ 10,612,800	1,2,3				$ 5,096,400	$ 5,216,400	$ 300,000	*$ 10,612,800*
Design & approvals	$ 8,844,000	-2,-1,0	$ 1,768,800	$ 2,653,200	$ 4,422,000				*$ 7,075,200*
Contract Management/QA/Safety	$ 2,653,200	1,2,3				$ 1,274,100	$ 1,304,100	$ 75,000	*$ 2,653,200*
Sub-total	**$ 110,550,000**								*$ -*
Contingency	$ 22,110,000	1,2,3				$ 10,617,500	$ 10,867,500	$ 625,000	*$ 22,110,000*
TOTAL	**$ 132,660,000**					**$ 59,458,000**	**$ 60,858,000**	**$ 3,500,000**	

Appendix T OPEX Estimate

HUIA WTP IMPLEMENTATION STRATEGY
Operating Cost Estimate Summary - Option 5B

Alternative 1 - Using on-site oxygen generation

ITEM		$/yr
Power	$	526,447
Chemicals	$	1,083,262
Other	$	1,742,545
Total	**$**	**3,352,254**

Alternative 2 - Using LOX

ITEM		$/yr
Power	$	475,764
Chemicals	$	1,343,002
Other	$	1,739,945
Total	**$**	**3,558,711**

HUIA WTP IMPLEMENTATION STRATEGY
Cost Estimate - Chemical Usage

ITEM	kg/day	$/kg	$/day	Basis of Estimate	WSL Ops Comments
Alum	8191	0.346	$ 2,834	Say average dose 25mg/L as 100% Alum supplied as 47% solution SG 1.3	OK
Cationic polymer	49.28	5	$ 246	Say average 0.32mg/L dose, allow 140ML/day plus 10% for internal recirculation flows	Current budget estimate is 0.32 mg/l dose across whole WTP
PAC	0	2.8	$ -	Assume not required with Ozone BAC	OK
Sodium bisulphite	200	1	$ 200	Assume 0.5mg/L dose (of 100% solution) to quench residual ozone and 35%w/w solution SG 1.37	OK
Filter aid polymer	14.7	5	$ 74	Say 0.1mg/L dose, allow 140ML/day plus 5% for filter washing	Ops feel use unlikely, will be retaining max filter loading rate of 6 m/hr
Chlorine	203	2.287	$ 464	Say average 1.45mg/L dose	Current budget estimate is 1.45 mg/l dose
CO2	700	0.37	$ 259	Assume average 5mg/L dose	OK
Lime	1610	0.15	$ 242	Assume average 11.5mg/L dose as supplied	Current budget estimate is 11.5 mg/l dose
HFA	636	0.311	$ 198	Assume 0.7mg/L dose of F using HFA (H2SiF6) as 20% w/w solution (15.4%F) assume SG = 1.2	OK
Sludge thickening/dewatering polymer	22.5	5	$ 113	Allow 5kg/tonne dry solids - average solids load 4.5Tonnes per day at 140ML/day (no PAC)	Included in our figure above
LOX (optional)	3000	0.37	$ 1,110	Production of 300kg/day ozone from LOX at 10% w/w	We have always assumed onsite generation.
TOTAL			**$ 5,739**	Daily chemical cost assuming plant operating at 140ML/day	

Usage based on average dose rates at max 140ML/day flow

Assuming 90ML/day average annual flow, this is equivalent to 234 days operation per annum at 140Ml/day

TOTAL ANNUAL COST	**$ 1,083,262**	Excluding LOX
TOTAL ANNUAL COST	**$ 1,343,002**	Including LOX

Total - Alum, poly, lime, HFA, Cl2 only **$ 4,170.33**

Budgetary figures for Bulk Liquid Oxygen supply to Huia from Air Liquide is as follows:

Annual Volume	(Sm3)	529,308	kg/yr	702000
Gas Price	($/Sm3)	$0.24	$/kg	$0.32
Delivery Price	($/Sm3)	$0.04	$/kg	$0.05
ANNUAL COST		$148,206	based on 702 tonnes/year	
Bulk Infrastructure Fee	($/month)	$3,950		
Contract Duration	years	5		

Watercare to provide civil works and suitable certified concrete pad, 3 phase earth plus neutral power, lighting, water, secure compound, dedicated phone line, large tanker access etc.

Orica pricing for Sodium Bisulphite solution
Currently in 1000L IBC's, and we could do in Bulk if required (Bulk would need to be Minimum 5000L drops into on site bulk tank) at $998.18 per Tonne.

Hi Maria,
Sorry for the delay.
Allow $0.030/m3 for alum, poly, lime, HFA, and Cl2 gas. Check rates/usage from above - $4170 for 140ML = $0.0298/m3 OK
Price for PAC approx. $2800/T
Price for CO2 approx $370/T

Regards,

Tom Surrey
Senior Process Engineer

Hi Chris and Maria,
Thanks for confirming this
HFA $311.20 Per Tonne (see spec sheet for details on %)
Cl2 (920Kg drums) $2,287.23 per drum
Alum $346.23 Per Tonne
prices exclude GST.
Prices are delivered to site
Regards

Jeroen Smal
Sales Team leader (Water)
Orica Chemicals NZ
Phone, DDI 09-368 2929, Mobile 021 926 138
Email jeroen.smal@orica.com

HUIA WTP IMPLEMENTATION STRATEGY

Cost Estimate - Power Supply - Option 5B (128mRL Service Reservoir)

Inlet PS	Load Dependant	Type	No. Duty units	Fixed/VSD	Head	Flow m3/s	Unit kW	Install kW	Motor Eff	VFD/Fixed Eff	Supply KW at ML/day 140	KVA at ML/day 70	% time operating	Average kW	Comment
Main pumps	y	Lineshaft	4	VSD	21.5	0.41	122.0	488.1	0.95	0.97	529.7	264.8	100%	488.1	
Sump pumps	n	Centrifugal	1	Fixed			2	2.0	0.95	0.97	2.2	2.2	1%	0.0	
Building services	n							10	0.95	0.97	10.9	10.9	20%	2.0	Air con for MCC, ventilation, crane, lighting
Misc power	n							10	0.95	0.97	10.9	10.9	10%	1.0	
DAF Tanks															
Flocculator drives	n		16	Fixed			1	16.0	0.95	1.00	16.8	16.8	100%	16.0	
DAF recirculation pumps	y	Centrifugal	12	Fixed	60	0.022	18.7	224.8	0.95	1.00	236.6	118.3	67%	150.6	
DAF air compressor	y	Screw	1	Fixed			50	50.0	0.95	1.00	52.6	26.3	40%	20.0	
Float tank pumps	y	Submersible	1	Fixed	6	0.032	2.7	2.7	0.95	1.00	2.9	1.4	50%	1.4	
Float tank mixer	n	Submersible	1	Fixed				2.0	0.95	1.00	2.1	2.1	50%	1.0	
Building services	n							10.0	0.95	1.00	10.5	10.5	20%	2.0	Air con for MCC, ventilation, crane, lighting
Misc power	n							10.0	0.95	0.97	10.9	10.9	10%	1.0	
Ozone															
O2 generators	y	VPSA	1				200	200.0	0.95	1.00	210.5	105.3	50%	100.0	Average dose say 50% of max (ie 1.6mg/L)
O3 generators	y		2				100	200.0	0.95	1.00	210.5	105.3	50%	100.0	Average dose say 50% of max (ie 1.6mg/L)
Sidestream injection pumps	y	Centrifugal	2	Fixed	30	0.018	7.4	14.7	0.95	1.00	15.5	7.7	100%	14.7	
Ozone destructor	n	Thermal	2				5.0	10.0	0.95	1.00	10.5	10.5	100%	10.0	
Building services	n							10.0	0.95	0.97	10.9	10.9	20%	2.0	Air con for MCC, ventilation, crane, lighting
Misc power	n							10.0	0.95	0.97	10.9	10.9	10%	1.0	
BAC															
Backwash pumps	n	Centrifugal	2	Fixed	10	0.482	67.6	135.2	0.95	1.00	142.3	142.3	10%	13.5	Flowserve MVE 400-400-380L 985rpm
Air scour blowers	n	Roots	1	Fixed	10	1.23	160	160.0	0.95	1.00	168.4	168.4	5%	8.0	Aerzen GM80
FTW return pumps	n	Submersible	2	VSD	10	0.037	5.2	10.5	0.95	0.97	11.3	11.3	50%	5.2	
Building services	n							10.0	0.95	0.97	10.9	10.9	20%	2.0	Air con for MCC, ventilation, crane, lighting
Misc power	n							10.0	0.95	0.97	10.9	10.9	10%	1.0	
Washwater thickeners															
Thickener feed pumps	y	Submersible	2	Fixed	10	0.056	7.8	15.7	0.95	1.00	16.5	8.3	50%	7.8	
Common supernatant return	y	Submersible	2	Fixed	10	0.054	7.5	15.0	0.95	1.00	15.8	7.9	50%	7.5	Includes sludge thickener supernatant
Thickener drives	y		2	Fixed				2.0	0.95	1.00	2.1	1.1	100%	2.0	
Polymer preparation	n							2.0	0.95	1.00	2.1	2.1	10%	0.2	
Polymer dosing pumps	n	PD						1.0	0.95	1.00	1.1	1.1	100%	1.0	WSL Ops - How many Poly dose pumps?
Sludge dewatering															
Sludge thickener feed pumps	y	PD	2	Fixed	10	0.033	4.6	9.2	0.95	1.00	9.6	4.8	50%	4.6	
Thickener drives	y		2	Fixed				2.0	0.95	1.00	2.1	1.1	100%	2.0	
Sludge press feed pumps	y	PD	2	VSD				20.0	0.95	0.97	21.7	10.9	5%	1.0	
Sludge Presses	y		2					10.0	0.95	1.00	10.5	5.3	20%	2.0	Membrane inflation, compressed air system etc
Building services	n							10.0	0.95	0.97	10.9	10.9	20%	2.0	Air con for MCC, ventilation, crane, lighting
Misc power	n							10.0	0.95	0.97	10.9	10.9	10%	1.0	
Chemical Dosing															
Polymer preparation system	n		3				5	15.0	0.95	1.00	15.8	15.8	10%	1.5	
Polymer dosing pumps	n	PD?	3	VSD			0.75	2.3	0.95	0.97	2.4	2.4	100%	2.3	
Coagulant dosing pumps	n	Diaphragm	2	VSD			0.75	1.5	0.95	0.97	1.6	1.6	100%	1.5	
Lime silo and prep system	y		2				15	30.0	0.95	1.00	31.6	15.8	50%	15.0	Alternate duty
Lime dosing pumps	dc	Hose	2	VSD			0.75	1.5	0.95	0.97	1.6	1.6	100%	1.5	
Lime sidestream pumps	dc	Centrifugal	1	Fixed			3	3.0	0.95	1.00	3.2	3.2	100%	3.0	
Hypo dosing pumps	dc	Diaphragm	2	VSD			0.75	1.5	0.95	0.97	1.6	1.6	100%	1.5	WSL Ops - This should be Gas Chlorine dosing, will require additional assets eg Booster Pumps
Fluoride dosing pumps	dc	Diaphragm	1	VSD			0.75	0.8	0.95	0.97	0.8	0.8	100%	0.8	
PAC preparation system	y		2				3	6.0	0.95	1.00	6.3	3.2	0%	0.0	Alternate duty
PAC sidestream pumps	y	Centrifugal	2	Fixed	60	0.002	1.7	3.4	0.95	1.00	3.5	1.8	0%	0.0	
Service water pumps	y	Centrifugal	?	VSD				10.0	0.95	0.97	10.9	5.4	20%	2.0	
Compressed air system	y	Screw	1	Fixed				30.0	0.95	1.00	31.6	15.8	20%	6.0	
Building services	n							10.0	0.95	0.97	10.9	10.9	20%	2.0	Air con for MCC, ventilation, crane, lighting
Misc power	n							10.0	0.95	0.97	10.9	10.9	10%	1.0	
Admin															
Building services	n							40.0	0.95	0.97	43.4	43.4	40%	16.0	Air con, lighting, workshop ventilation
Misc power	n							20.0	0.95	0.97	21.7	21.7	40%	8.0	
External site lighting	n							10.0	0.95	1.00	10.5	10.5	50%	5.0	

	Max Power	2010	1300		1038.7	
	Max KVA	2116	1368			
	Max Simult Load incl Diversity	1481	958			
	Max Single Load	217	217	Only Concerned about startup		
	POWER COST /ML PRODUCED			$	16.03	based on $0.09/kwhr
	POWER COST /YEAR			**$**	**526,447**	based on 90ML/day average production
Assume	**POWER COST /YEAR**			**$**	**475,764**	Excluding Oxygen generation for Ozone

Mains will have no Problem as will install a new dedicated Vector Feeder of 5 MVA Capacity

Install power factor correction to achieve power factor of 0.95

All motors over 55 kw will be started via either soft starters or controlled with VFDS

Start Current for motors under Soft start control will be a maximum of 3.8 times the Full Load Current

Diversity Factor attempts to quantify how many loads will be simultaneously running at full load DF= 0.7

Generator size: Criterion: All loads except the largest one running - then start it Sizing according to sum of all loads less the largest then add 3.8 times the largest

Hence For Generator	2089	1565

HUIA WTP IMPLEMENTATION STRATEGY
Cost Estimate - Other Operation and Maintenance Costs

ITEM	Annual cost		
Attendance Labour	$	320,000	Allow 4FT operators @$80,000/yr
Training	$	20,000	
General Maintenance	$	750,000	Assume 0.5% of capex cost of $150M (includes additional $18M for new PAC and Sludge facilities)
Consumables	$	50,000	Fuels, lubricants, workshop supplies, general spares, office consumables, light globes, staff welfare
Site laboratory	$	150,000	Chemicals, glassware, equipment renewals, lab tech, sampling and testing charges
Resource consent monitoring	$	40,000	Includes new Muddy Creek Pipeline
Vehicles	$	75,000	
Trade waste charges	$	50,000	
Misc	$	125,000	Operational support, technical, professional services etc
Sludge loading and disposal	$	52,500	Allow $15/m3 assume 3500m3/annum
GAC replacement	$	110,045	Allow 2.5% top up for loss @$2600/m3 and 1693m3 total volume
TOTAL	**$**	**1,742,545**	
Alternative Cost using LOX			
Reduction in maintenance	-$	50,000	Estimated annual labour and maintenance costs on VPSA oxygen generation system
Rental price LOX facility	$	47,400	Quote from Air liquide $3950/mth for equipment rental 2x25T
TOTAL	**$**	**1,739,945**	

HUIA WTP IMPLEMENTATION STRATEGY

Comparison with Watercare budgets for 2013 and 2014

		2013	2014	Option 5B	Comment
	PLANNED MAINTENANCE	$ 344,604	$ 344,400	$ 595,000	Additional equipment, higher levels of maintenance proposed (incl attendance labour & training), multiple sites
	UNPLANNED MAINTENANCE	$ 191,004	$ 188,400	$ 250,000	Additional equipment
X-20060-CH	**CHEMICALS**	$ 851,594	$ 950,187	$ 1,193,307	See attached worksheet plus $110K/yr GAC replacement)
X-20060-EN	**ENERGY**	$ 132,149	$ 92,865	$ 526,447	See attached worksheet
X-20060-MA	**MATERIALS**	$ 50,400	$ 49,950	$ 50,000	Consumables
X-20060-RU	**RIGHTS OF USE**	$ 20,057	$ 21,848	$ 20,000	Trade waste, consent monitoring etc
X-20060-AS	**ASSET SERVICING**	$ 26,700	$ 23,600	$ 25,000	General Maintenance item
X-20060-CL	**CLEANING**	$ 162,600	$ 213,600	$ 200,000	General Maintenance item
X-20060-LM	**LAND MANAGEMENT**	$ 13,560	$ 16,000	$ 20,000	General Maintenance item
X-20060-SH	**SOLIDS HANDLING**	$ 51,000	$ 53,600	$ 52,500	Sludge loading and disposal
X-20060-TS	**TECHNICAL**	$ 67,200	$ 69,600	$ 75,000	Misc
X-20060-VE	**VEHICLES**	$ 72,576	$ 74,808	$ 75,000	
X-20060-WC	**WATERCARE CHARGES**	$ 74,604	$ 64,800	$ 70,000	Trade waste, consent monitoring etc
X-20060-ST	**SAMPLING & TESTING PROGRAMME**	$ 126,110	$ 142,066	$ 150,000	Site lab
X-20060-PS	**PROFESSIONAL SERVICES**	$ 50,000	$ 50,000	$ 50,000	Misc
		$ 2,234,158	**$ 2,355,724**	**$ 3,352,254**	

Appendix U Email Confirming RL 128 TWL

Amy Clore

Subject: FW: North Harbour No.2 Watermain Project Plan
Attachments: WMNH Resilience Consultant Brief -draft 13_9_2012.docx; 20130125 PRO Trojan UV.pdf

---

From: MDalouche (Maria) [mailto:MDalouche@water.co.nz]
Sent: Wednesday, 13 February 2013 9:33 a.m.
To: James Peveril
Cc: Amy Clore
Subject: FW: North Harbour No.2 Watermain Project Plan

Hi James,

Please see below a confirmation note that Manuka Road at 128mRL will be suitable. This will be a topic for discussion at the MCA so this evidence is important.

I also attached the proposal from Trojan UV, which we may want to incorporate as an option at some point.

Please also note that I won't have a session with Ops prior to the MCA workshop. However a session is scheduled with them on the 22nd to gather additional comments post MCA.

Let me know if any query.

Thank you

Kind Regards

Maria Dalouche
Water Treatment Planner

Watercare Services Limited
Head Office, 2 Nuffield Street, Newmarket, Auckland 1023
Private Bag 92521, Wellesley Street, Auckland 1141
DDI: (09) 539 7549
Mobile: 021 98 7549
Ph: (09) 539 7300
www.watercare.co.nz

From: JBrennan (Jack)
Sent: Wednesday, 13 February 2013 8:56 a.m.
To: MDalouche (Maria)
Subject: FW: North Harbour No.2 Watermain Project Plan

From: JBrennan (Jack)
Sent: Thursday, 7 February 2013 2:03 p.m.
To: THawke (Tuan)

Cc: CWatson (Chris); SDanks (Sharon); BPark (Brian)
Subject: RE: North Harbour No.2 Watermain Project Plan

Hi Tuan

There has been no progress on this since the last meeting. Looking back at the last memo (link below), I had made the following recommendations

1. The combined supply capacity from the two North Harbour Watermains needs to equal 147Ml/d.
2. Under normal operation the WMNH2 should be able to supply Cuthill Reservoir by gravity.
3. The WMNH2 should be capable of supplying 113Ml/d to undertake a shutdown on the WMNH1 on an average day.
4. A TWL of 128m at Manuka Reservoir should be appropriate to meet these system requirements.
5. A lower TWL at Manuka will result in reduced pumping costs and lower velocities in the main but will slightly reduce the overall capacity of the watermain.

Anything above 128m should work for the TWL of Manuka and anything less will need to be reviewed depending on the proposed sites for the Huia facility plan.

The memo showed that the WMNH2 could back-feed the WMNH1 in a shutdown scenario and also indicated some possible connections within the local network. What has not been done is the exercise to see how a shutdown might be carried out on the WMNH1 when the WMNH2 is only partially complete. I did write a brief for this as an investigation (attached) but we decided not to put it out for tender. If you want to take a look at this to see if it will answer the unresolved questions then we can look at putting it out next year.

O:\Transfer\JBrennan\20121019 MEM WMNH2 Op Philosophy.docx

Regards
Jack

From: THawke (Tuan)
Sent: Thursday, 7 February 2013 11:48 a.m.
To: JBrennan (Jack)
Cc: CWatson (Chris); SDanks (Sharon); BPark (Brian)
Subject: North Harbour No.2 Watermain Project Plan

Hi Jack,

I was attending a WMNH2 project update meeting but remembered that the project plan hasn't been signed off yet.
If I remember rightly the main issue to resolve was one of the primary drivers for the WMNH2 project was to provide enough redundancy to the WMNH1 so we can shut it down and perform deferred maintenance.
We also needed to confirm the minimum level for Manuka Road to fulfil the operational philosophy for WMNH2 – required for Huia WTP facility plan.
Has any more progress been made since the last workshop?

Regards

Tuan Hawke
Water Transmission Manager

Watercare Services Limited
Head Office , 2 Nuffield Street, Newmarket, Auckland 1023
Private Bag 92521, Wellesley Street, Auckland 1141
DDI: (09) 539 7658
Mobile: 021 221 7658

Ph: (09) 539 7300
www.watercare.co.nz

---

mwhglobal.com

MWH
BUILDING A BETTER WORLD

MWH New Zealand Ltd
L3 Bldg C, Millennium Centre
600 Great South Road, Greenlane
Auckland 1642
Tel: +64 9 580 4500
Fax: +64 9 580 4514