Delmore Water and Wastewater Treatment Plant Design Report – For Consenting

25th November 2025

Apex Water

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Contents

Executive Summary

The Delmore land development project spans 109-hectares and upon completion shall provide approximately 1213 new residential lots and dwellings in the Wainui-Ōrewa region. Apex Water have been engaged to provide water and wastewater design services for private on-site treatment infrastructure, to support the planning and consenting stages of the proposed Delmore development.

This report has been structured into two sections, covering:

Section 1 - Wastewater

- Scenario 1 - Onsite wastewater treatment infrastructure covering Stage-1 of the development, up to 475 lots with allowance for future expansion to support up to 1213 lots.

- Scenario 2 – Onsite infrastructure for the storage and removal of raw wastewater covering Stage-1 of the development, up to 475 lots. This covers the infrastructure required to minimise any offsite effects.

Section 2 - Water

Onsite potable water treatment infrastructure covering Stage-1 of the development, up to 475 lots. The design of the infrastructure shall consider future expansion to allow for the full Stage-2 figure of 1213.

Wastewater

Scenario 1 - Onsite Wastewater Treatment Infrastructure

In scenario 1 where wastewater is to be treated and discharged on site (with some off-site removal), the proposed wastewater treatment plant will employ a hybrid biological nutrient removal system, featuring a 4-stage Bardenpho activated sludge treatment process, a Membrane Aerated Biofilm Reactor, Hollow Fibre Ultra-filtration membranes and Reverse Osmosis membranes to produce exceptionally high-quality permeate. This system is designed to treat wastewater to such an extent that the resulting treated water quality would be amongst the highest of any wastewater treatment system found in New Zealand. To demonstrate the extremely high quality of the permeate produced, there are several international examples where the treatment train proposed is employed as part of full drinking water re-use applications. However, this is not proposed by this report due to the aesthetic and cultural concerns around this type of re-use in New Zealand at the current time. It is also noteworthy that the proposed treated wastewater quality meets and exceeds the requirements of the new Wastewater Environmental Performance Standards (2025). A comparison between the proposed discharge quality and that required under the

Wastewater Environmental Performance Standards (WWEPS) (2025) is shown in Table 1 below.

Table 1 – Comparison of the WWEPS (2025) and the Proposed Delmore discharge quality

Parameter	**Proposed**	**WWEPS (2025)**	**Comment**
cBOD5 (mg/L) – Annual Median	0.5	5.0 *10.0 – 90th Percentile*	Exceeds the WWEPS – 10x
TSS (mg/L) – Annual Median	4	5.0 *10.0 – 90th Percentile*	Exceeds the WWEPS
Amm-N (mg/L)–Median	0.3	*1.0 – 90th Percentile*	The median proposed for the Delmore project outperforms this by 3.3x
Total Nitrogen (mg/L) – Annual Median	1.0	4.0	Exceeds the WWEPS – 4x
Total Phosphorous (mg/L) – Annual Median	.07	0.5	Exceeds the WWEPS – 7x
E.coli (cfu/100mL) – 90th Percentile	4	130	Exceeds the WWEPS – 32x

The wastewater treatment plant would initially be sized to service Stage-1 of the Delmore development (475 houses). However, the wastewater treatment plant has been designed to enable it to be upsized to treat wastewater from the full development if this is required. This report outlines the design of the treatment process, including the disposal system, and discusses its potential effects on the receiving environment due to the discharge.

Scenario 2 – Infrastructure for the Removal of Raw Wastewater

In this scenario the raw wastewater shall be removed from the site for offsite discharge and the wastewater treatment plant shall be replaced with storage and handling infrastructure. This infrastructure shall consist of a noise attenuated building housing headworks screens and screening collection bins, screened wastewater storage and pumping equipment. External to the building shall be storage for screened wastewater and an odour control unit for the abstraction and treatment of fugitive odours.

Drinking Water

The proposed drinking water treatment plant will be required regardless of the wastewater scenario adopted. This plant shall consist of either a cartridge filter and UV disinfection treatment process, or a multi-media filtration and UV disinfection treatment process. Based on the raw water quality information available, either of these processes will be able to produce potable water that conforms to the Drinking Water Standards for New Zealand. The design of the potable drinking water process has been limited to an options assessment on suitable treatment processes. The final technology selection shall be carried out during the detailed design stages of the project, however the physical infrastructure presented within this report shall be sufficient to support any of the selected technologies.

The drinking water treatment plant shall be initially sized to accommodate Stage-1 of the Delmore development which encompasses some 475 residential lots/dwellings. There shall also be consideration during this design process to ensure the treatment infrastructure is modular and can be scaled to accommodate the future stages of the development should no public water connection become available.

Introduction

The Delmore development is an approximately 1213 lot residential land development project located in the Wainui area of the Hibiscus coast. Over the past 15-years the Hibiscus coast has received significant investment for residential land development projects, as a result it has become one of Auckland's fastest growing areas. From the years 2013 to 2018 the Hibiscus and Bays Area observed a population growth of 15.8%, and while slowing since 2018, the region has still grown by 9.6% to 2024, outpacing Auckland's overall rate of 5.4% during the same period (Hibiscus Coast App, 2024). As a result of this increased growth the local wastewater infrastructure is nearing its capacity. In late 2024 Watercare made public notification that there was only sufficient capacity in the wastewater treatment infrastructure to connect up to another 4000 new homes (as at 14 November 2024). The area is forecasted to reach its capacity by 2027, with more residential lots in planning or having received resource consent than the existing Army Bay Wastewater Treatment Plant can service (Watercare, 2024). With upgrades to the treatment infrastructure planned for completion in 2031, Watercare has stated they will be actively managing new connections to its network in the area (Watercare, 2024).

To allow for the continued supply of houses in the event that the development is unable to connect to Watercare's wastewater network when first developed, the developer Vineway has engaged Apex Water (Apex) to provide engineering support for the planning and consenting of private on-site wastewater treatment and discharge infrastructure.

As part of the preliminary design process, various wastewater treatment options were assessed, and the selected system was chosen for its suitability. The chosen treatment process is a modular hybrid biological nutrient removal system, which includes a 4-stage Bardenpho activated sludge process, a Membrane Aerated Biofilm Reactor, and Hollow Fiber Ultra-filtration membranes with tertiary disinfection. This treated wastewater stream is further polished by Reverse Osmosis membranes, providing a resultant water quality that will be amongst the highest quality in New Zealand. This system ensures high-quality permeate production within a compact design. The treated wastewater will be discharged both to land when available, utilising available reserve land alongside a constructed land infiltration trench designed by the principal in collaboration with local stakeholders.

Vineway has also sought to provide for on-site water supply and has engaged Apex Water to assist with the design of the treatment infrastructure. The water treatment process shall employ either of a cartridge filter and Ultraviolet light (UV) disinfection process, or a multi-media filtration system with an Ultraviolet light (UV) disinfection process. When combined with ancillary processes, such as chemical dosing and online monitoring for quality assurance, either of these treatment processes will produce potable water that meets the Drinking Water Standards for New Zealand. As the physical abstraction infrastructure is yet to be completed, the design basis for technology selection has been made utilising raw water quality from existing bores adjacent to the Delmore project site which are serviced by the same aquifer. The physical treatment infrastructure detailed within this report shall allow for the integration of either of these treatment processes.

LIMITATIONS

The opinions, conclusions and recommendations in this report are based on conditions encountered and information provided at the date of preparation of the report. Apex has no responsibility or obligation to update this report to account for events or changes occurring after the date the report was prepared. The opinions, conclusions and recommendations in this report are based on assumptions made by Apex noted in this report.

Overview

SITE LOCATION

The proposed Delmore development is located approximately 35km to the north of central Auckland in the Wainui area. The location of the development can be seen in Figure 1 below.

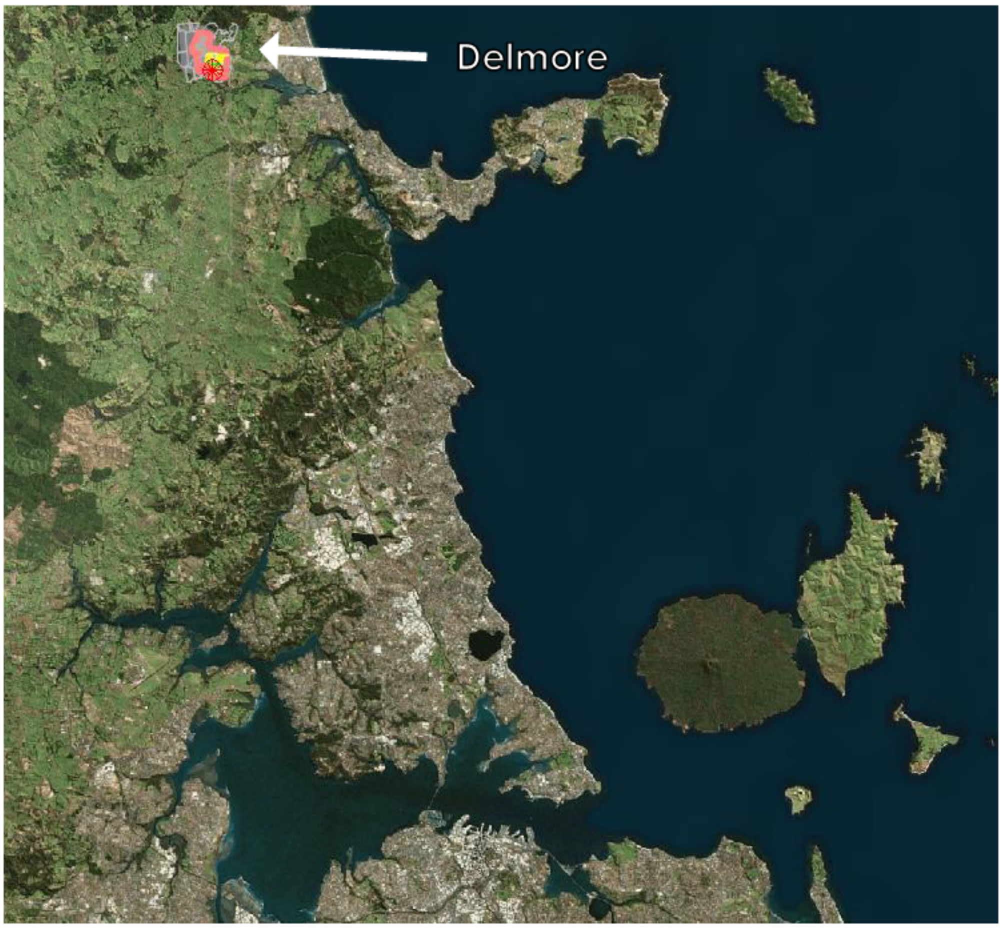


Figure 1 - Delmore Site Location

The Delmore project site is bound by a mixture of developed, future urban zoned, Department of Conservation reserve and rural land. The surrounding sites include residential developments under construction such as Ara Hills to the north-east and Milldale to the south. The broader setting of the Delmore project site in relation to these other extensive residential developments can be seen in Figure 2 below.

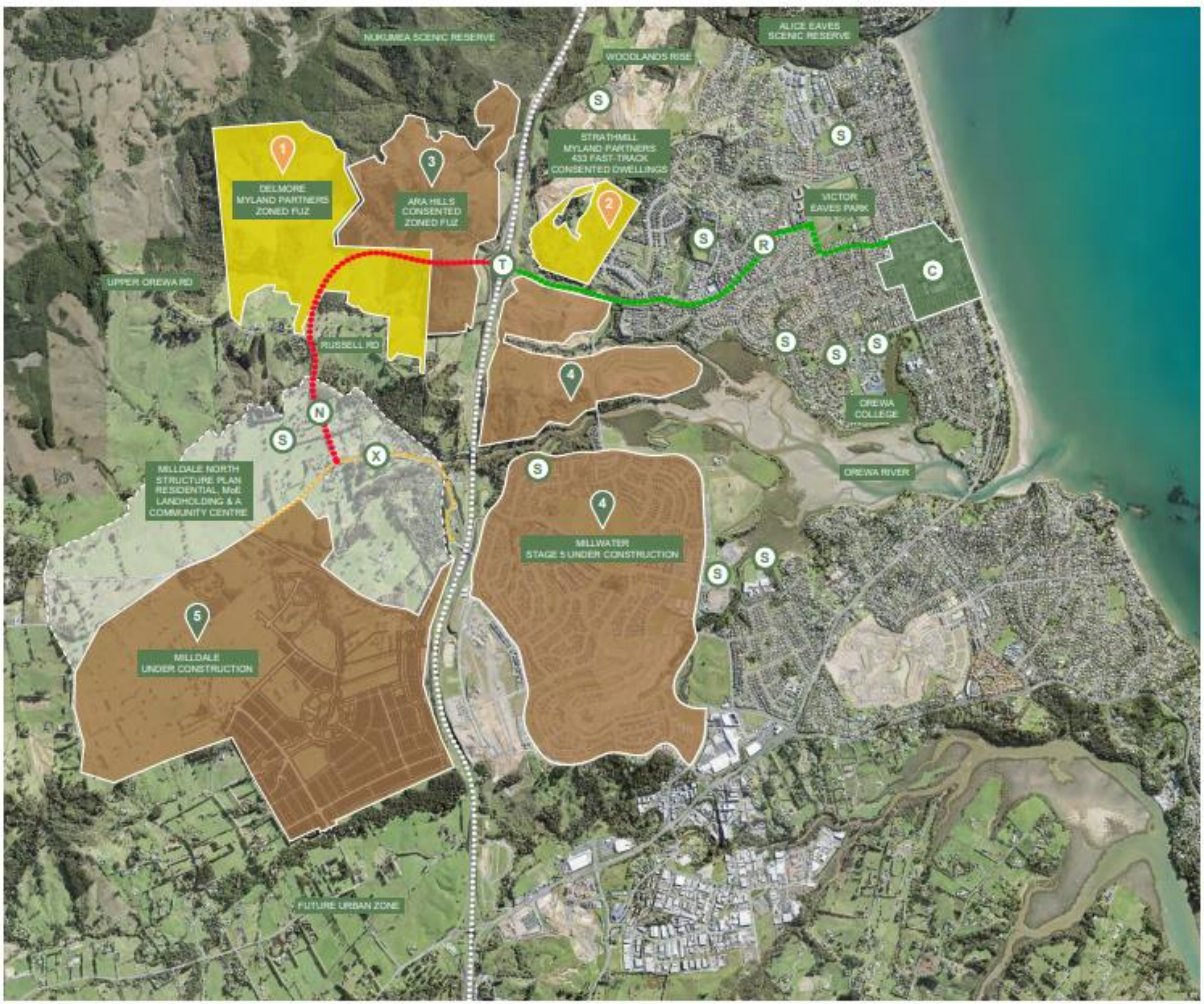


Figure 2 - The proposed Delmore project site and surrounds

The proposed lot for the water and wastewater treatment plant is bound on all sides by future residential lots. The extent of the proposed lots can be seen in Figure 3 below.

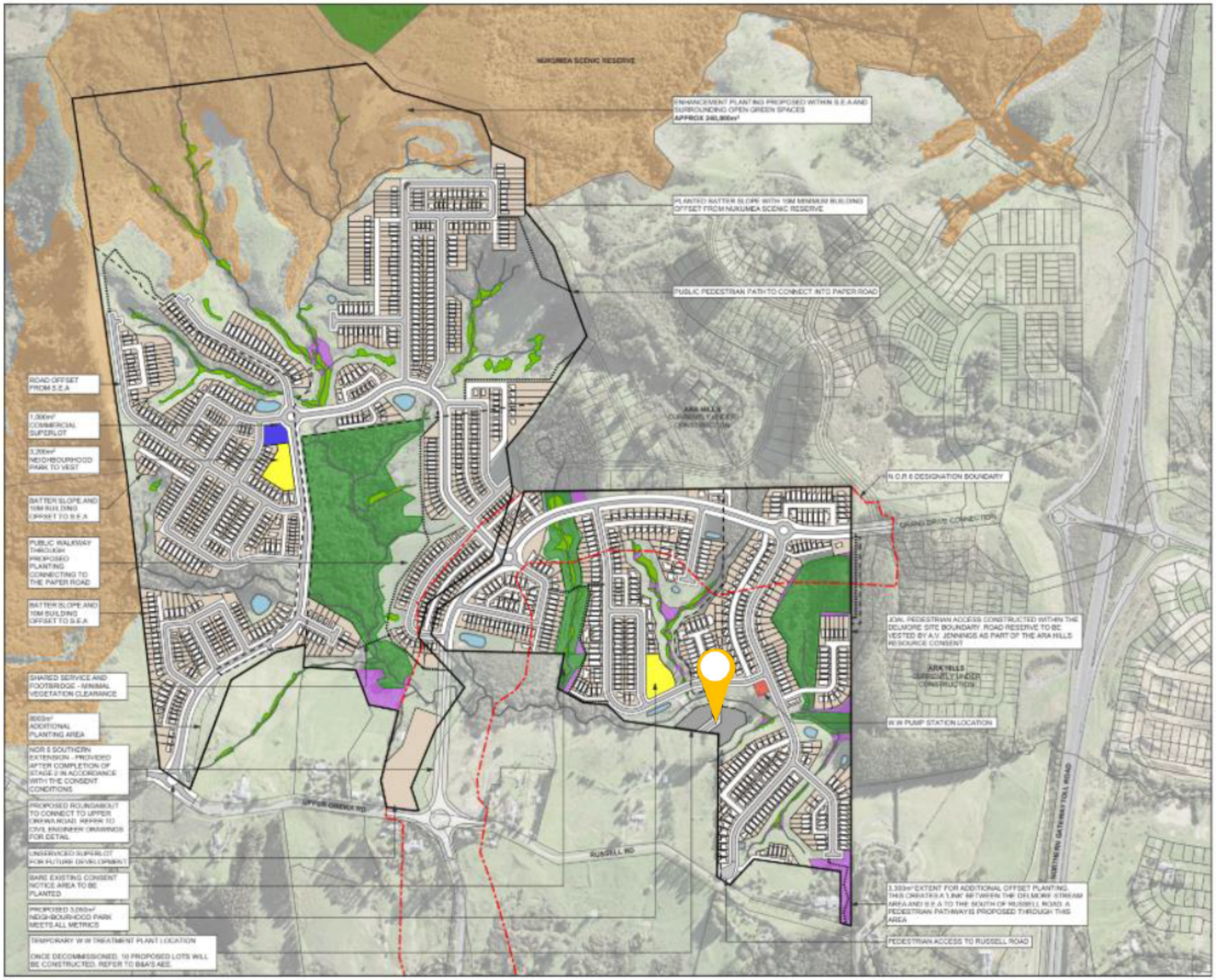


Figure 3 - Proposed Location of the Wastewater Treatment Plant on the Delmore Project Site

Wastewater Treatment

LOADING

The anticipated wastewater loading has been established in consultation with the client's civil engineer, Mckenzie & Co with reference to the Auckland Council Code of Practice for Land Development and Subdivision – Chapter 5: Wastewater. This document details what allowances should be made per dwelling when determining wastewater flows generated from different sized dwellings within new housing developments. Using the information provided within the *Auckland Code of Practice for Land Development and Subdivision - Chapter 5 Wastewater* and the development growth projections provided by Mckenzie & Co., a wastewater model has been developed. Table and 3 below outlines information related to the wastewater loading on the proposed treatment plant for each stage of the project.

Recommended Design Wastewater Flows

Table 2 - Recommended Design Wastewater Flows

Description	Number	Comment
Occupancy for Design (Persons)	3	Watercare CoP
Design Wastewater Flow Allowance (L/person.day)	180	Watercare CoP
Design Wastewater Flow Allowance (L/house.day)	540	
Peaking Factor	1.2	Low Pressure Sewer

Table 3 – Stage-1 Design Flows

Description	Number	Comment
Number of Houses	475	Provided by Client
Average Dry Weather Flow (m3/day	256.5	Watercare CoP
Peak Flow (m3/day)	307.8	No commercial flows included

Wastewater Conveyance – Infiltration, Inflow and Peak Flows

The Delmore community shall be serviced by a low pressure sewer (LPS) network providing pressurised raw wastewater to the wastewater treatment plant via a rising main. Each lot shall have its own dedicated pump station located near its boundary which shall receive raw wastewater generated by the household. This pump station shall deliver raw wastewater into the rising main which will subsequently arrive at the treatment plant site.

By virtue of their design, LPS networks are far less susceptible than conventional gravity sewers to increased hydraulic loading during wet weather events from stormwater infiltration and ingress. As LPS sewers operate under pressure, for any external source to be able to enter the network it must be at a higher pressure than the network itself. This pressurised network introduces a barrier to entry into the network, meaning traditional ingress routes such as misaligned or damaged pipework cannot result in stormwater ingress. By decoupling peak hydraulic loads from weather events, LPS sewers allow for treatment or handling infrastructure to be designed around diurnal cycles (morning and evening peak usage). To this end, the conveyancing infrastructure and wastewater handling infrastructure is designed to handle a peak wet weather flowrate of 1.2x the average dry weather flow (ADWF) rate. The Auckland Code of Practice for Land Development and Subdivision outlines that conventional gravity networks should be designed around a peaking factor of 6.7x the ADWF adding additional cost and complexity. Figure 4 below highlights common ingress and infiltration routes for stormwater into gravity networks.

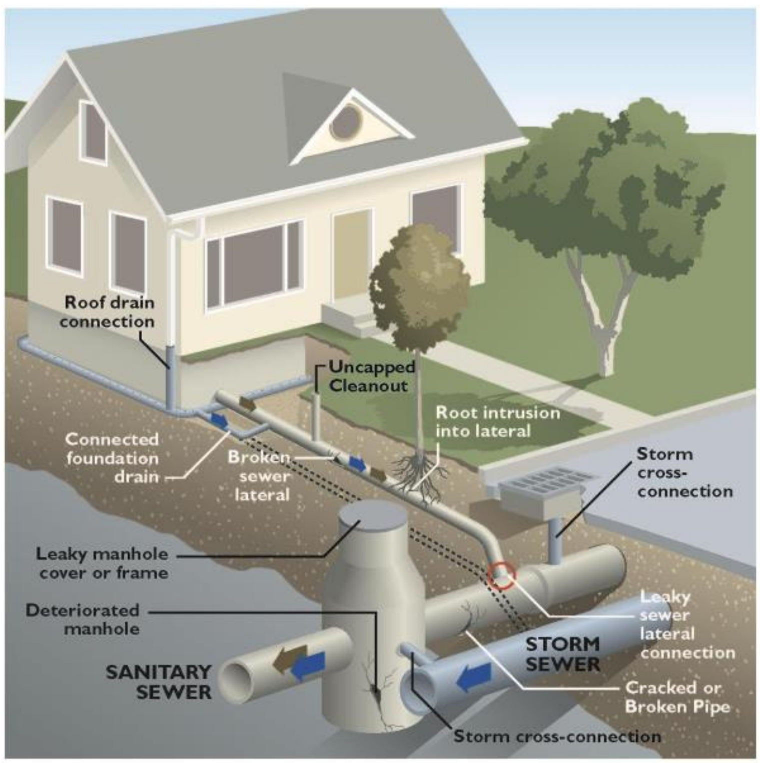


Figure 4 - Sources of Infiltration and Inflow (GHD Limited, 2015)

The following wastewater model has been produced based on the use of a LPS sewer network and the wastewater loading provided by Mckenzie & Co. While the wastewater handling infrastructure design is centred around the peaking factor of 1.2x the ADWF, the actual infrastructure, will inherently buffer out some of this flow to allow for operational flexibility.

Flow Buffering

Even with this lower peaking factor provided by the LPS sewer network, to ensure the most cost-effective treatment infrastructure is designed, the main biological and membrane filtration processes should still be decoupled from peaking events. The simplest approach utilised to decouple the treatment train from peak flows is via the installation of a balance tank at the start of the process. When utilising a balance tank, the treatment train is effectively de-coupled from peak flows and can be sized to accommodate the median flowrate, with any instantaneous peak flows in excess accumulating in the balance tank for later processing. A balance tank provides not only hydraulic buffering for the process but also allows for process and operational flexibility if downstream equipment or processes require attendance. An example of a wastewater treatment plant designed and built by Apex Water with a flow balancing tank is shown in Figure 5 below.

Figure 5 - A MBR WwTP with Flow Balancing

SCENARIO 1 – ONSITE TREATMENT AND DISCHARGE

SURFACE WATER QUALITY

An assessment of the ecological and environmental condition at the proposed locations of discharge has been carried out by Viridis. Understanding the condition of the receiving environment is critical to the selection of suitable technology to ensure a discharge quality that retains the environmental and ecological features of the site, minimising any potential impact.

The full report provided by Viridis can be found in the documentation supporting this application in which an assessment of the current in stream physiochemical and ecological quality. Table 4 below outlines the baseline physiochemical properties of the stream adjacent the treatment plant site which will ultimately receive flows from the land infiltration trench.

Table 4 - Stream Baseline Quality Monitoring Results

Parameter	Existing Quality	Comment
Total Suspended Solids (g/m3)	3	Compliant with ANZG DGV
cBOD5 (g/m3)	<2	Complaint with MfE Guidance for preventing fungus growth
E. Coli (MPN/100mL)	435	Attribute D
Ammoniacal nitrogen (g/m3)	<0.01	Attribute A
Nitrate nitrogen (g/m3)	<0.002	Attribute A
Total nitrogen (g/m3)	0.30	Exceeds ANZG DGV
DRP (g/m3)	<0.004	Attribute A and compliant with ANZG DGV
Total Phosphorus (g/m3)	0.015	Attribute A and compliant with ANZG DGV

While it is common to find waterways on pastoral land to be showing signs of degradation and ecological stress due to the introduction of external sources of nutrients and pathogens from the grazing of livestock, the findings from the Viridis assessment are reflective of a waterway that is in a good condition considering the current land use. Whilst not covered directly by this report, it is expected that the conversion of the Delmore project site from agricultural land to residential will reduce the overall nutrient loading currently occurring across the entire site (as the Viridis assessment notes). It is well documented that farming practices often result in a surplus of both nitrogen and phosphorous due to the application of fertilizers and supplementary animal feed (DairyNZ, 2013). As such, consideration should be given to the net impact the changing land use will provide, through the removal of livestock and the conversion from pasture to a residential land development.

Findings of the Viridis report have been taken into consideration in the following sections when assessing the suitability of the wastewater treatment processes for the Delmore project.

WASTEWATER TREATMENT OPTIONS ASSESSMENT

Treatment systems currently in use throughout New Zealand, which have been considered for suitability at the Delmore site include:

- Membrane Aerated Biofilm Reactor (MABR)
- Membrane Bioreactor (MBR).
- Activated Sludge
- Sequence Batch Reactors (SBRs).
- Submerged Aerated System (SAF).
- Trickling Filters; and,
- Recirculating Textile Packed Bed Reactors (rtPBR).
- Hybrid Membrane Bioreactor / Membrane Aerated Biofilm Reactor

The quality of the receiving environment has driven the options assessment for the wastewater treatment plant and has resulted in the addition of Reverse Osmosis membranes for the polishing of the treated wastewater prior to discharge. Taking this into consideration, and through consultation with the principal with respect of the desired flow ranges, operator inputs, constructability, project life and the lot allocated to the plant, this list has been further reduced to the following processes:

- Membrane Bioreactor (MBR) Nutrient Reduction Process with supplementary Reverse Osmosis polishing membranes.
- Membrane Aerated Biofilm Reactor (MABR) Nutrient Reduction Process with supplementary Reverse Osmosis polishing membranes.
- Hybrid Membrane Bioreactor / Membrane Aerated Biofilm Reactor Nutrient Reduction Process with supplementary Reverse Osmosis polishing membranes.

A review of the selected technologies is outlined below providing a summary of the suitability of these processes for the Delmore site. As each of the processes assessed make use of supplementary Reverse Osmosis for polishing of the treated wastewater, a separate section on the use of these membranes has been included below. Figure 6 below shows a Sequenced Batch Reactor servicing a private land development in Cardrona.

Figure 6 - A Sequenced Batch Reactor designed and built by Apex Water

Membrane Bioreactor (MBR)

An MBR system is a combination of the activated sludge process detailed above with a micro or ultra-filtration system that rejects particles above 0.1 – 0.4micron in size. By excluding particles of such a small size, the treated wastewater produced by a MBR plant can reject most pathogens, with samples of permeate from MBR plants designed by Apex often demonstrating E. coli concentrations of less than 1cfu/100mL. MBRs have two basic configurations: (1) an integrated configuration that uses membranes immersed in the bioreactor, and (2) a recirculating configuration where the mixed liquor circulates through a membrane module situated outside the bioreactor.

The MBR represents the best available technology for the application proposed for the Delmore development. The key benefits of MBR technology for this application include:

- Reliably high level of treatment achieved.
- Compact process.
- Good at handling seasonal loads.
- Good at treating high strength wastewater.
- Physical barrier prevents bacteria entering the treated water.
- Physical barrier provides exceptionally clear, low turbidity permeate suitable for further disinfection via UV irradiation or chlorine disinfection.

While an MBR is considered one of the best available technologies in wastewater treatment, the effects based assessment conducted by Viridis demonstrated that to achieve the levels of nutrient reduction required, a supplementary reverse osmosis treatment step would also be required to further reduce level of nutrients in the resulting wastewater. An example of above ground concrete membrane tanks at a membrane bioreactor treatment plant that has been designed and built by Apex Water for an industrial client can be seen in Figure 7 below.

Figure 7 - An MBR Membrane Tank on an Apex Water designed and built dairy site

Membrane Aerated Bioreactor (MABR)

A Membrane Aerated Bioreactor is a modified activated sludge process, where through the addition of gas transfer membranes, process monitoring and control, the conversion of ammonia in raw wastewater to nitrate (one of the key process steps in the removal of nutrients in the wastewater), known as nitrification is carried out in a very quick and efficient manner.

The MABR process provides aeration for the conversion of ammonia to nitrate directly to the bacteria carrying out the biological processes. The gas transfer membranes provide a large surface area on which the biofilm can grow and allows for efficient oxygen transfer rates. The result of this is that for the same nitrification rate, an MABR treatment process requires a smaller footprint (i.e., smaller tanks) and uses less aeration energy which often comprises one of the largest operational expenses.

The MABR process, in its standalone form, does not utilize filtration membranes and therefore lacks the ability to separate and remove bulk solids from the treated wastewater. Consequently, the treated wastewater will still contain solids unless an additional removal step is implemented. While nutrient removal is achieved efficiently through the MABR process, the presence of residual bulk solids makes the effluent unsuitable for discharge into sensitive receiving environments. However, by incorporating MABR gas transfer membranes along with the appropriate process control features into the MBR treatment process, this results in a highly effective nutrient removal system that occupies a small footprint and produces treated wastewater of superior quality

Other major benefits of MABR treatment processes include:

- They are easily scalable and can be designed to be modular
- They typically produce much less waste biological matter (sludge) due to the high efficiency of the biofilm requiring less biology to achieve the same rate of nitrification compared to other conventional treatment systems.
- Lower sludge production means lower operational, and disposal costs associated with sludge handling.
- Can be operated to accommodate fluctuating wastewater organic loads without significant performance losses
- By virtue of their energy efficient design, they offer better environmental performance when measured against other conventional treatment options

Hybrid Membrane Bioreactor / Membrane Aerated Bioreactor (MABR)

Through the integration of MABR gas transfer membranes into the MBR treatment process an efficient treatment process producing exceptionally high treated wastewater quality can be achieved on a small footprint. This process combines the advantages of both treatment processes providing a robust treatment process that can handle variable nutrient loads which can be designed and constructed with modularity in mind for future expansion.

A photograph of an MBR/MABR hybrid treatment plant being constructed by Apex Water for Watercare Services can be seen in Figure 8 below.

Figure 8 - An under construction MABR/MBR hybrid treatment plant designed and under construction by Apex Water for Watercare

While this hybrid treatment process would be considered the best available technology for sewage treatment in New Zealand, to achieve the levels of nutrient reduction required for discharge to surface water at this site, a supplementary reverse osmosis treatment step should also be carried out to achieve trace level of nutrients required in the resulting discharge.

Reverse Osmosis (RO) Polishing Membranes

While the Membrane Bioreactor detailed above makes use of membranes for the separation of bulk solids and the removal of pathogens from the treated wastewater stream, these membranes themselves do not provide the level of nutrient reduction required to discharge into the unnamed waterways adjacent the site. To achieve the required level of treatment, Reverse Osmosis Membranes have been included in each of the treatment processes considered above. Unlike conventional dead head filtration processes, a Reverse Osmosis membrane filter operates by subjecting a constant pressurised flow of water across the surface of the membrane. While moving across the membrane surface, water molecules permeate across the membrane while contaminants as small as salts and nutrient molecules are excluded. The result is an extremely high quality permeate stream and a concentrated reject stream containing the excluded contaminants.

While it is uncommon for conventional wastewater treatment application to require the addition of reverse osmosis membranes as a part of the treatment train, these are widely utilised in countries which treat and re-use wastewater for drinking water applications. Figure 9 below taken from the World Health Organisation report into Wastewater Re-use highlights a number of treatment processes adopted worldwide for the re-use of treated wastewater for the purpose of drinking water. The proposed Delmore treatment plant process has been identified in red overlaid onto these examples of treatment processes.

Figure 9 – A number of example of treatment plants worldwide where wastewater is reused for drinking water applications

It should be noted that of the examples detailed above, three of the four highlighted use the same process as proposed. In these examples, the discharge is directed to a form of reservoir or environmental buffer (aquifer) prior to becoming a feed source for a drinking water treatment plant. To this end, the Reverse Osmosis essentially produces drinkable water from the treated sewage and if employed here, as is proposed, it would almost certainly make this water discharged from the Delmore development the cleanest of any treated sewage in New Zealand.

PROCESS SELECTION

Hybrid Membrane Aerated Bioreactor with Ultrafiltration Membranes (MABR + MBR) with Supplementary Reverse Osmosis Membranes.

A multi-criteria assessment (MCA) has been carried out on the processes considered to evaluate each of these on Performance, Future Proofing, Operability, Constructability, Social and Environmental Impact and Resilience and Process Resilience. Each of these has been baselined next to what Apex considers as the more robust treatment solution which consists of a 4-stage Bardenpho activated sludge treatment process, a Membrane Aerated Biofilm Reactor and Hollow Fiber Ultra filtration membranes with Reverse Osmosis membranes for polishing of the resulting treated wastewater.

Table 5 - Multi-Criteria Assessment Carried out on the Treatment Processes Considered

Category	Criteria	Weighting	Base Option 1 MABR + MBR		Option 2 Bardenpho MBR		Option 3 MABR Alone	
			Score	Weighted Score	Score	Weighted Score	Score	Weighted Score
Performance	Treated Effluent Quality (suitable for Surface Water)	20%	0	0	0	0	-1	-0.2
	Reliability & Robustness	10%	0	0	-1	-0.1	-2	-0.2
Future Proofing	Phased Construction & Future Upgradability	10%	0	0	-1	-0.1	-1	-0.1
	Relocatable / Suitability for Interim plant	10%	0	0	-1	-0.1	-1	-0.1
Operability	Ease of operation	7.5%	0	0	-1	-0.075	-1	-.075
	Process safety	7.5%	0	0	0	0	0	0
Constructability	Ease of implementation	5%	0	0	0.5	0.025	0.5	.025
Social and Environmental Impact	Amenity impacts (noise, odour etc)	5%	0	0	0	0	0	0
	GHG emissions	5%	0	0	-0.50	-0.025	-1	-0.05
Resilience	Process stability under peak flow	5%	0	0	-0.5	-0.025	0	0
	Process stability under future load conditions	5%	0	0	1	0.05	0	0

Financial	Indicative capital cost Relative operating cost	5% 5%	0 0	0 0	1 -1	0.05 -0.05	1 -1	0.05 -0.05
Total Option Score				0		-0.35		-0.7
Rank				1		2		3=

Score	**Description**
-2	Much Worse
-1	Moderately Worse
0	Same as Base Option 1
1	Moderately Better
2	Much Better

Note: the RO system has been excluded from this assessment as it would be required for each of the options

Disadvantages of an MBR – MABR Hybrid Process

Whilst the MBR-MABR Hybrid Process is considered the most suitable for the Delmore application, it does have some limitations. The limitations of this process are well defined and through process design these can be mitigated. The disadvantages of MBR – MABR hybrid process systems include:

- Limitations to total flows that the plant can handle

While the membranes provide a physical barrier to solids and bacteria entering the discharge, they also provide a physical limit as to the total flow that the plant can handle. The surface area available for filtration, the level of fouling blocking liquid flow and the physical pressure limitations of membranes all contribute to providing a hydraulic upper limit to a membrane-based treatment process. Where systems exhibit large peak flows, mitigation measures need to be employed to handle peak flows. Whilst this is considered a disadvantage of the selected process, it is common to all treatment processes containing membranes. Membranes are considered a necessary process step for the Delmore WwTP due to the required treated wastewater quality and use of tertiary UV disinfection. Through the addition of flow balancing and detailed design this limitation can be mitigated.

- Membrane Organic and Inorganic Fouling

The blocking of the membrane pores over a period of operation due to the accumulation of organic fouling or deposition of inorganic scaling restricts flow through the membrane. Any restriction of flow requires an increase in pressure differential to provide the same flowrate up to the physical pressure limitations of the membranes. The cleaning of the membranes to remove these blockages adds an additional layer of operational complexity that must be managed through a clean in place (CIP). Processes for cleaning both MBR and MABR membranes are commonplace but must be managed and controlled according to good operational practices to ensure process performance is maintained and operator safety is not compromised. While membrane fouling is a disadvantage of the process it is common to all membrane treatment processes which would be required in an application such as that proposed for the Delmore residential land development. An example of hollow fibre membranes with organic and inorganic fouling on the surface of each fibre can be seen in Figure below.


Figure 10 - Hollow Fibre Membranes with visible fouling

- Reverse Osmosis Reject Waste Stream

The Reverse Osmosis process results in two liquid streams, one of exceptionally high quality that can be discharged into even the most sensitive environments or re-used and the other containing the rejected contaminants that cannot pass through the membrane. The reject stream which makes up approximately 15% of the total volume of the treated wastewater must be discharged or handled with consideration of the contaminants present. While this represents an operational constraint, due to the extremely high quality of the wastewater being fed to the RO treatment process step the quality of this retentate stream will still be exceptionally high. As such, there are various options for disposing of the reject stream of the quality that will result from the proposed Delmore wastewater treatment plant which are discussed in further detail below.

Prevalence of MBR – MABR Systems in the Auckland Region

The adoption of MABR treatment processes and other modified activated sludge systems in New Zealand has been gradual. Potential factors contributing to this include limited technical expertise, the size of the industry, and established design standards. However, in recent years, the uptake of MABRs and other modified activated sludge technologies, such as Moving Bed Biofilm Reactors (MBBR), has gained momentum. Notable new treatment plants utilizing these technologies have been implemented in Te Kauwhata, Waikato (MABR-MBR hybrid), Lake Hawea, Otago (MBBR), and Raglan, Waikato (MABR-MBR hybrid). Both the Lake Hawea and Raglan plants were designed and constructed by Apex Water.

Over the past decade, many new sewage treatment plants in the Auckland region and surrounding areas, including those discharging directly to surface water bodies, have adopted MBR systems. These include facilities in Pukekohe, Warkworth, Clarks Beach, Waiheke Island, Karaka North, and Meremere. Apex Water has been responsible for designing and constructing five of the plants mentioned above. Notably, the wastewater treatment system on Waiheke Island handles unusually strong wastewater, with peak concentrations up to ten times higher than typical sewage. Despite these challenges, the system consistently produces treated water meeting stringent standards, with <10 mg/L total nitrogen (TN), <2 mg/L BOD, <1 mg/L total suspended solids (TSS), and <1 CFU/100mL E. coli.

Expected Wastewater Quality from an MABR -MBR with Reverse Osmosis Membranes

An MABR-MBR treatment plant, such as that proposed for the Delmore development is a best practice wastewater treatment solution. The resulting treated water quality is of such a high quality that by the World Health Organization Standards it meets the requirements for bathing quality water and Australian guidelines for Grade A+ recycled water without further treatment. For similar treatment processes it is not uncommon for an MBR to have undetectable levels of bacteria in the discharge (e.g., <1 CFU per 100mL).

The addition of reverse osmosis membrane filtration as a processing step provides a significantly more robust physical barrier to the discharge of solids and nutrients ensuring that the treated water has close to zero solids and that virtually all bacteria are removed from the discharge. From a practical perspective and to allow for any minor leaks or damage to membranes, MBRs are often designed to achieve a treated water quality of <4 E. coli/100mL. Following this with UV and Reverse Osmosis would also remove almost all viruses from the wastewater. Table 6 below provides a summary of the expected water quality of the treated wastewater alongside the quality of a range of other consented discharges or reference water qualities for comparison.

Table 6 – Expected Treated Effluent Concentration

Parameter		Proposed Treated Water Quality Median	Literature Derived Stormwater Runoff Quality (Williamson, 1993)	Proposed Treated Water Quality Median without Reverse Osmosis	Consent Discharge Limits for Karaka North (1250 Lots)	Watercare Consent Limits for Direct Discharge to Ocean from Clark's Beach
$cBOD_5$	mg/L	**0.5**	8	5	5	5
TSS	mg/L	**4**	170	4	4	5
TN	mg/L	**1**	2.5	5	5	5
TP	mg/L	**0.07**	0.42	2	2	Not limited
AMM-N	mg/L	**0.3**	0.1	2	2	2
E. Coli	MPN/ 100mL	**<4**	<1	<4	<4	UV treatment required but no E. *Coli* limit specified

The comparisons highlighted in Table 6 above provide context to how the treated wastewater quality compares to both common sources of discharges into the environment, such as stormwater runoff and consented discharge. It can be seen that the proposed discharge exceeds the quality of the majority of the items detailed above.

Wastewater Environmental Performance Standards 2025

The New Zealand government has recently passed into legislation the Water Services (Wastewater Environmental Performance Standards) Regulations 2025 (WWEPS). These standards, whilst applicable only to local authorities or local authorities derived organisations provide a simplified consenting pathway by setting out discharge quality standards that treated wastewater discharges must meet for a range of receiving environments. If the proposed discharge can achieve the stated discharge quality prescribed by the standards, a consent application can be made on this basis alone. This provides a significantly less onerous consenting pathway for local authorities centred around demonstrating process performance. The proposed Delmore discharge quality meets and exceeds the required quality standards for all the parameter detailed. Table 7 below provides a comparison between the proposed treated wastewater discharge quality that will be provided by the Delmore wastewater treatment plant.

Table 7 – A comparison of the WWEPS (2025) quality limits compared to the proposed Delmore discharge

Parameter	Proposed	WWEPS (2025)	Comment
cBOD5 (mg/L) – Annual Median	0.5	5.0 *10.0 – 90th Percentile*	Exceeds the WWEPS – 10x
TSS (mg/L) – Annual Median	4	5.0 10.0 – 90th Percentile	Exceeds the WWEPS
Amm-N (mg/L)–Median	0.3	*1.0 – 90th Percentile*	The median proposed for the Delmore project outperforms this by 3.3x
Total Nitrogen (mg/L) – Annual Median	1.0	4.0	Exceeds the WWEPS – 4x
Total Phosphorous (mg/L) – Annual Median	.07	0.5	Exceeds the WWEPS – 7x
E.coli (cfu/100mL) – 90th Percentile	4	130	Exceeds the WWEPS – 32x

By reviewing the quality results provided above in Table 7, it can be clearly seen that the proposed Delmore discharge meets and exceeds the requirements of the WWEPS by many times depending on the contaminant. This highlights the extremely high treatment quality that is proposed resulting in a discharge many times higher in quality than what would be required for a local authority designing, building and operating the same treatment plant on the same site

Figure 1 below shows a Membrane Bioreactor designed and built by Apex Water for Watercare in Meremere in the Waikato.

Figure 11 - A MBR treatment plant designed and built by Apex Water for Watercare

TREATMENT TRAIN

A simplified process flow diagram of the MABR-MBR hybrid treatment train is illustrated in Figure below.

This process is characterized by the following unit processes on the main flow path,

1. Raw sewage pump station – This feeds raw sewage to the treatment plant
2. Headwork Screening – These screen bulk solids out of the raw sewage to protect the downstream process.
3. Flow Balancing – A tank which receives the screen sewage buffering peak flows.
4. Pre-Anoxic Tank – The first stage and heart of the biological process housing the MABR modules
5. Aeration Tank – Dissolved oxygen is pumped into this tank to feed the biological process
6. Post Anoxic Tank – The second stage and polishing step of the biological process.

7. Membrane Tank – The filtration step of the process, where bulk solids, bacteria and viruses are filtered out of the wastewater
8. UV Disinfection – The UV disinfection step where any remaining bacteria or viruses are deactivated through exposure to ultraviolet light.
9. Reverse Osmosis Filtration – Permeate from the MBR is pumped across the surface of the RO membranes producing two liquid streams, the permeate for discharge locally and the reject for beneficial re-use or discharge.
10. Permeate Storage – Where permeate (fully treated wastewater) is stored prior to discharge
11. Discharge System – Treated wastewater is discharge via land irrigation or into a land infiltration trench for land contact prior to entering the adjacent waterway

Ancillary or other unit processes on minor flow paths may not be shown on the simplified process flow diagram below, but include:

1. Activated Sludge is periodically wasted and stored in the Waste Activated Sludge (WAS) tanks to maintain the required levels of biological activity
2. WAS is dewatered and thickened typically using a centrifuge for discharge and removal as a dry cake. Polymer is dosed to improve the dewatering performance.
3. RO Reject is stored on site prior to being discharged to the Watercare network via a Trade Waste agreement (TBC), or on site for beneficial re-use throughout the development.
4. Aeration blowers feed high volume and medium pressure air to the MABR gas transfer membranes and the aeration tank.
5. Acetic Acid is dosed as a supplementary carbon source to provide food to the biological process
6. Sodium hydroxide is dosed to manage the pH of the treatment process. The biological process consumes alkalinity, decreasing the pH of the wastewater which if not managed negatively impacts biological activity.
7. Aluminium Sulphate is dosed to sequester phosphorous out of solution for removal
8. Citric Acid is used to remove inorganic scaling from the membrane surfaces through a Clean-in-Place (CIP) process.
9. Sodium hypochlorite is used to remove organic fouling from the membrane surfaces through a CIP process.
10. Headworks screenings are collected in a skip for removal to landfill
11. Dewatered sludge is collected in a skip for removal to landfill.

+

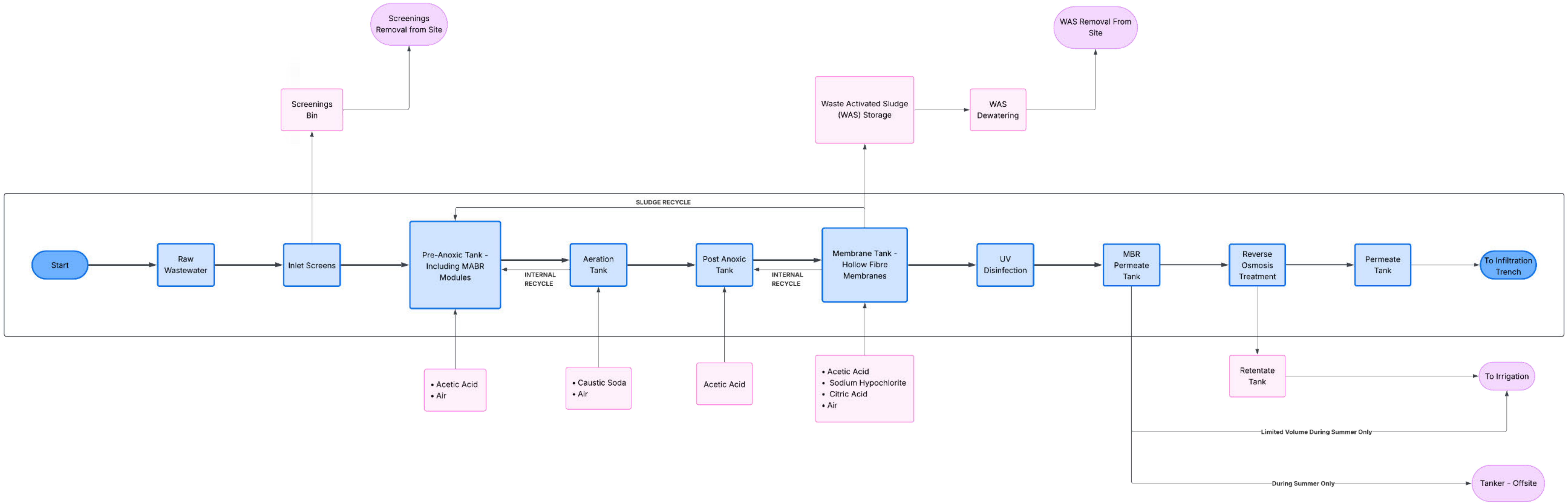


Figure 9 - Simplified Process Flow Diagram

Modelling of the Biological Process

Biological modelling of the treatment process has been carried out making use of Biological Modelling software. This design step is critical to both confirming the technology selection is appropriate for the wastewater volumetric and nutrient loading expected, but also in providing input to the planning and consenting of the overall project site.

The biological modelling process is carried out on Biowin software which is a tool that ties together the biological, chemical and physical process models. Through the development and optimisation of the model, the discharge quality can be determined for a range of flow scenarios. These scenarios allow a sensitivity analysis to be carried out on the proposed design to determine its suitability and stability under a range of influent flows and strengths.

One of the other key outputs of this stage of the design process includes bulk sizing of the unit processes which allows for a preliminary layout of the site including:

- Bulk dimensions of the treatment plant building – Planning and land use considerations
- Bulk dimensions of the treatment plant biological reactor tanks – Planning and land use considerations
- Volumetric consumption of the ancillary chemicals – Planning, land-use and hazardous substance considerations
- Site layout, permeable and impermeable surface make-up –Planning, land use, hazardous substances and industrial and trade related activities considerations
- Site layout – Noise generation, attenuation, vehicle movements, air discharges and operational ergonomics of the site – Planning, land-use, traffic and discharge to air considerations.

Further details related to planning and consenting is covered later in this document.

An overview of the BioWin model as visualised from the computer is illustrated in Figure below. The following subsections provide further details of the plant design.

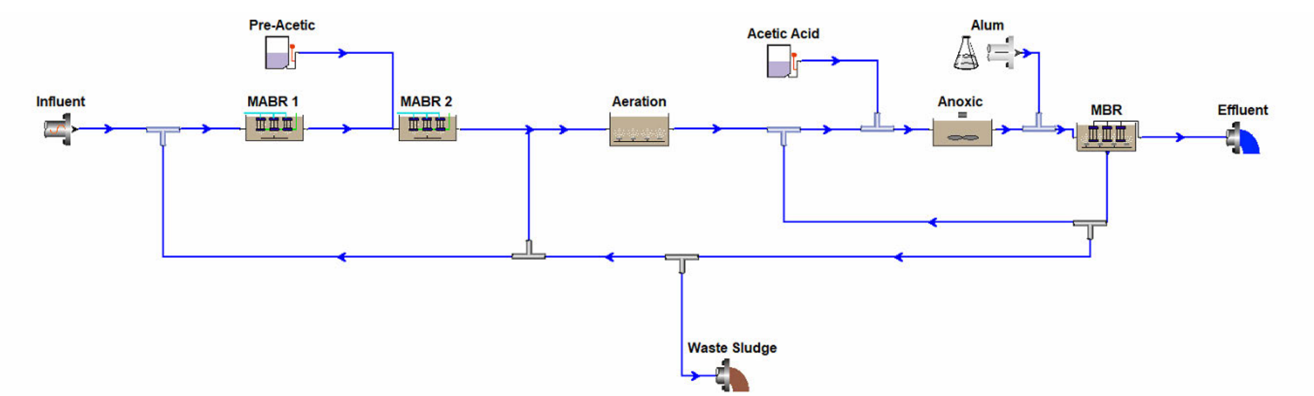


Figure 10 - Biowin Modelling Overview

MAIN UNIT PROCESSES

Headworks Screening

The incoming wastewater is directed through a wastewater receival pump station and delivered directly into the headworks system, where the screens are sized to handle the full hydraulic capacity of the development, including instantaneous peak flow conditions.

The wastewater enters a tank containing a screw compactor, which is fitted with a fine screen element. As the effluent flows through the screen, solids larger than 2mm are removed. Over time, these solids accumulate on the screen, which can cause a decrease in flow. This blockage results in a rise in water level, which is monitored by a level sensor inside the tank. When the water level reaches a predetermined point, a signal is triggered to automatically initiate the cleaning of the screen filter.

The screenings are then transported from the screening area to the dewatering or pressing section, where they are washed to remove organic matter. The collected solids are placed into sealed wheelie bins for removal from the site. Under full production, these bins will typically require emptying every one to two weeks.

Following screening, the effluent flows into a grit sedimentation tank (hopper), where grit particles are separated from the wastewater. The grit settles at the bottom of the hopper, and a horizontal screw conveyor at the base directs it to an extraction chamber. In this chamber, an extraction screw lifts, dewaters, and washes the grit, which is then discharged through a chute into a collection bin. Air diffusers inside the sedimentation hopper help enhance the separation of organic material from the grit. The removed grit is collected in a second sealed wheelie bin, which is also emptied periodically. Under full production, this bin will need to be replaced once or twice a month.

To ensure that all screenings are effectively captured, the wheelie bins are modified with a chute that passes through the lid, creating a tight seal. This system helps contain any odour and ensures that all screenings are directed into the bin. The headworks screens are installed on a sealed concrete surface, which drains to a sump that pumps the wastewater directly into the treatment plant. Typically, a heavy-duty plastic liner is used in the wheelie bins, and a duty-standby arrangement is employed to ensure an empty bin is always available for replacement. When a bin is full, it is replaced, the liner is removed, and the contents are disposed of in the dewatered sludge skip.

The headworks screening process performs the following functions:

- Removal of solids from the incoming wastewater.
- Washing, conveying, and dewatering of the screenings prior to disposal in the screenings bin.
- Separation of sand and grit.
- Lifting, dewatering, and washing of separated grit, which can be discharged to the screenings bin or a separate bin.
- Reduction in the volume of screenings by 40–60%, depending on the quality of the screenings.
- Dry solids content ranging from 25–35%, depending on the quality of the screenings.

Figure below shows both the coarse and fine inlet screens.

Figure 11 - Fine and Coarse Inlet Screens at a treatment plant designed and built by Apex Water

To reduce operational complexity the screens often sit on a raised platform hydraulically upgradient of the biologically process. While raw sewage is pumped into the screen, the screened sewage flows under gravity through the screens and into the rest of the process.

Balance Tank

The balance tank acts as a buffer protecting or decoupling the treatment processes from peak flows. Screened sewage passes directly into the balance tank under gravity where it is accumulated prior to treatment.

This balance tank consists of a large sealed tank where screened sewage is able to accumulate if it is received by the treatment plant at a rate higher than it can be processed by the downstream treatment process. The principle of decoupling the treatment process from peak flows allows the treatment plant to be sized for a lower flowrate, as opposed to the peak instantaneous flowrate which has the benefit of considerably reducing the size and cost of the process equipment required.

Pre-Anoxic Tank -

The Pre-Anoxic tank is an open-top vessel. The screened wastewater is pumped from the balance tank, where it is mixed and maintained at a fixed level, before passing into the subsequent stage of the treatment process: the aeration tank.

This tank functions as a biological treatment unit where nitrogen compounds and organic materials are removed through biological processes, converting them into carbon dioxide, water, and nitrogen gas.

By incorporating MABR membranes into the Pre-Anoxic tank, the system achieves highly efficient simultaneous nitrification-denitrification. The MABR membranes provide a surface for biofilm development, hosting large populations of nitrifying and denitrifying bacteria. In the Pre-Anoxic environment, oxygen diffuses across the MABR membranes, creating a gradient that decreases as it moves through the biofilm. This gradient enables both aerobic and anoxic bacteria to thrive in close proximity, optimizing the biological treatment process.

The Pre-Anoxic tank is equipped with the following components:

- MABR membrane modules
- Mixers to maintain effective suspension and mixing of bacteria with incoming contaminants
- A recirculation pump(s) to circulate wastewater between the anoxic and aeration tanks, with the wastewater flowing back into the Pre-Anoxic tank via a penetration in the dividing wall.

Aeration Tanks

From the pre-anoxic tank, the flow enters the aeration tank, in which naturally occurring bacteria grow and eat the organic contaminants in the wastewater. Ammonia is the main form of nitrogen present in the feed to this tank. The aerobic tank converts this to nitrate for removal by the anoxic tanks.

The aeration tank is fitted with fine bubble diffusers to efficiently transfer oxygen delivered by the blowers into the water. By keeping a positive level of dissolved oxygen in the aeration tank, aerobic conditions are retained, and the discharge of offensive odour is prevented. An aeration tank in operation can be seen in Figure below.

Figure 12 - An Aeration Tank in Action (Large Blue Tank)

Air is provided to the process through blowers which are to be housed in a soundproof plant room. As failure of the aeration system is one of the main odour risks of the site, a standby blower shall be included, in the event of a failure during operation. In addition to this, a back-up generator is installed on site which will automatically switch on should power supply to the site fail.

The blowers operate based on continuous measurement of dissolved oxygen. Alarms will be raised if the dissolved oxygen drops below a threshold value (e.g. 0.1ppm) for long enough to potentially develop anaerobic conditions (e.g. 4 hours). Under this scenario, a text message alarm is raised that alerts both the operators and maintenance staff that the plant requires urgent attention before conditions can develop that may result in a release of offensive odours.

Post Anoxic Tank

The nitrate-rich effluent from the aerobic tanks, is directed into the Post-Anoxic tank. Here, it is mixed with highly concentrated biomass recycled from the MBR tanks, allowing for the removal of any remaining nitrate, thus significantly improving the quality of the discharge.

The continuous supply of nitrate to the Post-Anoxic tank, combined with its very short hydraulic residence time (typically only one to two hours, depending on the incoming flow rate), ensures that anaerobic conditions—along with the associated risk of odours—are avoided.

When extremely low nitrogen concentrations are required in the discharge, as in this case, the wastewater may deplete its carbon-based contaminants, which are essential for the bacteria to process nitrogen. To address this, a supplemental carbon source is introduced to the Post-Anoxic tank to support the bacteria in removing additional nitrogen.
The recommended carbon source is 49% acetic acid, a cost-effective, safe, and natural chemical (essentially distilled vinegar).

For phosphorus removal, Aluminium Sulphate (Alum), a commonly used water treatment chemical, is dosed into the Post-Anoxic tank. This precipitates phosphorus from the solution. The precipitated phosphorus is then removed by the MBR membranes and is ultimately removed from the system along with the waste sludge.

MBR

A Membrane Bioreactor (MBR) is defined by the integration of a membrane filtration system that separates suspended solids and microorganisms from the treated effluent. The membranes used in this process have a pore size smaller than that of individual bacteria, thus providing a physical barrier that effectively prevents bacterial contamination in the final effluent.

This physical separation mechanism is what enables MBRs to consistently deliver some of the highest quality treated effluent available from commercially proven wastewater treatment technologies. An example of a modular and containerised MBR treatment plant designed and built by Apex Water for Watercare Meremere is shown in Figure 16 below.

Figure 136 - A modular and containerised MBR treatment plant designed and built by Apex Water for Watercare

Conventional sewage treatment plants typically produce effluent containing between 1,000 and 1,000,000 Colony Forming Units (CFU/100mL) of *E. coli*. In contrast, MBR systems commonly achieve effluent quality of less than 5 CFU/100mL, with several MBR plants managed by Apex Water routinely achieving undetectable bacterial levels (<1 CFU/100mL) without the need for additional disinfection processes.

It is proposed that this treatment plant will utilise submerged hollow fibre membranes. These membranes are air-scoured continuously during operation to prevent fouling and maintain performance. Additionally, the membrane tanks operate under high dissolved oxygen conditions to minimise the risk of odour generation.

In applications where significant nitrogen removal is required, such as in this proposal, the biological processes within the treatment plant can deplete the alkalinity present in the incoming wastewater. Without proper management through supplemental alkalinity dosing, a reduction in pH could occur, potentially harming the bacterial population and compromising the entire treatment process.

Biological modelling of the proposed plant indicates that, at the higher end of expected influent nitrogen concentrations, dosing of supplemental alkalinity is essential to maintain stable operational conditions.

The system design therefore incorporates automated dosing of caustic soda into the aeration tank, with the dosing adjusted according to real-time pH measurements to ensure that alkalinity levels are maintained within the optimal range for biological activity.

Phosphorus removal is also a key consideration, and the system is designed to actively reduce phosphorus to very low concentrations, which is particularly important in protecting the receiving environment. Phosphorus typically originates from domestic cleaning products and is more easily managed compared to other contaminants. A small dose of Aluminium Sulphate (Alum) is added to the Post-Anoxic tank to precipitate dissolved phosphorus, facilitating its removal via the MBR membrane system.

It should be noted that the addition of Alum increases the cleaning frequency of the membranes, as it leads to the formation of insoluble compounds that can contribute to membrane fouling.

UV Disinfection

The water that passes through the membranes is subjected to ultraviolet (UV) disinfection prior to entering RO system. High-intensity UV light is employed to deactivate microorganisms in the MBR permeate, rendering them incapable of reproduction. During passage through the UV reactor, over 99.9% of residual bacteria and viruses are effectively neutralised in addition to those already removed by the membrane filters.

The UV disinfection system is equipped with multiple individual lamps, failure monitoring capabilities, continuous online UV intensity (UVI) monitoring, and an automatic wiper system for maintaining the cleanliness of the lamps. Adequate clear space is provided around the UV unit to facilitate the easy removal and replacement of lamps and quartz sleeves.

The UV system is programmed to activate 3 minutes prior to the commencement of discharge flow, allowing for an appropriate warm-up period, and deactivates once the flow ceases. A notable advantage of MBR treatment is the typically consistent flow of treated effluent, which ensures the UV reactor operates optimally under continuous conditions.

By placing the UV before the RO system, any potential biofouling of the RO is also reduced.

Reverse Osmosis (RO)

The treated wastewater that has passed through the membranes of the Membrane Bioreactor and UV is of sufficient quality that is suitable many forms of beneficial re-use. However, for discharge via the land infiltration trench, the Viridis effects based assessment indicates that an even higher level of treatment than this is required to mitigate effects on the receiving environment. The treated wastewater is therefore passed through an RO membrane filter which will reduce the concentration of any remaining contaminants to trace levels.

While the permeate stream is suitable for tertiary disinfection prior to discharge into the local unnamed tributary via land contact, the reject stream must be handled and discharged separately. This is discussed in detail below.

Permeate Storage

The treated wastewater produced by the plant is of such a high quality that it can be beneficially re-used at the treatment plant as process water. The inlet screens are one such location where this re-use can occur, as they run through an automated cleaning process requiring high pressure water to be sprayed internally to dislodge and clear accumulated solids.

Solids Management

Sludge production is a by-product of the treatment process. The activated sludge contains the bacteria used to facilitate the nutrient reduction processes and is recycled throughout the tanks as required to continuously seed the biological process. The overall process uses naturally occurring bacteria to convert pollution in the wastewater to water, carbon dioxide, nitrogen gas, and more bacteria. As the membranes are continuously concentrating and recycling the solids as they separate them from the treated water, the bacteria if not removed accumulates in the process, eventually having a negative impact on the biological process. All that is required to manage this is to divert a portion of this bacteria in the form of a solids rich waste stream to sludge storage tanks in order to remove it from the process. While simple to achieve, solids management is a very important aspect in the management of the plants operation to ensure optimal performance.

This Waste Activated Sludge (WAS) is pumped and stored in two storage tanks with a combined volume of 60 m3. The sludge settles and thickens in the WAS storage tanks ahead of dewatering and removal. WAS collected in these tanks will be dewatered to a concentration of approximately 18% solids in a decanter centrifuge in order minimise the volume of waste sludge requiring disposal off-site. The decanter centrifuge is located inside a building to contain odour and noise.

The dewatered sludge is conveyed by the dewatering unit to a covered skip where it is collected. The cover of the skip is connected to the site's odour extraction and treatment system to ensure no odours are released from this area of the plant.

Dewatered sludge will be collected by a specialist waste collection company who will dispose of it at a suitably licensed landfill capable of receiving and disposing of biosolids generated at wastewater treatment facilities, such as that located in Hampton Downs.

Chemical Systems

The plant will incorporate the chemical systems detailed in Table 8 below.

Table 8 - Chemical Systems

Chemical	**Purpose / Details**	**Dose Point**	**Approx. Consumption**
Acetic acid (49%)	Provides a carbon source for nitrogen removal.	Post Anoxic	150L/day
Caustic soda (30%)	Provides pH adjustment as required. The biological reactions can consume all alkalinity available, dropping the pH into a range that is harmful to the bacteria.	Aeration tanks	50L/day
Aluminium sulphate	Precipitates out phosphorus as it can be filtered out by the MBR system. Note, the addition of aluminium sulphate does increase the MBR cleaning requirements.	Anoxic tank 2	40L/day
Sodium hypochlorite (13%)	Utilised for membrane CIP to remove organic fouling on the membranes	MBR tanks	100L/month
Citric acid	Utilised for membrane CIP to remove inorganic scaling from the membranes	MBR tanks	100L/month

TREATED EFFLUENT DISCHARGE

The wastewater treated by the MABR-MBR-RO plant is of such high quality that it meets World Health Organisation guidelines for bathing water (as well as meeting the other standards already addressed). While there are no standards in New Zealand covering for recycled water systems, the proposed system can meet the requirements in the Queensland Public Health Regulations 2005 for its highest grade: Class A+ Recycled water suitable for dual reticulation. Table 9 provides details of the minimum log reductions of pathogens and indicator organisms required for class A+ recycled water systems from the Department of Energy and Waste Supply, Queensland Government.

Table9 - Recycled Water Classifications (Department of Energy and Water Supply Queensland, 2008)

Indicative Log Removal Required to Achieve Class A+)[2]	**Microbiological Pathogen[1]**
5	Bacteria – Indicator E. coli
6.5	Viruses – Indicator F-RNA bacteriophages, Somatic coliphages
5	Protozoa – Clostridium perfringens
5	Helminths - Clostridium perfringens

Discharge of treated wastewater

In this report and in the following sections we refer to wastewater that has been through the full treatment process, including the RO membranes, as RO treated wastewater. We refer to wastewater that has been through the MABR-MBR treatment process but not the RO treated process and non-RO treated wastewater.

Due to the nature and quality of the receiving environment, the Delmore project is proposing a tiered approach to the management of treated wastewater discharges from the site.

Surface water quality sampling within the receiving environment carried out by Viridis highlighted low in stream nutrient concentrations, requiring the exceptionally high level of treatment proposed. These investigations also identified that not all of the RO treated wastewater could be discharged to the unnamed tributary via the land infiltration trench during the low flow (summer) period. During this period Viridis' advice is that to minimise any adverse effects that only 15% of the RO treated wastewater can be discharged via the infiltration trench. The remaining 85% of treated water needs to be discharged to an alternate location. Outside of the low flow (summer) period 100% of the RO treated wastewater can be discharged through the infiltration trench.

The RO reject stream which is generated by the RO treatment process also needs to be disposed of and we explain the process for this below in the section covering the discharges of RO reject from the treatment plant.

A summary of how the treated wastewater is proposed to be managed during the summer low flow period, and then during the rest of the year, is set out below with further information presented in the following sections:

Scenario	**Proposed Discharge Paths**	**Comment**
1. Low Instream Flowrates – Mean Average Low Flow (MALF) – summer	In the summer, only around 15% of the total treated wastewater is discharged through the RO membrane process, and this RO-treated portion is discharged to the infiltration trench. This 15% equates to an average dry-weather flow of 38.5m3/day, or a peak wet weather flow of 46.2m3/day. The RO process is not proposed for the remainder of the treated wastewater in summer (85% - this is known as the non-RO treated wastewater). This avoids the generation of RO reject and the need for its subsequent management and disposal. Some of the non-RO treated wastewater will be discharged into the irrigation zones across various areas on the site. A maximum application rate of 3mm/d of the non-RO treated wastewater to be discharged to the irrigation zones. The total volume to be irrigated in this scenario is covered in the irrigation section, below.	RO reject from the 15% of wastewater that is subject to the RO membrane process and discharged to the infiltration trench will be discharged to the irrigation zones.

	The rest of the non-RO treated wastewater (about 60 % of the total volume) is piped to a holding tank located at the bottom of Road 1 and collected there by truck. It is then taken to a third-party disposal site. This location(s) shall be detailed in documentation supporting the consent documentation.	
2. Median In Stream Flowrates (Average Condition)	All of the RO treated wastewater is discharged to the land infiltration trench.	During median conditions there is little impact to the ecology of the stream. RO reject will be discharged to the irrigation zones.
3. Peak In Stream Flowrates (Peak Wet Weather)	All of the RO treated wastewater is discharged to the land infiltration trench.	During peak conditions there is little impact to the ecology of the stream. RO reject will be discharged to the irrigation zones.

A summary of the treatment discharge pathways can be seen in Figure 17 below.

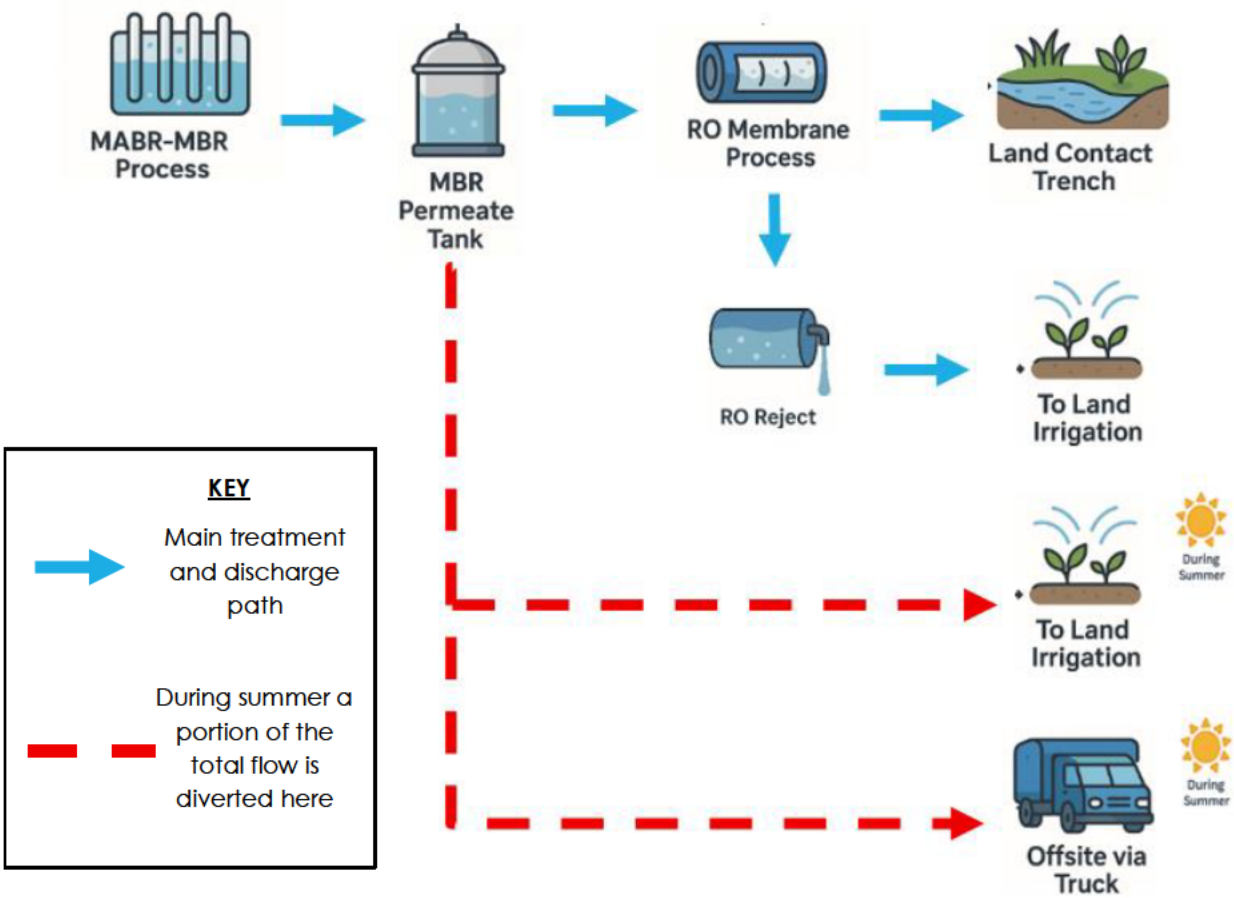


Figure 17 – The proposed treatment and discharge pathways for Delmore plant.

A summary of the **peak** volume of RO treated wastewater, non-RO treated wastewater and RO retentate discharged to each location under the three scenarios modelled is shown in Table 10 below.

Table 10 – Peak volumes discharged to each location under the three scenarios modelled.

Scenario	**RO treated wastewater to Infiltration Trench**	**RO retentate to irrigation**	**Non-RO treated wastewater to irrigation**	**Non-RO treated wastewater taken offsite**
1. Low Instream Flowrates – Mean Average Low Flow (MALF) – summer	46.2m3/day	8.1m3/day	54.9m3/day	198.7m3/day
2. Median In Stream Flowrates (Average Condition)	261.7m3/day	46.2m3/day	0.0m3/day	0.0m3/day
3. Peak In Stream Flowrates (Peak Wet Weather)	261.7m3/day	46.2m3/day	0.0m3/day	0.0m3/day

Discharge to Land Infiltration Trench

Whilst utilising this discharge pathway the RO treated wastewater shall be discharged to a constructed land infiltration trench. The proposed land infiltration trench shall consist of a rock filled infiltration trench and drainage blanket following the contours along and extending up to the riparian edge of the waterways adjacent the wastewater treatment plant compound. Whilst discharging to the land infiltration trench, the RO treated wastewater shall flow through the discharge pipework into the rock filled trench. Assimilation of this discharge shall occur through the soils surrounding this trench, however if the surrounding soils become saturated to the extent that they can no longer assimilate water at the rate of discharge, the trench shall accumulate water until it overfills (under the surface of the ground) and permeates through the drainage blanket below ground level towards the edge of the adjacent waterway into which it shall discharge. The drainage blanket shall be heavily planted making any nutrients within the RO treated wastewater permeating through this zone available for uptake by plants growing in the contact area.

The addition of planting along the drainage blanket and along the riparian edge may provide some additional polishing of the discharge, however it has not been considered in this report.

A graphical representation of this discharge pathway can be seen in Figure 18 below, with the final discharge location highlighted in red.

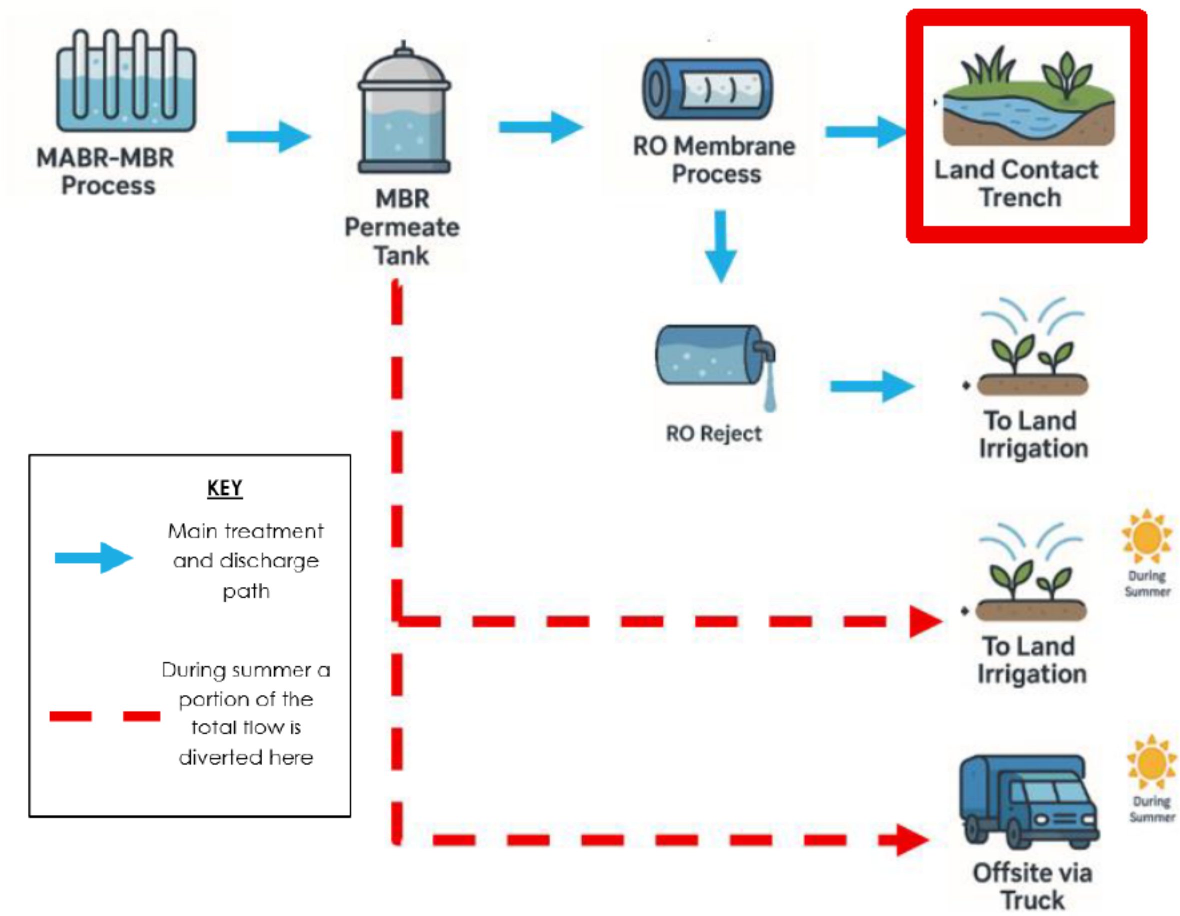


Figure 18 – The proposed land contact discharge pathway (red box)

Discharge Offsite

During the summer period from December through the end of February when the in-stream flowrates are likely to be low, not all of the RO treated wastewater will be discharged on site as already explained above. Instead, only 15% or approximately a peak volume of 46.2m3/day of the total volume will be discharged to the land infiltration trench.

It is proposed that the RO membrane process is only used for the volume that can be discharged to the infiltration trench. By not using the RO membrane process for the remaining volume, there will be no RO reject stream, meaning the discharge of RO reject to land, or transportation off site, is not required. This means that the treated water that is being collected from the holding tanks is non-RO treated water. While the discharge of RO retentate to land would not be required while the RO is not utilised, it is still proposed that the full capacity of the irrigation zones is utilised by discharging non-RO treated wastewater to this location. All treated wastewater that cannot be discharged on site will be piped down to a holding tank at the bottom of road 1 and taken off-site by trucks

By modelling the wastewater generated by Stage-1 against 10-years of rainfall data and comparing these volumes to the capacity for the site to receive discharges, an assessment of the actual volume of non-RO treated wastewater requiring removal during summer can be made. This can then be used to estimate the number of trucks that would be required to collect and remove the non-RO treated wastewater. This information is set out in Table 11. As this scenario is occurring during the summer months when there will generally be a moisture deficit in the irrigation area, there is the possibility that the non-RO treated wastewater could be discharged at this time. The assessment carried out below to determine the sustainable rate of irrigation has considered the application of non-RO treated wastewater during the summer months when no RO Reject is produced.

A graphical representation of this discharge pathway can be seen in Figure 19 below, with the final discharge location highlighted in red.

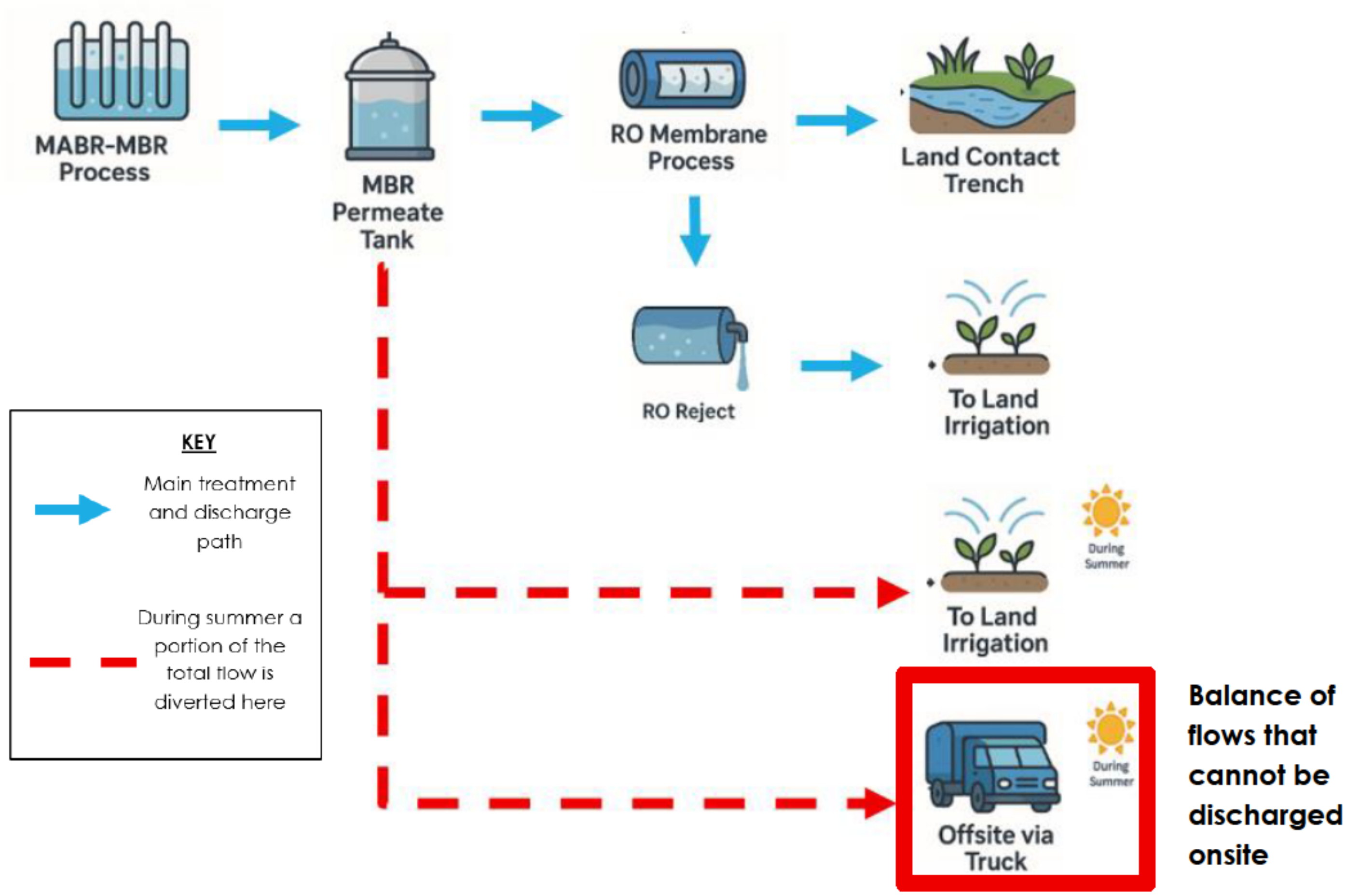


Figure 19 – The proposed summer discharge pathway (red box)

The removal of the non-RO treated wastewater during the summer period shall be carried out by road tankers. The number of trucks required will generally depend on the volume of wastewater treated or any excess that has been allowed to accumulate from the previous day. A model of the number of trucks required during the summer period has been carried out based on the various assumptions detailed within this report. Due to the extremely high level of treatment that the wastewater will be subjected to (even without the RO membrane stage being applied) it is proposed that larger road tankers are utilised for the transportation of treated wastewater off-site. We have included an image and commented on the nature and size of the trucks in the subsequent sections below. The treated wastewater will be free from solids and by all visual aesthetic qualities be considered clear non-potable water. The outcome from this is that fewer truck movements are required and a more sustainable approach to tankering offsite can be taken.

Rainfall data for the past 10-years has been factored into the model to account for peaking events. From this model the following average daily truck movements are required, as seen in Table 12 below:

Table 12 – Daily Truck Movements

Description	**No.**	**Comment**
Average No. Truck per day	5.4	December through February
Maximum No. Truck per day	6.9	December through February

Discharge to Land Irrigation

As detailed above, during the summer months when there is a limited ability to discharge to the land infiltration trench, the RO membrane treatment process will not be used for any treatment above and beyond the 15% of the total volume that can be sustainability discharged to this location. To this end, the balance of the 85%, would only be subject to treatment through the MABR-MBR treatment process.

As there is generally limited rainfall during the summer months, it is proposed that the non-RO treated wastewater is discharged to the irrigation zones up to the same volume limits as the RO reject (discussed below). The non-RO treated wastewater is lower in nutrients than the RO reject meaning that less nutrients are being discharged into the irrigation zones comparatively than if RO reject was being discharged.

It is important to highlight that while this stream will be directed to land in this scenario, the land will not be able to take the full volume produced and as such this does not remove the requirement for trucking waste off site but rather reduces the volume requiring removal.

A graphical representation of this scenario is shown in Figure 20 below.

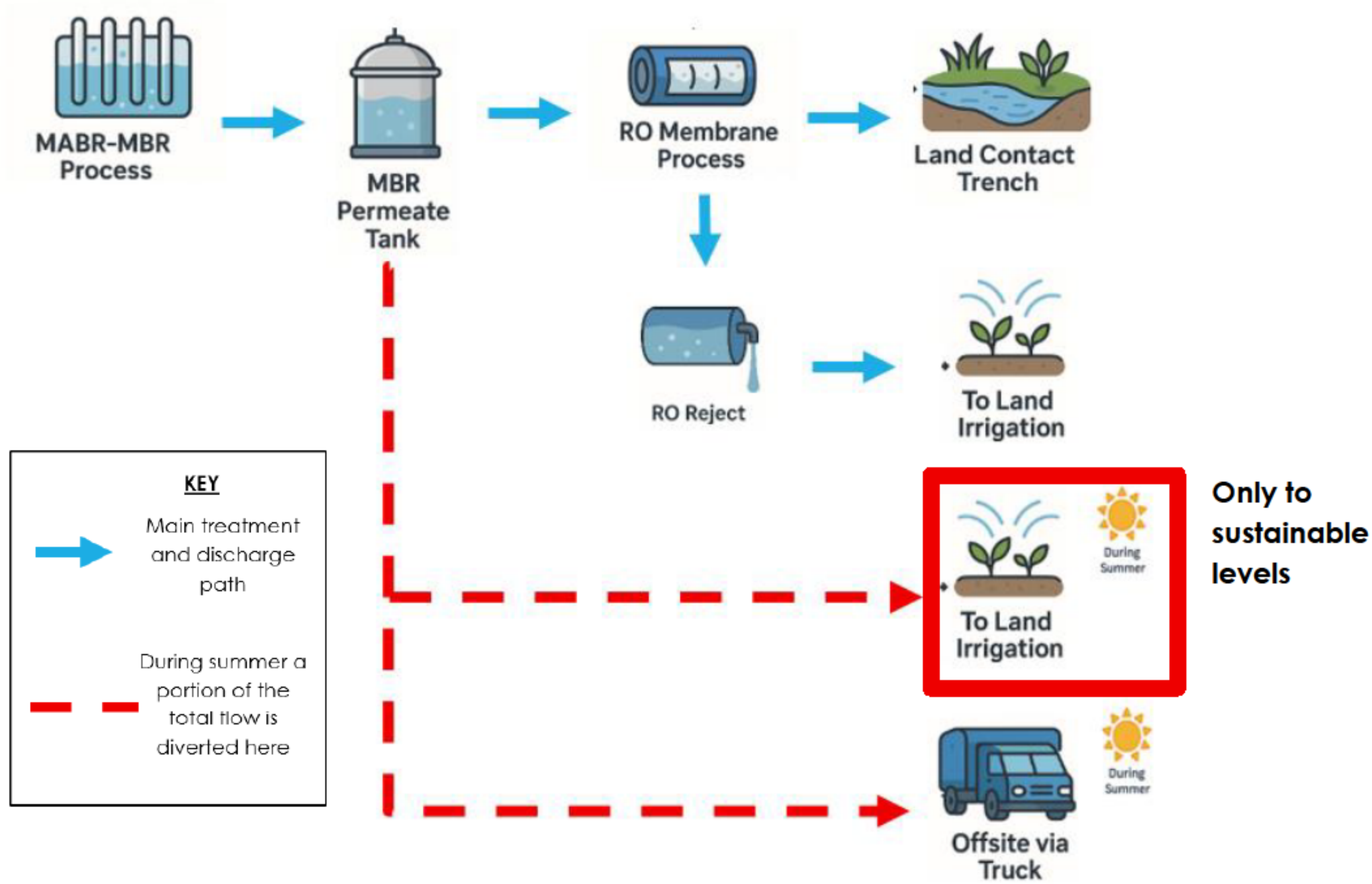


Figure 19 – The proposed irrigation discharge pathway during the summer months (red box)

Discharge of RO reject

The way in which the RO membrane filtration process removes contaminants from the feed source means the contaminants become concentrated into a liquid retentate waste stream. This stream must be handled and discharged appropriately. While this stream contains elevated concentration of some Total Nitrogen, Total Phosphorous, carbonaceous Biological Oxygen Demand, Ammoniacal nitrogen, amongst others it is important to note that the risk to human health is exceptionally low as the MABR-MBR process feeding the RO treatment step has already removed almost all pathogens.

As covered briefly above, it is proposed that this RO reject is discharged to land via surface mounted drip irrigation in the irrigation zones locations throughout the entire year.

Discharge to Land Irrigation – RO Retentate

The proposal to irrigate the RO reject from the wastewater treatment plant allows for the beneficial re-use of some of this stream through uptake by vegetation. The RO reject is conveyed to the irrigation area via a pressurised polyethylene rising main running between the treatment plant site and the irrigation zones where it is then distributed onto the irrigation zones via surface mounted drip irrigation lines. A visual representation of this discharge path is shown in Figure 20 below.

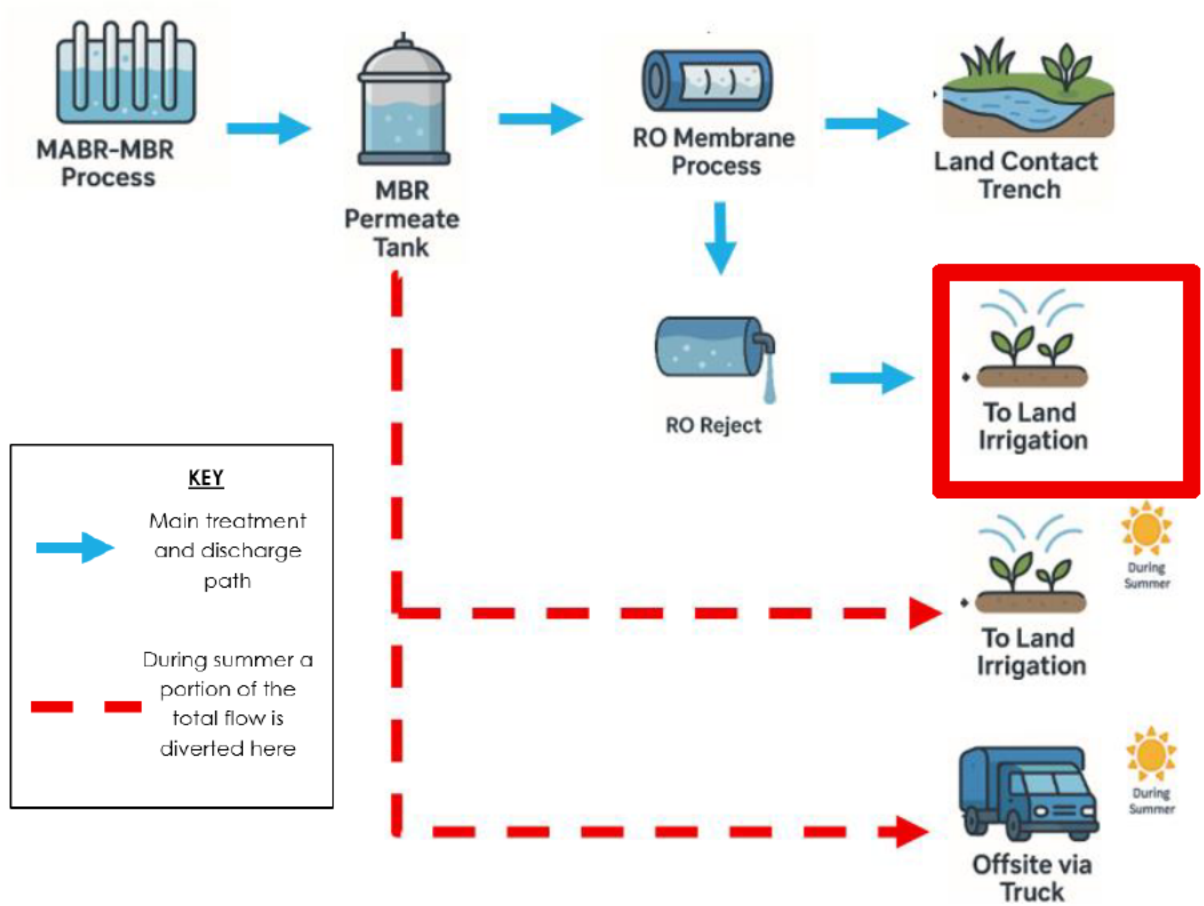


Figure 20 – The proposed RO retentate irrigation discharge pathway (red box)

Irrigation Rates and Volumes

Soil analysis testing completed on the proposed irrigation areas has determined the sustainable volumetric application rate of treated wastewater onto the site. This testing, carried out by Riley Consultants has determined the following:

…'the soils and its ability to transfer treated effluent into the groundwater via the underlying soils formations is between 2-3mm/day."

In addition to the sustainable volumetric application rate, the uptake and evapotranspiration rate by the plant life in the irrigation areas can also been assessed. Ten years of Penman evapotranspiration rates and soil moisture deficit records from the nearest weather station with suitable records have been reviewed as part of this modelling. These show that during the summer there is an average of 4-5mm/day of irrigation deficit based on evapotranspiration potential, and this drops to 0-1mm mid-winter. The maximum possible application rate by carrying out a moisture balance utilising 10-years of meteorological data and Penman Evapotranspiration records is 8.7mm/day.

A summary of the parameters used to model to discharge to irrigation are presented in Table 13 below.

Table 13 - Discharge Scenario Parameters

Parameter	**No.**	**Comment**
Irrigation zones Area (Ha)	2.1Ha	
Soil Sustainable Permeability (mm/d)	3mm/d	Without evapotranspiration
Reverse Osmosis Reject %	15%	
Nutrient Concentration of Discharge	Refer comment	RO reject concentration used except for during summer when MABR-MBR permeate will be used.
Sustainable Application Rate (m3/d)	63	3mm/d applied to 21,000m2
RO Retentate Produced at ADWF (m3/d)	44.4	

While evapotranspiration was originally considered in the modelling conducted, it is noteworthy that the volume of RO reject produced never exceeds the sustainable assimilation rate of 3mm/day over the irrigation area. This conclusion has been drawn prior to assessing the impact evapotranspiration will have on the soil water balance. As such, during the summer months there will be periods where the irrigation zones remain in moisture deficit regardless of the RO reject discharge occurring. To this end, it is not proposed that any land areas are held in reserve as the discharge is below the sustainable rate prior to allowing for evapotranspiration. This does not preclude future irrigation areas being included.

Maintaining Soil Health

Although the RO reject is of exceptionally high quality, consideration must be made to the nutrients it is providing to the soil in the irrigation zones. The sustainable limits for application of nutrients to soil are as per the following table.

Table 14 - Sustainable land application nutrient loading limits

Nutrient	Application Limit
Total nitrogen (TN)	220 kg/Ha.year
Total phosphorous (TP)	80 kg/Ha.year
Biochemical oxygen demand (BOD_5)	600 kg/Ha.day

The nutrient loading calculation has been based on the scenario where the RO reject is discharged to the irrigation areas. However, during the summer period when the RO reject volume produced is reduced due to the limited ability to discharge RO treated wastewater on site, a small portion of the non-RO treated wastewater shall also be discharged to the irrigation zones up to the maximum application rate of 3mm/d. This will allow for approximately 56.3m3/day of non-RO treated wastewater to be discharged to irrigation during the summer period. On this basis, the summary of the nutrient loading into the irrigation zones is detailed in Table 15 below.

Table 15 - Total nutrient loading limits for irrigation options at the discharge strength permitted by the proposed conditions

Description of the Scenario	Total N Loading Rate (kg/ha/yr)	Total P Loading Rate (kg/ha/yr)	BOD_5 Loading Rate (kg/ha/day)
Normal Site Conditions - ***Application of RO reject up to 3mm/day***	160.2	36.3	0.64
Summer Site Conditions – ***Application of non-RO treated wastewater up to 3mm/day***	60.7	10.7	0.58
Total	**220.8**	**47.0**	**1.22**

The irrigation volumes in Table 13 and the irrigation zones total area have been used to calculate the annual nutrient loading rates. Table 15 above provides the total nitrogen, phosphorous and cBOD5 loading rates at the proposed median discharge strength. As can be seen above, the modelled application rates for phosphorous and cBOD5 are all well below the sustainable application rates, however the Total Nitrogen loading rate is equal to the sustainable application rate of 220kg/ha.year. Based on this, the discharge of nutrients into the irrigation zones can be carried out sustainably, while a robust monitoring condition shall be included in the consent pack. It is noteworthy that while the infrastructure already exists for discharge offsite and this will be occurring during the summer period, should on-going monitoring indicate that the application of nutrients was to become non-compliant then additional volumes could be directed offsite without major changes to the process or infrastructure.

Description of Irrigation

Vineway has provided several areas that are available for the installation of surface mounted drip irrigation lines for the discharge of RO reject and non-RO treated wastewater. These irrigation areas comprise of zones that will be newly established with landscape planting, or reserve land that is currently and will remain planted in bush. The locations identified for irrigation can be seen in the Figure below in light blue and red.

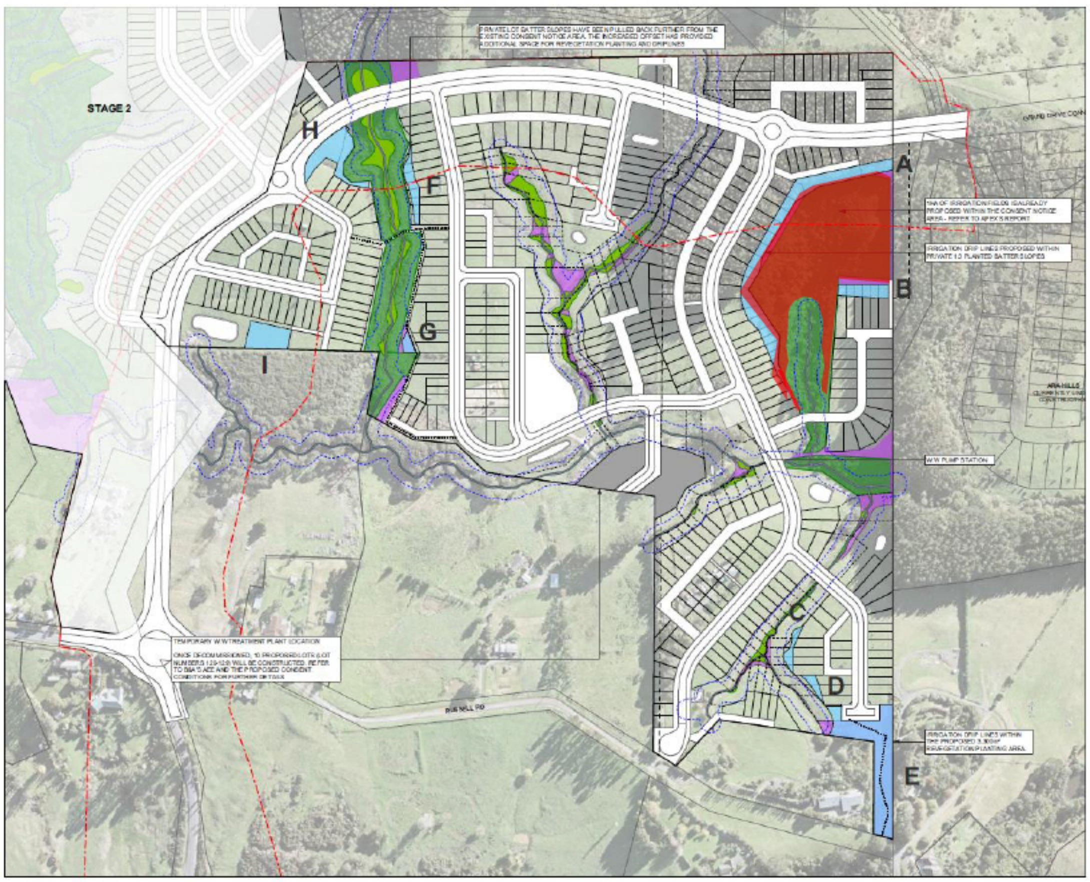


Figure 21 – Irrigation areas highlighted in red and light blue

As seen in the figure above, the irrigation zones are spread through the Stage-1 area of the development, the areas as presented allow for setbacks from wetlands, waterbodies and site boundaries, however these will be reconfirmed during the detailed design stage. While the irrigation system shall be operated in a number of discrete zones to promote uniform distribution across the application area, some of the smaller areas may operate together as a single zone to ensure the system is operated practically.

Initial visits to the development site and review of the civil design, indicate that the proposed areas are suitable for the installation of surface mounted drip lines. However, during the detailed design phase specialist technical advice will be sought where items such as slope stability and coordination with landscaping is required. One of the benefits of installing surface mounted drip irrigation through landscaped areas is that it provides the ability for the controlled dose of irrigation to the plant life while it is establishing. During the summer period, especially after the initial planting period this will provide nutrients and water to the area ensuring a moisture deficit does not result in stress to newly planted species.

Treated RO reject will be conveyed from the wastewater treatment plant to the irrigation zone via high-density polyethylene (HDPE) pipework. This conveyance system will operate on a closed pressure loop, regulated at the treatment plant to match the operational requirements of the active irrigation zone. The system will discharge treated effluent through surface-mounted, pressure-compensating dripline installed along the natural contours of each irrigation zone. The pressure-compensating emitters will ensure a consistent discharge rate across varying terrain, promoting even distribution of wastewater and minimising the risk of ponding, over-application and syphoning.

System control will be fully automated and integrated into the treatment plant's supervisory control and data acquisition (SCADA) system. Irrigation cycles will be initiated once the RO reject tank reaches a predefined minimum operating level. Upon activation, treated effluent will be delivered to one or more of the irrigation zones via dedicated irrigation pumps.

Based on the area of each zone, these will receive treated effluent up to the maximum daily application volume . Upon reaching this threshold, the control system will automatically switch to an alternate zone, placing the initial zone into rest mode until midnight. Volumetric flow will be monitored in real-time using an inline electromagnetic flowmeter located on the effluent delivery line to ensure compliance with consented discharge volumes. Table 16 below outlines the details of the proposed irrigation system.

Table 16 – Irrigation System Details

Description	Unit	Comment
System Type		Land Dispersal
Dispersal Irrigation Area	ha	2.1
Dispersal Type		Surface Drip Irrigation

Lateral and Emitter Type		Pressure Compensated – Netafim or similar
Emitter Discharge	L/h	1.6
Emitter Spacing	m	0.6
Lateral Spacing	m	Minimum 1m but to be determined
Maximum Daily Application Limit	mm/d	3mm/d
Maximum Daily Operational Hours	hours	24

There are a number of relevant examples of where other surface mounted driplines have been installed through bush throughout New Zealand, as described in Table 17 below.

Table 17 – Comparable examples of wastewater discharges via drip irrigation through bush

Location	Design Flow	Detail	Comment
Tawharanui Regional Park	21.4m3/d	7130m pressure compensate dripline laid on surface through bush	(Innoflow Wastewater Specialists, 2025)
Mahurangi Regional Park	14.2m3/d	4730m pressure compensate dripline laid on surface through bush	(Innoflow Wastewater Specialists, 2025)
Hot Water Beach Public Toilets	10m3/d	1250m pressure compensate dripline laid on surface through bush	(Innoflow Wastewater Specialists, 2025)
Momorangi Bay Camping Ground – Queen Charlotte Sound	77m3/d	38,500m2 of surface mounted pressure compensate drip irrigation	Installed by hand in existing native bush (Innoflow Wastewater Specialists, 2005)
Onetangi Public Toilets	Not reported	Length not reported, but detailed as being installed / placed in a scrub/bush covered hill area (see below)	(Innoflow Wastewater Specialists, 2007)

As can be seen in the table above, there are a number of examples where surface mounted drip irrigation has been installed by hand through bushed areas where minimal disruption to the bush has occurred as a consequence of this work. There is no need to remove trees or any large vegetation. Vegetation removed can be restricted to very low-lying species and can be coordinated with the removal of weeds and invasive species. Figure 22 below show some of the relevant examples detailed above giving some context to the installation location and topography.

Figure 22 – Examples of surface laid drip irrigation line installation for wastewater treatment plants of similar size and capacity as that proposed.

Notably, in the example presented above located at the Momorangi Bay Camping Ground in the Queen Charlotte Sound, Innoflow Solutions highlight how '…The *dripline was installed within existing native bush…*' and that the project could be implemented in a manner that did not disturb the local environment '*..a lot of care was taken not to impact on the surrounding environment or the facility itself…* ' (Innoflow Wastewater Specialists, 2005)

Watercare Services Limited currently operate a wastewater treatment plant in Omaha, north of Auckland that discharges treated wastewater via surface mounted pressure compensated driplines into both a wooded and densely planted bushy lots. The figures below show both the wooded and bush lots used for discharge at the Omaha site.

Figure 23 - Omaha Wastewater treatment plant wastewater discharge via surface mounted drip irrigation through both bushy and wooded areas.

While the irrigation shall be spread across the 2.1Ha available, the dose of 3mm/day is relatively low compared to other irrigation zones with underlying soils that are able to assimilate larger volumes of water. As such, the physical length of the dripline required to achieve the maximum volumetric dose rate shall be comparatively low. This allows for flexibility in the installation of the driplines. Based on the bulk dimensions of the largest irrigation area, it is estimated that to achieve a conservative discharge rate that the lateral spacing could be increased to up to 4m allowing allow for a lot of installation flexibility.

Irrigation Installation

The installation of the surface drip irrigation line shall be carried out in both newly developed and earth worked areas, as well as in existing bush. Where the driplines are to be installed through newly developed areas, this work shall be coordinated with landscaping.

In the areas covered in existing bush, it is proposed that the drip line installation will occur during weed clearing activities. Each drip line lateral shall be laid through the existing bush with foliage and debris on the ground in the location of the lateral to be removed by hand. Where established and native planting exists, the lateral shall be routed to avoid this. As the lateral is being pulled into position it shall be pinned into the soil using stainless steel pins. These pins shall extend deep enough into the underlying soils that the dripline shall be tightly held in position. The installation shall conform with Auckland Council documentation in its draft guidance for the on-site wastewater management in the Auckland region. The pressure compensating driplines proposed for the irrigation zone shall be '..*placed on, and pinned to, the ground surface within areas of established trees, or other vegetation, and covered with leaf fall or mulch where practicable.*' This approach will limit any minor damage to native vegetation to that which would normally be unavoidable during required weed clearing activities.

Impacts of Staging on Treated Wastewater Discharges

As previously detailed, during the summer months, approximately 60% of the treated wastewater, as non-RO treated wastewater will need to be removed from the treatment plant site. This conclusion has been drawn when modelling the impact of the full 475 lots that are to be covered by the proposed stage-1 treatment plant.

As the development will be staged, the completion and occupation of housing shall occur over a number of years. During the initial years, when there are few occupied houses the volume of treated wastewater will be low. Modelling carried out has determined that the site can accommodate 101.5m3/day of treated wastewater discharges during the summer low-flow months. This is split between 38.5m3/day to the land infiltration trench and 63m3/day to the irrigation zones. This means that as modelled no treated wastewater will need to be removed from the site until the average dry weather flowrate exceeds 101.5m3/day. This is the equivalent of 187 residential lots.

Discharge of emerging contaminants

In recent years, there has been an increased focus on a new set of contaminants that are often being found in natural waters and the broader environment. These contaminants often found in person care products, pharmaceuticals and everyday items are largely recognised as the environmental pollutants of the future, with many already being found at levels of concern. This broad range of pollutants covering microplastics through pharmaceuticals are recognised as pollutants due to their potentially toxic effects at low concentrations.

While trade waste bylaws control industrial sources of discharge into the environment, sources which enter the environment via consumer products have traditionally been overlooked. Due to the low concentration at which effects can be observed the focus is now shifting to include not only industrial discharges, but also via the personal use of products containing pharmaceuticals, shampoos, sunscreens, cosmetics and detergents.

Some traditional wastewater treatment processes can perform poorly at the removal of CECs, allowing these to pass through the process and into the discharge. However, the MABR-MBR at the centre of the Delmore wastewater treatment plant provides an effective barrier against a broad range of emerging contaminants. This is supported by Kwon and Lee's study into the removal of contaminants of emerging concern (CEC) through membrane bioreactors. Kwon and Lee's study carried out by Incheon National University showed that removal rates of CECs such as acetaminophen, ibuprofen, Diclofenac, ofloxacin, estriol, erythromycin and caffeine ranged from 90 to greater than 99% in membrane bioreactor systems, with many other CECs being removed at rates of 50-90% (Yongbum Kwon, 2019).

EFFECTS OF THE DISCHARGE ON SURFACE WATER QUALITY

A technical assessment of the discharge on the surface water quality has been carried out by Viridis and is presented in documentation supporting this application. This assessment has assumed that treated wastewater that has been discharged to the infiltration trench will permeate through the drainage bed and after land contact ultimately end up in unnamed stream. The assessment has considered how this discharge would impact the quality of these receiving environments under three different scenarios. These scenarios, prior to receiving any discharge from the wastewater treatment plant are described briefly below:

Scenario 1 – A dry weather low flow discharge.

Scenario 2 – A representation of average conditions.

Scenario 3 - A peak wet weather discharge.

A summary of these scenarios and a description of the effects are outlined in Table 8 below.

Table 1 - A Summary of the Assessment of the Effects detailed by Viridis (Good & Grant, 2025)

Scenario	**Description of Effect**
1	The Viridis assessment of effects describes that Scenario 1: *….'is projected to increase concentrations of total ammoniacal nitrogen and dissolved reactive phosphorus in the tributary, shifting water quality from NPS-FM Attribute Band A to Band B'….* *….'However, the proposed discharge is not expected to cause ammoniacal nitrogen or DRP concentrations in the stream to exceed the relevant ANZG (2018) DGV.'*
2	The Viridis assessment of effects describes that: *'Under average conditions (i.e., Scenario 2), the discharge is predicted to have minimal impact on receiving water quality.'*
3	The Viridis assessment of effects describes that: *'Under peak conditions (i.e., Scenario 3), the discharge is predicted to have minimal impact on receiving water quality.'*

ODOUR MANAGEMENT

Odour Sources

The mitigation of odour forming conditions, or the treatment of sources which cannot be mitigated is paramount due to the location of the treatment plant within the residential subdivision.

The following table identifies the potential sources of offensive odours and the mitigations, or treatment proposed to ensure the emission of the these to the surrounding environment is avoided.

Table 2 - Odour Sources and Mitigations

Treatment Process	**Potential Odour Source**	**Mitigation Measure**
Headworks screens	Raw Sewage and Screenings	System (including screening bins) is fully enclosed and connected to the odour extraction network under negative pressure.
Balance tank	Raw screened sewage	The tank is to be sealed and connected to the odour extraction network under negative pressure. In routine operation this tank will be operated at near 0% level and shall be designed with an internal sump.
Pre-Anoxic Tank	Raw Screened Sewage	Continuously recycle flow from the aeration tank, providing large quantities of nitrate rich water, and preventing anaerobic conditions from developing. The Oxidation-Reduction potential of the contents of this tank are continuously monitored which allows the

		contents to be monitored for generation of anaerobic conditions.
Aeration tank	Anaerobic conditions from overloading or aeration equipment failure can generate offensive odour	The aeration tanks are fitted with fine bubble diffusers to efficiently transfer oxygen from the air into the water. By maintaining a positive level of dissolved oxygen in the aeration tank, odour emissions are minimised meaning that this tank does not need to be covered.
Anoxic tank 2	Anaerobic conditions from overloading or aeration equipment failure can generate offensive odour	Continuous supply of nitrate to this anoxic tank, combined with its very short hydraulic residence times prevents anaerobic conditions from developing.
MBR tanks	Anaerobic conditions from overloading or aeration equipment failure can generate offensive odour	The membranes in these tanks are continuously cleaned by scouring with air. The contents of this tank have already had almost all dissolved contaminants (e.g. organic load and nutrients) removed by previous steps in the process. Therefore, the membrane tanks have a very high concentration of dissolved oxygen in them. These factors combine to mitigate the risk of the membrane tanks generating offensive odours.
WAS tanks	Contains sludge which has a high risk of releasing offensive odour.	The WAS tanks are fully enclosed and connected to the odour extraction and treatment network. The WAS is aerated to maintain

		conditions which mitigate the formation of offensive odours.
Sludge dewatering and dewatered sludge storage	Processes sludge which has a high risk of releasing offensive odour.	The sludge dewatering plant is fully enclosed and connected directly to the odour removal and treatment system. It is also housed in a building separately connected to the odour extraction and treatment network.
Site wastewater sump	Fully enclosed underground collection tank that receives discharges from any sludge dewatering/settling, any spillages of wastewater around the site and black water from the site's own amenities and toilets.	Sump is fully enclosed and connected to the odour extraction and treatment network.

Odour Control Units

The formation of offensive odours cannot be controlled in the network that feeds the wastewater treatment plant, and as such the inclusion of infrastructure to capture and treat offensive odours is required. An odour control system is used to remove or destroy odours or other contaminants from sources extracted from a facility. The air the is sent to an odour control system is generally collected from enclosed spaces which house equipment or liquids which have the potential to generate offensive odour. These enclosed spaces are maintained under negative pressure, meaning any fugitive odours are extracted and transported to the odour control device. A summary of common odour control devices found in industrial applications, and their advantages and disadvantages are shown below in Table .

Table 20 - Common Odour Control Devices found in Industrial Processes

Technology	**Operation**	**Advantages**	**Disadvantages**
Biofilter	Uses aerobic bacteria growing on a bed of bark chips to oxidise contaminants such as hydrogen sulphide	• Well-established technology. • Low capital and	• Treatment can fail if the moisture and pH of the bark bed is not kept within the optimum range. • Larger biofilters can be

	(the primary offensive odour compound from sewage). Air is extracted from plant odour sources by fan and passed through the bed of bark prior to being discharged to air.	operating cost.	prone to short-circuiting. • Larger biofilters can produce a plume of 'bark' scented air from passing high volumes of air (generally considered inoffensive but can be quite noticeable on neighbouring properties).
Carbon scrubber	Uses an activated carbon pallet bed. Odour causing compounds are adsorbed onto the activated carbon pallets and thereby removed from the air stream. The carbon pallets can also be doped with sodium hydroxide, which significantly increases the ability of the carbon to remove and neutralise acidic gasses, such as hydrogen sulphide from sewage and sludge.	• System relies on physical adsorption, so is more robust and reliable than biological oxidation.	• Higher capital and operating costs than a biofilter. • Carbon requires replacing every one to three years.
Multistage chemical scrubber	Uses product specific bed(s) to remove contaminants.	• Able to tailor removal to specific pollutants.	• Complex system. • High capital and operating costs. • More suitable for industrial sites where specific gaseous pollutants are targeted in conjunction with dust or other particulate matter.

Selection of Odour Control Device

Through an assessment of the advantages and disadvantages of each common odour control system detailed in Table above, the preferred odour control system is the carbon scrubber. The carbon scrubber offers reliability and well demonstrated performance without onerous operational requirements in a simple treatment process. A review of odour sources has been carried out by Air Matters and can be found in documentation supporting this application.

OPERATION INTO SERVICE

The commissioning of biological nutrient reduction processes can be complex and requires technical oversight by persons experienced in both their design and operation. As the core nutrient reduction process is biologically driven, a sufficient concentration of biomass (bacteria) must be available to consume available contaminants within the raw water.
The proposed wastewater treatment plant will need to be made available to receive waste upon the connection and completion of the first properties within the development site. The generation of sufficient biomass to sustain the treatment process during the early stages of the development when few houses are complete and occupied will require a significant amount of operation oversight by Apex Water. Apex's experience indicates that for a seeded and supplementary fed biological treatment process, the time required to develop sufficient biomass is typically up-to, and at times greater than 2 months post the receipt of wastewater, contingent on a number of conditions.

Biomass within wastewater treatment processes thrives and grows when subjected to optimal conditions, when these are upset the biology can underperform, become stressed and ultimately fail at removing nutrients from the wastewater. During the early stages of the development when there are few connections to the sewer network it is common for wastewater strengths to be lower in concentration. Low concentration waste and variable influent volumes can make the removal of contaminants more difficult due to there being sub-optimal conditions to support the bacteria required for nutrient reduction. During commissioning, operational intervention will be carried out to ensure the correct conditions are maintained to support healthy biomass and promote further growth. Some of the factors which can influence the health of the biomass are outlined below:

- Insufficient food (carbon-based contaminants in wastewater) available in the raw wastewater to sustain existing biomass and allow for growth
- Too much food available in the raw wastewater for the concentration of biomass available
- Insufficient alkalinity to support the required nutrient reduction levels
- Insufficient concentration of dissolved oxygen to support biological processes
- Biomass average residence time within the system is too high

- Biomass average residence time within the system is too low

As biomass growth and nutrient removal is dependent on wastewater being fed as a food source to the bacteria in the plant, the wastewater treatment plant cannot be fully biologically commissioned prior to receipt of first waste. To facilitate the completion and final sign-off of dwellings within the development, the treatment facility will be physically complete and able to receive wastewater with functionality testing sufficiently advanced to render to plant suitable to receive waste and begin developing biomass. Once sufficient waste is received, the automation sequences will be commissioned followed by tuning of the treatment parameters to optimize the treatment process. As the plant is sized to receive the wastewater from the stage-1 portion of the development, it is noteworthy that during the early stages the physical capacity of the plant will be grossly decoupled from the volume of waste produced. This allows for a large capacity for flow buffering. The Balance Tank proposed has sufficient capacity to buffer wastewater inflows for an extended period. This large volume allows for a large contingency in the time required to ensure biological commissioning and biomass growth processes are complete while the plant is receiving some incoming wastewater.

Although Apex's experience indicates that this may not be an issue, maintaining a suitable dissolved oxygen concentration within the raw accumulated wastewater will be required to ensure the development of anaerobic conditions and possible generation of foul odour is mitigated. To support this, the aeration system and odour control system will be key systems that will be functionality tested online prior to biological commissioning commences. Provision will also be available for removal of raw waste for disposal at a third-party treatment facility during the commissioning period.

RISK REGISTER

To review the design basis and potential for offsite effects, a qualitative risk assessment has been carried out covering the relevant items detailed in this report where there is potential for offsite effects. The risk assessment has been carried out by applying a qualitative rating to the frequency (likelihood) of the event occurring and the consequence (severity) of impacts if the event were to occur. The likelihood and consequence ratings consider the controls (mitigation and management measures) that will be in place.

The qualitative likelihood and effects ratings are described in Table 21and Table 22, respectively.

Table 21: Qualitative rating of likelihood

Frequency rating	Descriptor	Explanation
A	Almost certain	The event is expected to occur in most circumstances
B	Likely	The event will probably occur in most circumstances
C	Moderate	The event should occur at some time
D	Unlikely	The event could occur at some time
E	Rare	The event may occur only in exceptional circumstances

Table 22: Qualitative rating of consequence

Effects rating	Descriptor	Explanation
1	Insignificant	No discharge, negligible effects outside of the treatment plant compound
2	Minor	No offsite effect, onsite effects limited to the direct area surrounding the treatment plant. Nuisance, noise and odour.
3	Moderate	No offsite effects, onsite effects limited to the broader Delmore site. Nuisance noise and odour
4	Major	Major environmental damage to immediate environment, moderate damage to off-site property
5	Catastrophic	Fatalities both on and off-site, major and widespread environmental damage, exposure to harmful release by numerous people.

The likelihood and consequence ratings are then combined to qualitatively assess the overall level of risk associated with each hazard. The risk assessment matrix is shown in Table 23.

Table 23: Risk matrix

Consequence / ***Likelihood***	**Severity**				
	Insignificant (1)	**Minor (2)**	**Moderate (3)**	**Major (4)**	**Catastrophic (5)**
Almost certain (A)	Significant	Significant	High	High	High
Likely (B)	Moderate	Significant	Significant	High	High
Moderate (C)	Low	Moderate	Significant	High	High
Unlikely (D)	Low	Low	Moderate	Significant	High
Rare (E)	Low	Low	Moderate	Significant	Significant

Table 24: Risk management

		Residual risk		
Event	**Controls (Mitigation/ Management Measures)**	**Likelihood**	**Consequence**	**Risk**
Leak of chemical or diesel on site during filling, dosing, handling, transport, damage to tank (toxic, ecotoxic effects)	Deliveries are to be unloaded in the designated chemical unloading apron. Chemical delivery apron is self-contained with its own drainage to divert runoff to an appropriate location away from stormwater. Unloading undertaken by staff trained in safe handling procedures. Spill response plan will be in place, including spill kit provisions on site. Secondary containment bunds are self-contained and do not drain to stormwater Acid and base tanks are in segregated bunds to prevent mixing of incompatible spilled material. Tank filling is supervised by staff trained in delivery and emergency response procedures. Spill response plan will be in place, including spill kit provisions on site. Tanks are fitted with vents, liquid level indicators and high-level alarms.	Unlikely	Minor	Low

	Hoses, connections, and fittings associated with hazardous substance delivery are appropriately selected, tested and maintained. Double contained chemical dose lines			
Process overflow leading to discharge of raw or partially treated wastewater	All process vessels fitted with level monitoring, alarming, control and interlocks included in functionality for the process to respond accordingly Critical tanks and equipment fitted with dual level transmitters with fail over functionality in the event of single instrument failure Critical equipment (pumps etc.) designed for Duty / Standby (N+1) operation with automation fail over in the event of single failure Raw wastewater and MBR permeate buffering tanks present to allow for large volume of process buffering in the event of critical outage	Unlikely	Minor	Low
Leak leading to discharge of raw or partially treated wastewater to the environment	All pipework to be pressure tested in line with industry standards. Watercare code of Practice as reference document. Material selection of pipework and equipment to consider longevity of infrastructure. Daily equipment checks and daily site check sheet to hold standing item on daily visual inspection of pipework and equipment All flowmeters in the process to included totalisers for comparison of flows through process and identification of discrepancies (process losses)	Rare	Moderate	Moderate
Equipment failure leading to loss of process, leading to discharge of raw or untreated wastewater	All critical equipment to be installed as Duty / Standby (N+1 configuration). On shelf spare to be held for other non-critical, but important equipment.	Rare	Moderate	Low

	Infrastructure for the tankering and removal of treated / partially treated wastewater from the site already proposed as a part of the application, as a hard backstop.			
Loss of power leading to loss of control and discharge of raw or partially treated wastewater to the environment	Generator located on site with auto-change over, sized to run critical infrastructure to supply process in the event of a local (site only) power outage. Uninterruptible power supply (UPS) to supply critical control systems (PLC, SCADA Computer, Instrumentation etc.) Low pressure sewer throughout the development means that in the event of broader power outage will result in no flows to the treatment plant (i.e no power to resident's pump stations feeding the LPS)	Unlikely	Minor	Low
Discharge of odour from the site	Appropriately sized and designed odour scrubber to abstract the head space of high-risk areas for treatment through impregnated carbon bed prior to discharge to the air. High level process monitoring included in the overall treatment plant package	Unlikely	Minor	Low
Loss of power leading to formation of anaerobic conditions and discharge of odour from site	**Generator located on site with auto-change over, sized to run critical infrastructure to supply process in the event of a local (site only) power outage.** **Uninterruptible power supply (UPS) to supply critical control systems (PLC, SCADA Computer, Instrumentation etc.)** **Remote process monitoring and SMS alerting for critical alarms / process deviations for 24-hour notification of issues**	**Unlikely**	**Minor**	**Low**
Formation of anaerobic condition during normal operation	Online dissolved oxygen concentration monitoring included in the process monitoring with alarming and SMS alerting outside of normal operational hours. Anoxic process tanks to be well mixed with process monitoring (run feedback) and alarming in the event of failure	Unlikely	Minor	Low

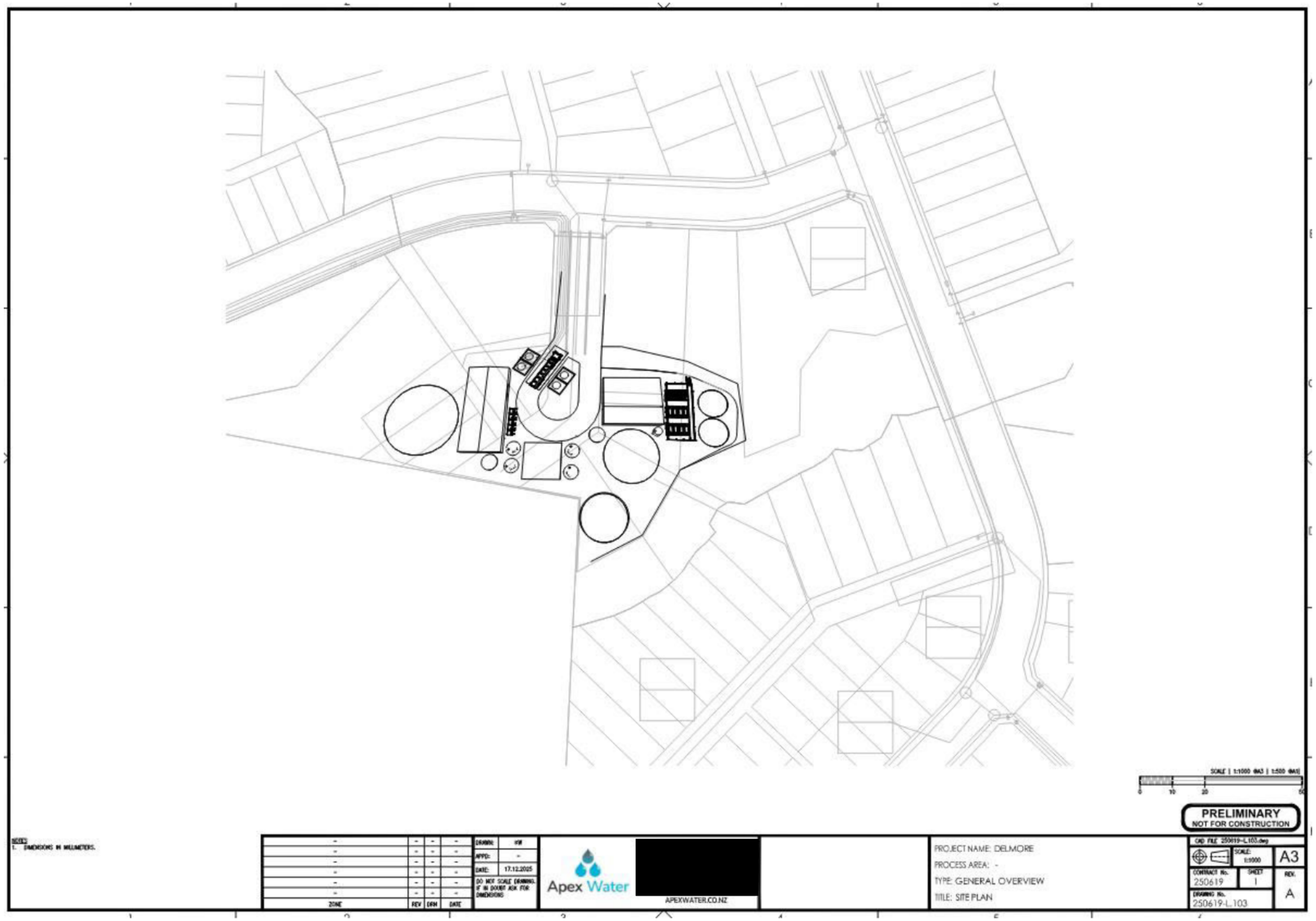
	ORP monitoring of the anoxic process tanks to ensure the process is operated under optimal conditions, with alarming the event of process upsets			
Failure of equipment leading to discharge of odour or untreated / partially treated wastewater from the site	High level process monitoring and control with alarming and operator alerts outside of normal operational hours in the event of equipment failure Critical equipment to be installed in Duty / Standby (N+1) configuration with auto fail over in the event of equipment failure.	Unlikely	Minor	Low
Nuisance noise discharge from the treatment plant site	All noisy equipment to be located within acoustically designed noise attenuated structure. Installation to be certified post construction	Unlikely	Minor	Low
Discharge of out of specification treated wastewater from the process	Well known and established treatment processes. Apex water has a lot of track record in the design, build and operation of the treatment process proposed. Robust set of discharge consent conditions Trained and competent operators. Process control, monitoring and alarming to alert operator of issue long before out of specification discharge occurs. Routine sampling and testing of the process to identify issues to be established as a part of the operational strategy Suitable technical competency available for process support / operational support	Unlikely	Moderate	Moderate
Long term impact on the receiving environment from the impact	Robust set of consent conditions covering ecological and surface water quality testing	Unlikely	Moderate	Moderate

PROPOSED SITE LAYOUT

The wastewater treatment facilities are to be located within a compound surrounded by security fencing to exclude non-operational personnel. The site shall allow provision for all access requirements from operational vehicles and personnel for servicing the facility. The following sections of the report cover the visual aspects of the site, make-up of the compound and details on the main structures to be located on the site.

Treatment Plant Location and Layout

The proposed wastewater treatment plant compound is shown in Figure 24 below, which identifies key structures and equipment.



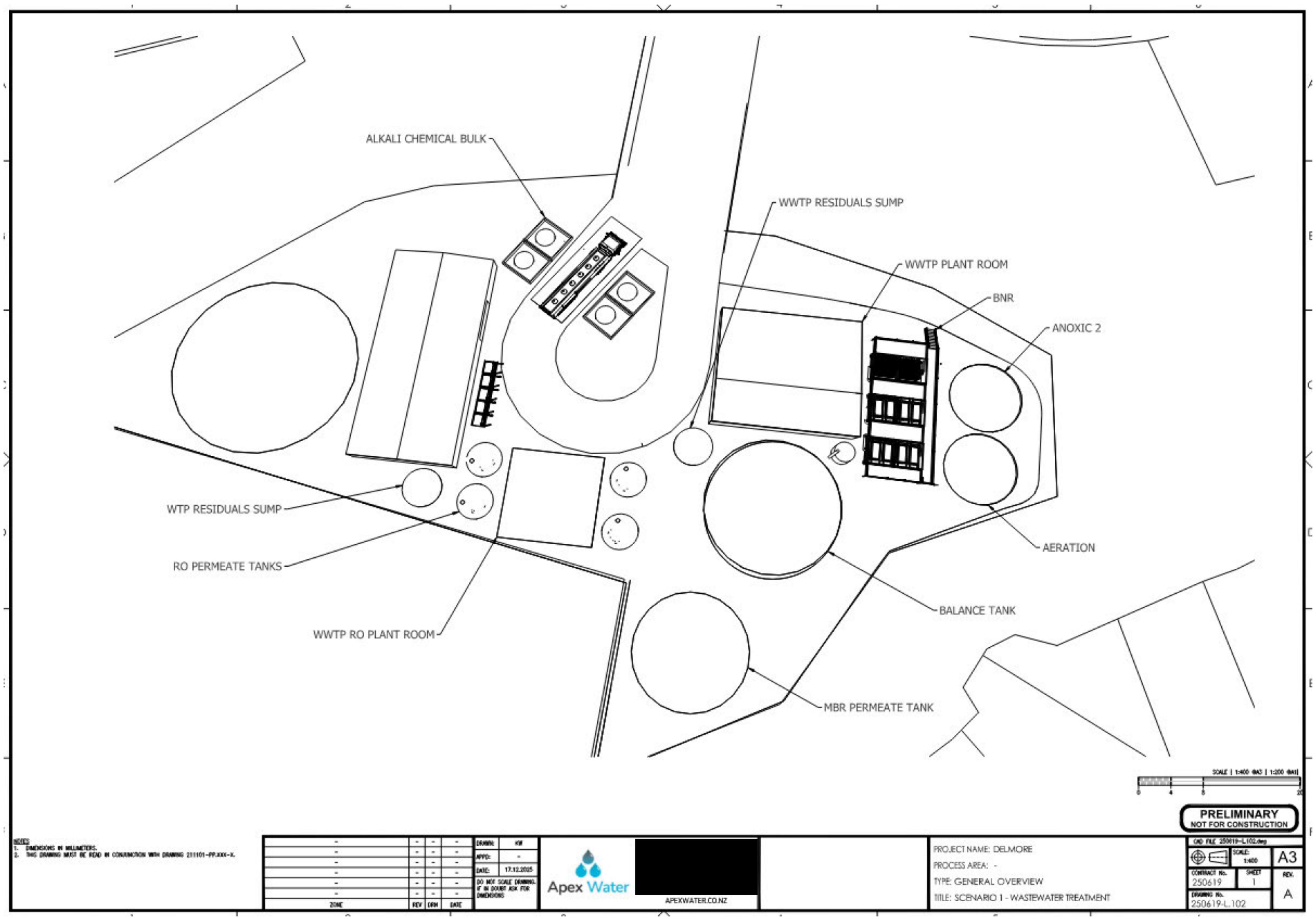


Figure 24 - Proposed Delmore WwTP Layout

Visual Renders

Renders of the proposed wastewater treatment plant and the associated structures can be seen in Figures 25 through 26 below.

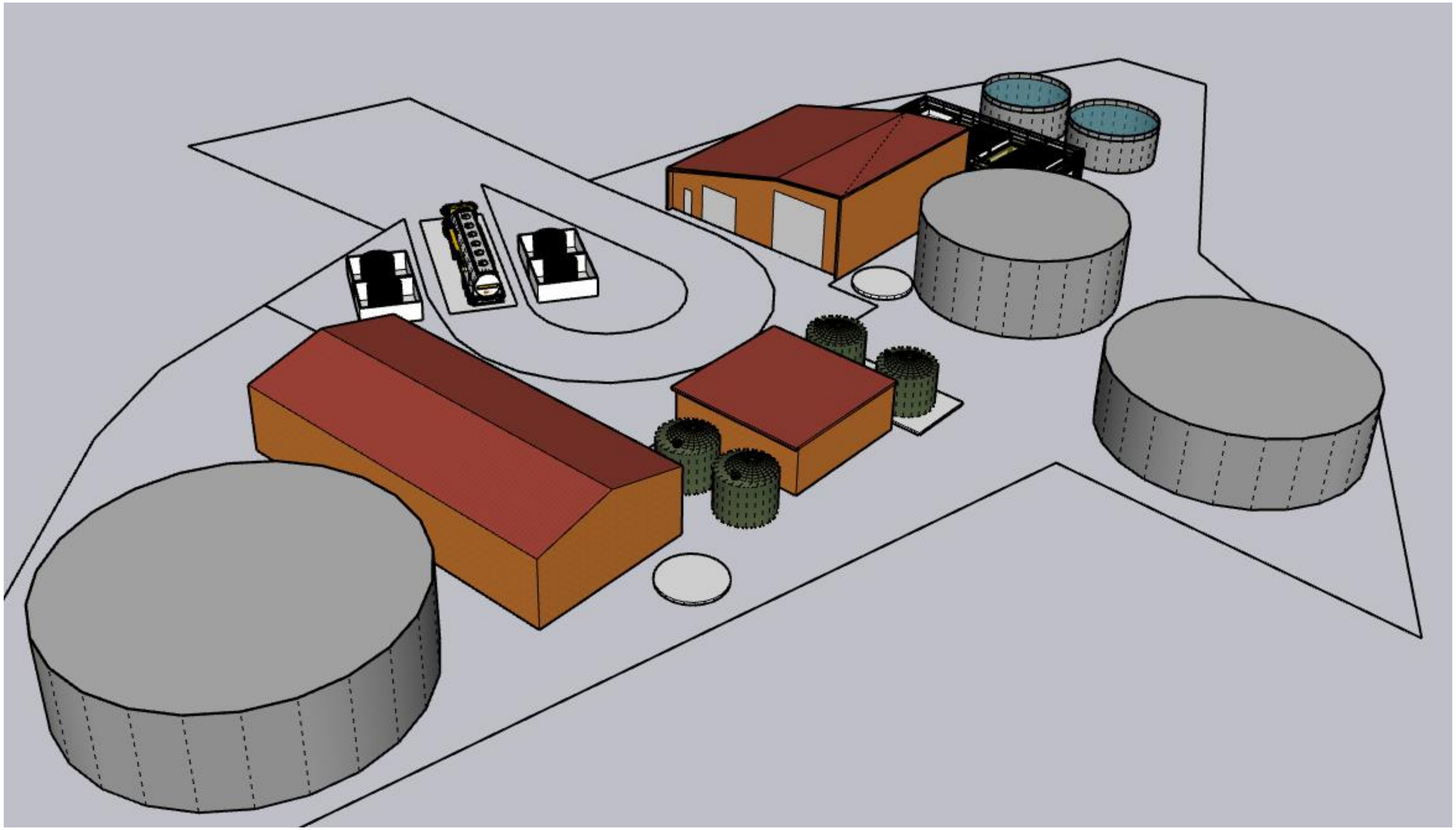


Figure 25 - Visual Render of the Proposed Delmore WwTP

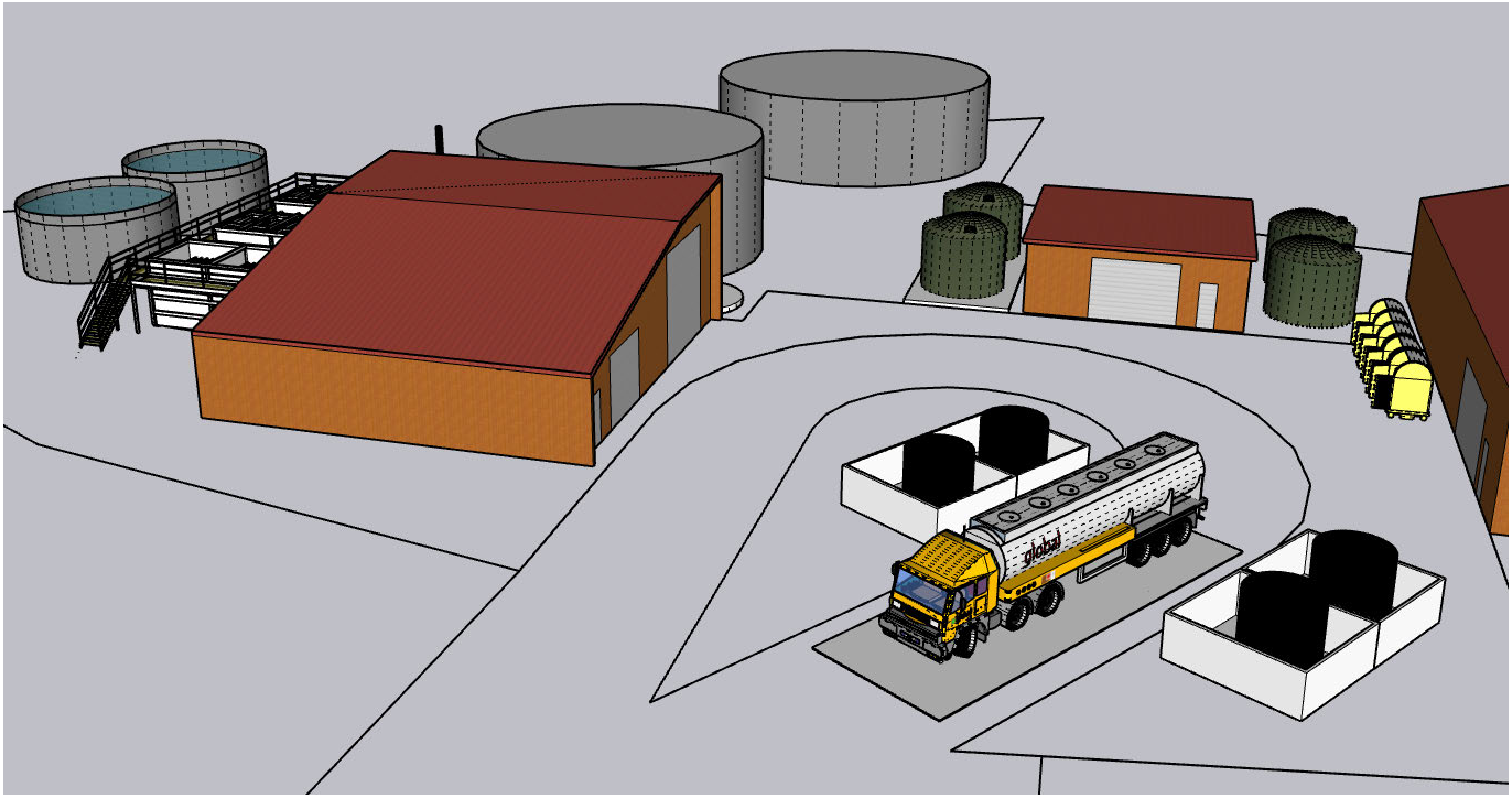


Figure 26 - Visual Render of the Proposed Delmore WwTP

Surface Make Up

A parcel of land of approximately 5610m2 has been allocated to the treatment plant and associated infrastructure. Based on the proposed site layout, the approximate breakdown of the site coverage between structures, impermeable surfaces and permeable or landscaped areas is shown in Table 25 below. A further breakdown of the site allocated to the wastewater treatment plant can be found in the architectural and landscape plans supporting the consent application.

Table 25 - Surface Make-up

Type of Surface	**Area (m2)**
Hard surfaces (Impermeable including structure)	1800
Landscaped (Permeable)	3810
Total	5610

Plant Structures

Wastewater Treatment Plant Building

In the context of the broader development, and the proximity of the proposed treatment plant to residential lots, noisy equipment shall be located within the treatment plant building which shall be constructed of material appropriate to the required level of noise attenuation. Alongside the key items of process equipment located within the treatment plant building, general site facilities such as the control room, toilets, and other site amenities shall be housed with separate partitions within the building. The general configuration of the proposed wastewater treatment plant building can be seen below in Figure 27.

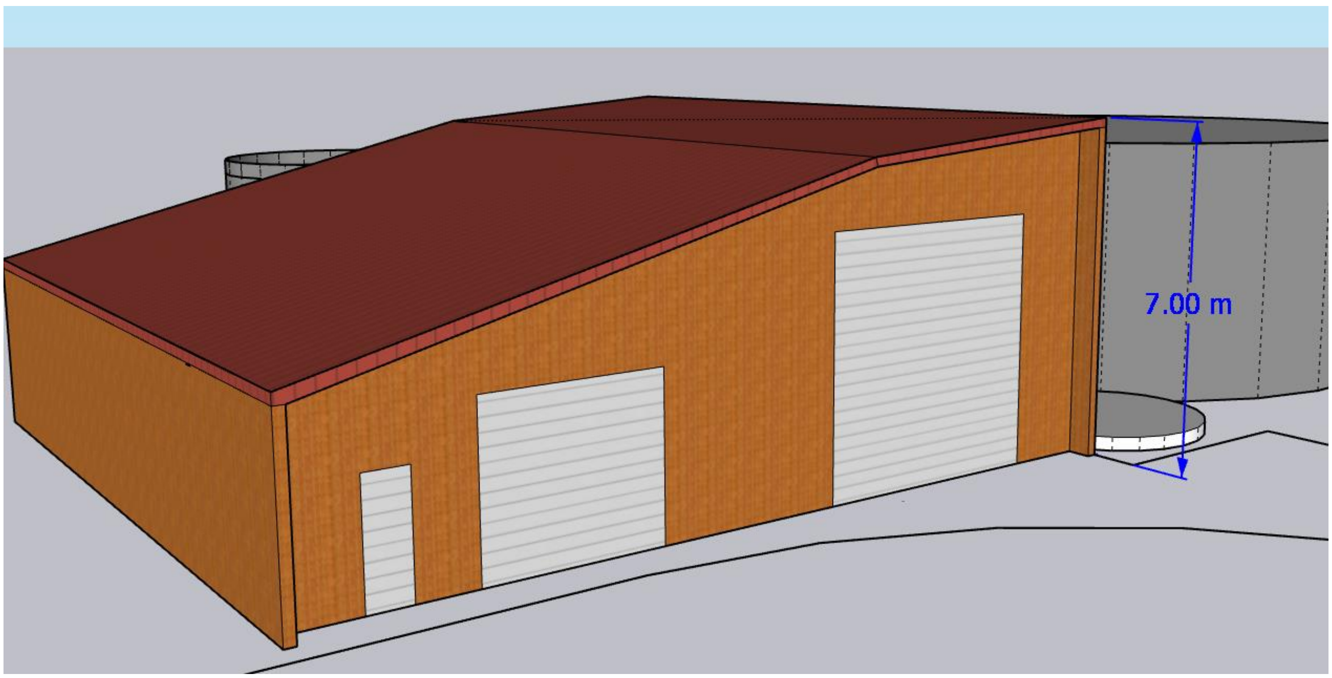


Figure 27 - Wastewater Treatment Plant Building

Balance Tank and Permeate Tank

The balance tank and permeate (treated wastewater) tank shall consist of sealed tanks up to a height of 7m. The balance tank shall be sealed and vented to the odour scrubber system and shall be operated at a low level. The purpose of the balance tank is to buffer peak flows. The proposed balance tank can be seen in Figure 8 below. The Permeate tank is used to buffer permeate discharges.

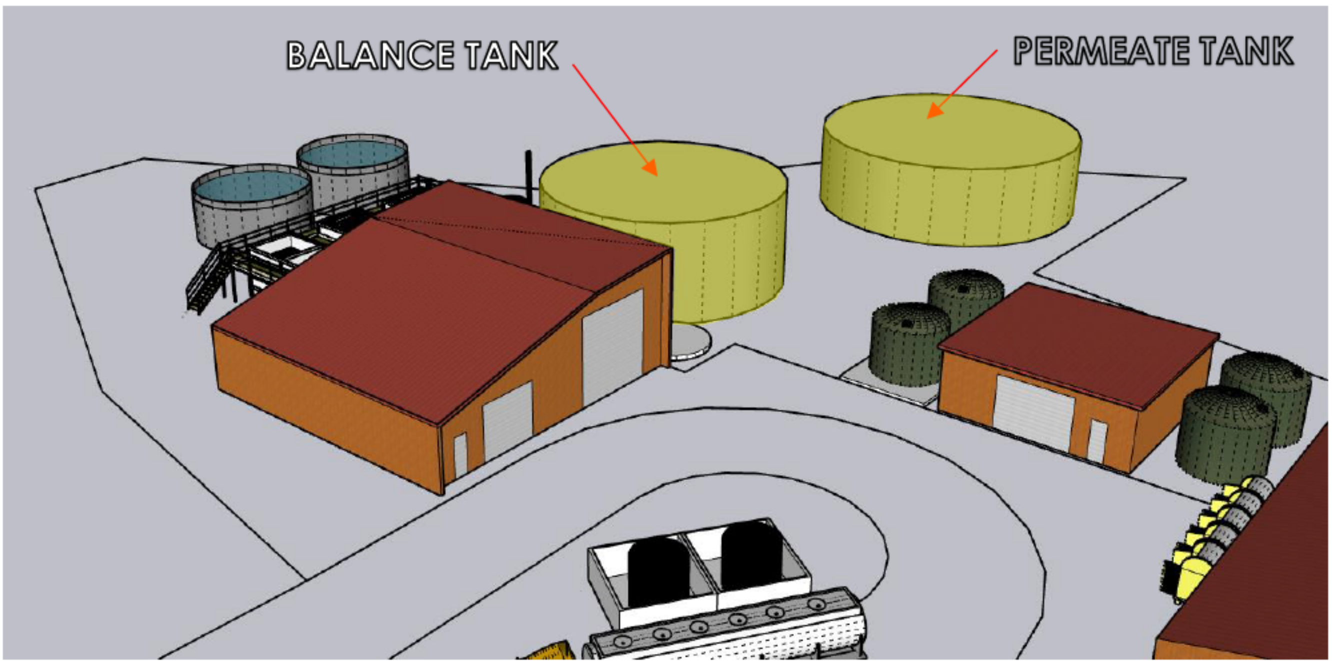


Figure 28 - The proposed balance tank for the Delmore development

Pre-Anoxic Tank - Membrane Aerated Biofilm Reactor Tanks

The Pre-Anoxic tank is located within the modular portion of the process The MABR membrane modules are also located within these tanks. Figure 9 below shows the Pre-Anoxic tanks, as required to treat Stage-1 volumes with an indication of where the future additional tanks can be placed should additional treatment capacity be required.

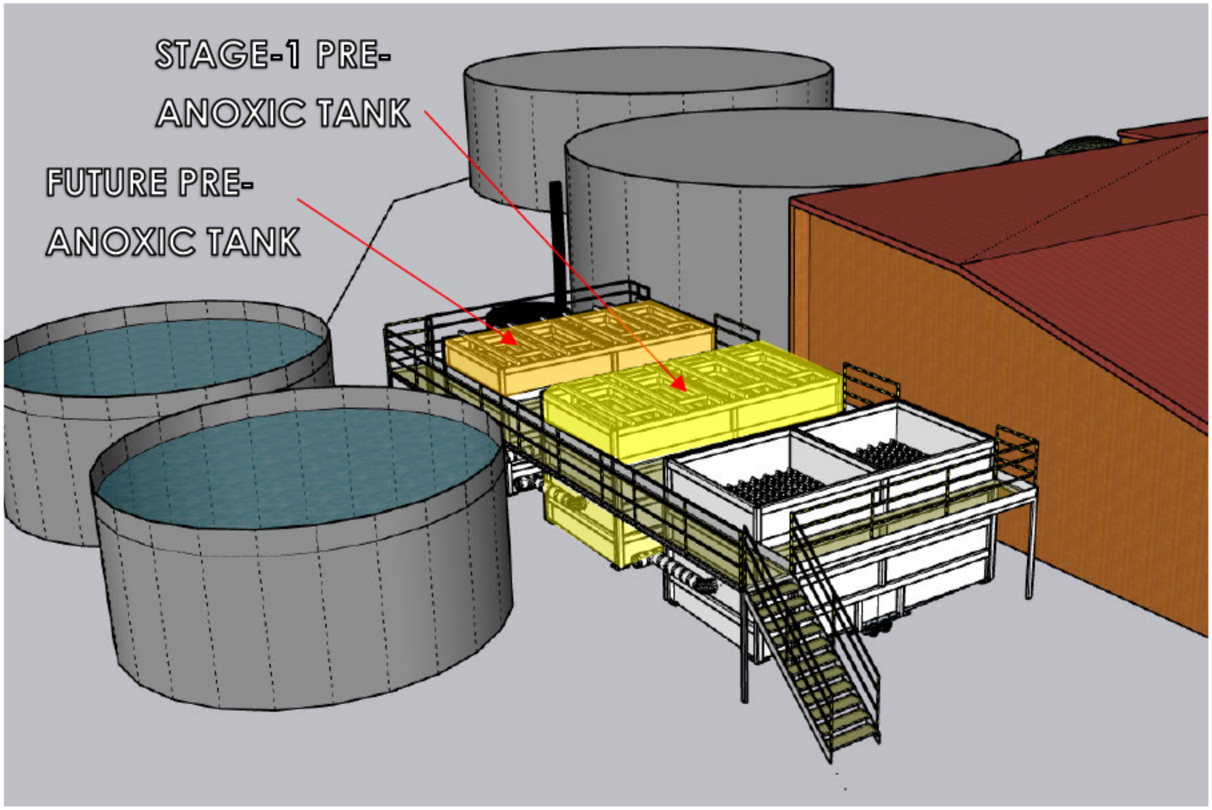


Figure 29 - Pre-Anoxic Treatment Tanks

Aeration Tank

The Aeration tank shall consist of a tank similar to the Balance tank. Figure 30 below shows the proposed aeration tank.

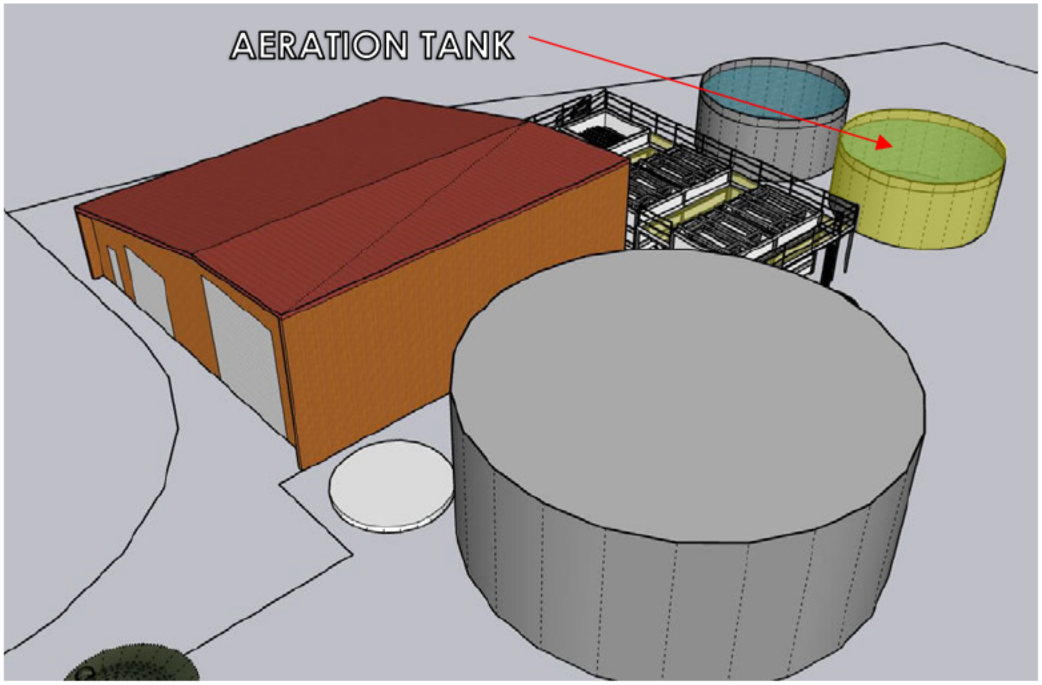


Figure 30 - The Delmore WwTP Aeration Tank

Post Anoxic Tank

Figure 31 below shows the proposed post-anoxic tank location.

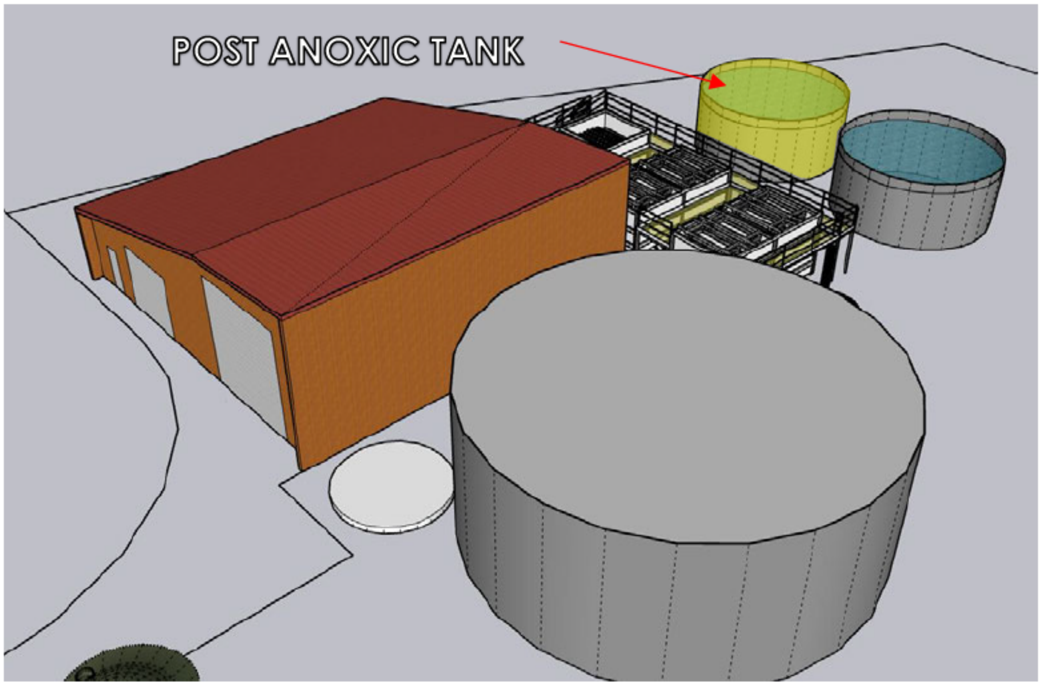


Figure 31 - Delmore Post-Anoxic Tank Location

Membrane Tank

These tanks are constructed of stainless steel and are sized to as closely as possible align with the general dimensions of a 20ft container to make them easily transportable and modular. The MBR membranes cassettes housing the hollow fibre membrane that sit within this tank are modular and can be installed as the wastewater loading increases. The location of the membrane tank can be seen in *Figure* below.

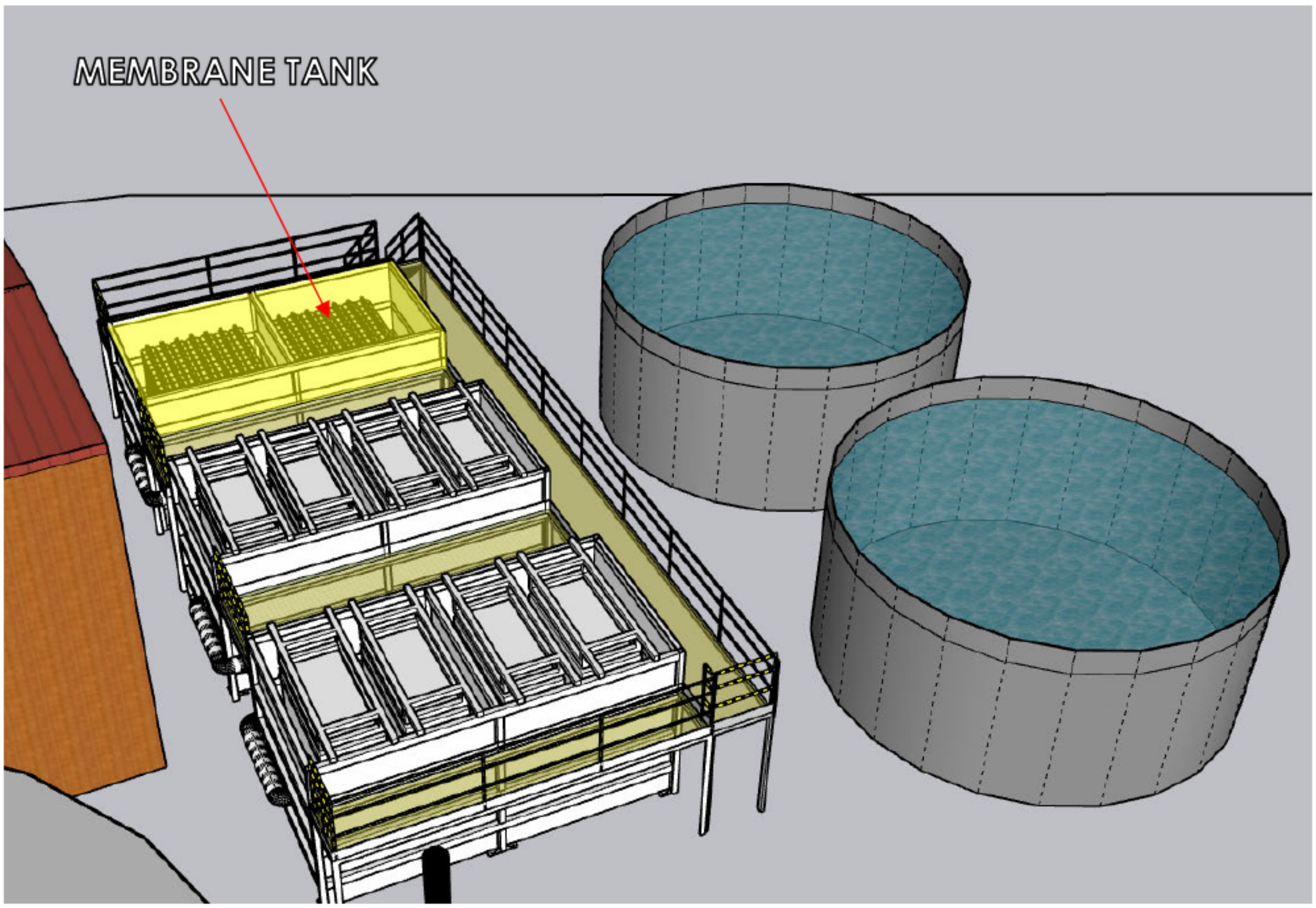


Figure 32 - Membrane tank

Other Structures

The site comprises of a number of other ancillary features which do not make up the treatment process, but service it and the site. These include:

- The overall site apron generally consisting of an impermeable surface providing vehicle access, parking and housing stormwater diversion and handling.
- The chemical load out bay, an area separated from the overall site's stormwater system consisting of an impermeable surface constructed to allow for deliveries of the chemicals used within the treatment process while minimizing any risk to the environment or personnel from spills.
- Waste Activated Sludge (WAS) tanks, consisting of two up-to 30m3 polyethylene tanks used for the settling of WAS which is a biproduct of the treatment process.
- Treated Wastewater (Permeate) storage tanks, consisting of two up-to 30m3 polyethylene tank used for the storage of permeate prior to discharge.
- Chemical storage tanks – consisting of two high density polyethylene storage tanks up-to 10m3 in volume. These two tanks will hold Sodium hydroxide and Acetic acid required in the treatment process.
- Intermediate Bulk Storage Bunds, consisting of 6no. relocatable covered bunds, used for the storage of bulk packaged chemicals which are delivered in 1000L containers. These chemicals include, Aluminium Sulphate, Sodium hypochlorite and Citric acid.
- A permeate tank for the storage and handling of permeate produced from the process for buffering periods where irrigation or re-use demand in low and allowing this stream to be discharged later. This tank has been sized to hold 1,000m3.
- Odour scrubber tanks and equipment typically consisting of a carbon vessel and vent stack used to draw-off and treat air from potentially odour generating areas in the process.

Conclusions and Recommendations

The Delmore land development consists of some 109 hectares of greenfield land in the Wainui-Orewa area and upon completion shall provide approximately 1250 new residential lots and dwellings. To deal with the risk of an infrastructure deficit in the local public wastewater network, Vineway Ltd is seeking that its resource consent approvals provide for private wastewater treatment and discharge facilities to be constructed if the need arises and until such a time that a public wastewater connection is made available to the site.

Apex Water have been engaged by Vineway to carry out design for the purpose of consenting, including an options assessment, biological modelling and the determination of key parameters of a proposed wastewater treatment plant to service the future development.

Through the assessment of different treatment plant options, Apex Water recommends the following:

- The proposed treatment plant consists of a hybrid modular 4-stage Bardenpho activated sludge treatment process, including a Membrane Aerated Biofilm Reactor, and Hollow Fibre Ultra-filtration membranes. The permeate produced can then be further treated via Reverse Osmosis membranes to produce exceptionally high-quality permeate that in many regards is better than drinking water quality.

- The treatment plant is designed such that it is partially modular, and its capacity can be increased as the development grows, with options to serve the full capacity of the development.

- Discharges of treated wastewater from the facility shall take a land first approach, making use of available land to preferentially receive discharges. Where the capacity of the land to receive flows from the plant is exceeded by the plant's capacity, the balance shall be directed to a land infiltration trench or (subject to commercial agreement) to the Army Bay treatment plant during off-peak periods.

- The resulting treated wastewater quality is expected to be of the highest quality of any treated sewage in New Zealand.

SCENARIO 2 – REMOVAL OF RAW WASTEWATER FROM SITE

In this scenario, the wastewater generated in stage-1 of the development is directed via a low-pressure sewer network to the plant compound. From here, the raw sewage is screened to remove bulk solids before transferring to a bulk storage tank. The bulk screened sewage will then be transported from the site in road tankers to be disposed of at an appropriate facility.

Screening the sewage is an important step as the removal of bulk solids shall make the wastewater suitable for transport in larger volumes than would be suitable for solid laden unscreened wastewater.

Site Infrastructure

The infrastructure required to store and load out raw wastewater requires some of the elements that make up the wastewater treatment plant however it does not require the treatment process at the core of the Scenario 1 proposal. By removing the treatment process, the infrastructure becomes centred around maintaining sufficient storage space and providing screening to remove bulk inorganic solids such that the raw sewage can be easily handled, as well as minimising the possibility of any offsite effects.

Inlet Screens

The raw wastewater that is conveyed to the treatment plant is first passed through the inlet screens. The inlet screens proposed for this purpose are equivalent to those described in detail under Scenario 1; however, their main purpose is to remove bulk solids from the wastewater received.

For a membrane bioreactor such as that covered by Scenario 1, the inlet screens serve a critical task of removing nonorganic material (rubber gloves, textiles, hard items. plastics etc) to protect critical downstream infrastructure from damage. For a raw sewage storage and load out facility such as that proposed in this scenario, the screens shall protect the downstream storage and load out infrastructure while also making the wastewater more suitable for transport in conventional higher volume road tankers, such as that shown in Figure 33, below.

Figure 33 – A large truck and trailer tanker unit, as used by Fonterra to transport milk. These can hold up to 28.8m3

Vacuum trucks which are often used for the handling and transport of raw sewage are well suited to solid laden liquid materials, however they generally are only capable of storing and transporting smaller volumes. To optimise the load out and transport process, it is proposed that the screened wastewater is transported in 28m^3 road tankers. Generally, these trucks are not designed for the transport of solid laden liquid waste. As such, it is proposed that the raw wastewater is screened with any bulk solids being collected in skip bins for removal from site as a solid waste. A vacuum truck, such as that used to collect raw sewage is shown in Figure 34, below.

Figure 34 – A vacuum truck emptying a manhole

Screened Wastewater Tanks

A tank of up-to 1,000m^3 tank shall hold the screened wastewater for removal from the site by truck. The tank is sized to accommodate peak flows with allowance for accumulating flows should operation require that some peak flows are accumulated. This tank shall be connected to the odour control system, meaning the air sitting in the head space of the tank will be continually abstracted through the odour control system.

Tanker Load Out

The stored wastewater shall be made available to road tankers for collection and removal from site. To convey the screened wastewater under pressure for collection, a pressurised pipe shall connect the stored wastewater to the tanker load out site. An example of the load out kiosk designed for the filling of road tankers with potable water is shown in Figure 35 below.

Figure 35 – A tanker load out kiosk, as used for the filling of potable water into tanks.

The system shall be configured such that tanker drivers can automatically collect screened wastewater from the load out site without requiring input from a third party. Appropriate security controls shall be provided for at the load out location and the system shall be monitored by the site's control system.

Odour Control

Similarly to scenario 1, the storage of screened wastewater on the site presents the risk that offensive odours are generated and discharged from the site. The generation of odorous conditions from sewage occurs when organic material begins to decompose under anaerobic conditions. To mitigate the impact of any discharges, it is proposed that the air in the head space of the screens, the screens building, the screened sewage tank and any other areas that could produce offensive odours are continuously abstracted and passed through an odour control unit for treatment prior before being discharged from the treatment plant site. This is further addressed in the Air Discharge Assessment prepared by Air Matters.

Following the technology selection principles followed under Scenario 1 of the report, an impregnated carbon scrubber shall be used to scrub the extracted air of any fugitive odours.

Proposed Site Layout

The proposed site layout covering the Scenario 2 infrastructure, including the water treatment plant can be seen in Figure 36, below.

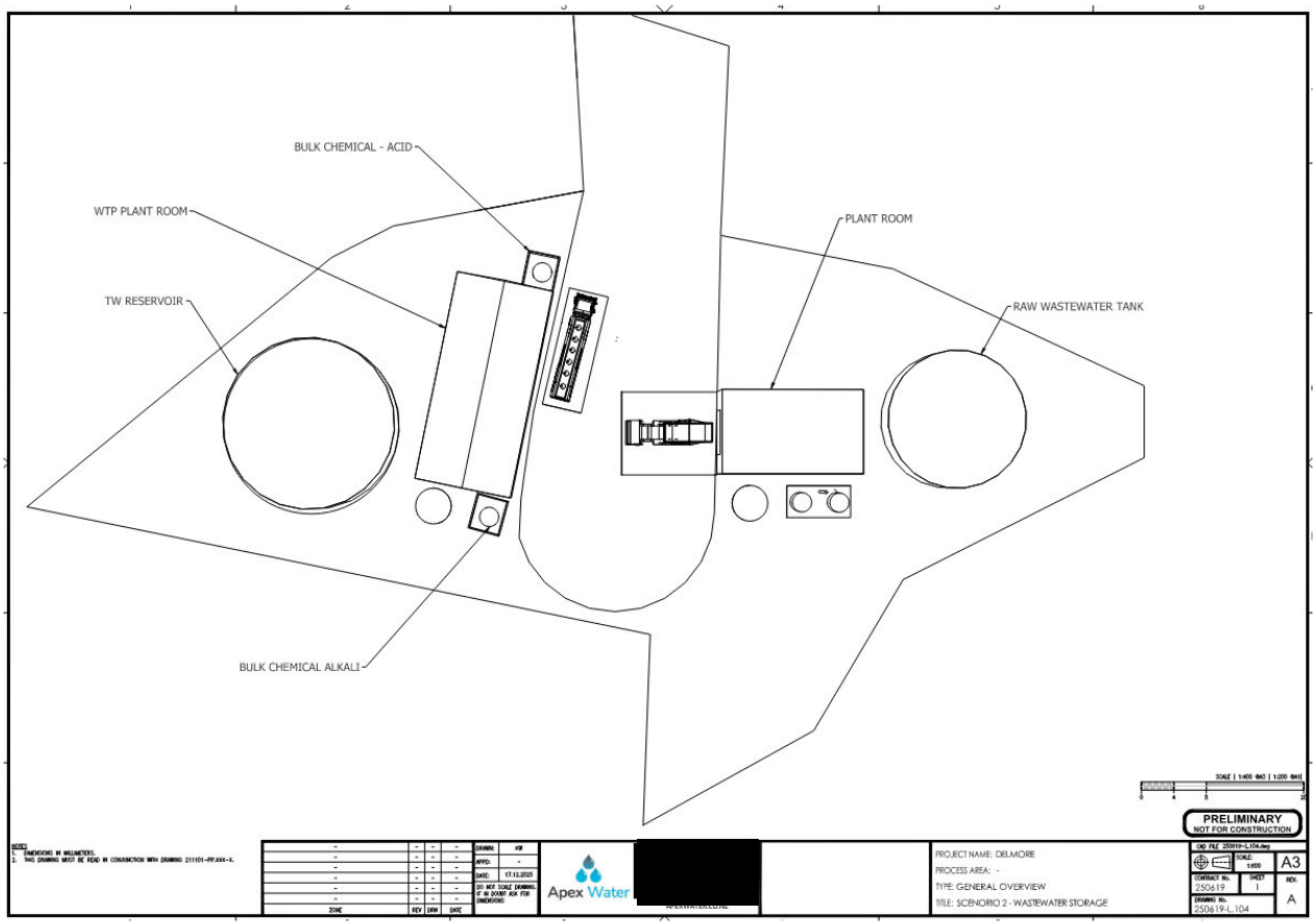


Figure 37 – The proposed scenario 2 plant layout

Visual Renders

A visual render of the proposed scenario 2 wastewater storage and load out site can be seen in Figure 38, below:

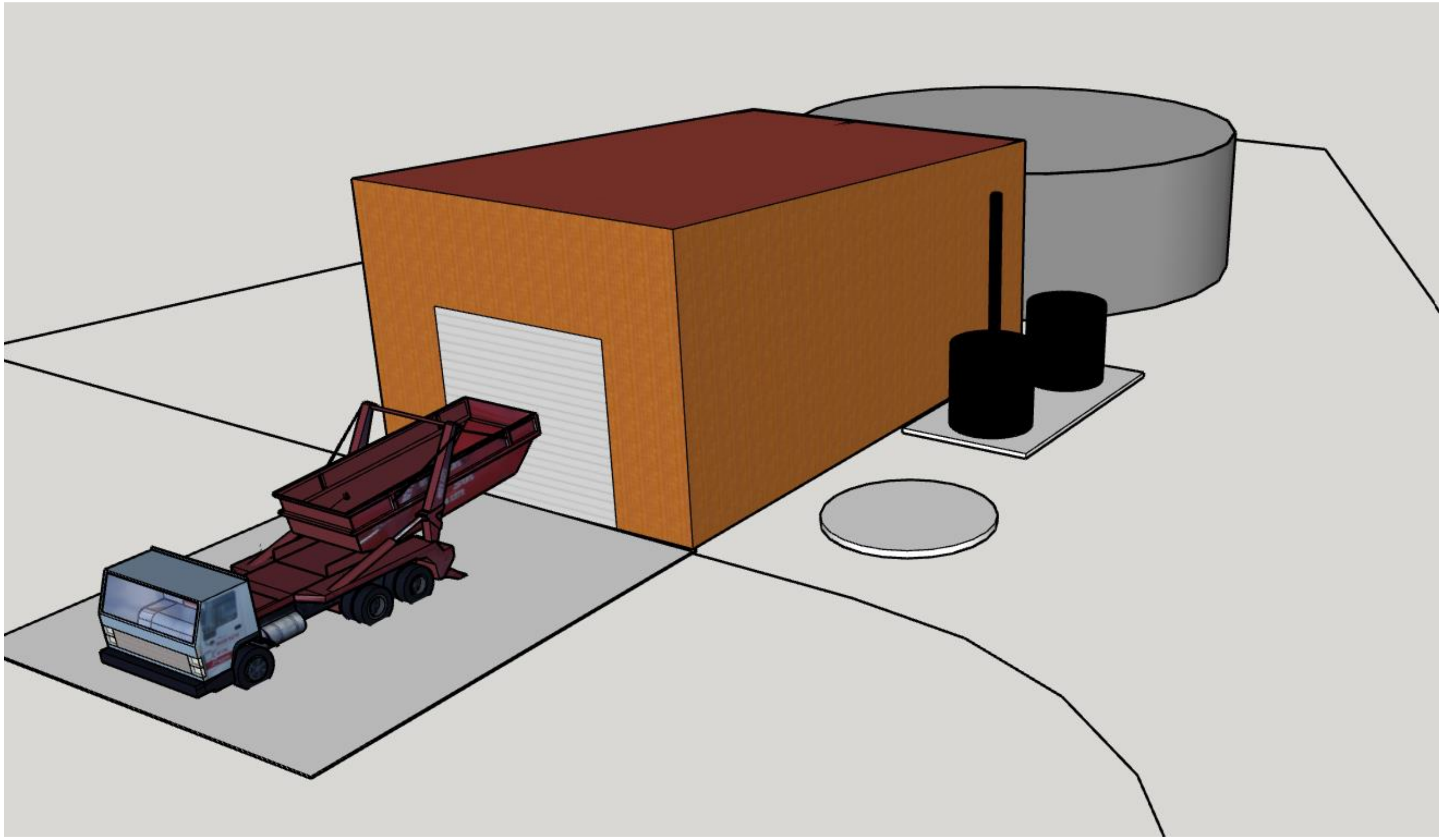


Figure 38 – A visual render of the scenario 2 building, tank and odour scrubber

Plant Room

The plant room shall consist of a noise attenuated structure up to 7m in height housing the inlet screens, screening collection skips, the plant control room, motor control centre and any other items of equipment that produce excess noise.

The height of the building is derived by the requirement for the raw wastewater to flow through the inlet screens under gravity into the screened waste storage tank. The solid screenings are collected in skip bins which will require collection and disposal offsite. A visual representation of the Plant Room can be seen in Figure 39 below.

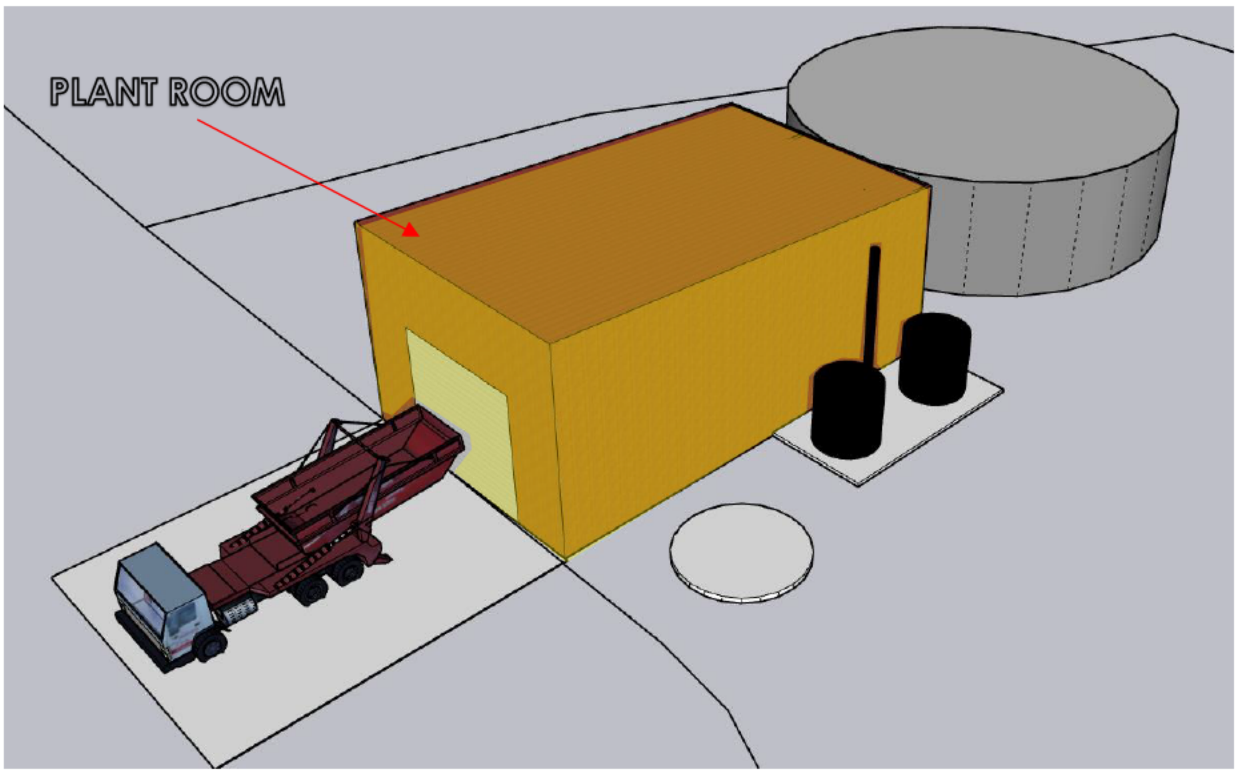


Figure 39 – A visual representation of the plant room for scenario 2

Screened Wastewater Storage Tank

The screened wastewater storage tank can be seen in Figure 40 below

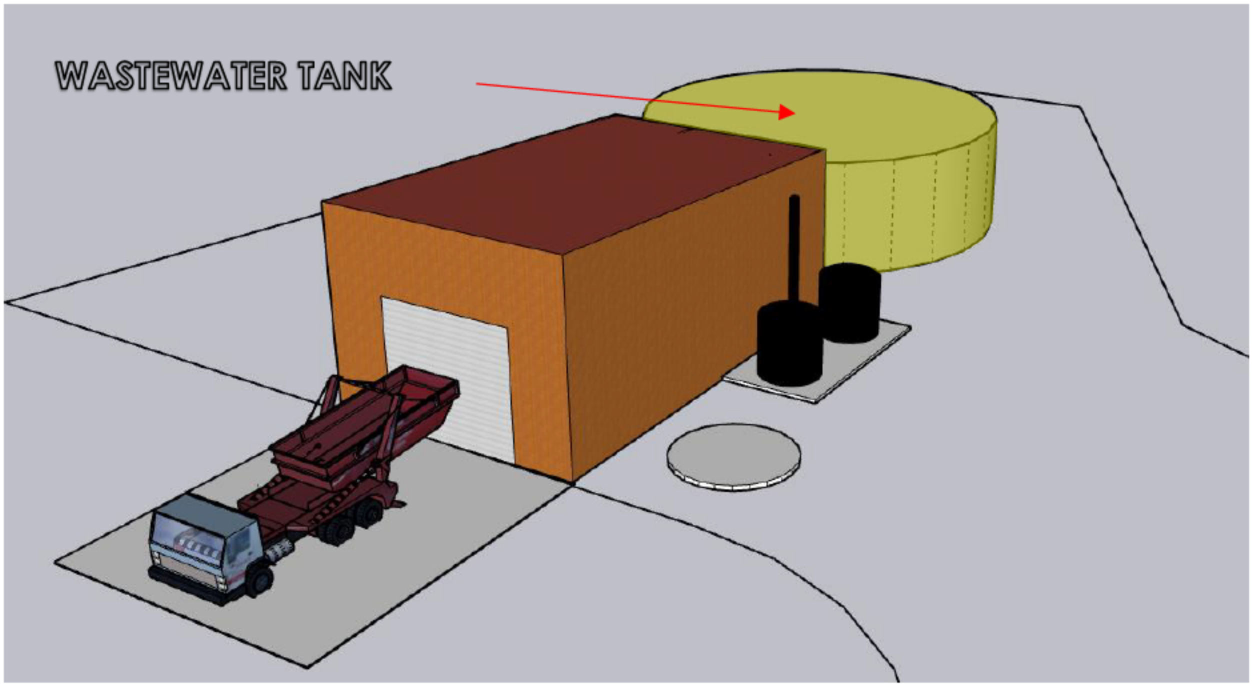


Figure 40 – A visual representation of the screened wastewater storage tank.

Odour Control Unit

The odour control unit can be seen in Figure 41 below.

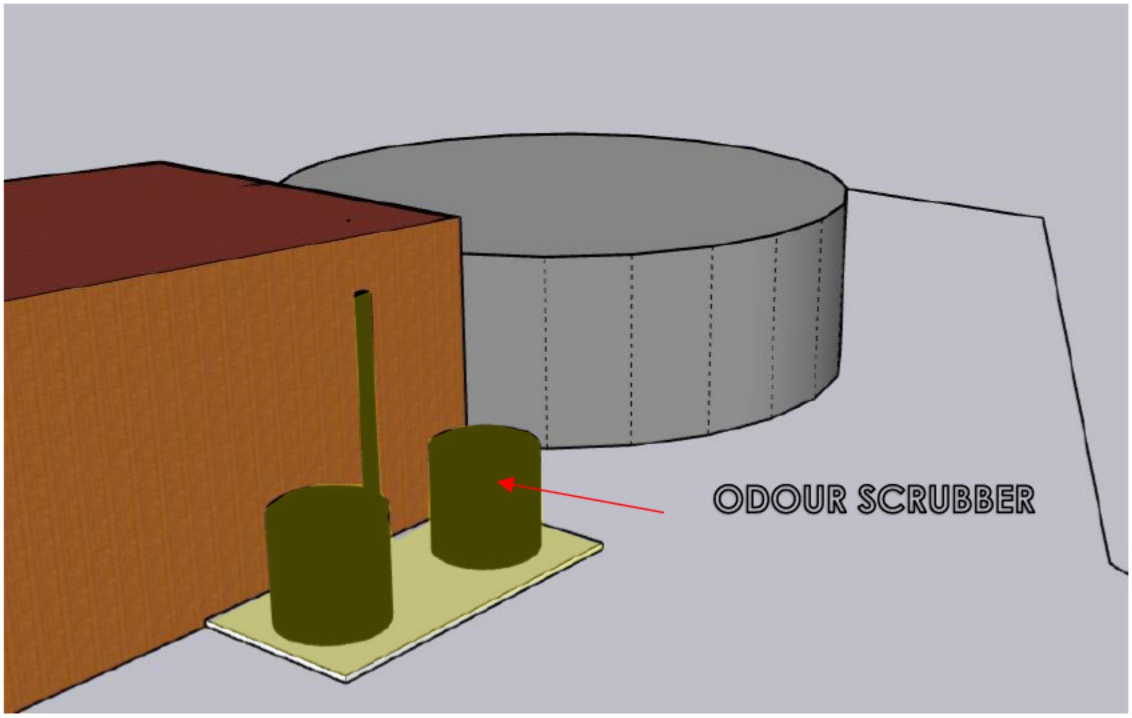


Figure 41 – A visual representation of the odour scrubber

Surface Make Up

A parcel of land of approximately 5610m2 has been allocated to the treatment plants and associated infrastructure. Based on the proposed site layout, the approximate breakdown of the site coverage between structures, impermeable surfaces and permeable or landscaped areas is shown in Table 26 below. A further breakdown of the site allocated to the water and wastewater treatment plant can be found in the architectural and landscape plans supporting the consent application.

Table 26 - Surface Make-up

Type of Surface	**Area (m2)**
Hard surfaces (Impermeable including structure)	1450
Landscaped (Permeable)	4160
Total	5610

Volumes Required for Removal

The maximum volume of wastewater produced by the Delmore project in Stage 1 is shown in Table 27 below. This is the volume that must be removed from the storage site daily for discharge at a third-party location.

Table 27 – Stage-1 Design Flows

Description	**Number**	**Comment**
Number of Houses	475	Provided by Client
Average Dry Weather Flow (m3/day)	256.5	Watercare CoP
Peak Flow (m3/day)	307.8	1.2x ADWF
Truck Volume (m3)	28.8	
Average Trucks Required (No)	9	A stage-1 completion

As the development is staged with housing completion and occupation likely to occur over a number of years, the number of trucks required shall initially be low and steadily increase until stage-1 of the development is fully complete and occupied.

Water Treatment

Demand

The anticipated demand has been established by the client's Civil Engineer, Mckenzie & Co, and with reference to the Auckland Council Code of Practice for Land Development and Subdivision – Chapter 6: Water.

Table 28: Delmore development water demand.

Parameter	**Unit**	**Value**
Stage 1 Average Daily Demand	m^3/d	321
Stage 1 Peak Daily Demand	m^3/d	642
Stage 2 Average Daily Demand	m^3/d	692
Stage 2 Peak Daily Demand	m^3/d	1385

Raw Water Quality

The raw water feed to the plant is to be supplied by four newly drilled ground water bores. A raw water grab sample was collected on the 14th of March 2016 from an adjacent site drawing water from the same aquifer and analysed by Hill Laboratories. A summary of the routine water profile results is demonstrated by Table 29 below.

The raw water results present a picture of a raw water source of reasonably good quality and on their own do not raise any concerns, however the pH does exceed the Drinking Water Standards New Zealand (DWSNZ) Guide Value (GV), so the treated water will require pH correction with an acid. Prior to the completion of the detailed design, additional raw water testing shall be carried out to provide a complete quality envelope.

Table 29: Bore quality results – routine water profile

PARAMETER	UNIT	14/03/2016
pH	pH units	9.3
Alkalinity	g/m³ as CaCO3	133
Total Hardness	g/m³ as CaCO3	24
Electrical Conductivity	uS/cm	374
Dissolved Aluminium	g/m³	0.016
Dissolved Antimony	g/m³	< 0.0002
Dissolved Arsenic	g/m³	< 0.001
Dissolved Barium	g/m³	0.009
Dissolved Beryllium	g/m³	< 0.0001
Dissolved Boron	g/m³	0.142
Dissolved Cadmium	g/m³	< 0.00005
Dissolved Calcium	g/m³	6.7
Dissolved Chromium	g/m³	< 0.005
Dissolved Copper	g/m³	< 0.005
Dissolved Iron	g/m³	< 0.02
Dissolved Lead	g/m³	< 0.0001
Dissolved Lithium	g/m³	0.0152
Dissolved Magnesium	g/m³	1.87
Dissolved Manganese	g/m³	0.0137
Dissolved Mercury	g/m³	< 0.00008
Dissolved Molybdenum	g/m³	0.0002
Dissolved Nickel	g/m³	< 0.0005
Dissolved Potassium	g/m³	0.31
Dissolved Selenium	g/m³	< 0.001
Dissolved Silver	g/m³	< 0.0001
Dissolved Sodium	g/m³	72
Dissolved Tin	g/m³	< 0.005
Dissolved Uranium	g/m³	< 0.00002
Dissolved Zinc	g/m³	< 0.001
Chloride	g/m³	34
Nitrate-N	g/m³	< 0.002
Sulphate	g/m³	5.2

Options Assessment

Turbidity and UV transmittance (UVT) of the bore water is unknown. It is assumed that UVT will be mid to high range (93- 97%), and turbidity will be low to mid-range (< 1 – 5 NTU). Direct filtration is ideal for the low turbidity and reasonably constant raw water quality we expect at Delmore.

A method of filtration will be required to remove the residual inert solids, silt, clay, bacteria, aquatic organisms (primarily protozoan cysts), and insoluble metals that are present in the water and require reduction in concentration. Our experience indicates that cartridge filtration can be considered for raw waters within the turbidity range of < 1 NTU and colour to 5 to 10 units, while multi-media filtration can be considered for raw waters within the turbidity range of 5 – 10 NTU and colour to 20 to 40 units. Higher values (say 15 NTU) can be tolerated for short periods, but filter runs between backwashes will become shorter.

Both options for direct filtration have been assessed in the following sections. UV disinfection will be used as the core treatment process with either filtration option, these are discussed further below.

Cartridge Filtration

Cartridge filters are comprised of a housing typically containing multiple cartridges that are made of a pleated material. Raw water is passed through the cartridges from the inside to the outside, removing particulate impurities by trapping them on the outside of the pleats as they pass through. Pressure differential is measured across the filter to monitor the accumulation of contaminants on the cartridge. When a setpoint differential pressure across the cartridges has been reached an operator is alerted that a change out is required. Cartridges cannot be regenerated with cleaning like other types of filters, so when the pressure differential setpoint is reached, the cartridges must be replaced.

Figure 42: Duty / standby cartridge filter units (Motueka WTP)

Cartridge filters provide a polishing function as opposed to a filtration function. Consequently, cartridge filters cannot be used when there is high turbidity loading in the raw water (i.e. raw water above 0.5 NTU). The raw water solids will blind the cartridge filters, obstruct flow and necessitating replacement at a frequency that is uneconomical. If the raw water turbidity is above 5 NTU, cartridge filter blinding will occur within a matter of minutes. Cartridge filters are disposable and replacement of them is manual, leading to a very expensive and time-consuming solution if solids removal is required.

Multi-Media Filtration

Multi-media filters remove particulate impurities by passing conditioned raw water through beds of porous media of differing particle sizes. Filtration removes the fine floc developed in the conditioning step, to practically 100% capture. The raw water delivered to the filters is first treated by a process called raw water conditioning, in which chemicals are added, with enough time to react, prior to filtration. An acid and a coagulant/flocculant are added into an inline static mixer, to create the rapid mixing energy and uniform chemical distribution required for adequate pH control and coagulation prior to the flocculation.
To prevent overdosing of any chemicals, highly accurate peristaltic dosing pumps are used which are flow paced to achieve a consistent chemical dose in proportion to the flow of raw water, with trim from a probe or analyser. Jar testing is used to determine an optimal coagulant/flocculant dose rate.

Figure 43: Horizontal multi-media filters (Braemar Springs WTP)

Pressure differential is measured across the media to determine filter media clogging (as well as filters being taken out of service for backwashing or maintenance, or variations in the plant flow). A typical filter cycle consists of raw water filtered through the dual media until a backwash sequence is initiated, under the following scenarios: Filter run time; Filter inlet and outlet pressure differential; High turbidity on outlet or manually (from the SCADA screen). Two multimedia pressure filters will be required with sufficient air scour, backwash and forward flush systems, as per Figure 43 (below):

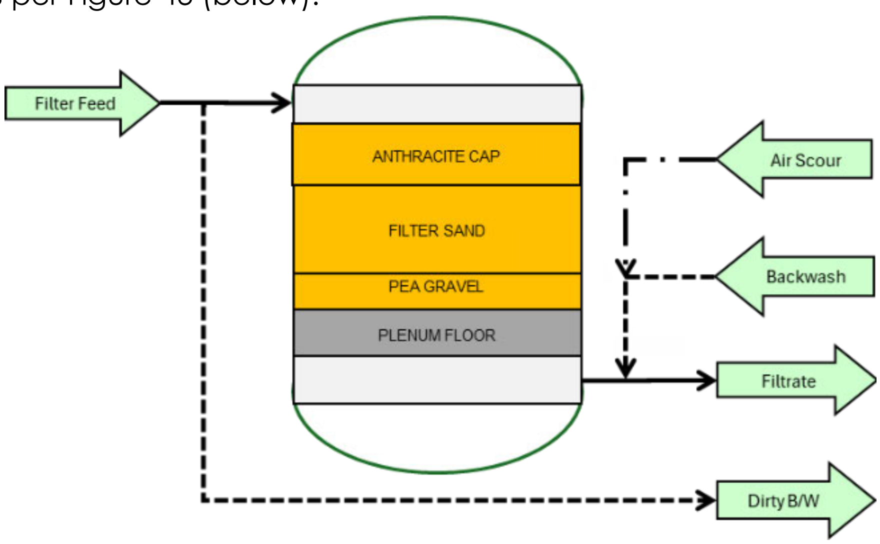


Figure 44: Multi-media filter process flow

The filters are typically backwashed once a day or if high pressure differential or high turbidity is detected (as above), with only one filter backwashed at one time due to the flow of treated water required and wastewater produced. The backwash sequence can vary but is typically: Filtration → Drain down → Air scour, then a pause → Backwash, then a pause → Filter to Waste (Ripening) → Back to Filtration.

- Drain Down – Decreases loading on the filter bed and allows for bed fluidisation.
- Air Scouring – Breaks up the surface scum and loosens dirt from the surface of the grains.
- Backwashing – At a suitable flow and velocity, this allows the media bed to expand and fluidise. Fluidising the media bed increases the interstitial space between the individual media grains allowing them to rotate adjacent to one another resulting in an abrasive effect and the removal of accumulated solids.
- Ripening – This ensures that any retained material sitting loose within the filter media is removed and sent to waste before the filter returns to operation.

A key limitation of multi-media filters is the generation of dirty backwash water. This reduces the net yield of treated water and produces a waste stream requiring appropriate management and discharge. It is planned to capture the dirty backwash water along with analyser drains and other waste streams from the WTP in a sump and pump it to the WWTP.

Ultraviolet Light Disinfection

The main unit process of the water treatment plant will be ultraviolet (UV) disinfection. It addresses both bacterial and 4.0 log protozoal treatment requirements. The term 4.0 log refers to logarithmic reduction of protozoa and is used in water treatment to represent an order of magnitude removal of contaminants (4-Log = 99.99% reduction). Immersed in water within a protective sleeve, the UV lamps emit UV radiation to inactivate micro-organisms by damaging the organism's DNA, therefore rendering to unable to reproduce and infect. It should be noted that inactivated micro-organisms (and other particles) are not removed from the water by UV disinfection.

The UV's effectiveness, or reduction equivalent dose, is determined by the combination of radiation intensity and time of exposure. A key factor in the radiation intensity received by the water is the UV transmittance (UVT) of the water, a measure of how much UV is absorbed by the water as UV waves pass through it. The lower the UV transmittance, the more UV light is required to achieve the same dose. The UV reactors are validated using the USEPA UV disinfection guidance manual and each UV will provide a reduction equivalent dose of 40 mJ/cm^2, operating as duty / standby. Each unit has a dedicated local control panel, measuring UV intensity (UVI) and providing information regarding the system's running condition (i.e. wipers running, warning alarms and critical alarms).

UVT and flowrate are set in the UV's controller to calculate the UV dose to be applied. The power output to the UV lamps is changed based on internal UVI reading to ensure the dose remains above 40 mJ/cm².

To ensure compliance is met, the following sampling is continuously monitored:

- Turbidity of the water entering the UV reactor
- UVT of the water entering or existing the UV reactor

Figure 45: Duty / standby UV disinfection units (Karaka Village North WTP)

Water Treatment Summary

The suitability of each method of direct filtration has been assessed, and either option can be employed with UV disinfection as the core treatment process to effectively remove particulate impurities and provide disinfection. The infrastructure provided for in this design report, shall allow provision for either method of direction filtration to be adopted if required while working within the structures and building footprint provided.

Chemical Systems

Chemicals	Purpose / Details	Dose Point	Approx. Consumption
Polyaluminium Chloride (23%)	Coagulation/flocculation of raw water feed to the water treatment plant	Prior to the multi-media filters	250 L/week
Sodium Hypochlorite (13%)	Disinfection of drinking water via FAC residual	After the UV disinfection units	60 L/week
Sulphuric Acid (9%)	pH control of raw feed water to the water treatment plant	Prior to the multi-media filters or after the UV disinfection units	200 L/week

Potable Water Reservoir

A potable water reservoir has been included to provide buffering a peak demand flows and resilience to the supply network. This reservoir has been sized by the client's civil engineer Mckenzie & Co considering the required daily demand and any firewater requirements. Information supporting the sizing of this reservoir can be found in documentation supporting the substantive application. The reservoir noted on the drawings within this report is sufficient to support stage-1 of the development, with some allowance for additional housing. Should additional treated water storage be required, it shall not be located on the same site as the treatment infrastructure. By locating any additional storage offsite, this provides an additional level of redundancy to the network ensuing that in the event of a localised incident, that there is still stored water available for use.

Proposed Site Layout

A layout of the proposed water treatment plant, as displayed on the Scenario 2 site can be seen in Figure 46, below. This water treatment infrastructure occupies the western side of the site and has as best as possible been kept segregated from any wastewater treatment infrastructure.

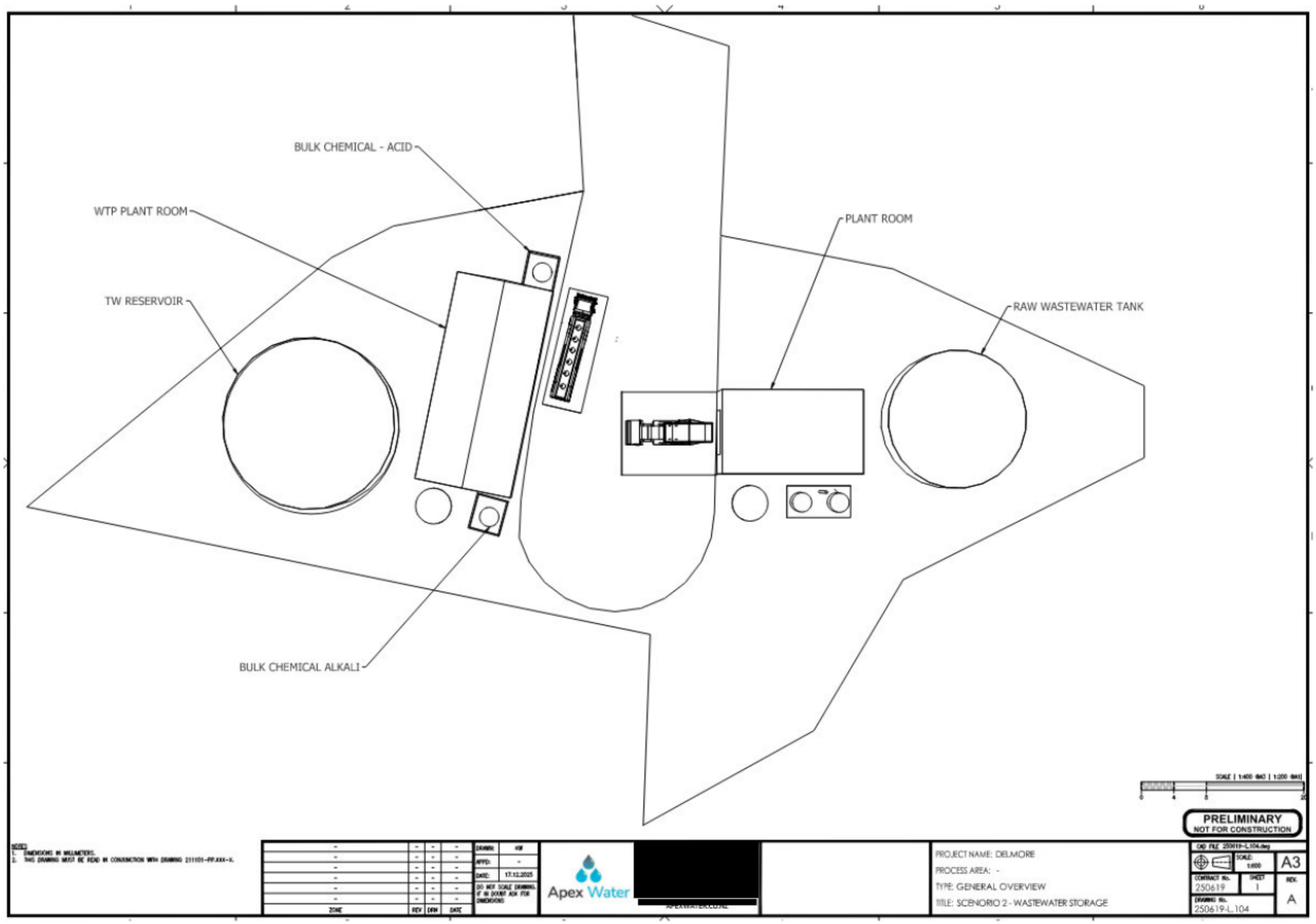


Figure 46 – The proposed water treatment plant (presented in the context of the scenario 2 site for wastewater

Plant Room

The plant room for the water treatment plant can be seen in Figure 46 below. Inside this building, the main treatment process and the pump skid feeding the reticulated network.

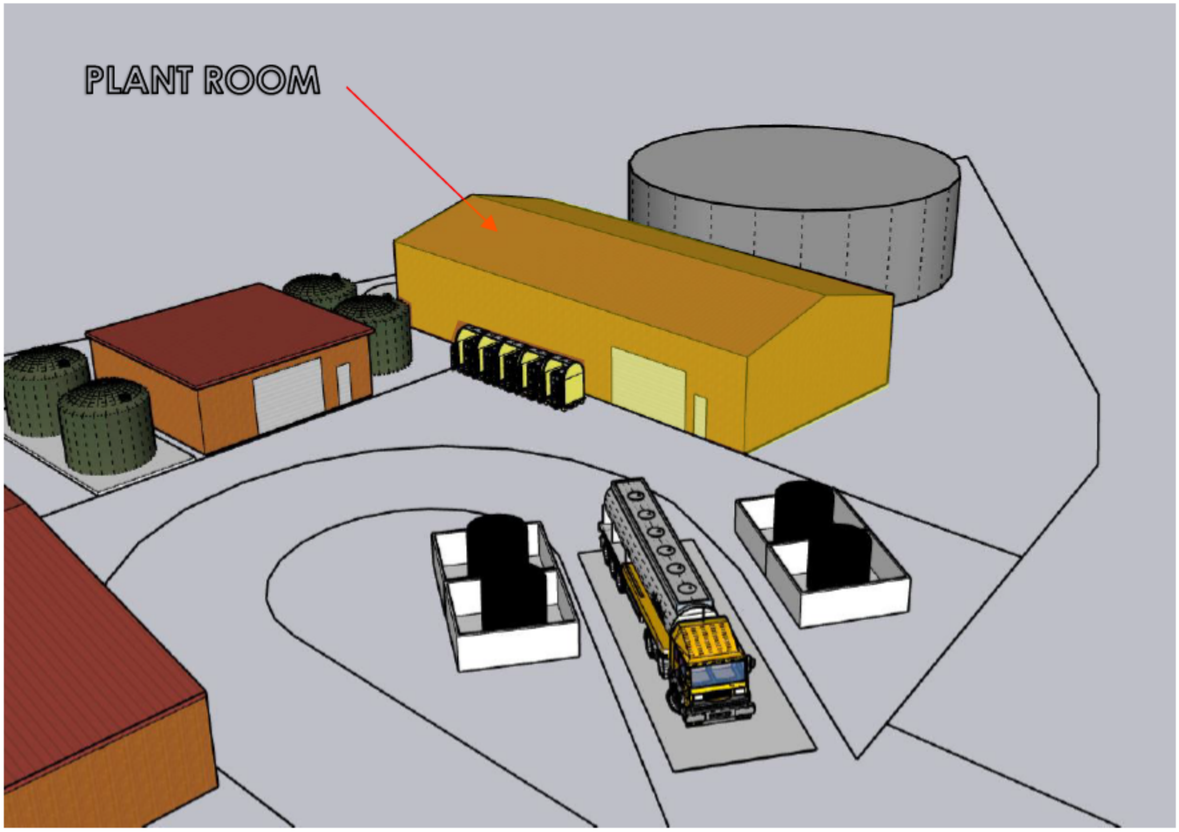


Figure 46 – The proposed water treatment plant room

Chemical Storage

The proposed locations of the bulk chemical storage tanks can be seen in Figure X below. HSNO requirements dictate that sufficient separation must be maintained between incompatible substances, as well as suitable controls to ensure the likelihood of exposure or discharge from the site is minimised. As shown in Figure 47 below, these tanks are located within their own dedicated bunds to capture any leaks or spills. These bunds shall be sized to capture at least 110% of the volume of the tank located within.

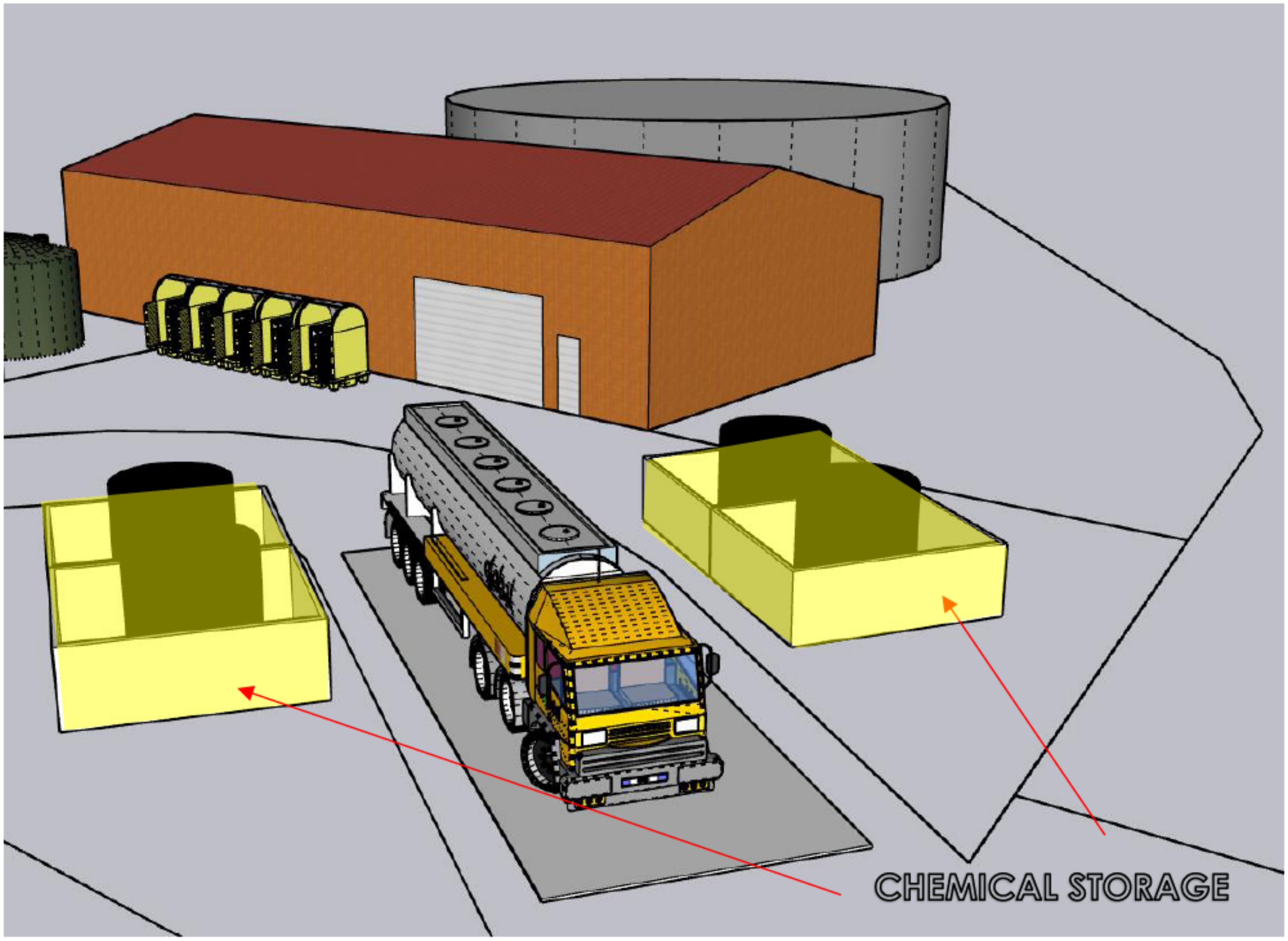


Figure 47 – Bulk chemical storage for the proposed water treatment plant

Treated Water Reservoir

The treated water reservoir of approximately 1.6ML shall be located in the location shown in Figure 48 below. This tank shall be sized to ensure the 475 lots which comprise stage-1 of the development have a resilient supply of drinking water.

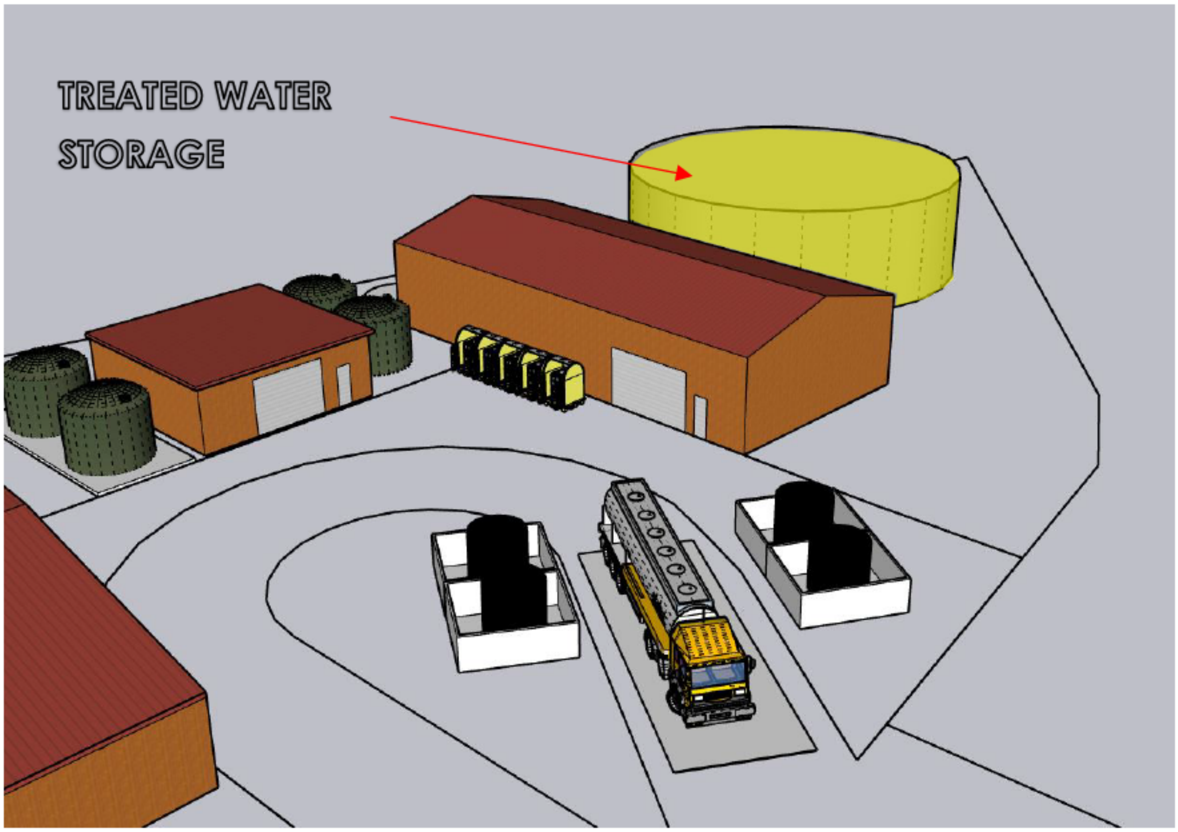


Figure 48 – Treated water storage tank

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Appendices

1. Emergency Response Plan

Apex Water

Emergency Response Plan

Delmore Wastewater Treatment Plant

PROJECT NUMBER: 241101

Revision 1
5 June 2025

Principal	
Site Address	
Project Number	
Revision	**1**
Date	5 June 2025
File Location	

REVISION HISTORY

Revision	Date	Purpose	Author	Reviewed
1				

DISTRIBUTION LIST

Date	Name	Title/Role	Organization

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APPENDICES

5 June 2025

Lead Compliance Officer – Northern Region
Licensing and Regulatory Compliance
Auckland Council
135 Albert Street
AUCKLAND CENTRAL
Emergency Response Plan –Consent BUNXXXXXXXX

1. INTRODUCTION

Consents have been issued for the construction wastewater treatment infrastructure at ADDRESS under consent reference BUNXXXXXXXX. The operation of plant and equipment associated with the treatment plant compound may present risks to personnel and the environment. While the Environmental Management Plan addresses how risks to the environment are handled from the hazardous substances stored and handled on site, this Emergency Response Plan identifies risks to personnel on site and within the vicinity of the plant and how these shall be responded to in the event of an emergency.

Apex Water have been engaged to design and build the treatment infrastructure, including chemical storage and handling facilities. This letter and the associated Emergency Response Plan has been prepared to fulfil Condition XX of BUNXXXXXXXX.

2. SITE OVERVIEW

The Delmore Wastewater Treatment Plant and its associated equipment and infrastructure can be seen in **Figure 1**, below. The main items related to the storage or handling of hazardous substances have been highlighted in red.

Figure 1 – Delmore Wastewater Treatment Plant

Description of Site Activities

The development of the Delmore Treatment Plant has been driven by the need to provide wastewater treatment infrastructure to the Delmore community. This compound contains a plant for wastewater treatment and discharge.

WASTEWATER TREATMENT

The core unit processes that comprise the wastewater treatment plant are:

- Raw sewage screening
- Anoxic Stage 1 Treatment and Flow Balancing
- Aerobic Treatment
- Anoxic Stage 2 Treatment
- Membrane filtration
- Ultraviolet Light Disinfection
- Sodium Hypochlorite Disinfection
- Permeate Storage
- Permeate Discharge
- Waste Activated Sludge Storage
- Waste Activated Sludge Dewatering

ANCILLIARY INFRASTRUCTURE

Ancillary infrastructure services both treatment plants and comprise of the following:

- 1% Sodium Hypochlorite Generation
- Centralised Plant Control
- Bulk Chemical Load Out
- Bulk Chemical Storage – 1% Sodium Hypochlorite solution
- Bulk Chemical Storage – 30% Sodium Hydroxide solution
- Bulk Chemical Storage – 49% Acetic Acid
- Back-up Generator (Diesel driven)

3. SUMMARY OF HAZARDOUS SCENARIOS

Emergency Type	Hazard	Scenario	Consequence	Location	Potential Offsite Effects	Control
Injury to Personnel (On-site)	Exposure to Hazardous substances stored on site.	Mishandling packaged chemicals.	Harm to personnel with the potential to cause long term injury, disability or death.	Site wide	N/A*	
Injury to Personnel (On-site)	Exposure to Hazardous substances stored on site.	Leak from chemical handling pipework or equipment.	Harm to personnel with the potential to cause long term injury, disability or death.	Site Wide	N/A*	
Injury to Personnel (On-site)	Exposure to Hazardous substances stored on site.	Maintaining chemical handling equipment or pipework.	Harm to personnel with the potential to cause long term injury, disability or death.	Site Wide	N/A*	
Injury to Personnel (On-site)	Exposure to Hydrogen Sulphide	Confined Space Entry	Harm to personnel with the potential to cause long term injury, disability or death.	Return Liquor Pump Station	N/A*	
Injury to Personnel (On-site)	Exposure to Hydrogen Sulphide.	Accumulation in the working areas (Screens room)	Harm to personnel with the potential to cause long term injury, disability or death.	Screens Room	N/A*	
Injury to Personnel (On-site)	Exposure to Low Oxygen Atmospheres.	Confined Space Entry (Residuals Pump Station, Return Liquor Pump Station)	Harm to personnel with the potential to cause long term injury, disability or death.	Liquor Pump Station	N/A*	
Injury to Personnel (On-site)	Exposure to Chlorine gas.	Pumping of acid into Sodium Hypochlorite tank	Harm to personnel with the potential to cause long term injury, disability or death.	Site Wide	N/A	
Injury to Personnel (On-site)	Slip, trip or fall.	Moving around site	Harm to personnel with the potential to cause long term injury, disability or death.	Site Wide	N/A*	
Injury to Personnel (On-site)	Harm caused by powered or non-powered tools.	Maintenance on plant and equipment	Harm to personnel with the potential to cause long term injury, disability or death.	Site Wide	N/A*	
Injury to Personnel (On-site)	Manual Handling.	Moving equipment or material around site	Harm to personnel with the potential to cause long term injury, disability or death.	Site Wide	N/A*	
Injury to Personnel (On-site)	Electrocution	Interacting with electrical system (lights, control systems, pumps, motors, computers etc.)	Harm to personnel with the potential to cause long term injury, disability or death.	Site Wide	N/A*	
Injury to Personnel (On-site)	Harm caused by moving machinery.	Automatically starting and stopping mechanical equipment	Harm to personnel with the potential to cause long term injury, disability or death.	Site Wide	N/A*	

Emergency Type	Hazard	Scenario	Consequence	Location	Potential Offsite Effects	Control
Injury to Personnel (On-site)	Harm caused by vehicle movements.	Movement of vehicles around site where pedestrians may be present	Harm to personnel with the potential to cause long term injury, disability or death.	Site Wide	N/A*	
Injury to Personnel (On-site and Off-site)	Fire or explosion	Electrical fault or spark resulting in fire or explosion	Harm to personnel with the potential to cause long term injury, disability or death.	Site Wide	Potential for offsite effects	
Environmental Disaster	Earthquake, Tsunami	Environmental Disaster	Harm to personnel with the potential to cause long term injury, disability or death.	Site Wide	N/A*	

* - Environmental offsite effects covered under the Environmental Management Plan

4. SPECIALIST TRAINING REQUIREMENTS

CHEMICAL SPILL - MINOR

In the event of a minor chemical spill that can be managed by the site operational staff, the Operator or responder shall be an approved Chemical Handler and be briefed on the use of the spill response kit.

SMALL FIRE

In the event of a fire occurring that can be put out using the fire extinguishers located around the site, this can be attempted. Instruction of the use of fire extinguishers, the different types and their areas of use must be provided. Location of fire extinguishers on-site is shown in Appendix A.

ALL OTHER EMERGENCIES

For all other emergencies, remediation of the hazardous conditions shall be carried out by external trained specialists or emergency services. In the event of an emergency, the main priority shall be to evacuate as many people as possible into places of safety and to address any individual harmed.

5. EMERGENCY EQUIPMENT

FIRST AID KIT

The Delmore treatment plant houses various first aid kits. The location of these first aid kits on a site layout can be seen in Appendix A. The location of these is to be highlighted during the induction of personnel onto the site and each shall be identifiable by the placement of a First Aid station sign.

The first aid signage (**Figure 1**) is in close proximity to the respective first aid kit.

Figure 1 – First Aid Kit Signage.

Each First Aid Kit includes at a minimum:

- Bandages
- Burn dressing
- Different types of wound dressings
- Foil blanket
- Nitrile Gloves
- Washproof plasters
- Resuscitation face shield with valve

- Shears
- Microporous tape
- Wound cleansing wipes box
- Saline eyewash pods
- Splinter probes

The inspection of each First Aid kit shall be carried out as a part of the regular weekly site inspection to ensure it is well stocked and in good condition.

SAFETY SHOWER STATION

Safety shower is for washing down hazardous substances off a person in the event of a chemical spill. There are X safety shower stations located on Delmore site. A safety shower station is located on the chemical load out bay, by the dosing cabinets, at the entrance to the walkway and one inside the main room. See **Figure 2 and 3** for their specific locations.

Figure 2 – Location of Safety Shower Stations near the Wastewater Treatment Plant

Figure 3 – Location of Safety Shower Stations near Wastewater Treatment Plant.

CHEMICAL SPILL KIT

The spill kit, for the Wastewater Treatment plant is located central to the site on the bulk chemical location out pad. All of the spill response equipment is located within the yellow wheely bin highlighted below (**Figure 4**).

Figure 4 – Spill Kit location.

The spill kit includes:
- Absorbent pads, pillows and socks
- Waste disposable bags
- Cable ties + breakaway red cable tie
- Disposable gloves
- Instruction card

Detailed instructions on the use and application of chemical spill kit is described in Code of Practice W-00-COP-004 The Use of and Application of Chemical Spill Kits. The Spill kit can be used to clean up minor spills that can be controlled and safely cleaned up. All hazardous spills shall be handled by trained personnel.

FIRE EXTINGUISHER

Fire extinguishers are to be used only for extinguishing small fires and under condition that it is safe to do so. There are X No. 4.5kg Dry Powder fire extinguishers located around the treatment plant compound, each extinguisher is located adjacent signage, as shown in **Figure 5** below.

Figure 5 – A location sign of the fire extinguisher.

Dry powder fire extinguishers are suitable for the following types of fire:

- flammable solids (paper, plastic etc),
- flammable liquids (petrol, oil etc),
- flammable gases (hydrogen sulphide, hydrogen gas etc),
- electrical equipment (cables, computers, switchboards etc).

Fire extinguishers shall be inspected and tagged according to legislative requirements.

6. NOTABLE PERSONNEL

Treatment Plant Operator

The duty treatment plant operator is responsible for the day-to-day operation of the site and shall be the first responder to any emergency situations. They shall act as the Emergency Controller and Fire Warden until such a time that they are relieved of their duty by Emergency Services, in which case they shall support the response through their intimate knowledge of the treatment plant compound. All operators shall be First Aid Trained to the Level 2 certification.

Delmore - Vineway Land Development Representative

Delmore is the ultimate owner of the wastewater treatment plant. They hold all consents associated with the treatment plant and its operations. Third party stakeholders shall direct all enquiries, complaints or identified issues with the networked supplies to Delmore who shall action these accordingly between their operations and maintenance partners.

7. RESPONSE PLAN

GENERAL INFORMATION

Designated Emergency Assembly Point:The Main Gate

Site First Aid location:	Main Plant Control Room
Site Fire Extinguishers location:	Various locations, refer attached
Site Emergency Spill Kit location:	Chemical Load Out Bay

Emergency phone number:	111
Healthline:	0800 611 116
Worksafe:	0800 20 90 20
Civil Defence:	111
Poison Centre:	0800 76 47 66
The Doctors Drury:	09 xxxx xxxx (not for emergencies)
The Franklin Hospital:	09 xxxx xxxx (not for emergencies)

Medical Facilities for Minor Injuries

ADDRESS

See **Figure 6** for the route to the DOCTORS NAME

Figure 6 - Screenshot of Google Maps route to nearest medical facility with directions.

Medical Facilities for More Severe Injuries

ALWAYS CALL 111 AND SPEAK TO THE OPERATOR FOR A SERIOUS INJURY. IF THE ADVICE IS TO DRIVE THE INDIVIDUAL TO THE HOSPITAL REQUEST INFORMATION ON THE BEST HOSPITAL.

NEVER LET THE INJURED PERSON DRIVE THEMSELVES IF THE INJURY IS SERIOUS.

See **Figure 7** for the route to LOCAL HOSPITAL
Figure 7 - Screenshot of Google Maps route to nearest hospital with directions.

Emergency Call Dialogue

The emergency phone numbers for Fire, Ambulance, Police, Gas, Chemical Spills:

Dial 111

When calling 111, read the following:

We have an emergency at:	Delmore Wastewater Treatment Plant, it is located at ADDRESS
We need help from:	Ambulance / Fire / Police
Directions to the emergency are:	DIRECTIONs. Someone will guide you into site, if available.
Our phone number is:	Duty Operator phone number
The medical problem seems to be:	Medical, Chemical, Fire, Explosion (all of the above)

Send someone outside to meet the emergency services.

Response in the Event of Injury to Personnel (On-site)

Before helping someone, who is injured, all workers must remember to:

STOP – LOOK – ASSESS – AND DON'T TAKE ANY RISKS!

If you are the person injured:

1) If you're seriously injured and you are able to do so, call 111 immediately and follow their instructions.
2) If you're injured, but you don't think it is serious, notify your nearby co-worker or if that is not possible, call your supervisor or on-site co-worker.
3) If possible, get another co-worker to find or call the trained first aider on-site.
4) If no-one is available and you have assessed your injury as non-serious and you are capable of driving, take yourself to the nearest Accident and Emergency medical center.

If you come across an injured person / people:

1) STOP – LOOK – ASSESS – AND DON'T TAKE ANY RISKS!
2) Do not approach the individual(s) until you are certain you are not putting yourself at risk.
3) Call 111 immediately, follow the dialogue above.
4) Notify a nearby co-worker, the Operator or any other person close by to support you.
5) If you are First Aid trained and it is safe to do so, commence First Aid.
6) DO NOT LEAVE THE INJURED PERSON BY THEMSELVES.
7) Request the support person to bring anything you require to support the injured individual (ie, First Aid kit)
8) If possible, send someone outside to meet the ambulance.
9) Once the ambulance arrives, brief them on the situation and hand over the response.

Complete incident report and notify Delmore after the emergency. The effectiveness of the emergency plan shall be reviewed. Delmore shall investigate the cause and carry out steps to prevent it from repeating if possible.

Response in the Event of a Fire Emergency

The first concern in an event of fire is always the immediate safety of all people present.

In the event of small fire on-site that can be extinguish with fire extinguisher and it is safe to do so, follow this procedure:

1) Retrieve the nearest extinguisher and follow the steps below to extinguish the fire.
2) Locate the closest fire extinguisher and emergency exits.
3) Ensure you are using the correct extinguisher for the fire type.
4) Ensure you always keep an emergency exit or exit path behind you, away from the fire.
5) Stay low to avoid the effects from heat and smoke.
6) Direct the extinguisher stream at the base of the flames.
7) Move the extinguisher stream in a side-to-side sweeping motion.
8) If the fire gets to the point where you are no longer able to control it or there is too much heat or smoke, retreat and close the doors.
9) Call 111 immediately.
10) Notify the Fire Warden – Duty Operator, who shall retrieve the sign-in sheet, sounds the alarm and ensure the site is clear of personnel.
1) If possible, send someone to meet the emergency services and direct the services to the emergency event.
11) Notify Delmore who can manage any response within the community.

In the event of large fire on-site the following procedure must be followed:

1) Notify the Fire Warden – Duty Operator.
2) The Fire Warden shall coordinate evacuation.
3) Call 111 and notify Delmore.
4) When calling 111, read the emergency dialogue above.
5) Send someone to meet the emergency services and direct the services to the emergency event.

Incident report shall be completed, and the effectiveness of the emergency plan shall be reviewed after the emergency. Delmore shall investigate the cause and carry out steps to prevent it from repeating if possible.

Response in the Event of a Chemical Spill Emergency

Refer to Environmental Management Plan for detailed spill response.

Response in the Event of a Gas Emergency

Gas detection is installed in the Screens Room to notify personnel in the event of the detection of potentially hazardous gases. These detectors monitor for the presence of Hydrogen Sulphide (H_2S), Lower Explosive Limit (LEL), Carbon Monoxide (CO) and Oxygen (O_2).

In the event of a detection, an audio-visual alarm located at the pedestrian entrance to each of these rooms shall energise highlighting the potentially hazardous conditions. These alarm limits shall be set far below the limits at which there is a risk to personnel on site. The control system shall also alarm notifying the operator in the Control Room. If this occurs outside of the manned site hours, an SMS shall be sent to the operator.

In the event of gas detector alarming, follow this procedure:

1) If you are inside Screens Room, immediately evacuate the room and close the door behind you.
2) If you are not inside the Screens Room, do not enter the room if you hear the alarm and see flashing visual alert above the entrance door.
3) Notify the duty Operator immediately who shall manually increase the ventilation rate of these rooms.

Response in the Event of a Natural Disaster

When disaster strikes follow this procedure:

- The priority is the protection of people over anything else. Get yourself and others to a safe location whether that is offsite, or on-site.
- In the event of an earthquake, tsunami or volcanic eruption, get yourself to the nearest safe location. This may be off-site.
- Do not return inside any buildings or to any locations where hazardous substances may be kept until it is safe to do so.
- If the site emergency back-up generator auto-change over has occurred and the plant is energised, the control system may be available remotely.
- The treatment plant is designed to be resilient in the event of an emergency and shall operate to feed the water supply to the development in the case of fires or emergency needs. Do not turn the plant off unless you have received guidance from emergency personnel.

If earthquake strikes remember:

- Keep calm
- Stay indoors where practical
- Drop, cover and hold (Get under something that covers you, like a strong table or other sturdy structure. Hold onto it if you can.)
- Keep away from windows and heavy furniture
- If necessary (the earthquake is too strong or lasts more than a minute), evacuate using a previously identified route
- After the earthquake, proceed immediately by the safest identifiable route to the designated emergency assembly point
- Remain there, until all persons are accounted for and the Duty Operator has given the official clearance to return to work or leave site.

During the volcanic eruption:

- Stay indoors as much as possible.
- Save water as early as possible as supplies may become contaminated.
- If it is safe to do so, keep gutters and the roof clear of ash to prevent your roof collapsing.
- If you must go outside, use protective clothing, cover your head, breathe through a mask and carry a torch.
- Wait for Civil Defence instruction and follow their recommendations.

8. HAZARDOUS SUBSTANCES

Where to Find Information on Hazardous Substances

Information on Hazardous Substances can be found in several locations. These are detailed below:

If the hazardous substance emergency occurs around the location of storage or use, the best location to receive all relevant information is the Main Control Room as this will minimise any risk to personnel involved. Collect the MSDS folder from the control room.

Location	Colour Reference	Description
Main Control Room	(red)	The MSDS and chemical inventory
Bulk Storage	(purple)	On each bulk tank HSNO Pictograms are shown identifying the hazards associated with the chemical stored
Bulk Storage	(yellow)	On each bulk tank HSNO Pictograms are shown identifying the hazards associated with the chemical stored
Packaged Chemical Storage	(green)	On each package of packaged chemicals HSNO information is shown on the label
Chemical Dosing Pumps	(blue)	On each of the dosing cabinets, HSNO pictograms identify what chemical is being pumped.

Hazardous Substance Inventory

The chemical inventory is a live document which is updated if any new chemicals are delivered to site, regardless of the volume held. A general inventory can be found in Appendix C of the Environmental Management Plan, however this contains the maximum volumes allowable under the Industrial and Trade Activity consent and does not include incidental chemical that may also be found on site, such as cleaning chemicals, oils for motors and gear boxes, chemicals used in the maintenance and repair of plastic pipework, paints etc.

Hazardous Substances Locations

Hazardous substances are stored on site either in bulk or packaged. Chemicals stored in bulk are shown in **Figure 8**. Each bulk chemical storage tank has a secondary containment – a chemical bund. Alkalis and acids are separated. Acid storage includes Sulphuric Acid tank and Acetic Acid tank. Alkali storage includes Sodium Hydroxide tank and Sodium Hypochlorite tank.

Figure 8 – Location of Bulk Chemical Substances.

Figure 10 – Packaged chemical storage in the wastewater treatment plant.

9. TESTING THE PLAN

The Emergency Response Plan is to be tested annually. The results of the testing will be recorded in Appendix B.

10. AUDITING PROGRAMME

The site shall be subjected to yearly management audits to ensure it is adhering to the requirements of this Emergency Response Plan. XXXXXX as the operator of the treatment plant does not stipulate the external auditing requirements, however it is expected that the owner of the plants shall be carrying out regular audits to ensure conformance to this plan and their requirements.

11. STAFF TRAINING

All staff and subcontractors working or regularly visiting the Delmore Treatment PLant shall be inducted prior to commencing activities on site. Within this induction, the requirements of the site's emergency response plan shall be outlined.

If a change in this document occurs, these changes shall be distributed and re-briefed to all staff.

Delmore holds a training register that is managed by the company's health and safety personnel. This register identifies training requirements, stores certifications and provides automated notifications when training needs to be updates.

Appendix A

Appendix B

2. Environmental Management Plan

Environmental Management Plan

Delmore Wastewater Treatment Plant

PROJECT NUMBER: 241104

Revision 1
5 June 2025

Principal	Delmore
Site Address	
Project Number	
Revision	**1**
Date	5 June 2025
File Location	

REVISION HISTORY

Revision	Date	Purpose	Author	Reviewed
1	17/03/2025	Outline Document		

DISTRIBUTION LIST

Date	Name	Title/Role	Organization

CONTENTS

APPENDICES

Date:
Lead Compliance Officer – Northern Region
Licensing and Regulatory Compliance
Auckland Council
135 Albert Street
AUCKLAND CENTRAL
Industrial and Trade Activities Environmental Management Plan

1. INTRODUCTION

Consents have been granted to Delmore for Industrial or Trade Activities related to the operation of wastewater infrastructure at ADDRESS. This includes the storage and handling of volumes of chemicals utilised in the treatment processes which fall above the permitted activity threshold limits required by the Auckland Unitary Plan.

This letter and the associated Environmental Management Plan appended has been prepared to fulfil Condition XX of consent BUNXXXXXXXXX.

2. ENVIRONMENTAL MANAGEMENT

Site Overview

The Delmore Wastewater Treatment Compound and its associated equipment and infrastructure can be seen in **Figure 1**, below. The main items related to the storage or handling of Hazardous Substances related to the Industrial or Trade Activities consent have been highlighted in red.

Figure 1 – Delmore Wastewater Treatment Compound

Description of Site Activities

The development of the Delmore Wastewater Treatment Plant has been driven by the need to provide wastewater treatment infrastructure to the Delmore community. This compound contains plants for wastewater treatment and discharge which utilise a number of chemicals and hazardous substances within their unit processes.

WASTEWATER TREATMENT

The core unit processes that comprise the wastewater treatment plant are:

- Raw sewage screening
- Anoxic Stage 1 Treatment and Flow Balancing
- Aerobic Treatment
- Anoxic Stage 2 Treatment
- Membrane filtration
- Ultraviolet Light Disinfection
- Sodium Hypochlorite Disinfection
- Permeate Storage
- Permeate Discharge
- Waste Activated Sludge Storage
- Waste Activated Sludge Dewatering

ANCILLARY INFRASTRUCTURE

Ancillary infrastructure services both treatment plants and comprise of the following:

- 1% Sodium hypochlorite Generation
- Centralised Plant Control
- Bulk chemical load out
- Bulk Chemical Storage – 1% Sodium hypochlorite solution
- Bulk Chemical Storage – 30% Sodium hydroxide solution
- Bulk Chemical Storage – 49% Acetic acid
- Back-up Generator (Diesel driven)

HAZARDOUS SUBSTANCES

The hazardous substances utilised within the treatment processes can be seen in **Table 2.1** below. Refer to Appendix A to respective SDS.

Table 2.1 Hazardous substances volumes and classifications

Substance	HSNO Classification	Classification Definition	State	Volume	Location

**- The dewatered waste activated sludge isn't well characterised, but may contain BOD levels above 10,000mg/L*

HAZARD IDENTIFICATION

Table 2.2 below outlines the mechanism for hazardous substances stored or handled on the Delmore site entering the local environment.

Table 2.2: Risks and contaminants of the Industrial and Trade Activity

Activity	Pollution Risk	Contaminants

Management of Environmental Risks

The basis of design of the treatment plant compound has considered the storage of hazardous substances on the site as a central element of the design process. In addition to the design elements, operational controls are in place to ensure the likelihood of spillages and mishandling is minimised.

GENERAL OPERATIONAL CONTROLS

Numerous general operation controls are in place to aid in the effective and safe operational of the treatment plants. These controls pertain to the handling and storage of hazardous substances or anything that may be contaminated with a hazardous substance. Further information on these can be found with the site's overall Standard Operating Procedures, which include but are not limited to:

- Standard Operating Procedure – The Use of and Application of Chemical Spill kits
- Standard Operating Procedure - Secondary containment rainwater testing and discharge.
- Standard Operating Procedure – Removal and Replacement of Bins for Dewatered Waste Activated Sludge
- Standard Operating Procedure – Handling and Storage of Packaged Chemicals
- Standard Operating Procedure – Bulk Chemical Handling (provided by Ixom)

BULK CHEMICAL STORAGE

Each bulk chemical storage tank sits within a chemical bund which has been designed to conform with the requirement of the Hazardous Substances and New Organisms Act, this includes:

- Bulk tank secondary containment capable of containing in excess of 110% of the volume of the largest tank.
- Separation of incompatible substances
- Redundancy in the tank level instrumentation with automatic fail over with high and high-high level alarming
- Tank overfill protections, see the Bulk Load out section below.
- HSNO compliant labelling
- Bulk secondary containment bund dimensions to account for tank dimensions and crest locus of the bulk chemical storage can be seen in **Figures 2** and **3** below.

Figure 2 –Site layout with bulk chemical storage locations highlighted.

Figure 3 –Bulk chemical storage locations

PACKAGED CHEMICAL STORAGE

Packaged chemicals are utilised through the two treatment processes for conditioning of water or waste streams. The conditioning of wastewater is typically carried out to aid the treatment processes, or to ensure the wastewater meets any compliance requirements.

The packaged chemicals utilised on the Delmore site are as follows:

- Sodium hypochlorite
- Aluminium Sulphate

A conservative approach to the storage of packaged chemicals has been taken to ensure that there is sufficient space available to allow for volumes of storage that will provide for prolonged periods of treatment without a requirement to re-stock regularly.

Each packaged chemical sits within or on a dedicated containment bund or spill collection bund. Where applicable HSNO requirements exist, these have been adhered to, or otherwise an engineered *off the shelf* storage solution has been procured for storing packaged chemical products, these include:

- 20l Carboys – Drip trays or containment bunds
- 200L Drums – Drip trays or containment bunds
- 1000L Intermediate Bulk Containers – Drip trays or containment bunds

The configuration of the location of packaged chemical storage can be seen in **Figures 4** and **5** below.

Figure 5 – Packaged chemical storage in the wastewater treatment plant.

BULK AND PACKAGED CHEMICAL DELIVERIES AND HANDLING

The delivery of bulk chemicals and packaged chemicals represents the activity with the highest risk of spillage. Bulk chemical deliveries are made directly from tankers which pump their products into the corresponding bulk storage tank. The delivery of packaged chemical products is carried out by approved dangerous goods transportation companies which are offloaded by site operational staff and stored in the corresponding packaged chemical storage locations identified in **Figures 4** and **5** above.

Bulk Chemical Deliveries

Bulk chemical deliveries will be carried out by Ixom Chemicals Limited. They are specialist producers and suppliers of chemicals into the water treatment industry of New Zealand and own a fleet of chemical tankers whose operators are specifically trained in the handling and unloading of hazardous chemicals. The bulk unloading infrastructure has been designed in coordination with Ixom to ensure their high standards are met and that all HSNO and other relevant legislative requirements are adhered to.

All bulk deliveries are to be made on the dedicated load out pad. This load out pad contains the following controls to ensure any spillages are appropriately contained:

- Dedicated and separate drainage
- Capacity to contain a volume greater than the largest compartment of the delivery tanker
- Dedicated load in point for each chemical
- Dedicated digital display for each bulk storage tank, with current volume and safe fill volumes displayed.
- Dedicated overfill flashing light and siren for each bulk chemical storage tank.

The dedicated bulk chemical load out pad can be seen in **Figure 6** below.

Figure 6 – Bulk chemical delivery load out pad

Packaged Chemical Deliveries

Packaged chemical deliveries will be carried out by an approved chemical supply company. These companies hold the certifications for transporting hazardous substances in volumes greater than typically allowed by other standard delivery organisations.

Once the delivery vehicle has arrived on site, the unloading process will be handled by the site's operation staff. This will either be by hand for smaller packages, or forklift for larger volumes.

All packaged chemicals shall be unloaded onto the chemical load out pad before being transported to their respective storage locations.

The delivery vehicle shall park adjacent the load out pad and the forklift shall operate on the load out pad to remove the packages and place them onto the contained area, before relocating these to their final positions.

The dedicated packaged chemical load out pad can be seen in **Figure 7** below.

Figure 7 – Packaged chemicals load out pad

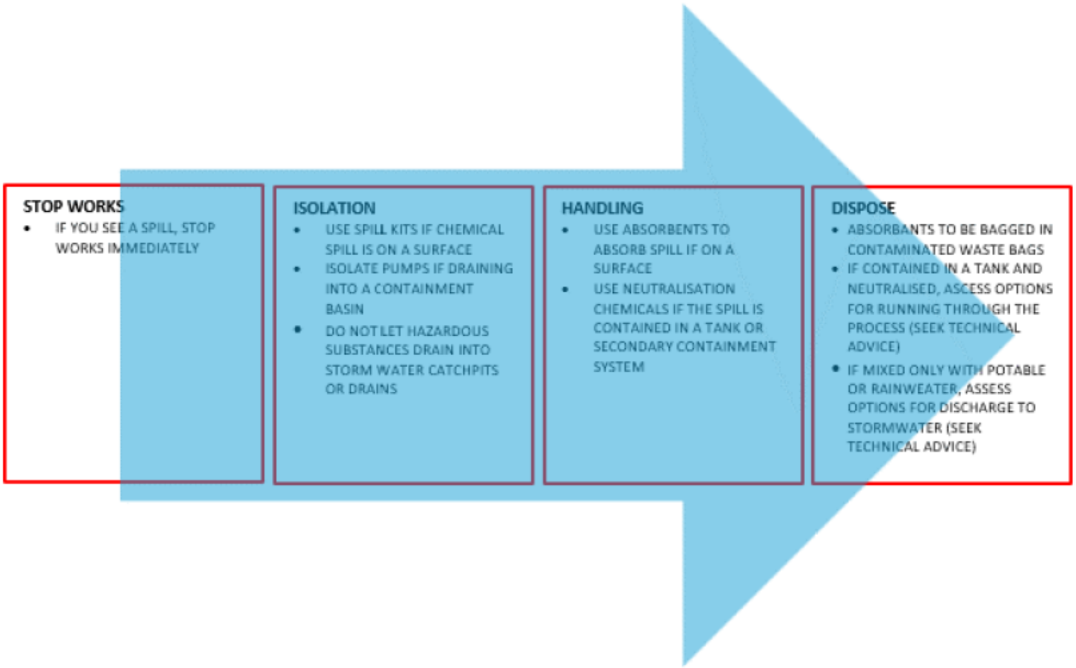
Handling

The handling and movement of chemicals on site presents the high risk of chemical exposure to personnel and any sensitive environments.

All individuals handling or relocating chemicals shall be appropriately trained and competent in both the handling of chemicals and the operation of supporting plant or equipment.

A training register is maintained by Apex Water which contains records or training and any certifications held by staff. This is managed by the company's Health and Safety personnel and is updated to ensure training and certification remains up to date.

Spill Response Plan



DO NOT ALLOW ANY CHEMICALS OR HAZARDOUS SUBSTANCES TO ENTER THE STORMWATER SYSTEM

If a spill is identified and safe to do so, it must be prevented spreading into protected places. It must be confined to the immediate area. If safe to do so, barriers must be put in place or drain covers installed to block access to stormwater catchpits.

Notify people in the immediate area of the hazard and send someone to report this to Site Management immediately after it has been contained. If the substance is known, ensure its location and an idea of the volume is reported.

Using the site's Material Safety Datasheet (MSDS) register, identify the substance spilled and identify the precautions that must be taken (is it flammable, is there a risk of explosion, gassing off, is it corrosive, is there a risk of it combining with an incompatible material etc.)

Using the Personal Protective Equipment stipulated on the MSDS as a minimum and anything else identified as necessary commence the tidy up of the spilled substance.

For minor spills that can be controlled and safely cleaned up, place the contaminated material into Hazardous Waste bags and have these stored and disposed of appropriately.

DO NOT WASH DOWN THE AREA

For large spills or hazardous spills that are either too large or dangerous to clean up, contact the Fire Brigade on 111 and follow emergency procedures.

A major spill is:

- Any amount of flammable, very toxic substance
- Anything with a product label says EXTREMELY FLAMMABLE, TOXIC, OXIDISER or CORROSIVE
- More than 200L of any substance

A minor spill is:

- A spill involving 200L or less any other substances or fuel

Immediately report the spill to the Auckland Council's 24-Hour Pollution Hotline 09 377 3107 if:

a) Spill is over 20 litres.
b) Environmentally Hazardous substances (see pictogram in SDS and below) has entered the stormwater system.
c) Environmentally Hazardous substances (see pictogram in SDS and below) has entered a waterbody.
d) Environmentally Hazardous substances (see pictogram in SDS and below) has contacted unsealed ground.

Any incidents resulting in the discharge of hazardous substances to the environment shall be reported to the Council of within 24 hours of incident occurring.

Site Drainage Plan

Refer to Appendix B of this document for site drainage plan which identifies catchpits, channel drains, treatment devices and discharge points.

Chemical Inventory

The chemical inventory is a live document which is updated if any new chemicals are delivered to site, regardless of the volume held. A general inventory can be found in Appendix C of this documents, however this contains the maximum volumes allowable under the Industrial and Trade Activity consent and does not include incidental chemical that may also be found on site, such as cleaning chemicals, oils for motors and gear boxes, chemicals used in the maintenance and repair of plastic pipework, paints, cedar oil etc.

Risk Register

A qualitative risk assessment of the identified hazards/failure modes has been undertaken in **Table 2.6** for all of the scenarios identified in **Table 2.2** where there are potential for offsite effects. The qualitative risk assessment has been carried out to assess the associated risks with chemical storage and handling. The risk assessment has been carried out by applying a qualitative rating to the frequency (likelihood) of the failure occurring and the consequence (severity) of impacts if the event were to occur. The likelihood and consequence ratings take into account the controls (mitigation and management measures) that will be in place.

The qualitative likelihood and effects ratings are described in **Table 2.3** and **Table 2.4**, respectively.

Table 2.3: Qualitative rating of likelihood

Frequency rating	Descriptor	Explanation
A	Almost certain	The event is expected to occur in most circumstances
B	Likely	The event will probably occur in most circumstances
C	Moderate	The event should occur at some time
D	Unlikely	The event could occur at some time
E	Rare	The event may occur only in exceptional circumstances

Table 2.4: Qualitative rating of consequence

Effects rating	Descriptor	Explanation
1	Insignificant	No injuries, negligible environmental damage
2	Minor	First aid treatment required, on-site release contained, minor damage to property
3	Moderate	First aid treatment required, minor environmental damage, damage to off-site property
4	Major	Extensive injuries, major environmental damage to immediate environment, moderate damage to off-site property
5	Catastrophic	Fatalities both on and off-site, major and widespread environmental damage, exposure to toxic release by numerous people.

The likelihood and consequence ratings are then combined to qualitatively assess the overall level of risk associated with each hazard. The risk assessment matrix is shown in **Table 2.5**.

Table 2.5: Risk matrix

Consequence Likelihood	**Severity**				
	Insignificant	**Minor**	**Moderate**	**Major**	**Catastrophic**
	(1)	**(2)**	**(3)**	**(4)**	**(5)**
Almost certain (A)	Significant	Significant	High	High	High
Likely (B)	Moderate	Significant	Significant	High	High
Moderate (C)	Low	Moderate	Significant	High	High
Unlikely (D)	Low	Low	Moderate	Significant	High
Rare (E)	Low	Low	Moderate	Significant	Significant

Table 2.6: Risk management

		Residual risk		
Event	**Controls (Mitigation/ Management Measures)**	**Likelihood**	**Consequence**	**Risk**

Inspection and Maintenance Requirement

The Operational and Maintenance manuals for the treatment plant includes provision for the ongoing maintenance and inspection of systems storing or handling hazardous substances.

Please refer to the Operational and Maintenance manuals for the plant and the overall site for specific inspection and maintenance activities, these include but are not limited to:

- Daily visual inspections of all chemical dosing lines, pumps, and cabinets for the leaks.
- Daily visual inspections of all chemical tanks and bunds for accumulated rainwater, leaks, or signs of damage.
- Daily visual inspections of all Waste Activated sludge tanks, pipelines, and associated equipment.
- Daily visual inspections of all stored packaged chemicals.

An example of a daily inspection sheet can be found in Appendix D.

Auditing Programme

The site shall be subjected to monthly management audits to ensure it is adhering to the requirements of this Environmental Management Plan. Apex Water as the operator of the treatment plant does not stipulate the external auditing requirements, however it is expected that the owner of the plants shall be carrying out regular audits to ensure conformance to this plan.

Staff Training

All staff and subcontractors working or regularly visiting the Delmore Wastewater Treatment compound shall be inducted prior to commencing activities on site. Within this induction, the requirements of the site's environmental management shall be outlined.

If a change in this document occurs, these changes shall be distributed and re-briefed to all staff.

Apex Water holds a training register that is managed by the company's health and safety personnel. This register identifies training requirements, stores certifications and provides automated notifications when training needs to be updates.

Appendix A

Appendix B

Appendix C

Appendix D

3. Odour Operations and Maintenance Manual

Operations and Maintenance Manual – Odour Control

Delmore WwTP

PROJECT NUMBER: 241104

Revision 1
5 June 2025

Principal	Delmore
Site Address	
Project Number	
Revision	**1**
Date	5 June 2025
File Location	

REVISION HISTORY

Revision	Date	Purpose	Author	Reviewed
1				

DISTRIBUTION LIST

Date	Name	Title/Role	Organization

CONTENTS

APPENDICES

Appendix A	Vacuum Pressure Inspection Sheet
Appendix B	Saturation of Adsorptive Media Sheet
Appendix C	Complaints Procedure

DATE

Lead Compliance Officer – Northern Region
Licensing and Regulatory Compliance
Auckland Council
135 Albert Street
AUCKLAND CENTRAL

Operations and Maintenance Plan – Odour Control — Consent BUNXXXXXX

1. INTRODUCTION

Consents have been granted to Delmore for the discharge of non-hazardous vapours to the air which are associated with to the operation of wastewater infrastructure.

This letter and the associated Operations and Maintenance Manual – Odour Control appended has been prepared to fulfil Condition XXX of BUNXXXXXXXX.

2. OVERVIEW OF SITE OPERATIONS

PURPOSE OF THE FACILITY

The Delmore Wastewater Treatment Plant has been established to meet the community's need for effective wastewater processing. The facility design anticipates and addresses the potential for odour emissions, particularly fugitive odours, arising from the treatment process.

CORE WASTEWATER TREATMENT PROCESSES

The facility includes the following key treatment stages:

- Preliminary Screening – Removal of large solids from raw sewage.
- Stage 1 Anoxic Treatment & Flow Equalization – Initial nutrient removal under low-oxygen conditions.
- Aerobic Biological Treatment – Oxygenated treatment to further break down waste.
- Stage 2 Anoxic Treatment – Additional denitrification and nutrient removal.
- Membrane Filtration – Fine filtration of treated water.
- Ultraviolet Disinfection – UV exposure to inactivate pathogens.
- Chemical Disinfection with Sodium Hypochlorite – Final disinfection using chlorination.
- Permeate Storage – Holding of treated effluent before disposal.
- Permeate Disposal – Discharge to land treatment or rapid infiltration systems.
- Waste Activated Sludge (WAS) Storage – Interim holding of biological solids.
- Sludge Dewatering – Reduction of sludge volume through water removal.

SUPPORTING INFRASTRUCTURE

The following ancillary systems support plant operation:

- Centralized control and automation systems
- Loading facilities for bulk chemical transfer
- Storage for:
  - 1% Sodium hypochlorite
  - 30% Sodium hydroxide
  - 49% Acetic acid
- Emergency diesel-powered backup generator

2. AIR EMISSIONS AND ODOUR MANAGEMENT

PRINCIPAL ODOUR GENERATION MECHANISMS

Odour emissions at the plant are primarily due to anaerobic bacterial activity, which occurs when organic waste breaks down in the absence of oxygen. These conditions can arise when:
The biological oxygen demand of wastewater exceeds the available dissolved or molecular oxygen.
Although anaerobic processes are standard in some wastewater systems, the Delmore plant is specifically engineered to prevent anaerobic conditions through:

- Continuous aeration,
- Monitoring of oxygen levels,
- Redundant systems for fail-safe operation.

Key odour risk areas include:

- Raw sewage reception and screening
- Waste activated sludge (WAS) handling and thickening
- Raw Sewage Reception
- Sewage is delivered via a pump station connected to the gravity sewer network.
- Longer retention times in the sewer can lead to oxygen depletion and the formation of odours before arrival at the plant.
- The screening system is therefore a high-risk area for odour emissions.
- Waste Activated Sludge (WAS) Handling
- Proper solids retention time (SRT) is crucial to maintain process stability.
- Sludge that remains too long in storage tanks may become anaerobic, generating odours.
- Consistent sludge removal and forced aeration help mitigate this risk.

ADDITIONAL POTENTIAL ODOUR SOURCES

Other areas that could emit odours under certain conditions include:

- Inlet screening units
- Screenings collection skips
- Decanter centrifuge for sludge dewatering
- Skips containing dewatered sludge
- Return liquor pump station
- Main plant building (housing screening and dewatering equipment)
- WAS storage tanks
- Biological treatment stages
- The Odour Control Unit itself

ODOUR CONTROL MEASURES

Inlet Screening Area

1. Located in a sealed plant room maintained under negative pressure.

2. Vapours from the screening chamber and skip bins are extracted and treated via the Odour Control Unit.

Decanter Centrifuge

1. Treats aerated WAS to prevent anaerobic conditions.

2. Centrifuge housing is negatively pressurized and connected to the odour extraction system.
3. Associated skips are also enclosed and ventilated.

Return Liquor Pump Station

1. Collects liquid residuals from various process areas.
2. The pump station is continuously vented under negative pressure to the Odour Control Unit.

Main Plant Building

1. Contains major odour sources including screens and centrifuge.
2. Maintained under slight negative pressure to prevent fugitive emissions.
3. Ventilated air is treated prior to discharge.

WAS Storage Tanks

1. Continuously aerated to prevent the formation of anaerobic conditions.
2. Tank headspace is extracted at a higher flow rate than the aeration input, ensuring containment.

Biological Treatment Zones

1. To balance nutrient removal and odour control, the plant uses targeted aeration and monitoring:
2. Anoxic Stage 1: Receives recycled aerated water. Oxidation-reduction potential (ORP) is monitored to prevent anaerobic activity.
3. Aeration Stage: Dissolved oxygen (DO) is continuously measured to maintain optimal aerobic conditions.
4. Anoxic Stage 2: Mirrors Stage 1 control strategy using ORP monitoring.
5. Membrane Stage: Aeration supports both treatment and membrane scouring.

3. ODOUR CONTROL UNIT SPECIFICATIONS

The Odour Control Unit treats air extracted from all high-risk zones, including:

- Headworks screening
- Sludge tanks and skips
- Dewatering equipment
- Wastewater sumps
- Main process room

Design parameters include:

- Use of activated carbon media impregnated with chemicals like sodium hydroxide or potassium iodide.
- Media depth designed for minimum 3 seconds residence time at maximum airflow.
- Maximum gas velocity through media: 0.2 m/s, unless approved otherwise.

SUMMARY OF KEY OPERATIONAL PARAMETERS

Table 1 below summarises each area of potential fugitive odour generation and the design features or operational parameters that exist to prevent against odour release.

Table 1 – Barriers and Mitigations to Fugitive Odour Release.

Source	Primary Barrier and Operational Parameters	Secondary Barrier and Operational Parameters	Tertiary+ Barriers and Operational Parameters	Other
Raw Sewage Inlet Screens	**BARRIER** 1. Enclosed headspace **OPERATIONAL PARAMETER** 1. N/A	**BARRIER** 1. Inlet Screens are located inside. **OPERATIONAL PARAMETER** 1. N/A	**BARRIER** 1. Headspace maintained at negative pressure. **OPERATIONAL PARAMETER** 1. Confirmation of vacuum pressure monitored and recorded weekly	
Dewatering Centrifuge	**BARRIER** 1. Enclosed headspace **OPERATIONAL PARAMETER** 1. N/A	**BARRIER** 2. Dewatering centrifuge is located inside. **OPERATIONAL PARAMETER** 1. N/A	**BARRIER** 1. Headspace maintained at negative pressure. **OPERATIONAL PARAMETER** 1. Confirmation of vacuum pressure monitored and recorded weekly	
Main Plant Room	**BARRIER** 1. Room has forced ventilation. **OPERATIONAL PARAMETER** 1. N/A			
Waste Activated Sludge Tank	**BARRIER** 1. Headspace maintained at a negative pressure **OPERATIONAL PARAMETER** 1. Confirmation of vacuum pressure monitored and recorded weekly	**BARRIER** 1. Forced aeration of tank contents to avoid anaerobic conditions **OPERATIONAL PARAMETER** 1. Aeration blowers operational and available		The aeration system has been designed and installed with the following redundancy: - Three blowers in the configuration of Duty, Standby and Jockey have been installed. - An emergency back-up generator with auto changeover will power these units in the event of a power failure. - UPS system to ensure power of the control system in the event of a power change over or total power failure
Return Liquor Pump Station	**BARRIER** 1. Enclosed headspace **OPERATIONAL PARAMETER** 1. N/A	**BARRIER** 1. Headspace maintained at negative pressure **OPERATIONAL PARAMETER** 1. Confirmation of vacuum pressure monitored and recorded weekly		
Biological Treatment Process	**BARRIER** 1. Anoxic 1 ORP Continuous Monitoring 2. Aeration Dissolved Oxygen Concentration Monitoring 3. Anoxic 2 ORP Continuous Monitoring 4. Membrane Tank Forced Aeration			The aeration system has been designed and installed with the following redundancy: - Three blowers in the configuration of Duty, Standby and Jockey have been installed. - An emergency back-up generator with auto changeover will power these units in the event of a power failure.

	OPERATIONAL PARAMETER 1. Refer Functional Description 2. Dissolved Oxygen Concentration must not drop below 0.1mg/L for more than 12 hours. 3. Refer Functional Description 4. Refer Functional Description			- UPS system to ensure power of the control system in the event of a power change over or total power failure
Odour Scrubber Unit	**BARRIER** 1. Chemically impregnated, steam activated carbon bed. **OPERATIONAL PARAMETER** 1. Inline duct heater capable of reducing the RH of the incoming air at the maximum design flowrate from 100% to 70% at 20 degrees Celsius 2. Residence time of minimum 3 seconds in carbon bed at maximum flowrate 3. Maximum gas velocity of 0.2m/s through the carbon bed, exceptions with Auckland Council approval 4. Monitoring of saturation of adsorptive media on a monthly basis 5. Weekly monitoring of temperature and RH of airflow into and out of the heater			An emergency back-up generator with auto changeover will power the Odour Control Unit in the event of a power failure. A UPS system ensures power of the control system and monitoring systems in the event of a power change over or total power failure

3.1. Critical Spares

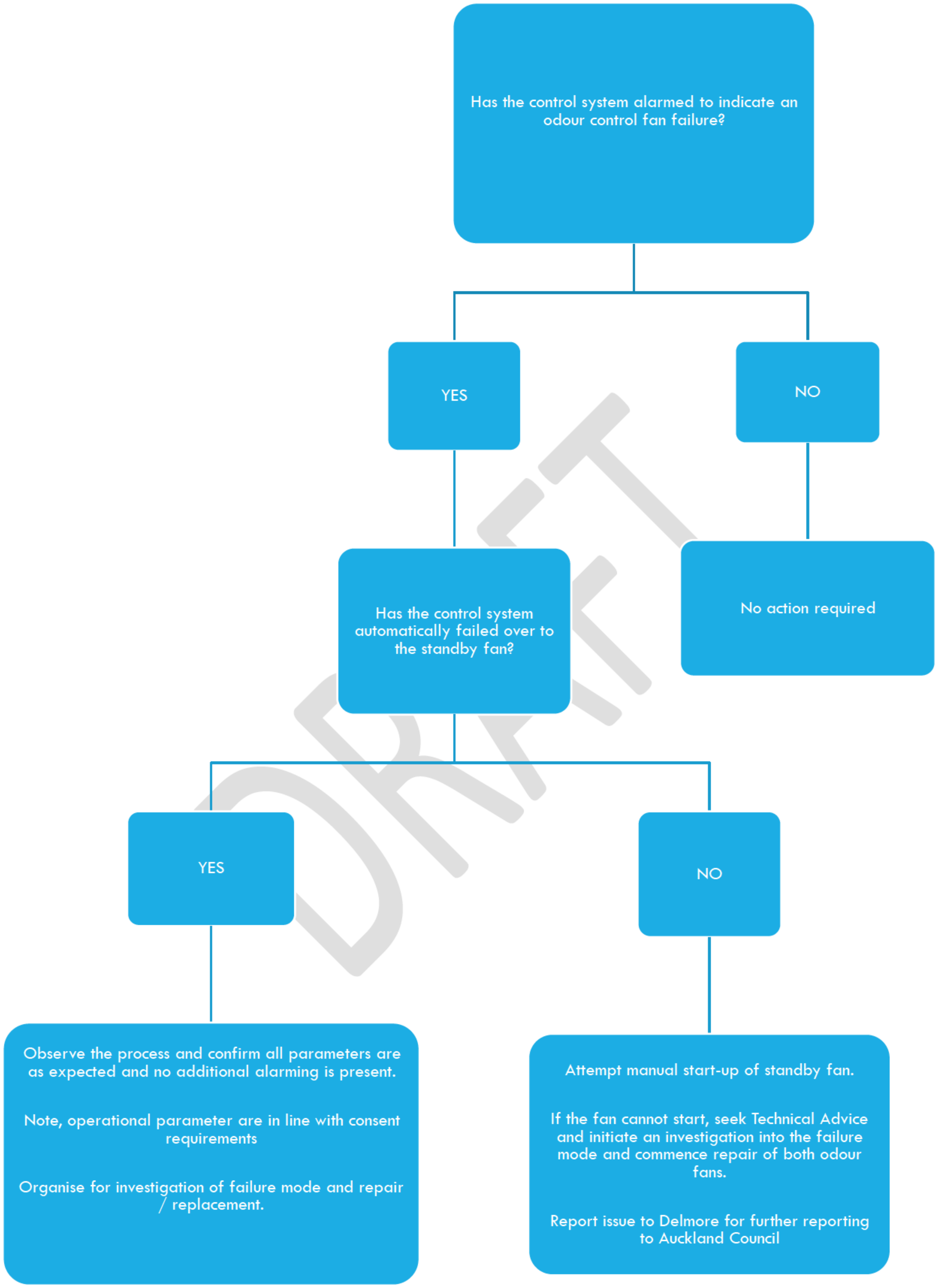
The following items have been identified as critical spares which must be held on site or must be regularly stocked items held by third parties, or by the Apex Water Service and Sales Team. Criticality is qualified by the item being necessary for the operation of any system that protects against fugitive odour generation or emission.. Table 2 below, outlines the critical spares identified.

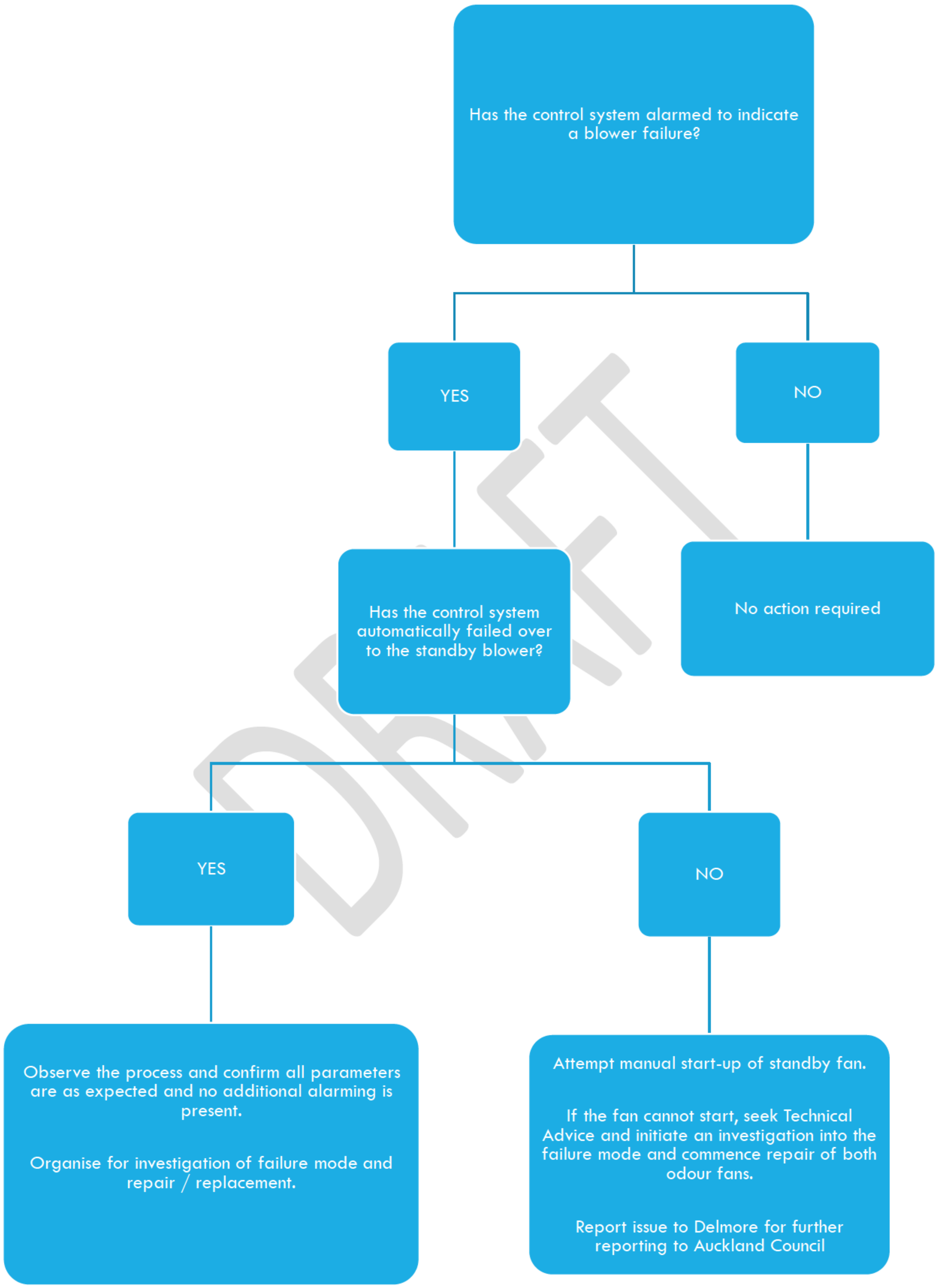
Table 2 – Critical Spares required for Odour Control.

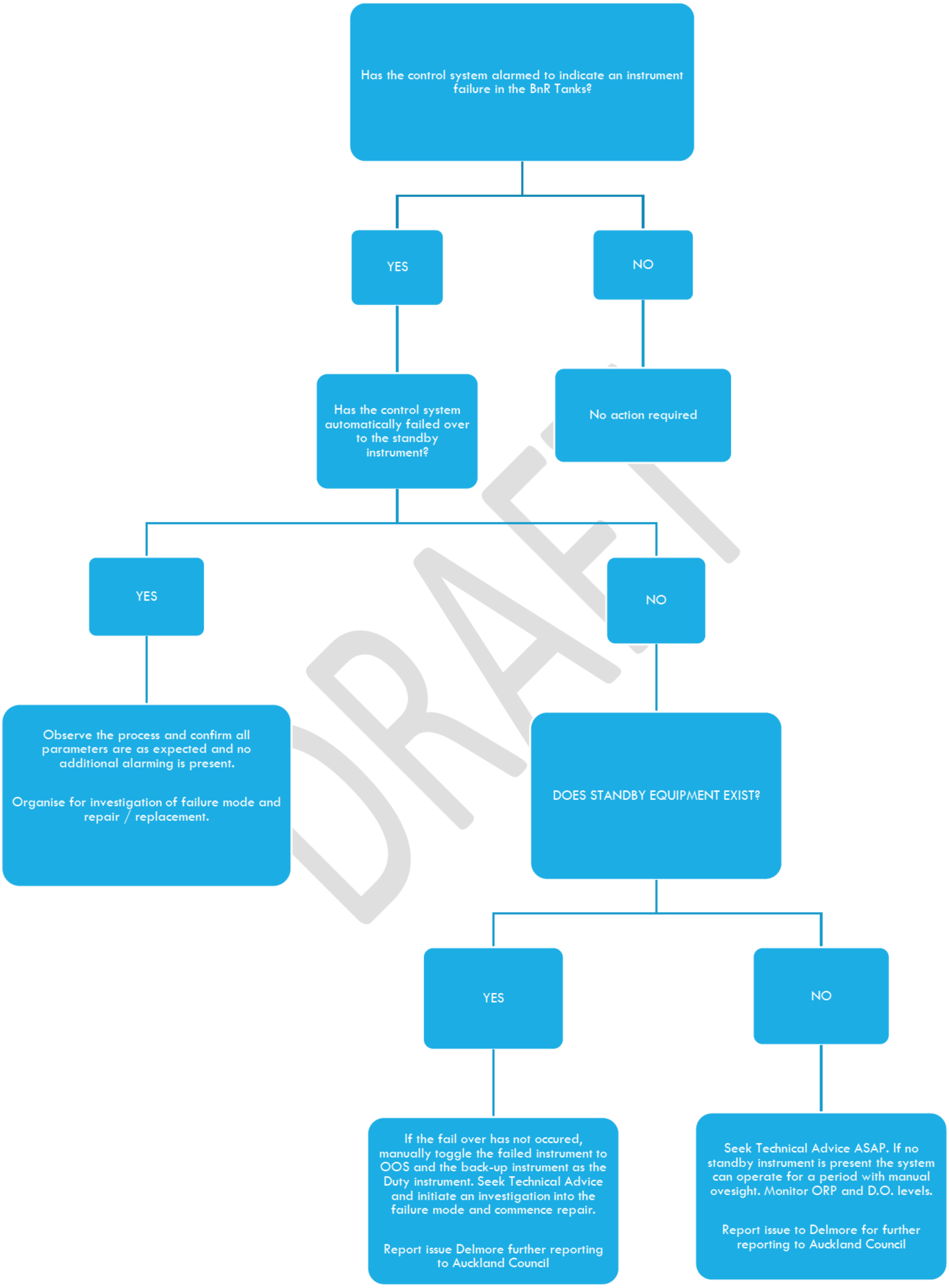
Description	Location	Function	Requirement

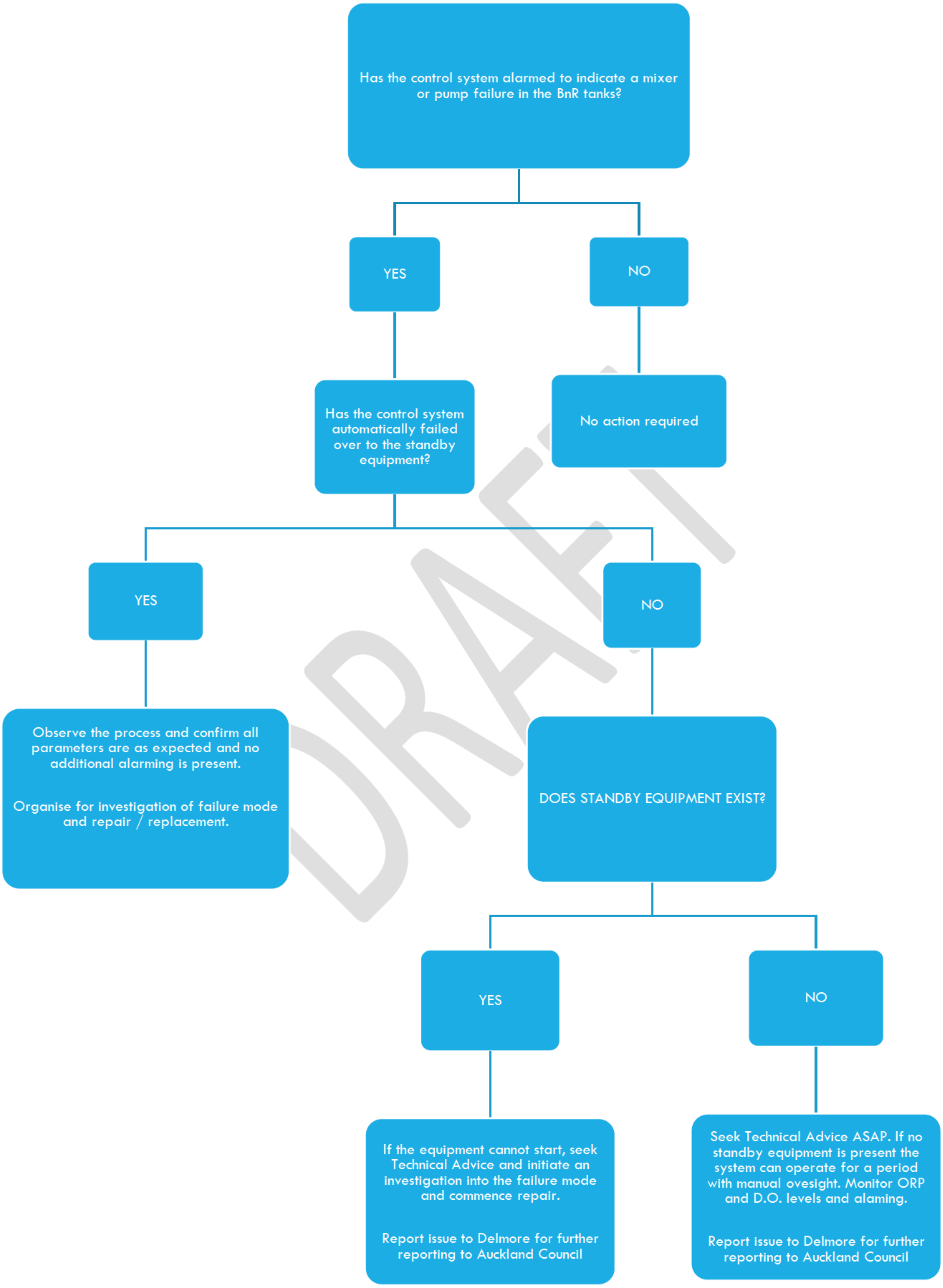
3.2. Contingency Procedures

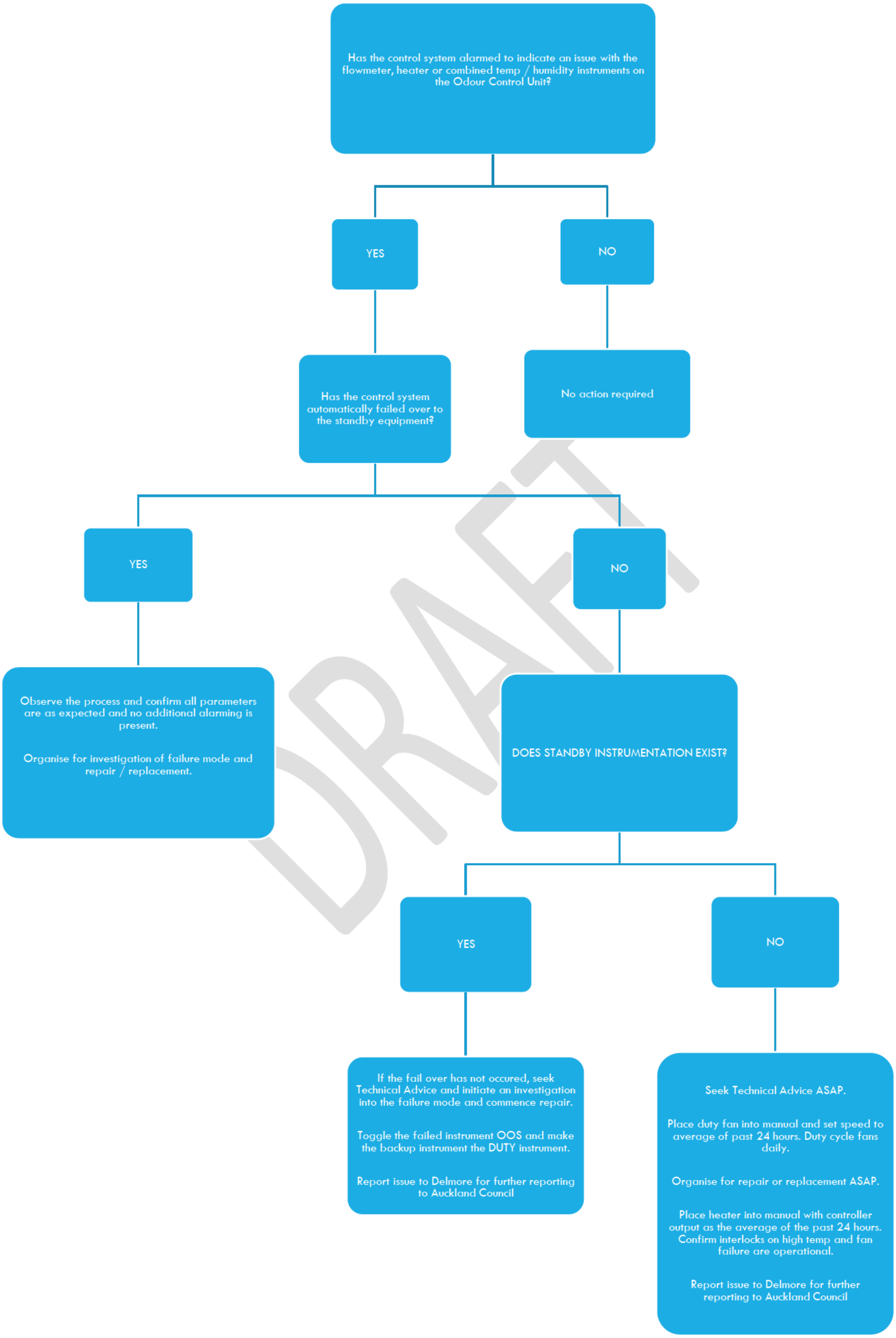
As the plant is largely automated and has been designed to include redundancy for critical elements, the control system will in most cases automatically respond to any plant breakdowns, equipment failures or malfunctions. Although the plant control system will manage most failures, flowcharts below outline a response to the failure of equipment or instrumentation which may impact the Odour Control Unit or equipment central to the protection against fugitive odours.


Has the control system alarmed to indicate an odour control fan failure?
YES
NO
Has the control system automatically failed over to the standby fan?
No action required
YES
NO
Observe the process and confirm all parameters are as expected and no additional alarming is present.
Note, operational parameter are in line with consent requirements
Organise for investigation of failure mode and repair / replacement.
Attempt manual start-up of standby fan.
If the fan cannot start, seek Technical Advice and initiate an investigation into the failure mode and commence repair of both odour fans.
Report issue to Delmore for further reporting to Auckland Council


Has the control system alarmed to indicate a blower failure?
YES
NO
Has the control system automatically failed over to the standby blower?
No action required
YES
NO
Observe the process and confirm all parameters are as expected and no additional alarming is present.
Organise for investigation of failure mode and repair / replacement.
Attempt manual start-up of standby fan.
If the fan cannot start, seek Technical Advice and initiate an investigation into the failure mode and commence repair of both odour fans.
Report issue to Delmore for further reporting to Auckland Council


Has the control system alarmed to indicate an instrument failure in the BnR Tanks?
YES
NO
Has the control system automatically failed over to the standby instrument?
No action required
YES
NO
Observe the process and confirm all parameters are as expected and no additional alarming is present.
Organise for investigation of failure mode and repair / replacement.
DOES STANDBY EQUIPMENT EXIST?
YES
NO
If the fail over has not occured, manually toggle the failed instrument to OOS and the back-up instrument as the Duty instrument. Seek Technical Advice and initiate an investigation into the failure mode and commence repair.
Report issue Delmore further reporting to Auckland Council
Seek Technical Advice ASAP. If no standby instrument is present the system can operate for a period with manual ovesight. Monitor ORP and D.O. levels.
Report issue to Delmore for further reporting to Auckland Council


Has the control system alarmed to indicate a mixer or pump failure in the BnR tanks?
YES
NO
Has the control system automatically failed over to the standby equipment?
No action required
YES
NO
Observe the process and confirm all parameters are as expected and no additional alarming is present.
Organise for investigation of failure mode and repair / replacement.
DOES STANDBY EQUIPMENT EXIST?
YES
NO
If the equipment cannot start, seek Technical Advice and initiate an investigation into the failure mode and commence repair.
Report issue to Delmore for further reporting to Auckland Council
Seek Technical Advice ASAP. If no standby equipment is present the system can operate for a period with manual ovesight. Monitor ORP and D.O. levels and alaming.
Report issue to Delmore for further reporting to Auckland Council


Has the control system alarmed to indicate an issue with the flowmeter, heater or combined temp / humidity instruments on the Odour Control Unit?
YES
NO
Has the control system automatically failed over to the standby equipment?
No action required
YES
NO
Observe the process and confirm all parameters are as expected and no additional alarming is present.
Organise for investigation of failure mode and repair / replacement.
DOES STANDBY INSTRUMENTATION EXIST?
YES
NO
If the fail over has not occured, seek Technical Advice and initiate an investigation into the failure mode and commence repair.
Toggle the failed instrument OOS and make the backup instrument the DUTY instrument.
Report issue to Delmore for further reporting to Auckland Council
Seek Technical Advice ASAP.
Place duty fan into manual and set speed to average of past 24 hours. Duty cycle fans daily.
Organise for repair or replacement ASAP.
Place heater into manual with controller output as the average of the past 24 hours. Confirm interlocks on high temp and fan failure are operational.
Report issue to Delmore for further reporting to Auckland Council

3.3. Compliance Monitoring Procedures

Table 3 below outlines the processes by which Resource Consent compliance is obtained.

Table 3 – Resource Consent conditions relevant to Odour management.

Condition Number	Wording	Compliance

3.4. Personnel Training and Induction

Personnel operating the wastewater treatment plant on the Delmore wastewater treatment plant shall at a minimum hold experience in the operation of wastewater processes or shall be trained according to Apex's Operator Training Manual and working towards a formal certification. Refresher training and site-specific scenario awareness training is conducted by the Apex Technical and Operation team and is tailored according to the requirements of the operator and the plant. A training plan shall be created for each new operator with regular auditing and review by the appropriate management staff.

Induction shall be provided to all personnel and subcontractors working on the treatment plant to highlight hazards associated with the site and general controls on works. Works cannot be carried out before an induction is carried out.

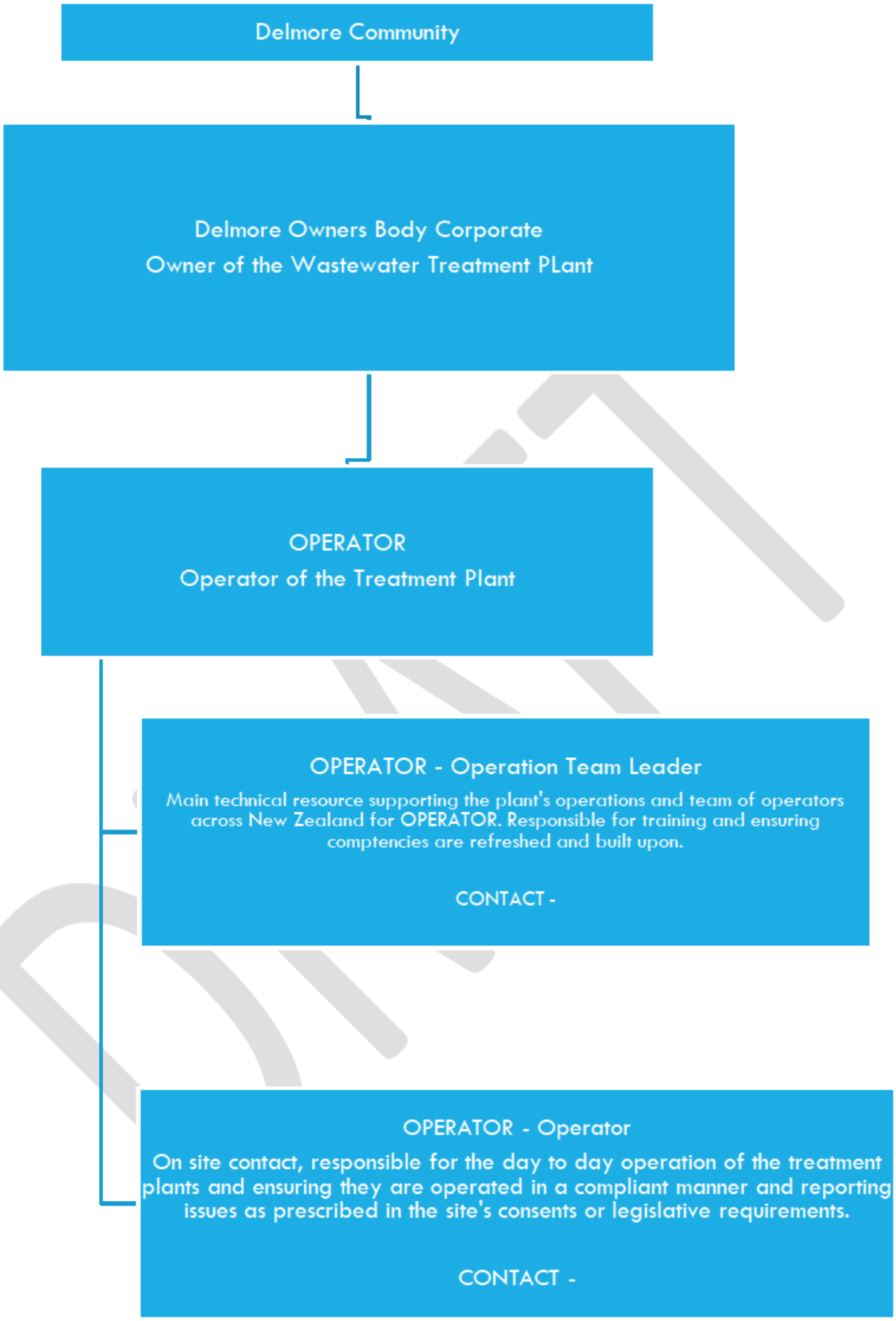
3.5. Responding to Complaints

As a general rule, Apex Water shall not respond to complaints directly. Complaints shall be handled by Delmore or their nominated party. Apex Water staff will be briefed on interaction with the public and shall direct any verbal complaints received to the appropriate parties.

Apex Water at their discretion may hand out a copy of the generic complaints form shown in Appendix C to any individual complainant at the gate of the treatment compound. They may scan and pass this information onto their contact at Delmore. The generic complaint form includes a section where the bearing of the complainant (North-South-East-West) can be noted, alongside the direction of the wind, as measured at the treatment plant on day and time in question.

3.6. Roles and Responsibilities

Apex Water is to abide by this OMM and makes sure every employee is introduced to it. Every employee must read and understand this OMM before starting to work in WwTP. It is up to employee's responsibility to ask the employer if something is not understandable. An employee's signature is needed as acknowledgment. All records are to be kept by the Operator and presented if needed. A summary of the roles and responsibilities held by the site are detailed below, with a hierarchy through to the plant owner.


Delmore Community
Delmore Owners Body Corporate
Owner of the Wastewater Treatment PLant
OPERATOR
Operator of the Treatment Plant
OPERATOR - Operation Team Leader
Main technical resource supporting the plant's operations and team of operators across New Zealand for OPERATOR. Responsible for training and ensuring comptencies are refreshed and built upon.
CONTACT -
OPERATOR - Operator
On site contact, responsible for the day to day operation of the treatment plants and ensuring they are operated in a compliant manner and reporting issues as prescribed in the site's consents or legislative requirements.
CONTACT -

3.7. Reviewing and Improving OMM

The OMM will be reviewed every 2 years and updated. All staff must be introduced to any changes. This review shall be conducted and carried out in coordination with Delmore.

4. Operations and Maintenance Plan

Apex Water

APEX WATER

OPERATION AND MAINTENANCE MANUAL

DELMORE WASTEWATER TREATMENT PLANT

Contract Number

Project Number

Customer

Installation Address

Date of Installation

Revision No.

CONTENTS

The following documentation should be referred to in conjunction with this manual:

- As-built drawings
- Engineering calculations
- OEM manual
- Standard operating procedures
- Functional description
- Commissioning records

1 INTRODUCTION

2 PROCESS OVERVIEW

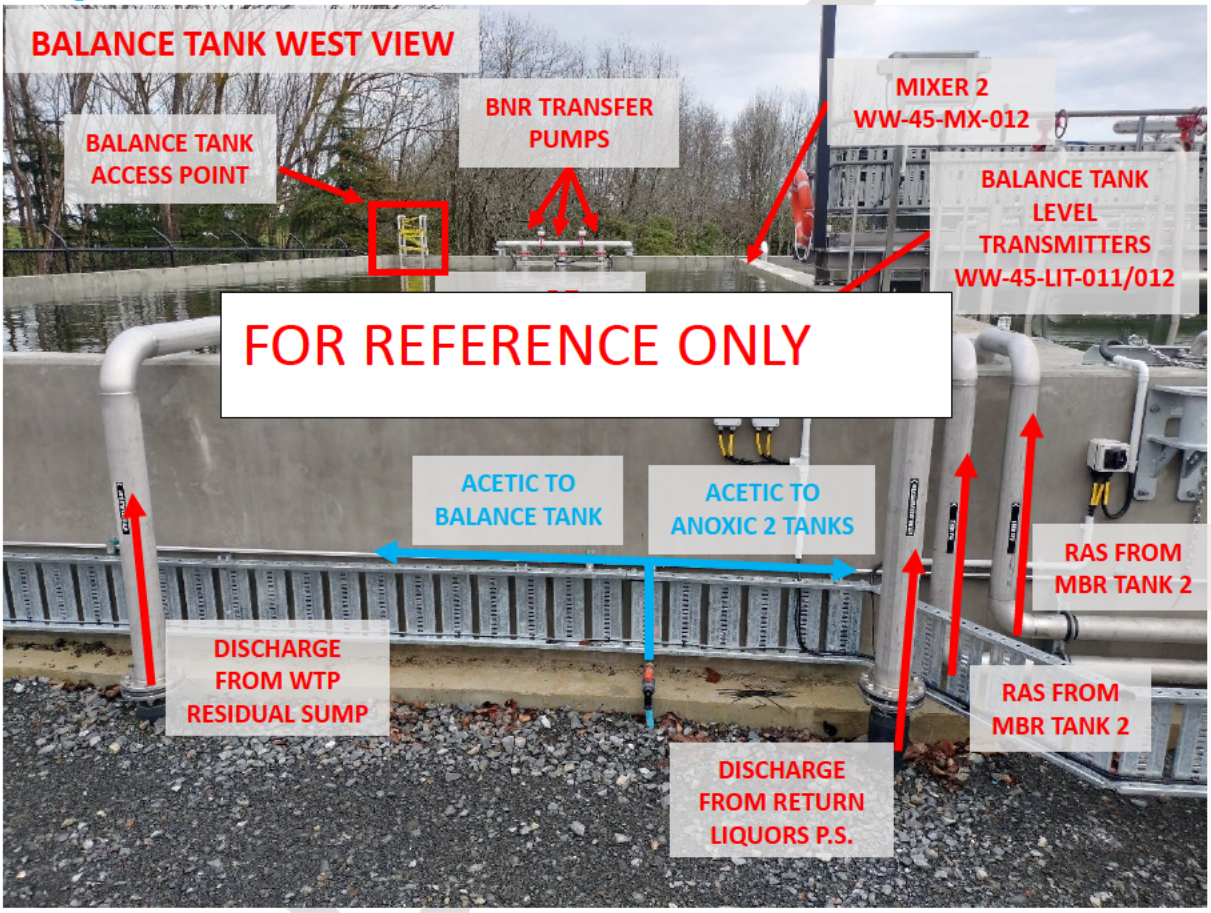
The following provides a brief overview of the control philosophy. Refer to the Functional Description and P&IDs for further detail.

3 PLANT OVERVIEW

SOME IMAGES HAVE BEEN SHOWN FOR REFERENCE ONLY

Plant inflow:

Biological Treatment Tanks:



MBR discharge pipework:
UV disinfection and pumping:
Process water pumps:

WAS tanks:

Recycled Water Tanks (Permeate):

Gas detectors:

Blowers:

Aeration Blowers, HVAC and Compressors

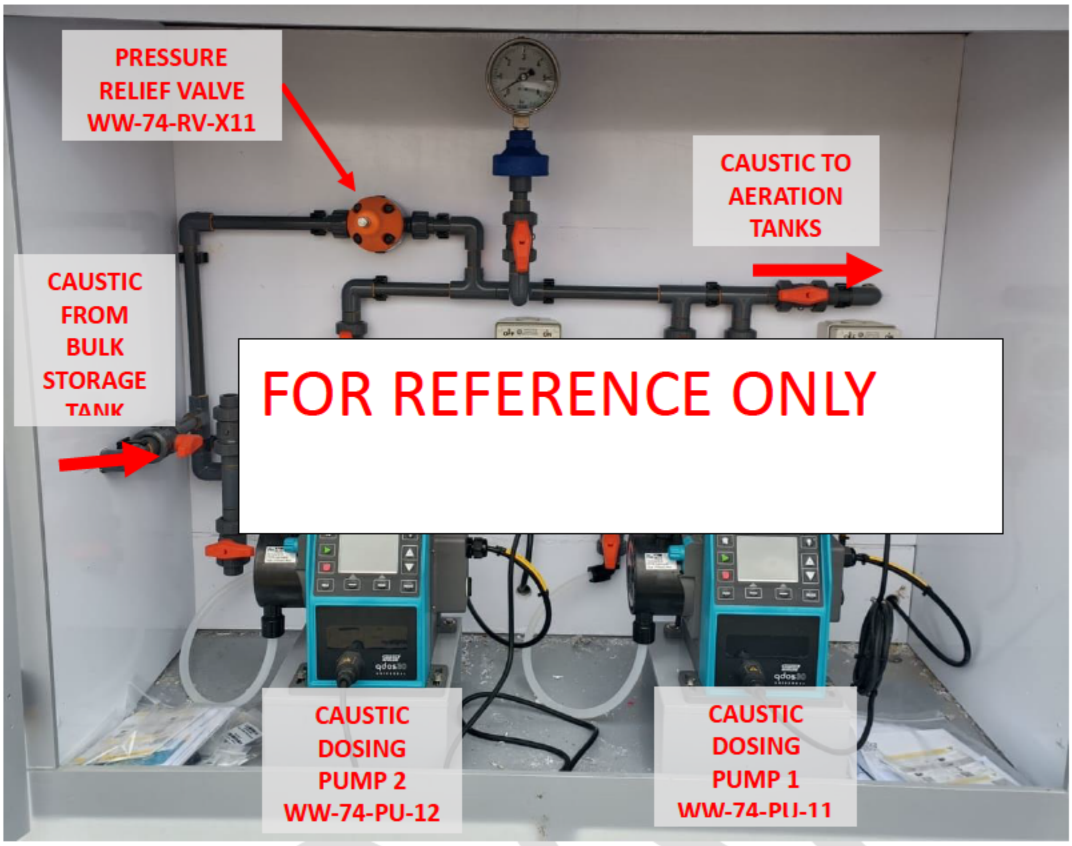
Waste Activated Sludge Handling (WAS):

Alum dosing board:

Caustic storage:

Alum Dosing Cabinet

Caustic Dosing Cabinet



Acetic Acid Dosing Board

Sodium Hypochlorite (Hypo) Dosing Board:

Chemical Load out Bay:

Site generator:

MCC and switchboard:

Odour Control:

4 CONTROL SYSTEM

The plant is controlled by a xxxxxx PLc. The plant has a local SCADA PLC, which has an Application Object Server (AOS), I/O server, workstation and historian.

The main PLC communicates with the following:

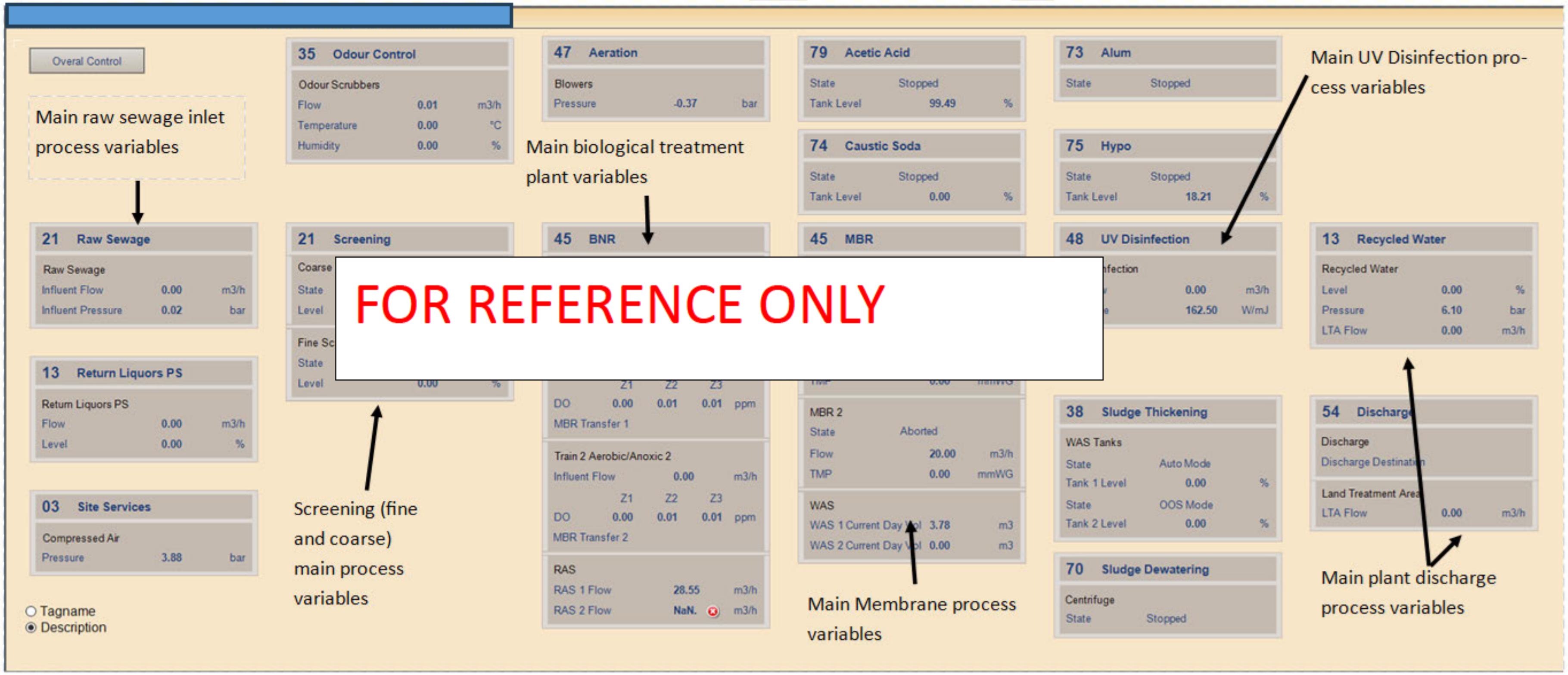
- Dewatering centrifuge
- Motor VSDs
- Analyser transmitters
- UV reactors
- Process water pumps

The following screenshots provide a guide of how to navigate the SCADA system. Do not reference the process values at the time of the screenshot. Refer to the setpoint list in the functional description for the intended values.

Overall plant monitoring:

SOME INFORMATION HAS BEEN SHOWN BELOW FOR REFERENCE ONLY

This page is the landing page for all things related to the wastewater treatment plant. The critical process variables of each area are displayed within the individual boxes, which are broken down according to Watercare area codes. From this page an operator can view everything from a high level that is required to oversee the operation of the plant in automatic. The operator must go further into the process and equipment to troubleshoot or change specific parameters. Each specific process areas and their parameters are shown on their related page (see below)

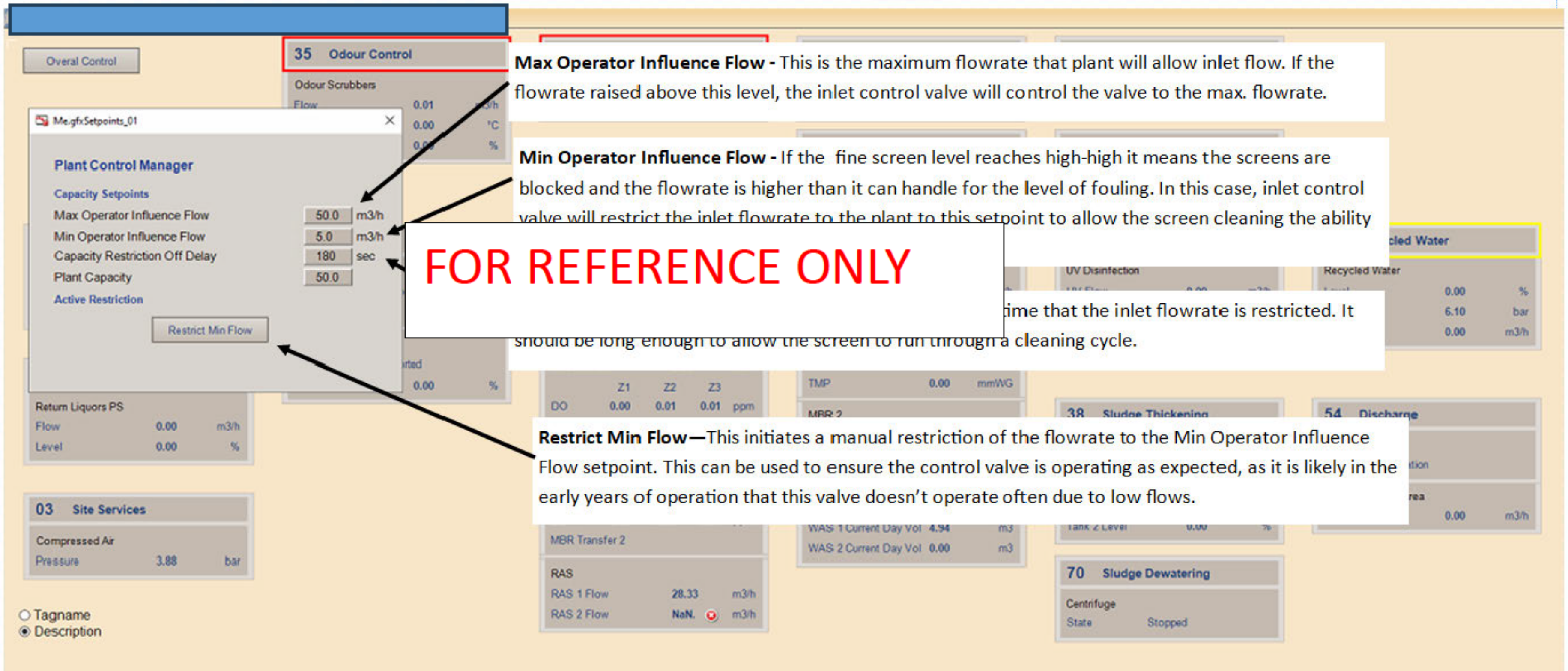


Navigating the home page:

Overall Plant Control Setpoints:

INFORMATION FOR REFERENCE ONLY

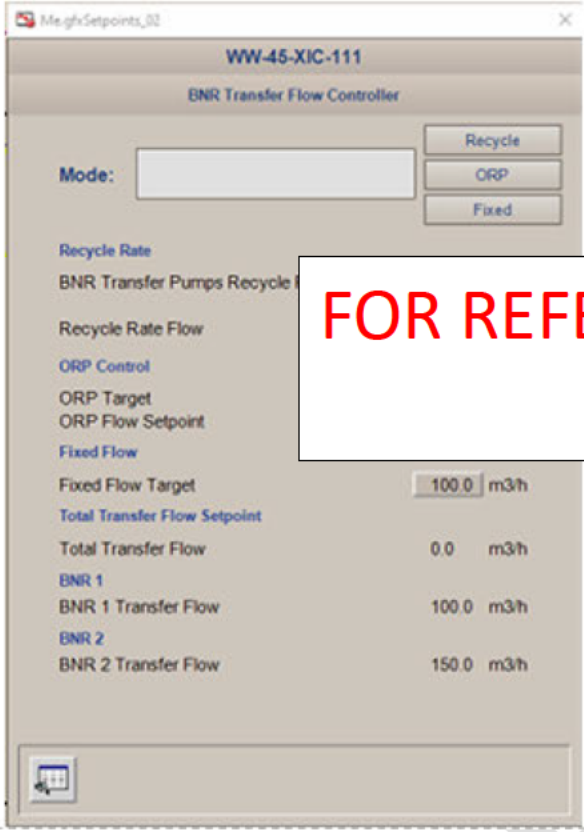
A overview and description of the overall plant control setpoints can be seen below.



Anoxic Balance Tank Setpoints

INFORMATION FOR REFERENCE ONLY

The BnR (Biological Nutrient Reduction) transfer pumps are the heart of the treatment process. These pumps control the bioloigcal process and can be operated in a number of ways.A description of the setpoints and controL modes is shown below. It is important to note that a core understanding of biological processes, specifically Activated Sludge Processes is required to operate this plant from which provides context of the different control modes. The O&M manual does not replace wastewater ptreatment plant training, experience and knowledge.



FOR REFERENCE ONLY

Mode —Highlights the current control mode of the BnR transfer pumps (Recycle, ORP or Fixed)

Recycle Mode— If the Recycle mode is selected the BnR pumps operate to recycle the flowrate through the aeration tanks at a multiple of the plant inlet flowrate (ie, if the inlet flowrate is 1m3/hr and the Recycle rate was set to 10, the transfer pumps will be targeting 10m3/hr recycle flowrate. 10x the incoming flow rate)

ORP Mode— If ORP mode is selected, the BnR pumps adjust their speed to recycle the flowrate through the aeration tanks to achieve an ORP setpoint value (see ORP Control setpoint below). ORP levels corre- ... process is targeting optimal deni- ...

... tpoint.

ORP Flow Setpoint—This is the flowrate the ORP controller is targeting from the BnR pumps in this mode.

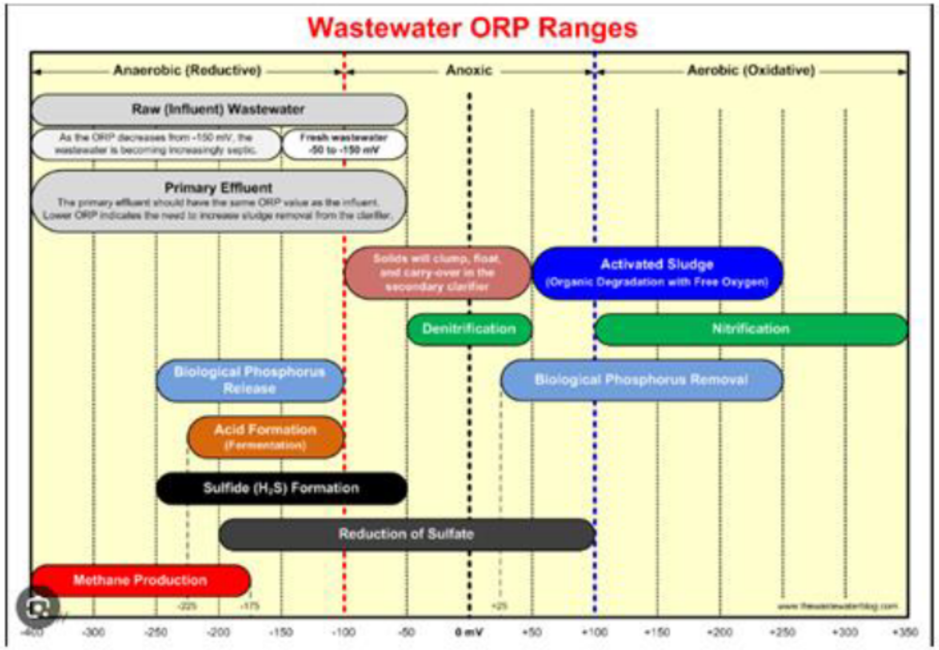
Fixed Flow Target— This is the fixed flowrate target setpoint if the fixed flow mode is selected.

Total Transfer Flow—This is the current total instantaneous flowrate into the aeration tank(s). Combined outlet flowrate of both BnR transfer pumps

BnR 1 Transfer Flow—Current instantaneous flowrate from BnR 1 transfer pumps

BnR 2 Transfer Flow—Current instantaneous flowrate from BnR 2 transfer pumps

A general overview of how ORP infers to the state of an activated sludge process can be seen below, however, this shouldn't be used to inform setpoint changes which should be made in conjunction with engineering support if knowledge and expertise is not known.



Biochemical Reactions and Corresponding ORP Values

Biochemical Reaction	ORP, mV
Nitrification	+100 to +350
cBOD degradation with free molecular oxygen	+50 to +250
Biological phosphorus removal	+25 to +250
Denitrification	+50 to -50
Sulfide (H_2S) formation	-50 to -250
Biological phosphorus release	-100 to -250
Acid formation (fermentation)	-100 to -225
Methane production	-175 to -400

Nitrification—This process occurs mainly in the aeration tanks

cBOD Degradation - This is broadly the range that the biology will use free molecule oxygen (DO) to proliferate and consume cBOD as a consequence

Denitrification - This is broadly the ORP range that will result in the biology removing nitrogen from the wastewater. These are the conditions we want to promote in the balance tank.

RED ZONE— These are the ORP conditions we want to avoid as they can risk odour generation.

A

Aerobic and Anoxic 2 Reactor Trains:

Aerobic and Anoxic 2 Setpoints:

MBR Tanks

The annotated mimic below shows the SCADA mimic related to the Membrane portion of the process

MBR Tank Setpoints

The MBR Tank pop-ups and a description of their setpoints can be seen below.

Permeate Pumps

UV Disinfection

The SCADA mimic outlining the UV Reactors and the respective process equipment and instrumentation can be seen below.

Recycled water:

This mimic displays the tanks and process water pumps, and their related controls and parameters.

Waste Activated Sludge Tanks

The Waste Activated Sludge storage and settlement can be seen on the SCADA mimic page below.

Return Liquor Pump Station

The Return Liquors Pump Station receives liquid waste from a number of process areas and recycles it through the treatment plant. The SCADA mimic with annotations of this process area can be seen below.

Return Liquor Pump Station Setpoints

Aeration Blowers:

The aeration blowers primarily feed the aeration tanks, the MBR tanks and the WAS tanks. The annotated SCADA mimic can be seen below which highlights the key items of equipment, instrumentation and other related items.

Aeration Blower Setpoints:

Odour Control:

The Odour Scrubber annotated SCADA mimic can be seen below.

Sludge Dewatering

The Dewatering Centrifuge annotated SCADA mimic can be seen below.

Acetic Acid Dosing

The annotated acetic acid dosing SCADA mimic can be seen below.

Acetic Acid Dosing Setpoints

Caustic Dosing

The annotated Caustic Dosing SCADA mimic can be seen below.

Caustic Soda Dosing Setpoints

Alum Dosing:

The annotated Alum dosing SCADA mimic can be seen below.

Alum Dosing Setpoints

Sodium Hypochlorite Dosing

The annotated Sodium hypochlorite dosing mimic can be seen below.

Compressed Air & Services:

The annotated Compressed air and other services SCADA mimic can be seen below.

5 FUNCTIONAL DESCRIPTION

SITE HAZARDS

5.1 HAZARD SIGNAGE

Lock out plant before performing maintenance procedures.

Beware of hot surfaces such as the blowers and stainless-steel pipework from blowers.

Take necessary precautions including wearing personal protective equipment and thoroughly sanitise hands when working around biological hazards, such as wastewater.

Adhere to working at heights safety requirements, safe and correct use of work platforms and ladders when working at heights.

Take necessary precautions including wearing personal protective equipment when working around chemicals, such as sulphuric acid, PACl and sodium hypochlorite.

Do not enter confined spaces without a permit to work. Be aware of the potential for toxic gases to accumulate in confined spaces.

5.2 HAZARD INFORMATION

5.2.1 Biological System

Both raw and treated wastewater can contain different types of bacteria, viruses, or other pathogens. To reduce the risk of becoming ill from infections caused by these microbes, follow the guidelines below:

- Thoroughly clean your hands/arms, or any body part that has come into contact with the fluid, with water and soap or disinfectant. You should also use disinfectant on clothes or tools that have come into contact with wastewater.

- Always wear rubber gloves, particularly if you have an injury, and/or abrasion on the skin.
- Do not eat, drink or smoke with dirty hands or in the vicinity of the treatment plant.
- Immediately wash clothing that was worn while working on the treatment plant.
- Immediately consult a doctor if you swallow any fluid.

5.2.2 Electricity / Electrocution

Power should be isolated to plant/equipment before any diagnostic or maintenance work is completed. Only trained personnel are to conduct this diagnostic work.

Only trained personnel shall open the plant's control system and MCC, as these contain live wires that can cause electrocution.

5.2.3 Confined Spaces

Potential by-products of wastewater and stagnant potable or raw water are methane, carbon monoxide, carbon dioxide and hydrogen sulphide. These gases are all potentially fatal upon direct exposure. The nature of these gases is that they sit at the bottom of holes/chambers/access points. Under no circumstances should you enter any tank or any chamber, whether it is full or empty, that has been classified as a confined space, without taking the necessary precautions.

5.2.4 Hot Surfaces

The blowers generate heat when running and the blowers and associated pipework can reach temperatures above 60°C. Do not touch the blower surfaces when they are operating; wait for them to stop and cool down. Observe the warning signs posted on the blowers and associated pipework.

All blower parts are made from a high-quality aluminium alloy (except for the motor rotor, stator, shaft, and fan) to ensure efficient cooling of the hot surfaces once no more heat is generated.

The metallic pipelines leading from the blowers to the aeration tanks can remain hot for an extended period of time.

Having the heat generating equipment installed in a small, enclosed plant room will increase the temperature in the room significantly, especially in the already warmer summer months. A ventilation fan is located inside the site shed to ensure temperatures remain acceptable for working in. It is important that the site fan is working at all times.

5.2.5 Noise

All rotating machinery will generate noise when operating. It is recommended that operators wear hearing protection if performing tasks inside the site building for any length of time while the plant is operating.

5.2.6 Chemical Hazards

The following chemicals are stored and utilised onsite:

- Acetic acid is dosed to anoxic tank 1 and 2 in the wastewater treatment plant.
- Aluminium sulphate (alum) is dosed to anoxic tank 2 in the wastewater treatment plant.

- Caustic soda (caustic) is dosed to aeration tanks 1 and 3 in the wastewater treatment plant.
- Sodium hypochlorite (hypo) are dosed into the raw water and filtrate in the water treatment plant, as well as the permeate in the wastewater treatment plant.
- Sulphuric Acid is dosed into the raw water in the water treatment plant.

It is critical that the safety data sheets (SDS) for each chemical are strictly followed to ensure the safe storage, handling, and disposal of onsite chemicals.

Avoid or minimise handling of these chemical substances to reduce the risk of exposure and always wear the required PPE when handling these chemicals.

In the event of a chemical spill, follow the site emergency procedure, which must comply with the emergency procedures in the relevant SDS.

6 TASKLISTS

6.1 DAILY TASKLIST

INFORMATION FOR REFERENCE ONLY
The following task list should be completed daily when operator is on site.

Task	Description	Checked/Value
1.	Check over all plant for visible and audible issues.	
2.	Check the SCADA and investigate any active alarms.	
3.	Check the coarse screen for blockages, obstructions and fat build-up, and reset on the SCADA once the lid is closed.	
4.	Check the fine screen for blockages, obstructions and fat build-up, and reset on the SCADA once the lid is closed.	
5.	Confirm process water is available and reset the process water pumps locally if they have tripped.	
6.	Compare yesterday's total raw sewage flow with yesterday's anoxic balance tank discharge to aeration tanks • Yesterday's total raw sewage flow • Anoxic balance tank discharge to aeration tank 1 • Anoxic balance tank discharge to aeration tank 2	 ________ m^3 ________ m^3 ________ m^3
7.	Document yesterday's total treated effluent discharge from the	
8.	Manually clean the ORP probe	

Task	Description	Checked/Value
9.	Manually clean the DO probes and confirm the dissolved oxygen in the aerobic BNR tanks is within the appropriate range and close to the SCADA setpoint (between 0.5 – 2.0 ppm) • • • • • •	______ ppm ______ ppm ______ ppm ______ ppm ______ ppm ______ ppm
10.	Manually clean the pH probes and confirm the pH within the aerobic tanks is within the appropriate range (between 6 – 8 pH units). • • • •	______ pH ______ pH ______ pH ______ pH
11.	Manually clean the TSS probes and confirm the TSS within the aerobic tanks is within the appropriate range (between mg/L). • •	______ mg/L ______ mg/L
12.	Manually clean the ORP probes in the anoxic 2 tanks. • •	
13.	Confirm the TMP across the MBR trains is below 1,900 mm. • MBR train 1 TMP: • MBR train 2 TMP: Schedule a CIP is the TMP is greater than xxxx mm	______ mm ______ mm

Task	Description	Checked/Value
14.	Manually clean the pH probes and confirm the pH within the MBR tanks is within the appropriate range (between 6 – 8 pH units). • •	______ pH ______ pH
15.	Manually clean the MBR TSS probes and confirm the total suspended solids within the MBR tanks is within the appropriate range (between mg/L). • •	______ mg/L ______ mg/L
16.	Check for scum build-up, foaming or leaks on the BNR and MBR tanks and hose down if required. If foaming occurs, check sludge waste history and increase wasting if MLSS levels are acceptable (old bugs can increase foam production).	
17.	Check chemical dosing cabinets and bunds for leaks.	
18.	Monitor levels of chemical tanks and drums. • Emulsion polymer tank (approximate): • Acetic acid tank • Alum drum (approximate): • Caustic tank	________ % ________ % ________ % ________ %

Name ______________________ Signature ______________________ Date __________________

6.2 WEEKLY TASKLIST

Task	Description	Checked/Value
1.	Complete the following checks on the coarse screen • Run manually in the field and listen for scraping or knocking. • Confirm solenoid wash valves are actuating and spraying efficiently • Spray down screen internals with washdown hose	
2.	Complete the following checks on the fine screen • Run manually in the field and listen for scraping or knocking. • Confirm solenoid wash valves are actuating and spraying efficiently • Spray down screen internals with washdown hose	
3.	Check the blowers are well ventilated and sound healthy. • Plant blower 1	
4.	Open the condensate valve on each of the aerobic tanks' zones to check for moisture in the aeration manifold. • • • • • •	

Task	Description	Checked/Value
5.	Inspect the air pattern across the aeration tank zones for even distribution. Any unusually high towers of air in one point indicate diffuser failure or leakage, and scheduled maintenance is required. • • • • • •	
6.	Check the sludge age and adjust the sludge wasting setpoints as appropriate.	

Name ______________________ Signature ______________________ Date ___________________

6.3 MONTHLY TASKLIST

Task	Description	Checked/Value
1.	Note run hours and check all pumps for any unusual noise, knocking, vibration and underperformance (refer to flow and / or pressure trends).	
	•	_______ hours
	•	_______ hours
	•	_______ hours
	•	_______ hours
	•	_______ hours
	•	_______ hours
	•	_______ hours
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	•	_______ hours
	•	_______ hours
	•	_______ hours
	If pumps are underperforming, investigate (as appropriate) the pump alignment and coupling condition, bearing condition, wear plate condition, oil level in bearing assembly, impeller condition and blockage by debris or rag.	
2.	Visually inspect and actuate each actuated valve to confirm correct movement.	
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Task	Description	Checked/Value
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3.	Calibrate the aerobic tanks' DO probes	
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	•	

Task	Description	Checked/Value
4.	Note the run hours and clean the air filters on the plant blowers. The blowers require full inspection after every 4000 hours of operation.	
	• Plant blower 1	_______ hours
	• Plant blower 2	_______ hours
	•	_______ hours
5.	Check the calibration of the of the analyser for the following parameters:	
	•	
	•	
	•	
	•	
	•	
6.	Complete the dose time calibration of the chemical dose pumps and note the time to pump 100 mL.	
	•	______ sec
	•	______ sec
	•	______ sec
	•	______ sec
	•	______ sec
	•	______ sec

Name ______________________ Signature ______________________ Date ___________________

6.4 SIX-MONTHLY TASKLIST

Task	Description	Checked/Value
1.	UV lamps need to be replaced after every 8000 hours of operation. Note run hours for the following equipment. • Permeate UV reactor 1 • Permeate UV reactor 2	 _____hours _____hours
2.	Lower the water level in the MBR to 100 mm below the top of the membrane modules and visually check the condition of permeate manifold and suction tubes. • Avoid entering the tanks and if entry is required, treat as confined space entry • Hose down the top of the membranes and the suction tubes to clean exterior sludge off them • If any suction tubes are discoloured on the inside, the associated membrane and tube should be replaced • Check for sludge accumulation between membrane sheets. If the gap between sheets is filled with sludge cake, or water does not drain from between the sheets as the level is lowered, then sludge will need to be manually removed by extracting the sheet and scraping the sludge off it with a rubber window cleaning blade or by hose.	
3.	If required, undertake a CIP hypo clean.	
4.	If the CIP hypo clean (above) does not restore the TMP, complete a CIP citric acid clean.	
5.	Complete a six-monthly inspection of analyser.	
6.	Manually test all process stops for functionality.	

Name ______________________ Signature ______________________ Date ___________________

7 PROPRIETARY INFORMATION

8 TROUBLESHOOTING GUIDE

NOTE: This is provided as a guide only.

Ref	Fault	Possible cause/remedy
1.	Raw sewage flow () is much higher than the combined flow from anoxic tank 1 to the BNR trains (	• Check if the permeate flow setpoint is too low for incoming flows – increase on MBR setpoint page if required. • Check if coarse screen is tripped, blocked, and/or overflowing. • Check if fine screen is tripped, blocked, and/or overflowing. • Check if the anoxic balance tank low level alarm is active, interlocking the BNR transfer pumps • Check if the either BNR aerobic tanks' level () is above the high working level setpoint, interlocking the BNR transfer pumps. • Check the BNR transfer pump operation (compared to flow data to establish if there is poor pump performance or a blockage.
2.	BNR transfer pump(s) not operating	• Check if pump is in auto or manual on MCC panel. • Overload in MCC panel may have tripped. Reset and contact maintenance staff if it trips again. • Confirm the plant sequence that is currently running. • Check if any e-stops are triggered. • Check if any of the BNR transfer pump interlocks are active: - Anoxic balance tank low level - BNR transfer flowmeters low flow - BNR aerobic tank 1 or 2 high level
3.	BNR tanks overflowing.	•
4.	Aerobic tanks – aeration bubbles appear to be concentrated in one area or in a stream.	•
5.	Low dissolved oxygen in the aerobic BNR tanks	•

Ref	Fault	Possible cause/remedy
6.	Plant blowers are not operating	•
7.	Blower pressure relief valves venting when operating	•
8.	Foaming	This could be caused by: • Poor system start-up, especially if a healthy bacterial seed is unavailable. • Changes in influent waste quality, such as chemicals in industrial discharges • Filamentous bacterial. Carry out microscopic examination and treat system for excess filaments. • Low food to mass ratio if the system has been starved. • Nutrient deficiency if the nitrogen removal rate is too high. Reduce acetic acid dose if this is the case. • After a membrane chemical clean, watch for foaming due to residual cleaning chemicals in the system.
9.	MBR transfer pumps not operating or not producing flow.	-
10.	Permeate pumps not operating or not producing flow	-
11.	MBR tank(s) overflowing	•
12.	Low TMP and low permeate flow	• .
13.	High TMP and low permeate flow	• .
14.	Poor permeate flow following a CIP clean	•
15.	Chemical not penetrating the membranes during a CIP clean	•
16.		•

Ref	Fault	Possible cause/remedy
17.	UV unit interlocked.	•
18.	Process water not available (no hose water or water to the screens and sludge decanter)	•

5. OPEX Estimates

A model of the operational expenditure has been developed covering the scenario 1 wastewater treatment plant and a direct filtration water treatment plant. It is expected that the annual cost to operate the treatment plant will be approximately $500,000/year.

This model considers only direct costs associated with the operation of the two treatment plants, including labour, power, chemical, removal of solid waste streams and some quality assurance related to the testing of the discharged wastewater and testing required by the Drinking Water Standards for New Zealand.

Some of the items not considered in the model include:

- Operator's margin
- Third party technical support
- Other related consent condition compliance items (i.e environmental monitoring)
- Lines fees
- Operational auditing and oversight (Director's fees)
- Maintenance of a system for the processing and issuing of invoices for drinking water supply and wastewater treatment
- Insurances
- Equipment replacement
- Any funding towards the renewal of the infrastructure at the end of its functional life

	Direct Cost					
Cumulative houses	Labour ($/yr)	Cost Power WTP ($/yr)	Cost Power WWTP ($/yr)	Chemicals ($/yr)	Misc ($/yr)	Total ($/yr)
475	$165,595.18	$57,452.73	$100,872.70	$80,054.74	$101,000.00	$ 504,975.35