Fulton Hogan Land Development - Woods

Wastewater Treatment Plant Design Report – For Consenting

2025

20th of February 2025

Apex Water

Apex Water

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Reviewed By: Dr Matthew Savage (Principal Engineer)

Approved By: Andrew Paton (General Manager)

Apex Water Limited
Unit B5 570 Mount Wellington Highway, Mount Wellington, Auckland

safe water by design

Statement of Qualifications and Experience

Matthew Savage

My full name is Dr. Matthew John Savage.

I am a Principal Engineer and founder of Apex Water. I hold a Doctorate in Chemical and Process Engineering specialising in Wastewater Treatment. I am a chartered professional engineer with Engineering New Zealand and a chartered member of the international Institute of Chemical Engineers. I have over 25 years' experience in wastewater treatment plant design.

Apex Water designs, constructs and operates drinking water and wastewater treatment plants at a similar scale to those required to service the proposed development detailed in this application.

I recently prepared assessments of environmental effects for the treatment and discharge of wastewater from a 1200 house subdivision at Karaka North Village to a level suitable for discharge to land and to water via land. This treatment plant is now complete and awaiting construction of houses in order to commence operation.

I confirm that I have read the Code of Conduct for Expert Witnesses contained in the Environment Court Practice Note 2023 and have complied with it in preparing this evidence. I confirm that the issues addressed in this evidence are within my area of expertise and I have not omitted material facts known to me that might alter or detract from my evidence.

Jack Taylor

I am a Senior Project Manager at Apex Water. Apex Water designs, constructs and operates drinking water and wastewater treatment plants at a similar scale to those required to service the proposed development detailed in this application. I have been employed at Apex Water since August 2019.

I hold the qualification of Bachelor of Chemical and Process Engineering with Honours from the University of Canterbury, which I completed in 2012. I am a member of the Institute for Professional Engineers New Zealand.

I have 12 years of professional experience in the delivery of water and wastewater treatment projects and other relevant fields including roles such as Process Engineer, Project Engineer and Project Manager for various organisations in New Zealand, Australia and the United Kingdom. My experience includes the delivery of water and wastewater treatment infrastructure projects, such as the Project Manager overseeing the design, construction and the future operation into service of the Karaka North Village Water and Wastewater Treatment Plants which will service a subdivision of approximately 1200 lots. The wastewater treatment plant in this application treats wastewater to a level suitable for discharge to both land, and to water via land contact. This wastewater treatment plant is complete awaiting receipt of first waste and commencement of biological commissioning

I confirm that, in my capacity as an author of this report, I have read and abide by the Environment Court of New Zealand's Code of Conduct for Expert Witnesses Practice Note 2023.

Contents

EXECUTIVE SUMMARY

Milldale is a 300-hectare master planned project which started in 2014 to accommodate 4500 new dwellings in the Wainui-Orewa area. To allow for the completion of the final stages, Fulton Hogan Land Development Limited in collaboration with Woods has identified the need for a new temporary Wastewater Treatment Plant capable of servicing up to 1250 dwellings. This private temporary Wastewater Treatment solution will be required in the event that Army Bay municipal treatment plant is at capacity and Watercare are no longer accepting wastewater connections. Watercare is currently forecasting that the Army Bay Treatment Plant will be at capacity by 2027, and an interim solution will be required until 2031. Our proposal addresses this shortfall for the Milldale Development with some redundancy in the event circumstances change.

It is proposed that this treatment plant is based on a hybrid biological nutrient removal system which includes both a 4-stage Bardenpho activated sludge treatment process, a Membrane Aerated Biofilm Reactor, Hollow Fibre Ultra filtration membranes and Reverse Osmosis membranes to produce permeate containing only trace amounts of nutrients and other contaminant. The treatment process proposed can produce treated wastewater to such a high level of quality that its nutrient concentration profile will be significantly lower than both acceptable drinking water and stormwater, as obtained from literature in the Urban Runoff Data Book (Williamson, 1993). It is noteworthy that the client is not seeking to re-use this water as a drinking water source. The discharged wastewater will be amongst the highest quality found in New Zealand. Recent examples of treatment plants utilising similar technologies that are consented and commissioned in the wider Auckland area include those servicing Karaka North (private), Te Kauwhata (Watercare) and Meremere (Watercare). Apex Water has designed and built both the Karaka North and Meremere plants detailed above.

The treatment process involves raw sewage screening, flow balancing, an anoxic stage incorporating a membrane aerated biofilm reactor, an aerobic stage, a second anoxic stage, hollow fibre MBR membrane filtration, UV disinfection and Reverse Osmosis membranes. Within the system there are recycle loops (nitrate and activated sludge) and chemical dosing (to provide a supplementary carbon source, adjust pH and remove phosphorus). This treatment train produces two waste stream, sludge and reverse osmosis reject. Sludge is periodically wasted by the system to storage tanks, from where it is dewatered by a centrifuge ahead of removal from site in skips. The reverse osmosis reject stream shall be reintroduced into the Watercare network under a bespoke Trade waste Agreement between FHLD and Watercare.

This report provides details on the treatment process design including the design of the disposal system with a particular focus on the discharge's effects on the receiving environment.

INTRODUCTION

Fulton Hogan Land Development (FHLD) in collaboration with Woods have engaged Apex Water (Apex) to provide professional engineering services for the design of wastewater treatment infrastructure to support future growth of the Milldale Development.

The Milldale (Wainui East) development is a Master Planned and Live Zoned development which has been under planning and construction since 2014. Upon completion the Milldale development will accommodate approximately 4500 new dwellings. Through the development stages completed to date, the area already houses some 3300 new dwellings and an approximate population of 9,900, including a town centre, retirement village and local neighbourhood centres.

While Milldale is progressing well towards completion, Watercare has recently announced publicly, that due to forecasted network and treatment capacity constraints, future residential wastewater connections will be actively managed. Watercare expects the Army Bay treatment plant to reach its current design capacity by 2027.Upgrades to increase its capacity are presently in the planning stages, with construction forecasted for completion in 2031. In lieu of providing public wastewater infrastructure with sufficient capacity to support the growth of Milldale, FHLD intends to provide a private interim wastewater treatment solution.

As a part of the preliminary design process for the temporary wastewater solution for Milldale, the proposed treatment train has been selected and compared to other common wastewater treatment processes for suitability. The selected treatment train consists of a modular hybrid biological nutrient removal system which includes both a 4-stage Bardenpho activated sludge treatment process, a Membrane Aerated Biofilm Reactor with Hollow Fibre Ultra filtration membranes to produce treated water of an exceptionally high quality in a compact footprint. This treated wastewater stream shall then be further treated via the use of Reverse Osmosis membranes to produce a treated water quality that would be considered amongst the highest in New Zealand, utilising a process typically reserved for applications with the object of treated wastewater as a potable water source. The treated wastewater from the treatment plant will be discharged to a land contact infiltration basin designed by the principal in consultation with local stakeholders.

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 Milldale project site is located approximately 35km to the north of central Auckland in the Wainui-East area. The location of the project site in relation to central Auckland can be seen in Figure 1below:

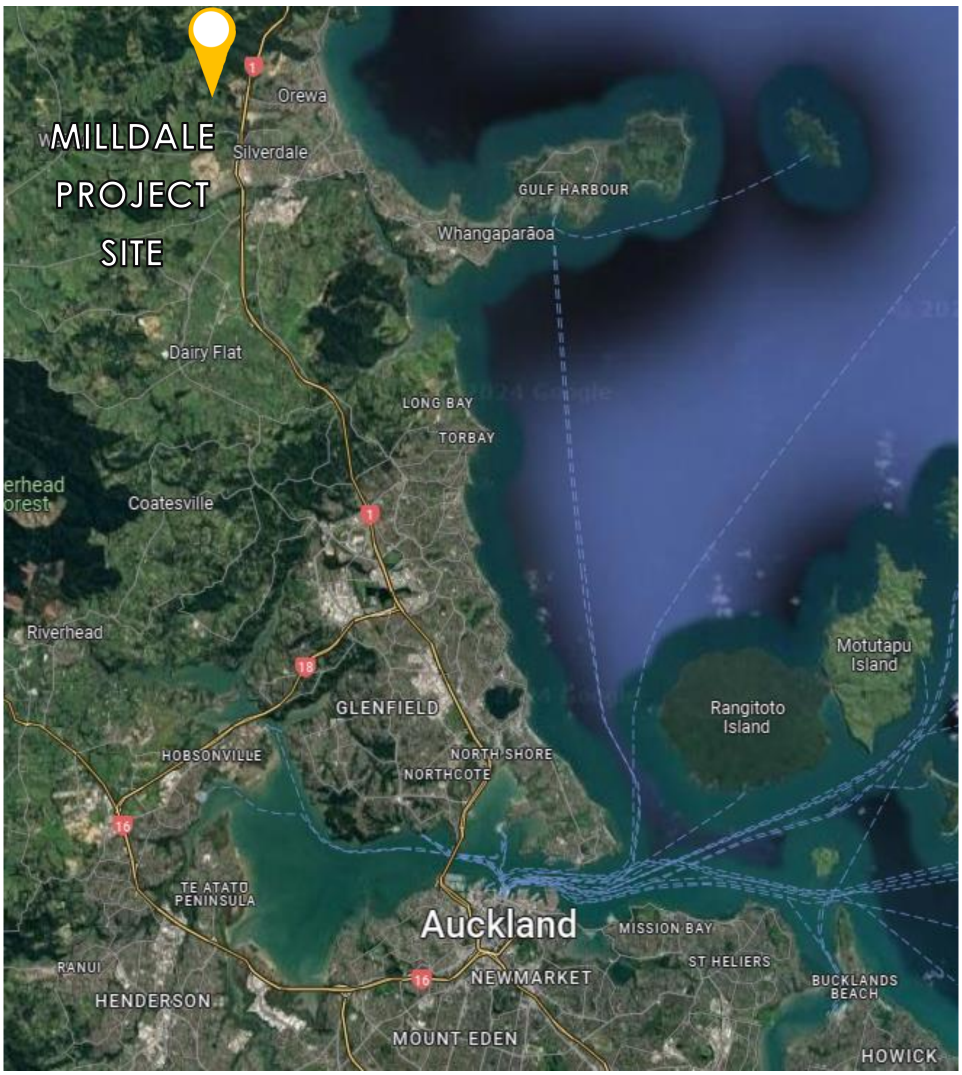


Figure 1 - Milldale Project Site Location

The Milldale Wastewater Treatment Plant is located on Lysnar Road and is bound by Lysnar Road to the south, and existing rural properties which make up the development's future growth area to the north and west and by the Waterloo creek to the east. The Waterloo creek represents the eastern bound of the Milldale project site.

Figure 2 below shows the proposed wastewater treatment plant site's area in relation to the overall project site.

Figure 2 - Site Location – The above aerial image shows the indicative location of the project site.

EXISTING SURFACE WATER AND ECOLOGICAL QUALITY

Water quality monitoring and an assessment of the ecology was carried out at the proposed discharge location into the Waterloo creek, as well as locations upstream and downstream of the discharge point as shown in Figure 3 below. The following summarises the water quality monitoring results with the full details appended below:

With reference to the ecology, the Babbage report notes that:

"In summary, macroinvertebrate communities at Waterloo Creek reflect a waterbody in poor ecological health, as indicated by low MCI and QMCI scores, absence of EPT taxa, and high dominance of mud snails."

With reference to the physiochemistry of the Waterloo creek, the Babbage report notes that:

"Despite the relative healthy condition observed by water quality results (particularly in relation to nutrients), the biological assessment indicate high level of ecology degradation, where the macroinvertebrate communities at Waterloo Creek reflect a waterbody in poor ecological health, as indicated by low MCI and QMCI scores, absence of EPT taxa, dominance of tolerant species and high dominance of mud snails"

A technical assessment of environmental effects has been carried out to determine the impact the discharge from the wastewater treatment plant will have on the receiving environment, information on the discharge system is presented later in this report and in the Discharge Assessment technical report carried out by Babbage included in the Assessment of Environmental Effects supporting this appplication.

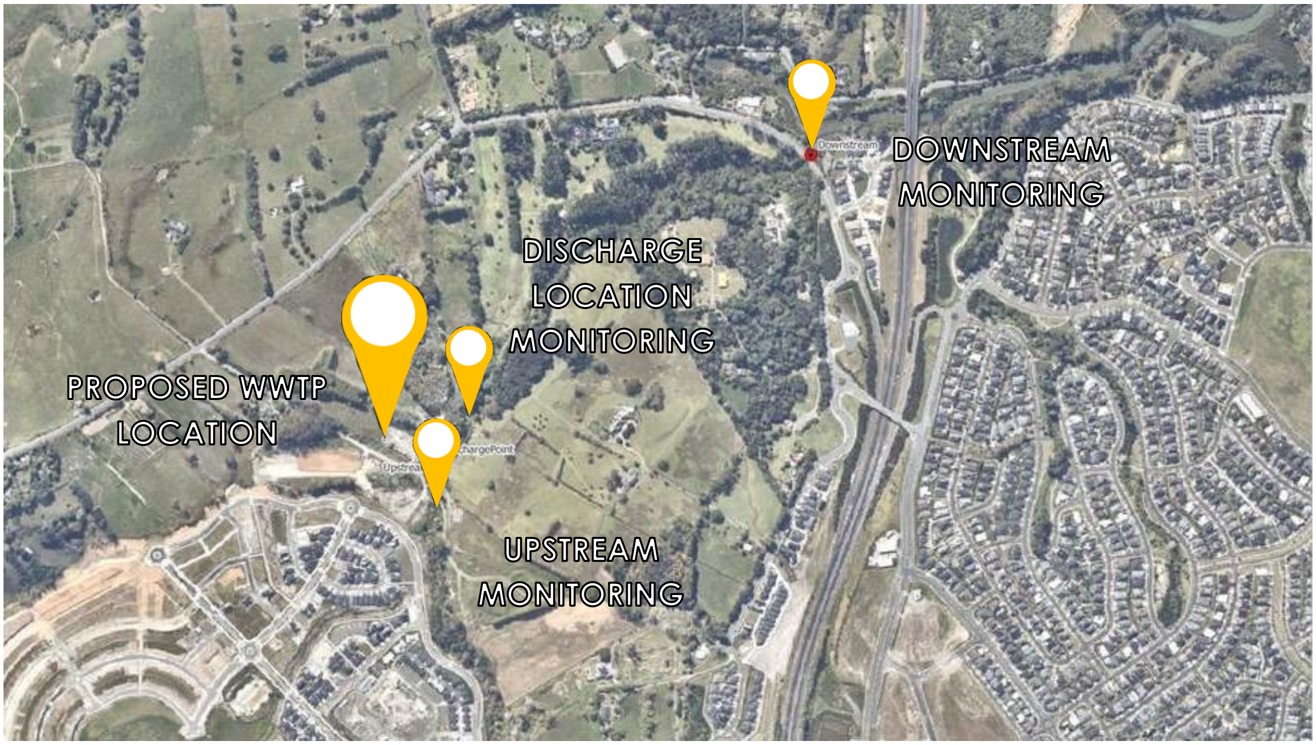


Figure 3 - Discharge Monitoring Locations

PROPOSED SITE LAYOUT

The wastewater treatment facilities are to be located within a secured and fenced compound, allowing provision for all access requirements from operational vehicles and personnel for servicing the facility. Proposed landscaping details for the broader area surrounding the site are shown in the Landscape Layout Plan developed by Beca which can be found in documentation supporting the overall fast track consent package.

The treatment plant is made up of the following structures which are detailed below:

- Treatment Plant Building – Housing noisy equipment, common services like aeration and compressed air and the operator's facilities.
- Biological Treatment Tanks – A series of semi-modular tanks housing the biological treatment process
- Bulk Chemical Storage – Two high density polyethylene tanks housing chemicals required by the treatment process

- Permeate and Waste Activated Sludge (WAS) handling – Four 30,000L polyethylene tanks for the storage of permeate and WAS.
- This Land Contact Infiltration Basin – An infiltration basin designed for the handling and infiltration of permeate into the Waterloo creek.
- Packaged Chemical Storage – Covered and self-bunded storage for packaged chemicals used by the treatment plant site.
- The Chemical Delivery apron – A concrete area used for the delivery of bulk chemicals via road tankers which can capture and divert any drips or spills.
-

TREATMENT PLANT LOCATION AND LAYOUT

The proposed location of the wastewater treatment plant compound is shown in Figure 4 below, which identifies key structures and equipment. A full suite of drawings can be found within the appendices attached.

Figure 4 – Milldale Treatment Plant Site Layout

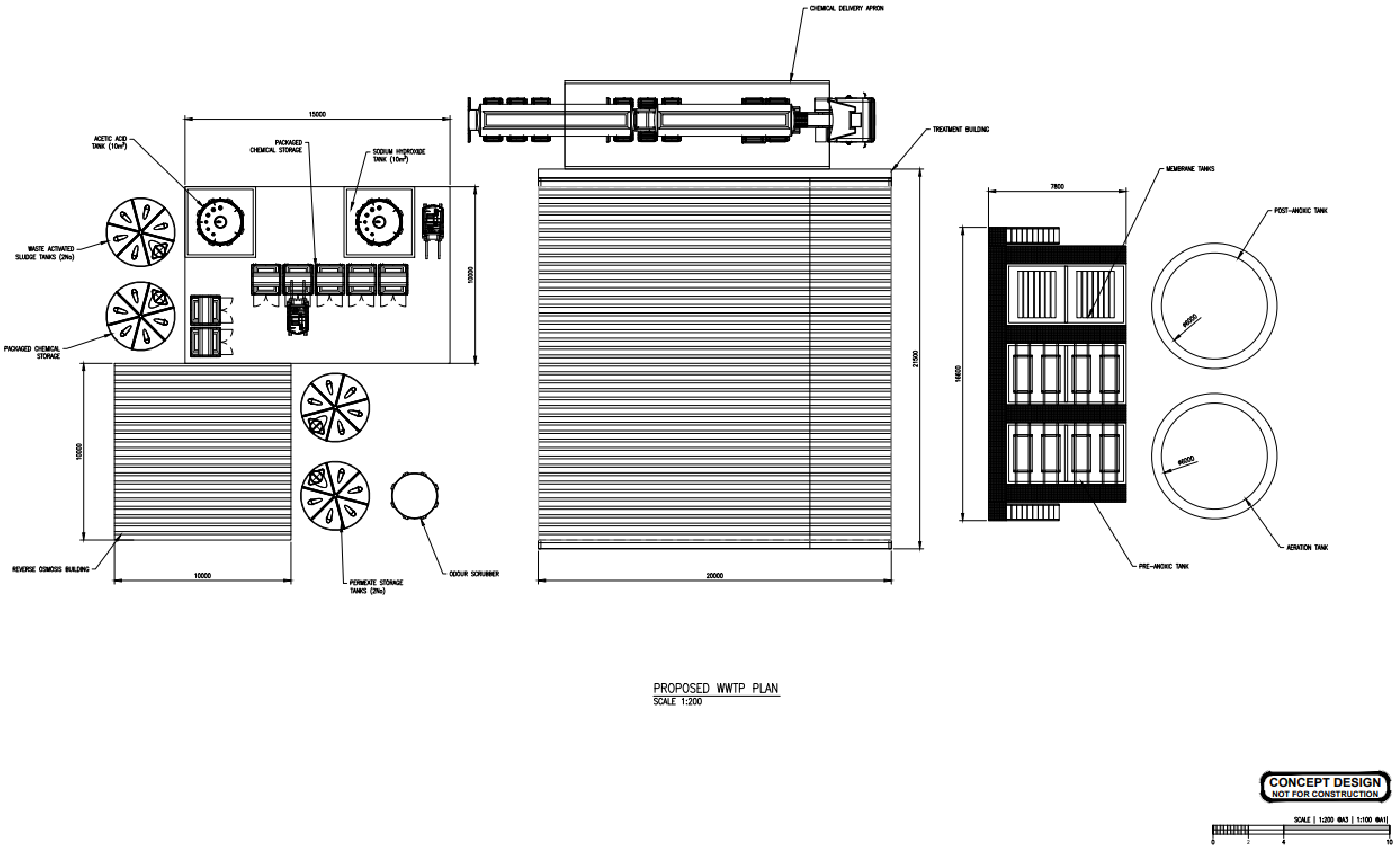


Figure 5 - Site Layout

VISUAL RENDERS

Architectural renders of the proposed wastewater treatment plant and the associated structures can be seen in Figure 6 through Figure 8 below

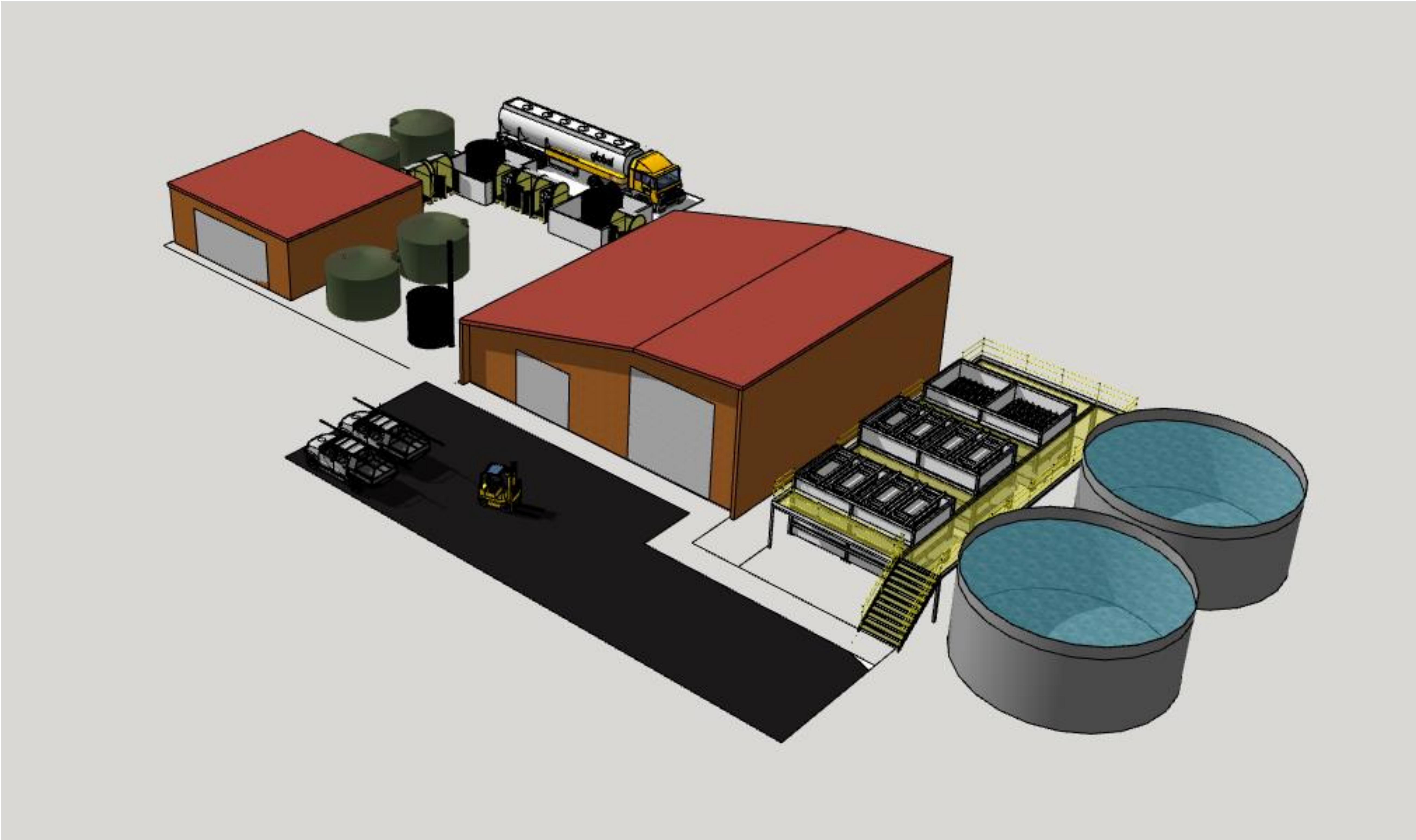


Figure 6 - Proposed Milldale WwTP - Northern View

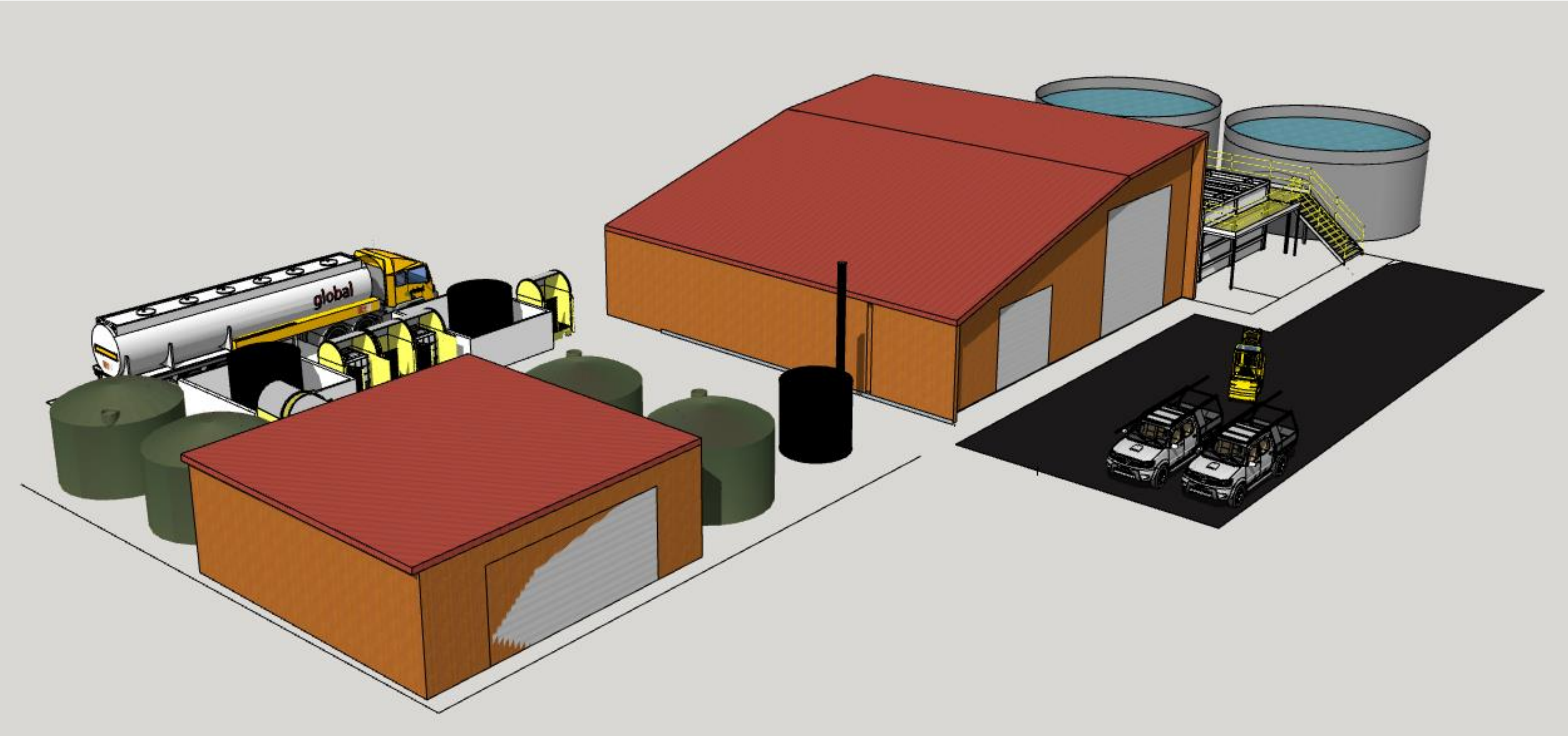


Figure 7 - Proposed Milldale WwTP - Eastern View

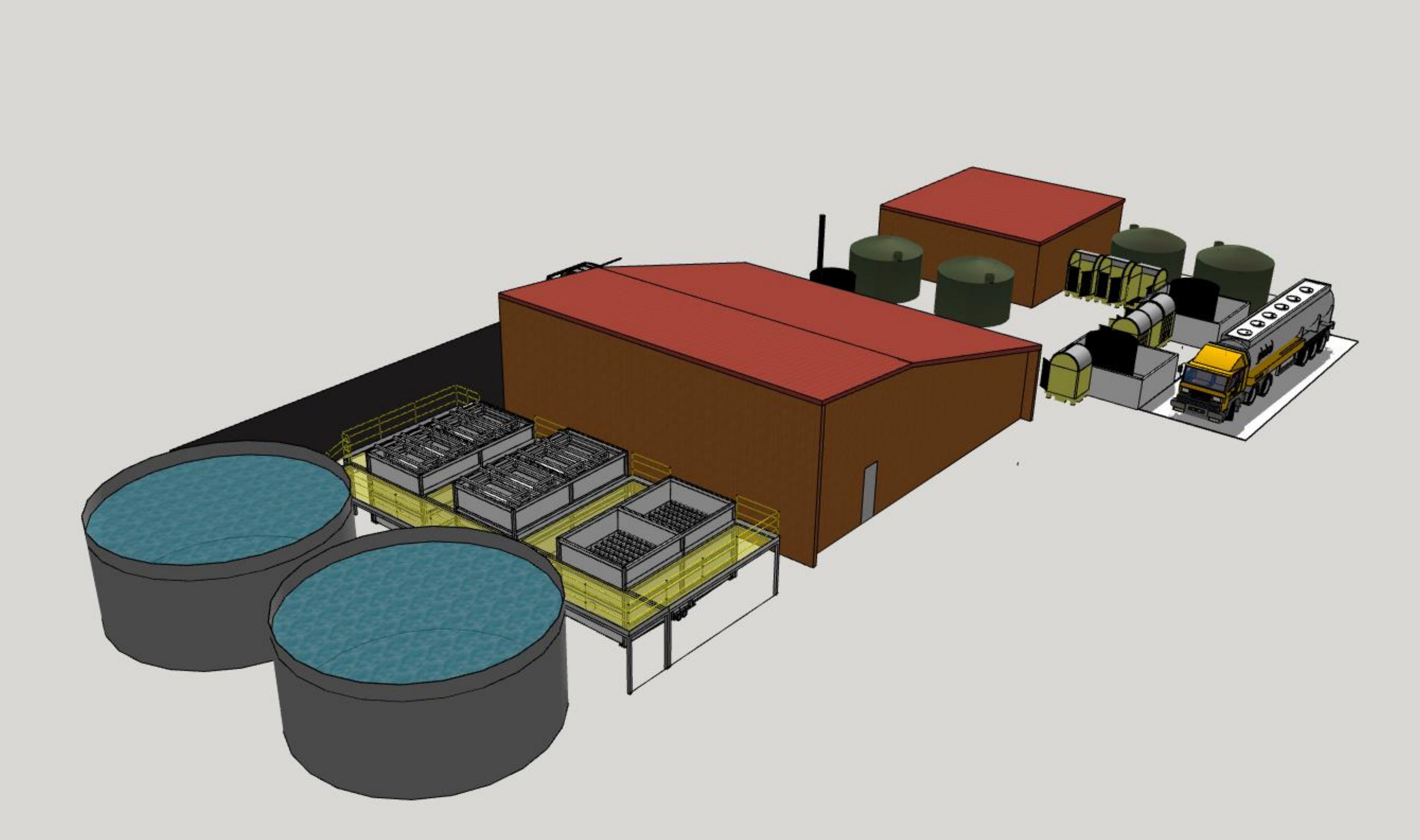


Figure 8 - Proposed Milldale WwTP - Western Outlook

SURFACE MAKE-UP

A parcel of land of approximately 12,100m2 has been allocated to the treatment plant and associated infrastructure. Based on the proposed site layout, the approximate breakdown of the site coverage between impermeable surfaces including structures and permeable or landscaped areas is shown in Table 1 below. For further details of the overall area allocated to the treatment plant site, refer to the Infrastructure and Landscaping reports submitted with the overall application.

Table 1 - Surface Make-up

Type of Surface	Area (m2)
Hard surfaces (Impermeable including structures)	3,670
Landscaped (Permeable)	6,921
Total	10,591

STRUCTURES

Wastewater Treatment Plant Building

To provide a high degree of noise attenuation and odour containment, a building of a suitable construction and material, being pre-cast concrete has been proposed for the main wastewater treatment plant. Key items of process equipment will be located within the treatment plant building, which shall also house general site facilities such as the control room, toilets, and other site amenities.

Housing equipment indoors to mitigate odour emissions is coupled with the direct extraction of vapours from equipment handling sewage. Additionally, the entire treatment plant hall where much of the equipment can be found will be extracted to the odour scrubbing system.

Ventilation air shall be allowed into the building via attenuated louvres designed to minimise noise escape whilst providing minimal restriction to air passage, allowing large volume of air into the building as will be required by the odour extraction and aeration systems. The proposed wastewater treatment plant building can be seen below in Figure 9.

The Reverse Osmosis treatment process is located in its own building separated for the main treatment plant. The building housing the Reverse Osmosis equipment can be seen in the figure below.

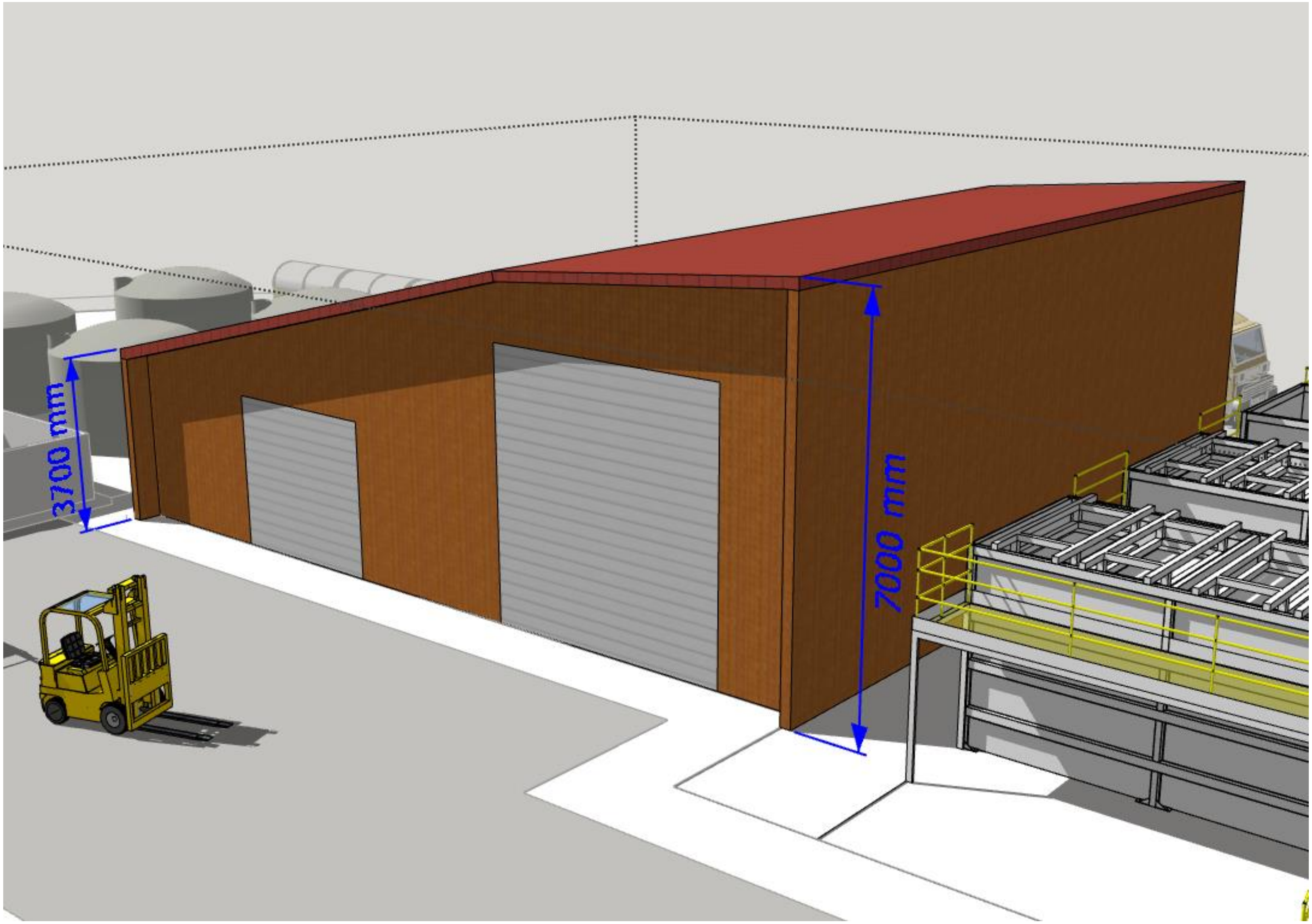
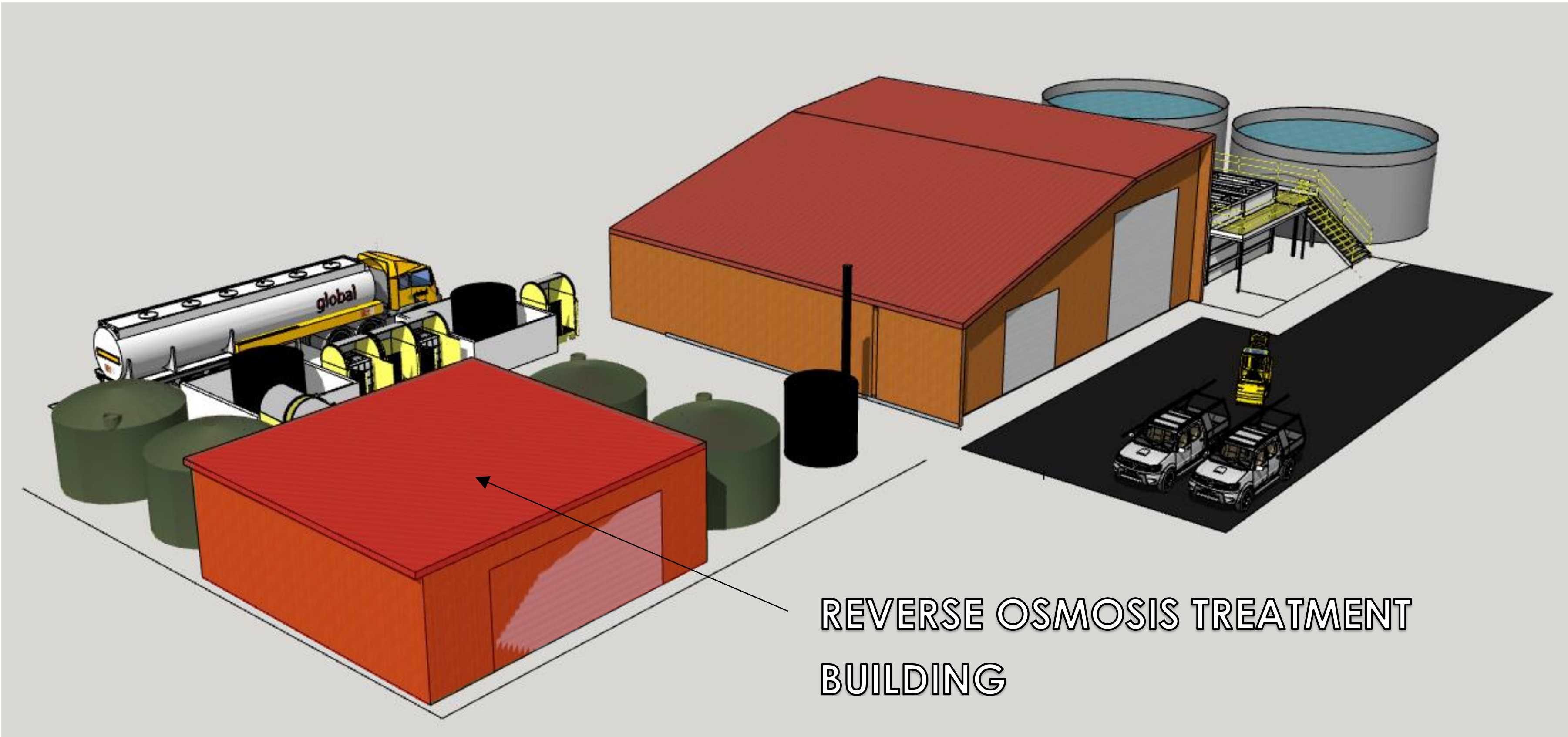


Figure 9 - Wastewater Treatment Plant Building Visual Impact Render


global
REVERSE OSMOSIS TREATMENT
BUILDING

Wastewater Treatment Tanks

The biological process which is central to the treatment train consists of a series of modular, semi-relocatable tanks. These tanks house critical process equipment, such as the MABR modules and membranes, mixers, aeration equipment and are sized to provide the retention times and provide the required conditions for biological treatment. A simple render of the proposed wastewater treatment tanks can be seen in

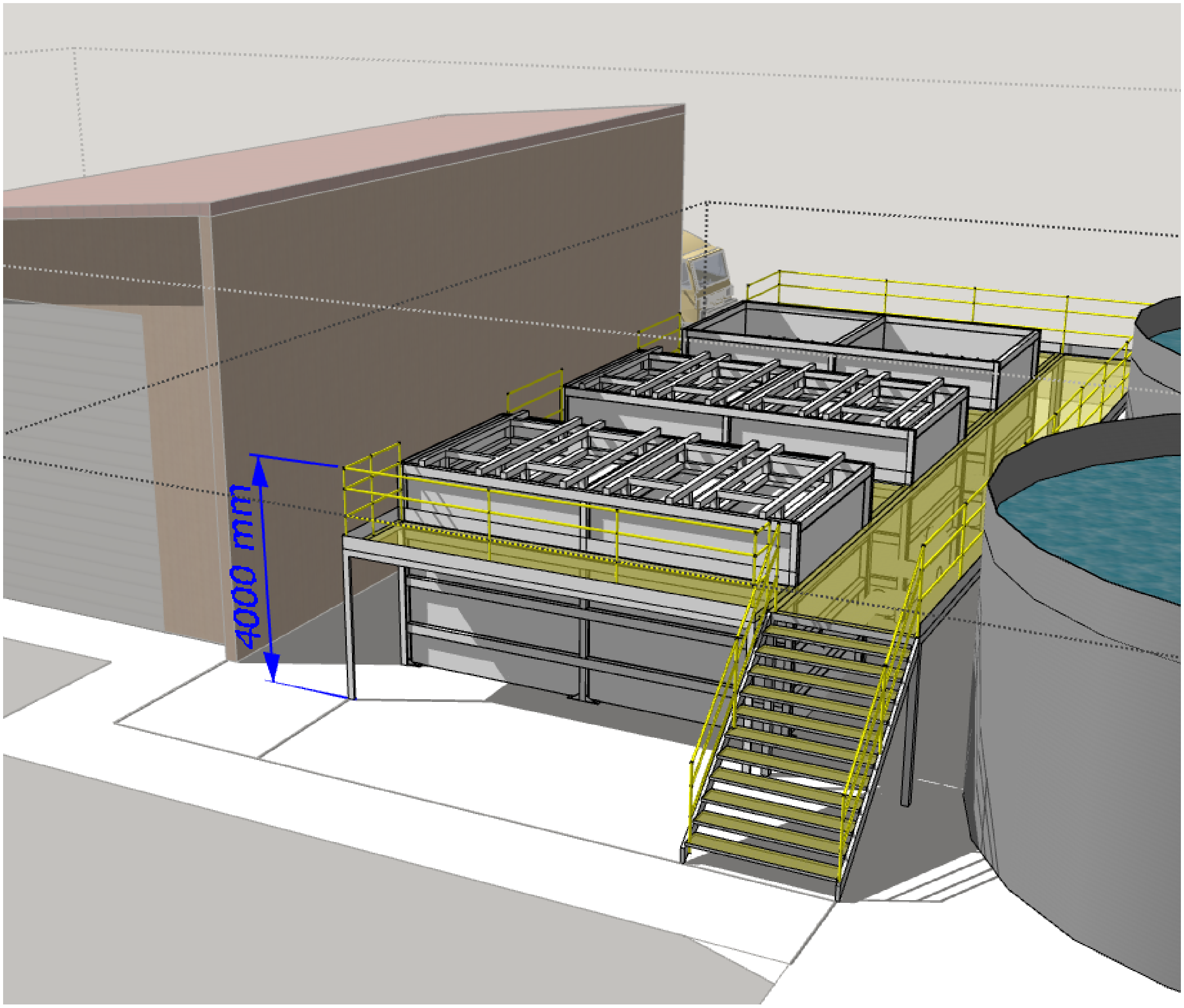


Figure 10 and Figure 10 below.

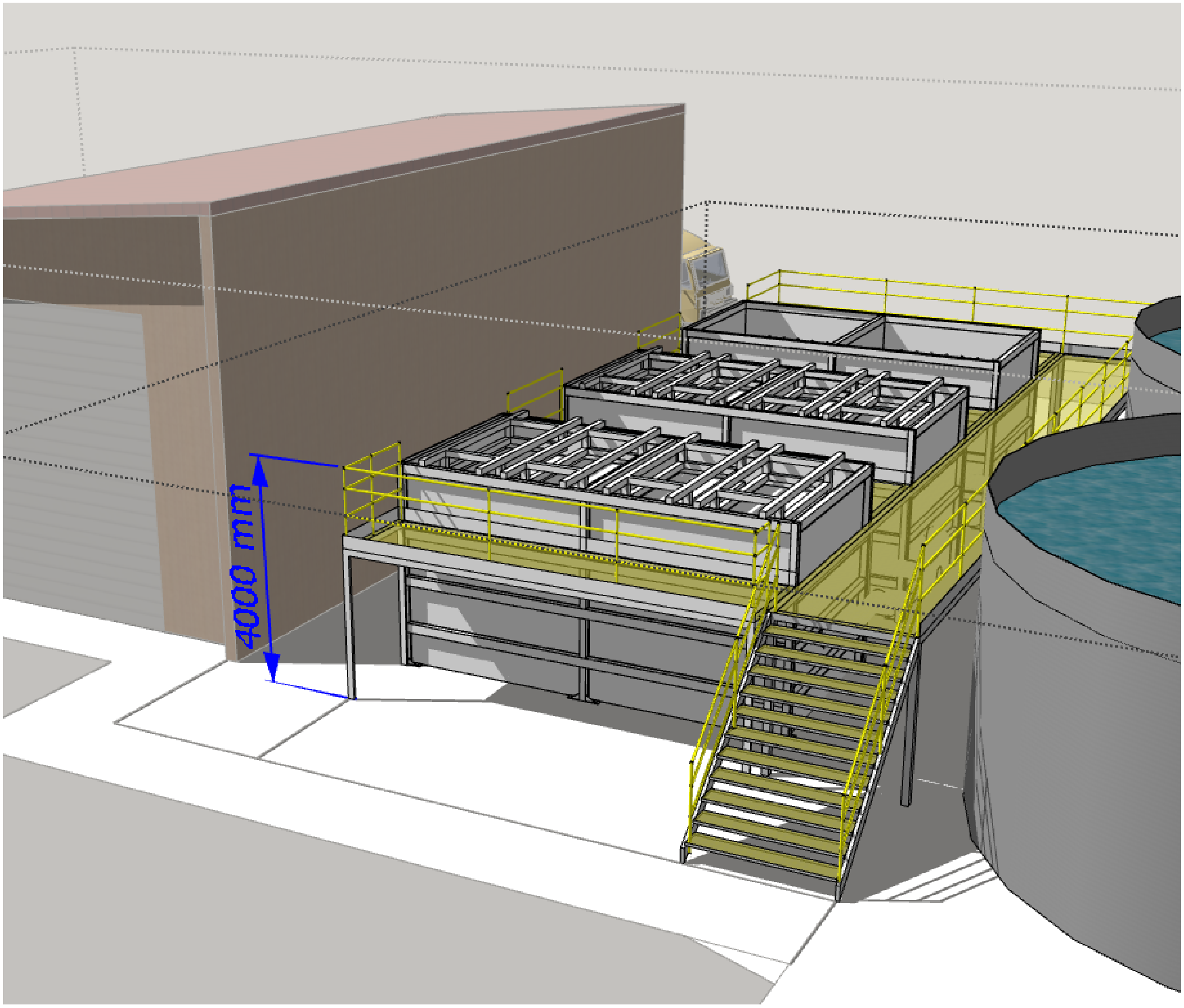


Figure 10 – Pre-Anoxic and Membrane Tanks - Biological Treatment Process Visual Impact

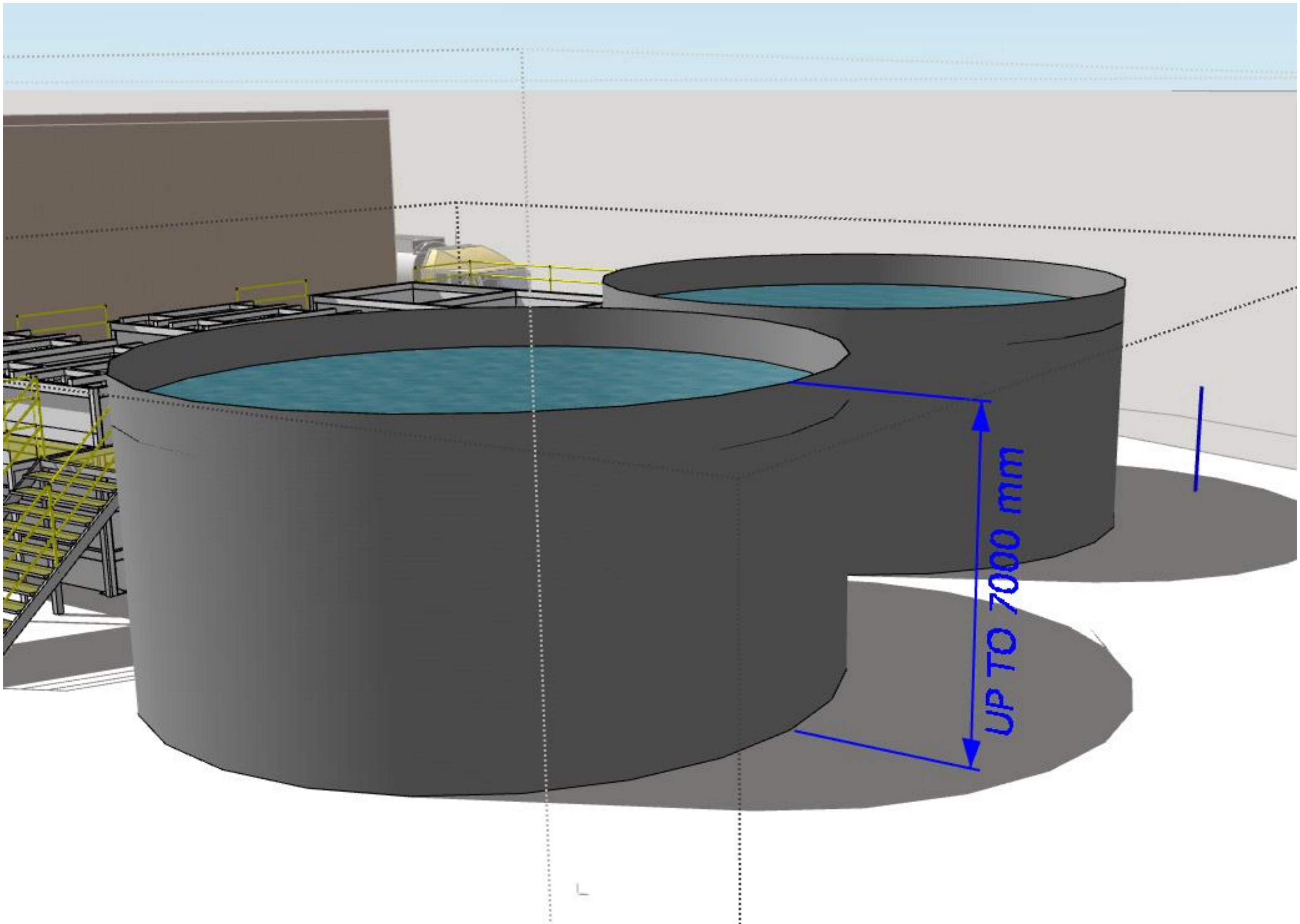


Figure 11 – Aeration and Biological Treatment Tanks Visual Impact

Odour Scrubber

The odour scrubber captures and treats potential nuisance odours from the treatment process. While the condition of the wastewater within the treatment process can be maintained such that the formation of offensive odours is minimised, the odour scrubber mitigates against potential minor releases from the process as well as extracts potentially offensive odours from raw sewage handling and sludge dewatering equipment. While the odour scrubber vessel, housing the media which extracted gases are passed through for treatment is relatively small, the system will incorporate a chimney stack for discharge. A render of the proposed odour scrubber can be seen in Figure 12 below.

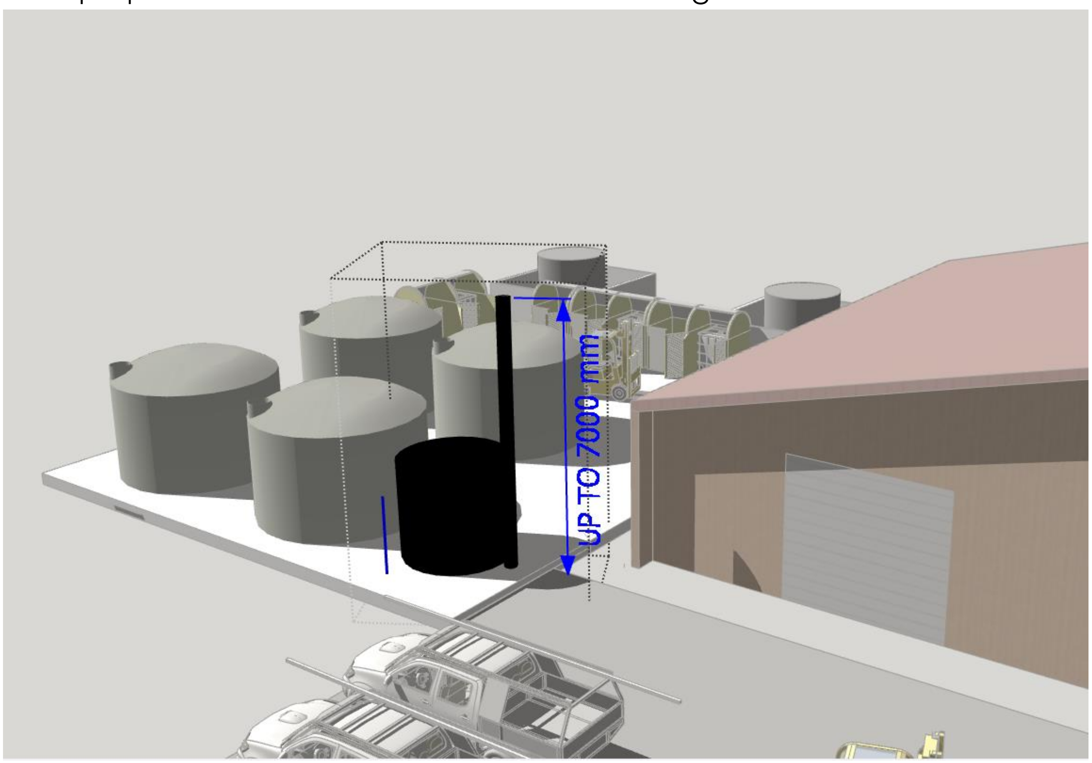


Figure 12 - Visual Impact of the Odour Scrubber

BIOLOGICAL PROCESS

Pre-Anoxic - Membrane Aerated Biofilm Reactor Tanks

The Membrane Aerated Biofilm reactor (MABR) tanks are proposed to be housed within two modular stainless-steel tanks, each containing four Membrane Aerated Biofilm reactor modules. These tanks also act as the Pre-Anoxic step of the treatment process.

The proposed approach allows for the staged installation of both the MABR tanks and the MABR modules within these tanks, as required by the growing development. Figure 13 below highlights the general configuration of the MABR tanks and MABR modules.

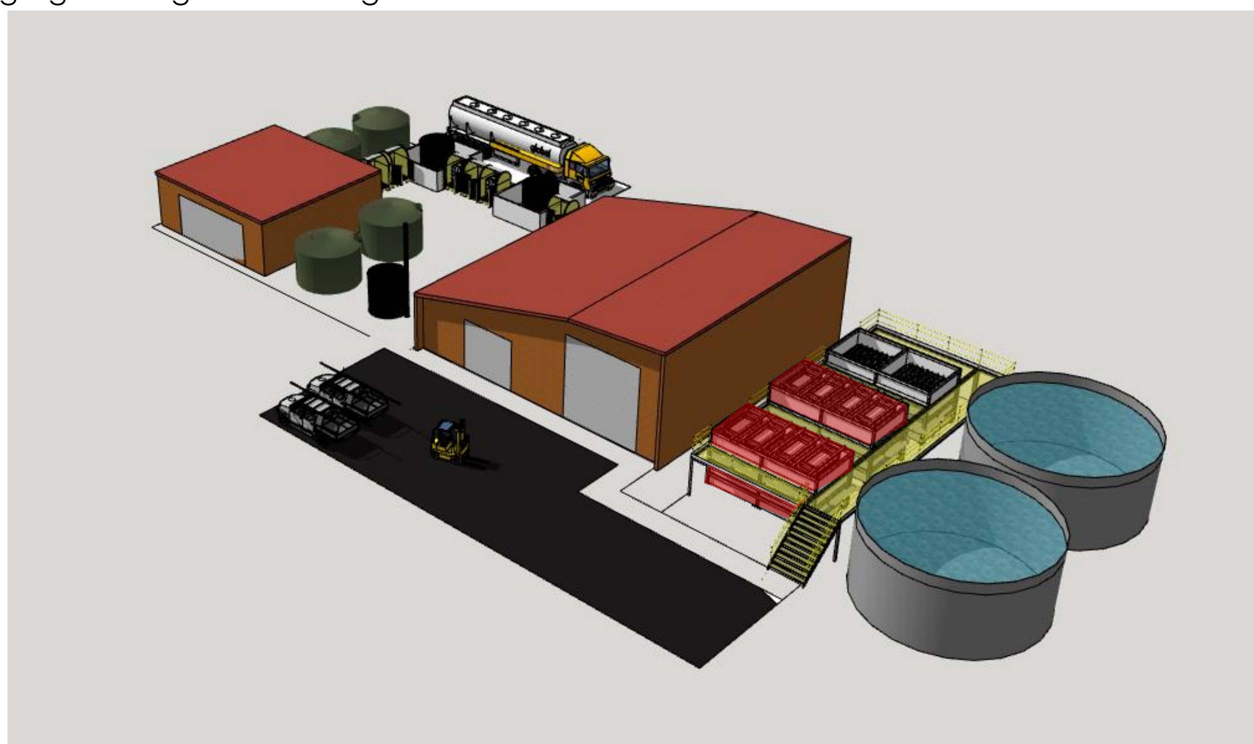


Figure 13 - Pre-Anoxic Tanks housing MABR Equipment Highlighted in red below

Figure 13 below shows the modular components of the Pre-Anoxic – MABR tanks which include one of the Pre-Anoxic tanks, as well as the individual MABR modules housed within both of these tanks. Only the required vessels and membrane modules shall be installed in the first stage of construction to meet the initial flowrates fed to the plant. Figure 13 below highlights the Pre-Anoxic tank and individual MABR modules whose installation can be staged to match increased demand due to the completion of additional houses in the Milldale catchment.

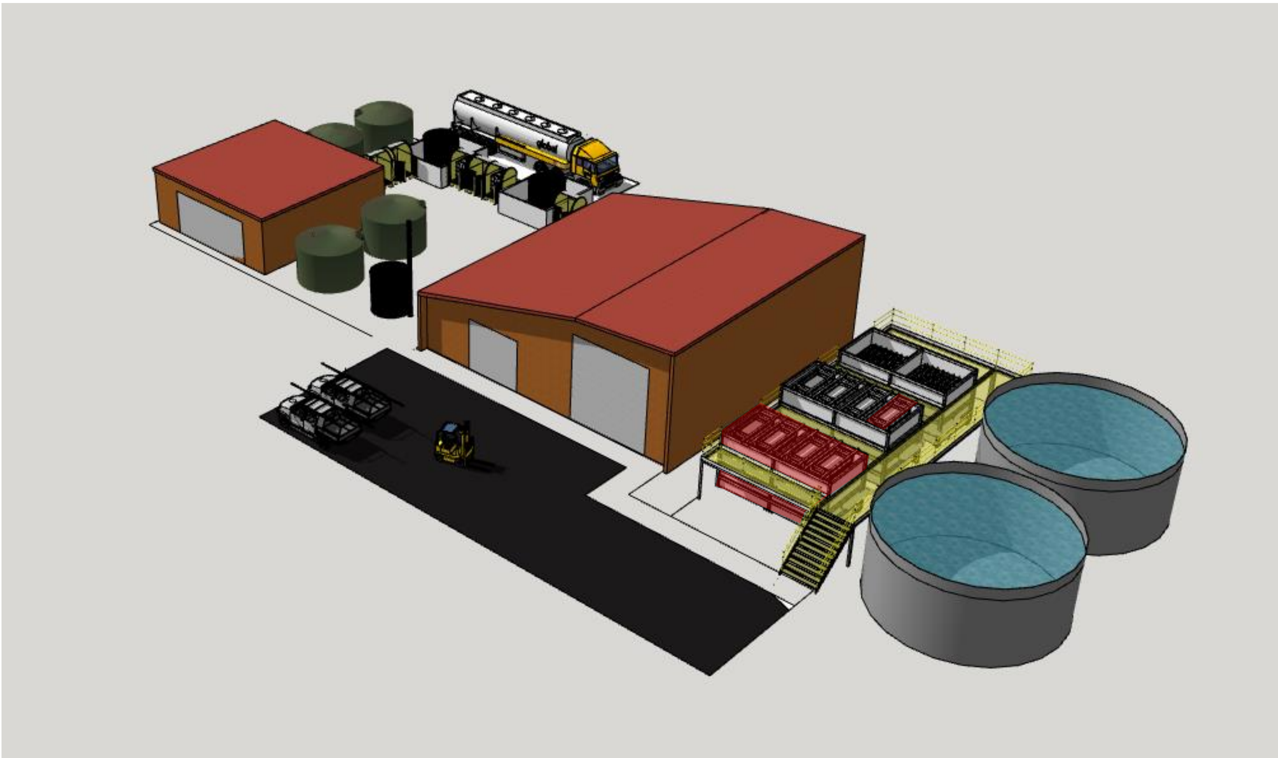


Figure 14 - Pre-Anoxic Tank and MABR Modules that can be installed at a later date (highlighted in red)

Aeration Tank

The aeration tank is sized to accommodate the full treatment plant capacity. It will not need to be expanded upon as the development grows towards the plant's ultimate 1250 dwelling capacity. The aeration tank is proposed to be constructed from a bolted steel panel tank. This style of tank has been selected due to its ease of construction and the ability to easily dismantle and reuse it when decommissioning of the site is required. The proposed general location of the Post-Anoxic tank and the Aeration tank is highlighted in Figure 15 and Figure 16, below.

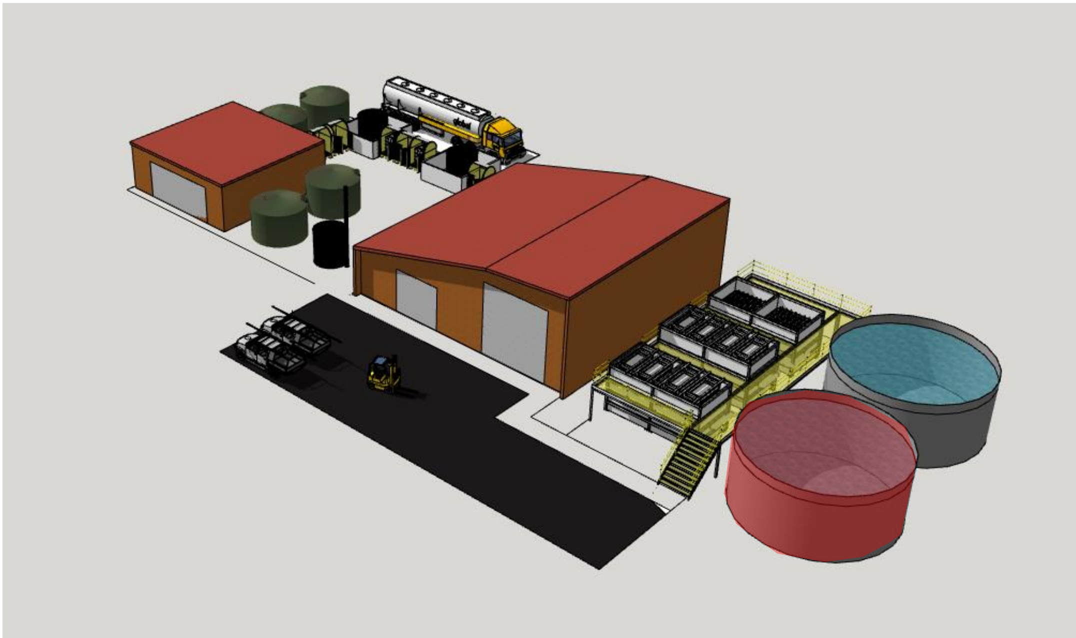


Figure 15 - Aerobic Tank (Highlighted in red)

Post Anoxic Tank

The post-anoxic stage of the process is proposed to be housed in a bolted steel panel tank. This tank provides removal of any residual nitrate from the wastewater prior to discharge. This tank has been sized to accommodate the full future flows and as such is not modular and will not need to be expanded upon while the development grows. This style of tank has been proposed as it has a suitable level of corrosion resistance, is quick to construct and can be readily disassembled when the plant requires decommissioning. The Post-Anoxic tank can be seen in Figure below.

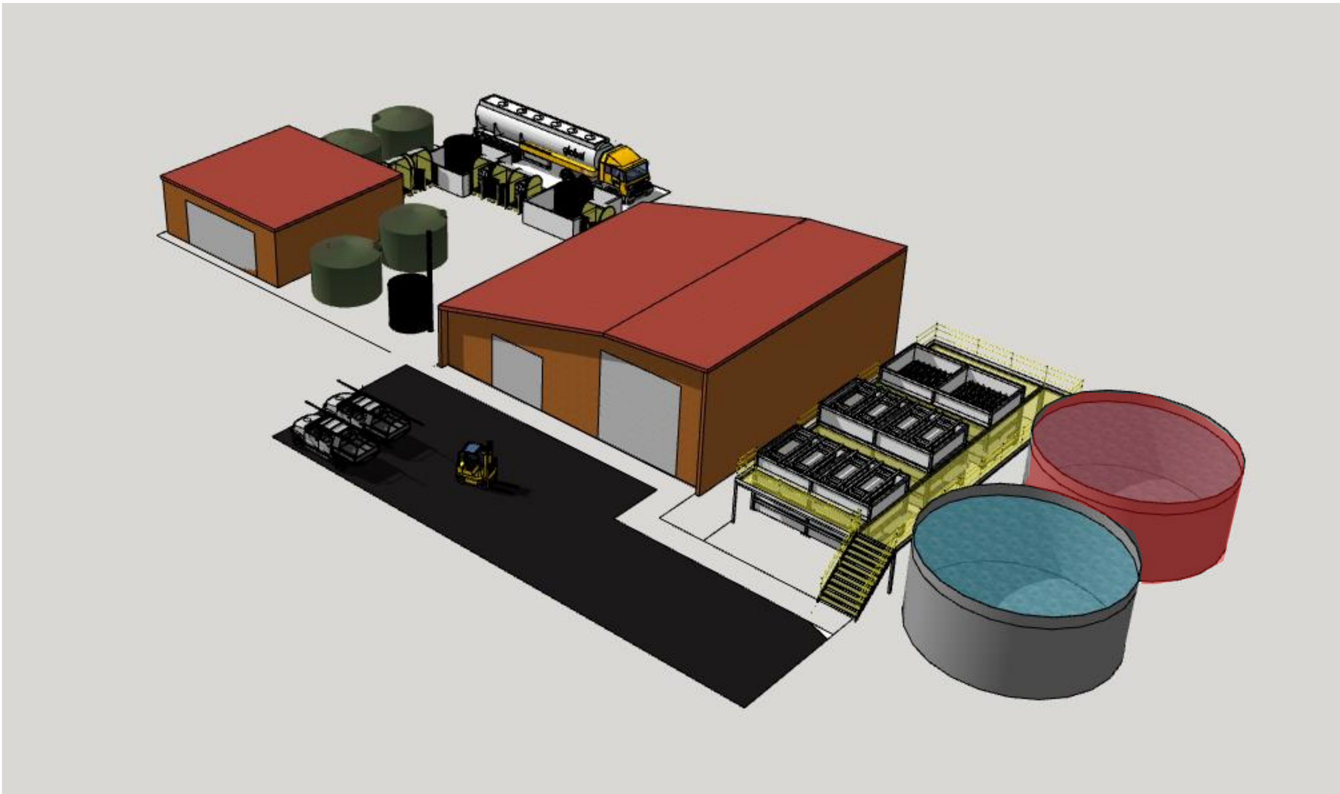


Figure 16 - The post-anoxic tank as proposed for the Milldale WwTP (highlighted in red)

An example of bolted steel panel tanks can be seen in Figure 17 below, as taken from a large wastewater treatment plant designed and constructed by Apex Water in the Waikato.

Figure 17 - Bolted Steel Panel Tanks on an Apex Designed and Built WwTP for a dairy site. The Milldale site will make use of a similar style of tanks as those coloured blue for the aeration and post-anoxic tank, the other equipment is unrelated to the Milldale sites.

MEMBRANE BIOREACTOR TANKS

The stainless-steel membrane tanks house the hollow fibre membranes used to remove almost all of the solids and pathogens from the treated wastewater prior to its discharge. The number of hollow fibre membrane modules installed in these tanks can be increased as the development grows to accommodate increased loading on the wastewater treatment plant. An example of a hollow fibre membrane module similar to those proposed for the Milldale treatment plant is shown in Figure 18 below.

Figure 18 - A Hollow Fibre MBR Membrane Module on an Apex Wastewater treatment plant

The proposed membrane tanks are highlighted in Figure 19 below. While the treatment plant only initially requires one MBR membrane tank, the hollow fibre membranes which sit submerged within these vessels can be installed in stages as the Milldale development grows.

Figure 19 - The MBR Membrane Tanks for the proposed Milldale WwTP

OTHER STRUCTURES AND TANKS

The site comprises of several 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 re-use as non-potable process water.

- Chemical storage tanks – consisting of two high density polyethylene storage tanks up-to 10m3 in volume. These two tanks will hold solutions of 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.
- 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.

Figure 20 - A Chemical Dosing Pump Cabinet from an Apex Water site

WASTEWATER TREATMENT

LOADING

The anticipated wastewater flows have been established through consultation between FLHD-Woods and Watercare and are based on the agreement that the proposed wastewater treatment plant shall draw a specified volume of raw sewage off the existing gravity sewer main servicing the entire Milldale catchment. The Auckland Council GIS map highlighting the existing gravity sewer main running adjacent to the proposed wastewater treatment plant location can be seen in Figure 21 below.

Figure 21- Auckland Council GIS Information Showing the Existing Gravity Sewer

The existing gravity main is sized to accommodate all current and future connections from the Milldale development.

Sewer Harvesting

The extraction and treatment of an agreed volume of raw wastewater from a larger existing source is commonly referred to as sewer harvesting. Examples of the abstraction and treatment of a smaller flow from a larger raw sewage source are detailed below:

- Clarks Beach Membrane Bioreactor – Designed and Constructed by Apex Water to take load off the existing treatment plant
- Warkworth Membrane Bioreactor – Designed and Constructed by Apex Water to take load off the existing treatment plant
- Meremere Membrane Bioreactor - Designed and Constructed by Apex Water to take load off the existing treatment plant –

To facilitate the abstraction of raw sewage to feed the Milldale wastewater treatment plant, it is proposed that a private wet well and pump station is constructed to allow for the harvesting of flows from the existing gravity sewer line servicing the completed stages of the development. Flow monitoring has been carried out by Watercare to determine the diurnal cycle of wastewater flows through the gravity main, as well as to assess and determine the intensity and duration of peaking events due to wet weather flows. The finalised abstraction rates are to be established through private agreement with interested parties,

Real time meteorological information will be collected by a weather station located on the treatment plant site which will relay real time continuous data to the plant's control system. This data will automatically initiate a transition from the dry weather to the wet weather feed rate. To account for rain events that are short in duration, low intensity or are such that they do not have any impact on peak flows through the existing gravity network it is proposed that rain events of less than 2mm/hour do not register a change in flowrate. Additionally, the transition from the dry-weather to wet-weather feed flowrate shall be maintained for a duration that matches observed increases in flows through the network post rain events. These details are to be finalised through a separate agreement with Watercare.

Table 2 - Rainfall Intensity and Duration Limits Propsed

Description	Value
Rainfall Intensity)	2 mm/hr
Wet Weather Flow Duration (Post Cessation of Rainfall Event)	60 minutes

Flow Balancing – Infiltration, Inflow and Peak Flows

The Milldale development is currently serviced by a conventional gravity sewer network. While easy to implement and maintain, gravity sewers have the disadvantage that they are susceptible to infiltration and inflow. Infiltration and inflow refer to the introduction of other sources of water, typically stormwater into the sewer network, increasing the hydraulic loading on conveyancing and treatment infrastructure especially during wet weather events.

In wastewater treatment design peaking factors characterize the maximum hydraulic loading the conveyancing and treatment infrastructure must be designed to accommodate, relative to dry-weather average flows. During dry-weather, peak flows occur daily due to diurnal cycles (morning and evening increases in water usage), these are referred to peak dry-weather flows. During wet-weather events, peak flows occur where rainwater inflow and ingress into the network occurs increasing the flowrate through the network (peak wet-weather flows).

Infiltration typically occurs where damaged or misaligned underground pipework allows groundwater to infiltrate into the sewer network as rainwater saturates soils or flows around conveyancing infrastructure. Inflow sources enter directly into the wastewater network and generally are caused by misconnected stormwater pipework or damaged wastewater infrastructure at or near ground level where they may be susceptible to inflow from surface flooding. Common sources of infiltration and inflow are shown in Figure 22 below.

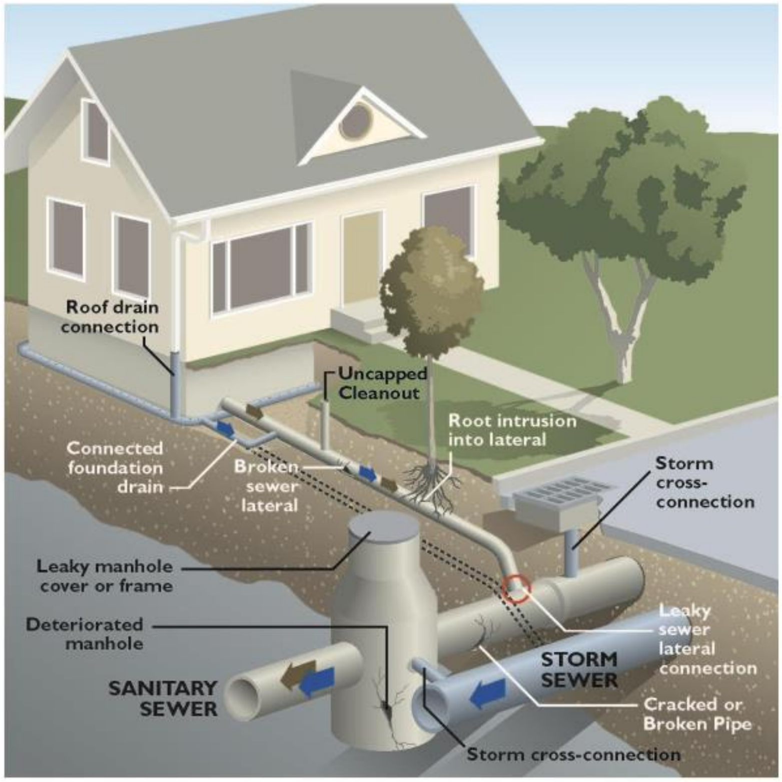


Figure 22 - Common Sources of Infiltration and Inflow (GHD Limited, 2015)

In wastewater treatment plant design, peaking factors have a significant impact on size, cost and complexity of the overall process. Without mitigation, this leads to the oversizing of treatment equipment and processes to accommodate events which result in peak flows. Due to the cost and complexity of treatment infrastructure, this would lead to inefficient treatment plant design by catering to a low frequency event that could be mitigated via other means. One of the design strategies utilized to minimize the impact of peak flows on the sizing of the overall process is flow balancing. Flow balancing refers to the buffering of peak flows, generally through the addition of a large tank upstream of the treatment process. This balance tank allows the treatment process to be designed to accommodate an average instantaneous flowrate as opposed to a peak instantaneous flowrate, with any excess flows accumulating in the balance tank for later processing. An example of a wastewater treatment plant biological treatment process with a flow balancing tank can is shown in Figure 23, below.

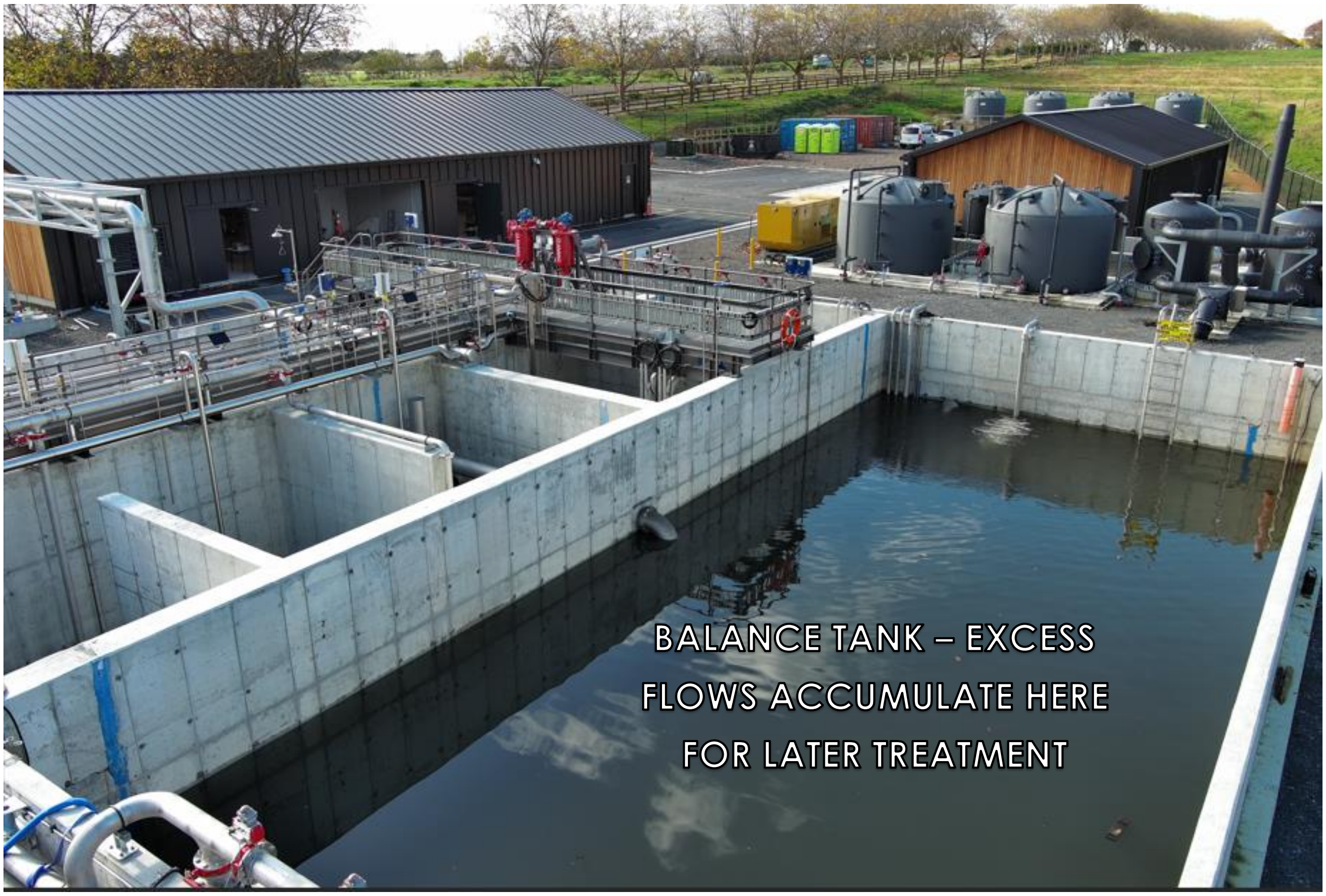


Figure 23 - A MBR WwTP with Flow Balancing. The Milldale site does not require any flow balancing

By adopting the sewer harvesting approach, the requirement for influent flow balancing at the Milldale interim wastewater treatment plant can be effectively eliminated. By selecting a dry-weather flowrate (DWF) that accommodates the average diurnal flows, and a wet-weather flow rate (WWF) that accommodates the average flow observed over the duration of a peaking event, two separate, but constant flows of wastewater can be fed from the pumpstation into the plant. Providing the plant with a near constant feed of wastewater allows for a more stable process, with the only process upsets occurring when the feed flow transitions from the dry-weather to wet-weather flowrate.

The adoption of sewer harvesting is only suitable in this scenario where base minimum diurnal flows through the gravity main feeding the entire Milldale development are above the agreed dry-weather flow setpoint for the interim WwTP. Provision will be made in the monitoring and control of the wastewater treatment plant to ensure flow conditions maintain the required minimum flows.

RAW WASTE QUALITY

The Milldale development is primarily a residential development with some commercial land uses, a school site and a retirement village. For a staged development, it is common for the sewage produced to be stronger when there are fewer connections, which then gradually approaches more normal sewage strength as the development grows.

As the wider catchment consists of an occupied and mature residential land development, the sewage strength is expected to be near normal concentrations from the first day of commissioning. An aerial overview of the entire Milldale catchment as of December 2024 can be seen in Figure 24 below, demonstrating that the development is well progressed.

Figure 24 - December Aerial Image of the Milldale Development

An overview of the expected wastewater strength is shown in Table 3 below, as per the Auckland Regional Council Guidance Document GD06 and from test results of raw sewage from the community of Clarks beach.

Table 3 Raw waste quality comparison (Auckland Regional Council Guidance Document GD06 and a similar community)

Influent Concentrations	Guidance Document GD06	Clarks Beach	
		Median	95th Percentile
Flow	-	1,250	1,250
COD	-	550	1,100
COD-filtered	-	200	332
BOD	250 - 350	270	420
TSS	300 - 400	-	-
TKN	-	65	94
NH_4-N	-	48	65
NH_3	Varies	-	-
NO_3	<1	-	-
TN	Varies	-	-
PO_4	10 - 30	-	-
TP	-	10	13
Faecal coliforms	10^8 - 10^{10}		

The varied strengths and flowrates that could be observed must be considered when developing a biological treatment process, such as that proposed for the Milldale development. Diurnal cycles, meteorological conditions and other factors like time of year and commercial to residential make-up of wastewater catchments all work to making the flows and concentrations of sewage variable over time. When variation in strength and volume is not appropriately considered during the design process, the treatment quality can become unstable. The design of the Milldale wastewater treatment plant has been centred on maintaining consent compliance when the plant is experiencing 95th percentile inflow conditions, based on the Clarks beach results shown in Table 4 above. The Table 3 figures are both more conservative than the Guidance Document 06 figures and are more relevant to what would be expected in this new development as the residential / commercial mix is similar.

Another important aspect of consideration is the nutrient make-up of the raw wastewater received. The bacteria that proliferate in wastewater treatment plants require specific ratios of nutrients to grow optimally and breakdown organic matter. The most common nutrient ratio used is the Carbon: Nitrogen: Phosphorous ratio, which describes that optimal bacterial growth will occur when there is a ratio of 100:10:1 carbon to nitrogen to phosphorus. For every 100 parts of carbon, bacteria will need 10 nitrogen and 1 phosphorus. When designing biological treatment processes consideration must be given to how the process will respond to scenarios when these ratios are not maintained, as the removal of nitrogen and phosphorous are critical parameters to control when discharging to sensitive environments and a cleaner raw sewage in terms of carbon concentration can make it harder to remove nitrogen and phosphorus. . This can occur if there are a lot of bars or restaurants contributing to the flow, or during early stages of development where residence times in the network are high due to low flows and BOD begins degrading in the sewer network.

Whilst the plant is expected to operate at similar nutrient ratios to those provided in the table above, sufficient flexibility must be designed into the plant to accommodate the high end of nitrogen and phosphorus strength, even when median Biological Oxygen Demand (BOD) and Chemical Oxygen Demand (COD) strength wastewater is received. This will be achieved by providing the ability to dose additional BOD into the plant if required to adequately remove nitrogen.

PROCESS SELECTION

Membrane Aerated Bioreactor with Ultrafiltration Membranes and Reverse Osmosis Membrane (MABR + MBR)

A multi-criteria assessment (MCA) has been carried out on the processes described to evaluate each of these on the following metrics:

- Performance, Future Proofing
- Operability
- Constructability
- Social and Environmental Impact
- Process Resilience.
-

Each of these has been baselined next to what Apex considers as the most robust treatment solution which consists of a 4-stage Bardenpho activated sludge treatment process, a Membrane Aerated Biofilm Reactor incorporating Hollow Fiber Ultra filtration membranes for the separation and removal of solids prior to UV disinfection and Reverse Osmosis to polish the treated wastewater discharge.

The result of the assessment carried out in the MCA shown in Table 4 below highlights the MABR-MBR hybrid process as the most suitable for the Milldale project site. A summary of the alternative considered can be found in the following sections.

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Options Assessment

Typical treatment processes found in New Zealand have been assessed for their suitability at the Milldale site. However, the condition of the receiving environment has become the limiting factor for technology selection, requiring a treatment process capable to removing all but trace levels of nutrients and other contaminants. The following list represents common treatment processes that were initially considered for the Milldale wastewater treatment plant.

- Membrane Aerated Biofilm Reactor (MABR)
- Moving Bed Biofilm Reactor (MBBR)
- Membrane Bioreactor (MBR).
- Hybrid Membrane Aerated Biofilm Reactor with Tertiary Membrane Treatment. (MABR-MBR)
- Activated Sludge
- Sequencing Batch Reactors (SBRs).
- Submerged Aerated Filter System (SAF).
- Trickling Filters; and,
- Recirculating Textile Packed Bed Reactors (rtPBR).

Taking into consideration the requirement to reduce the concentration of nutrients in the treated wastewater to trace levels which will require the addition of Reverse Osmosis membranes, the list of suitable processes has been reduced to the following:

- Activated sludge configured for Biological Nutrient Removal
- Sequencing Batch Reactor (SBR)
- Membrane Bioreactor (MBR) with Reverse Osmosis Membranes
- Membrane Aerated Biofilm Reactor (MABR) with Reverse Osmosis Membranes
- Hybrid Membrane Aerated Biofilm Reactor with Tertiary Membrane Treatment. (MABR-MBR) with Reverse Osmosis Membranes

An options assessment has been carried out on the short list of three treatment options which is discussed in further detail below. As each of the treatment processes proposed require the addition of Reverse Osmosis membranes, a standalone section on this has been included. Overall, it has been determined that the best option for the Milldale Wastewater Treatment Plant is a MABR-MBR hybrid process with Reverse Osmosis membranes.


Figure 25 - Cardrona Valley Wastewater Treatment Plant (SBR).

Membrane Bioreactor (MBR)

An MBR system is a combination of the activated sludge process (a wastewater treatment process characterised by a suspended growth of biomass) with a micro or ultra-filtration system that rejects particles above 0.1 – 0.4micron in size (which is smaller than an individual bacteria). 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. An example of a Membrane Bioreactor servicing the community of Meremere designed and built by Apex Water for Watercare can be seen in Figure 26 below.

Figure 26 - Watercare Meremere Wastewater Treatment Plant (MBR). Note, there will be no pond at the Milldale site.

The MBR represents the best available technology for the application proposed for the Milldale 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.

An example of the membrane tank used to house the hollow fibre membranes as proposed for the Milldale treatment plant is shown in Figure 27 below.

Figure 27 - The membrane tank of an MBR treatment plant designed and built but Apex Water. The Milldale site will make use of above ground tanks like those shown, but in steel.

Membrane Aerated Bioreactor (MABR)

An MABR is considered a recent modification to the activated sludge process, where through the addition of gas transfer membranes the conversion and removal of nutrients can be carried out more efficiently than traditional processes. The addition of the submerged gas transfer membranes provides a surface on which a biofilm of wastewater treatment bacteria can grow allowing for the transfer of oxygen directly to this biofilm. 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 the largest operational expense, alongside chemicals and labour.

As an MABR process is considered a modified activated sludge process, it can often be used to improve the performance of treatment plants that are based on the same process, such as an SBR and MBR treatment plant. Improved performance, a smaller plant footprint, and improved OPEX costs are some of the benefits that can result from this addition.

On its own, an MABR process does not have the means to effectively separate and remove bulk solids from the treated wastewater. Without some form of solids separation, the treated effluent quality would be unsuitable for further tertiary disinfection or discharge to a sensitive receiving environment. However, through the integration of gas transfer membranes, an MBR process can be designed to consume less energy and take up less space for the same throughput.

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 Aerated Bioreactor and Membrane Bioreactor (MABR + MBR Hybrid)

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 at Raglan can be seen in Figure 28 below.

Figure 28 - Watercare Raglan MBR/MABR WwTP. Designed and under construction by Apex Water. This is a broadly similar process however it is not designed to be modular and hence the biological treatment tanks are made of concrete and buried. Milldale will have above ground modular, steel treatment tanks.

Reverse Osmosis Polishing Membranes

The Membrane Bioreactor (MBR) system described above relies on a membrane filter to separate bulk solids and remove pathogens from the treated wastewater stream. However, these membranes alone do not provide the necessary level of nutrient reduction required for discharge into the Waterloo creek. To meet the required treatment standards, Reverse Osmosis (RO) membranes have been integrated into each of the treatment processes outlined. Unlike conventional dead-end filtration systems, an RO membrane operates under constant pressure, with the wastewater passed across the surface of the RO modules. As water passes over the membrane surface, it permeates through, while contaminants, including salts and nutrient molecules, are effectively excluded. This results in a high-quality permeate, with the rejected contaminants being concentrated in the reject stream.

While the MBR membranes have pore sizes small enough to exclude solids as tiny as individual bacteria, RO membranes feature even finer pores that also reject salts and nutrient molecules, such as ammonium, nitrate, and phosphate ions. This capability allows for the removal of salts, bacteria, and other impurities, ensuring a higher level of treatment.

Though it is uncommon for conventional wastewater treatment applications to incorporate RO membranes into the treatment train, they are widely used in countries where wastewater is treated and reused for potable purposes.
It is important to note that the use of RO membranes produces water of that has a nutrient concentration profile lower than acceptable drinking water. If employed in this instance, it would likely make the discharged water from the Milldale development the cleanest treated wastewater in New Zealand.

In Table 4 below details each of the four main processes considered and have been compared to MABR + MBR process as the Base Option 1.

Table 4 - Multi Criteria Assessment carried out to determine the most suitable treatment technology

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
		5%	0	0	-0.50	-0.025	-1	-0.05

	GHG emissions							
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	5%	0	0	1	0.05	1	0.05
	Relative operating cost	5%	0	0	-1	-0.05	-1	-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

Disadvantages of an MBR – MABR Hybrid Process

Although the MBR-MABR process has been selected as the most suitable for the Milldale site, it does have some inherent disadvantages which must be assessed. Understanding the disadvantages of such a process to ensure any mitigation does not introduce an unacceptable level of technical complexity or cost is important. The disadvantages of MBR – MABR hybrid process systems include:

- Limitations to total hydraulic capacity of the plant

While the addition of tertiary membranes provides 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. In the Milldale application, the agreement to provide two fixed feed rates to the treatment plant mitigates this disadvantage entirely. By fixing the feed rates to the plant, the peak design case is pre-determined allowing for a less conservative design without the need for feed balancing.

- Membrane Organic and Inorganic Fouling

Organic fouling through the deposition and growth of a biofilm on the wastewater membranes leads to a restriction of fluid flow through the membranes. Inorganic scaling is caused by the deposition of contaminants with low solubilities blocking the membrane pores restricting their capacity to transfer fluid.

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 clean in place (CIP) processes. Processes for cleaning both MBR and MABR membranes are well described and commonplace but must be managed and controlled according to good operational practices to ensure the process performance is maintained and operator safety in not compromised. While membrane fouling is a disadvantage, this is common to all membrane treatment process. Figure 29 below shows a hollow fibre membrane module with visible fouling on the surface of the fibres.

Figure 29 - An example of fouling on hollow fibre membranes (Bates, 2018)

- Reverse Osmosis Reject Waste Stream

Reverse Osmosis (RO) membrane filtration is a form of crossflow filtration, where water is passed across the surface of a membrane. This process allows water molecules to pass through, while effectively blocking most other contaminants, thereby significantly reducing their concentration in the filtered water. As a result, two distinct liquid streams are produced: one is of exceptionally high quality, suitable for discharge into sensitive environments or for reuse, and the other contains the rejected contaminants that could not permeate through the membrane. The reject stream, which accounts for approximately 30% of the total volume of treated wastewater, must be appropriately managed or disposed of.

While this represents an operational constraint, several viable options exist for managing the reject stream produced by the proposed Milldale wastewater treatment plant. It is proposed that this stream be returned to the sewer

Prevalence of MBR – MABR Systems in the Auckland Region

Over the past decade, most new sewage treatment plants in the Auckland area and surrounding areas including those that discharge direct to surface water are MBRs. These include systems in Pukekohe, Snell's Beach, Warkworth, Clarks Beach, Waiheke Island, Karaka

North and Meremere. Of the plants detailed above, Apex Water has been responsible for designing and constructing five of these. In the Waiheke Island application, due to the nature of the location and the occupancy and diet over the holiday periods, the wastewater can be unusually strong with peaks up to ten times as strong as typical sewage. Despite this, the system can produce treated water with <10mg/L total nitrogen (TN), <2 mg/L BOD, <1 mg/L total suspended solids (TSS) and <1 CFU/100mL E. coli. Figure 30 below shows the Clark's beach MBR treatment plant designed and built by Apex Water for Watercare Services. This plant discharges to surface water.

Figure 30 - The Clarks Beach MBR treatment plant. No treatment ponds are proposed at the Milldale site, however the Clarks Beach site is modular and relatocatable.

The adoption of MABR treatment processes and other modified activated sludge processes in New Zealand has been slower than in other developed wastewater treatment industries. Technical expertise, industry size and intrenched design standards may be the cause of this slow adoption. In recent years however, a number of MABRs and other modified activated sludge processes, such as Moving Bed Biofilm Reactors (MBBR) have been built with notable new treatment processes located in Te Kauwhata, Waikato (MABR-MBR hybrid), Lake Hawea, Otago (MBBR) and Raglan, Waikato (MABR-MBR Hybrid). Both the Lake Hawea and Raglan treatment plants have been designed and constructed by Apex Water. Figure 31 below shows the Raglan MABR-MBR plant currently under construction for Watercare Services.

Figure 31 - Watercare Raglan MBR-MABR Designed and Built by Apex Water. This is being constructed on the site of an existing pond based WWTP. The Milldale site does not include any pond based treatment steps.

Expected Wastewater Quality from an MABR -MBR-RO Plant

The configuration of the nutrient reduction process coupled with a membrane filter on the discharge provides an exceptional treated wastewater quality. By forcing the wastewater through a membrane close to zero residual solids pass through into the discharged wastewater, excluding effectively all bacteria also. While a traditional sewage treatment plant that relies on gravity settling (like activated sludge or SBR) will still have very high concentrations of bacteria such as E. Coli, it is normal for an MBR to have undetectable levels of bacteria in the discharge (e.g., <1 CFU per 100mL). With the wastewater being further disinfected by means of a process such as UV disinfection, the removal or deactivation of pathogens in the permeate is remarkably high. 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 Queensland guidelines for Grade A recycled water without further treatment.

The inclusion of Reverse Osmosis (RO) membrane filtration as an additional processing step offers a significantly more robust physical barrier for the removal of solids and nutrients, ensuring that the treated water contains almost no solids and that virtually all bacteria are removed. By using RO membranes to further polish the effluent from the Membrane Bioreactor (MBR), the resulting discharge will surpass the quality of stormwater runoff, as sourced from literature (Williamson, Urban Runoff Data Book: A Manual for the Preliminary

Evaluation of Urban Stormwater Impacts on Water Quality, 1993). In fact, the quality of the treated water will far exceed the nutrient concentrations that are allowable by the Drinking Water Standards for New Zealand, highlighting the extreme level of treatment proposed. 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 5 - 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	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

Figure 32- An Apex Water employee taking a sample of crystal-clear treated water from an MBR treatment plant

TREATMENT TRAIN

A simplified process flow diagram of the MABR-MBR hybrid treatment train is illustrated in Figure 33 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 dosed to a land contact infiltration basin 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. Aeration blowers feed high volume and medium pressure air to the MABR gas transfer membranes and the aeration tank.
4. Acetic Acid is dosed as a supplementary carbon source to provide food to the biological process
5. 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.
6. Aluminium Sulphate is dosed to sequester phosphorous out of solution for removal
7. Citric Acid is used to remove inorganic scaling from the membrane surfaces through a Clean-in-Place (CIP) process.
8. Sodium hypochlorite is used to remove organic fouling from the membrane surfaces through a CIP process.
9. Headworks screenings are collected in a skip for removal to landfill
10. Dewatered sludge is collected in a skip for removal to landfill.

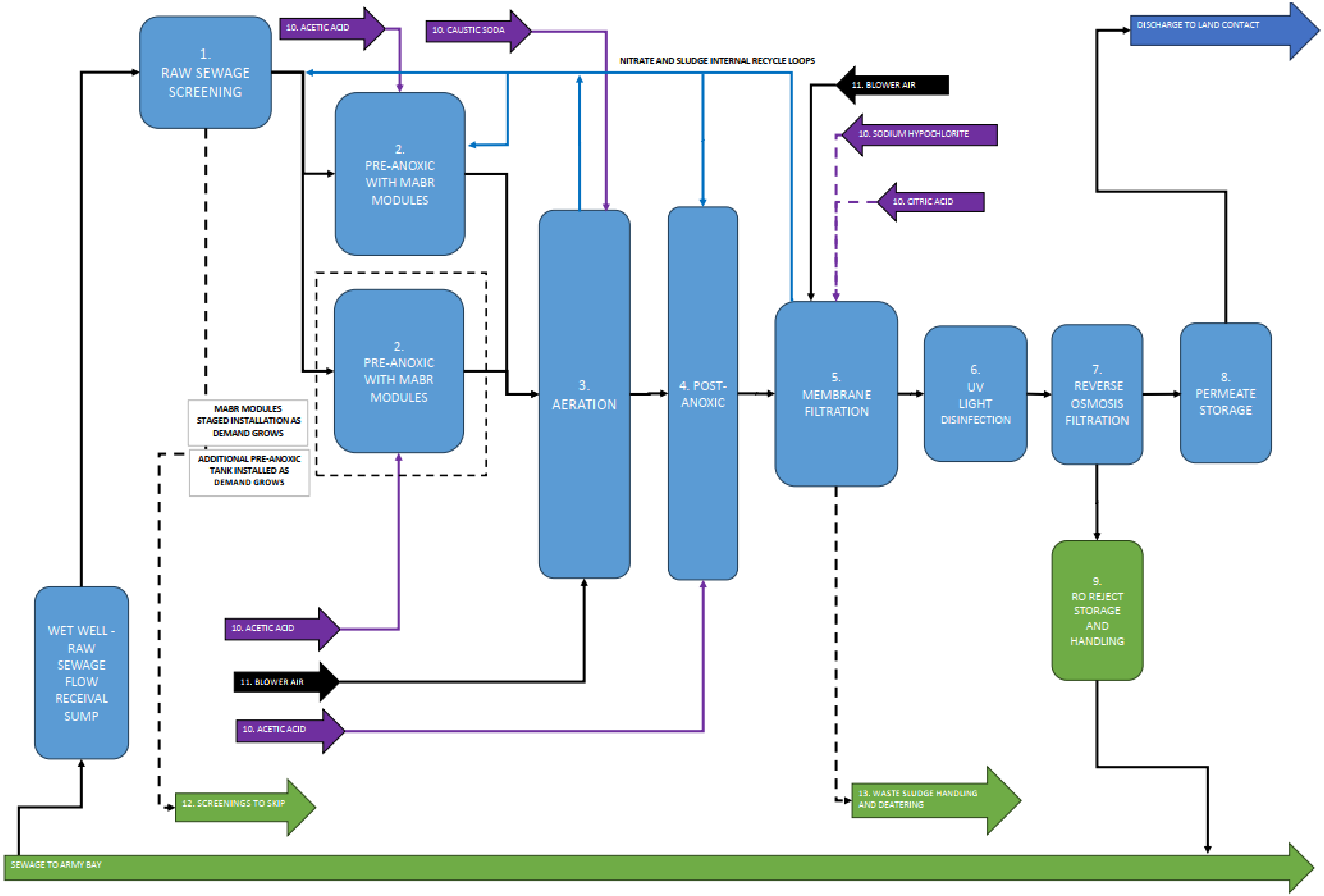


Figure 33 - Simplified Process Flow Diagram – The location of these can be seen in the following figure, overlaid onto the site layout

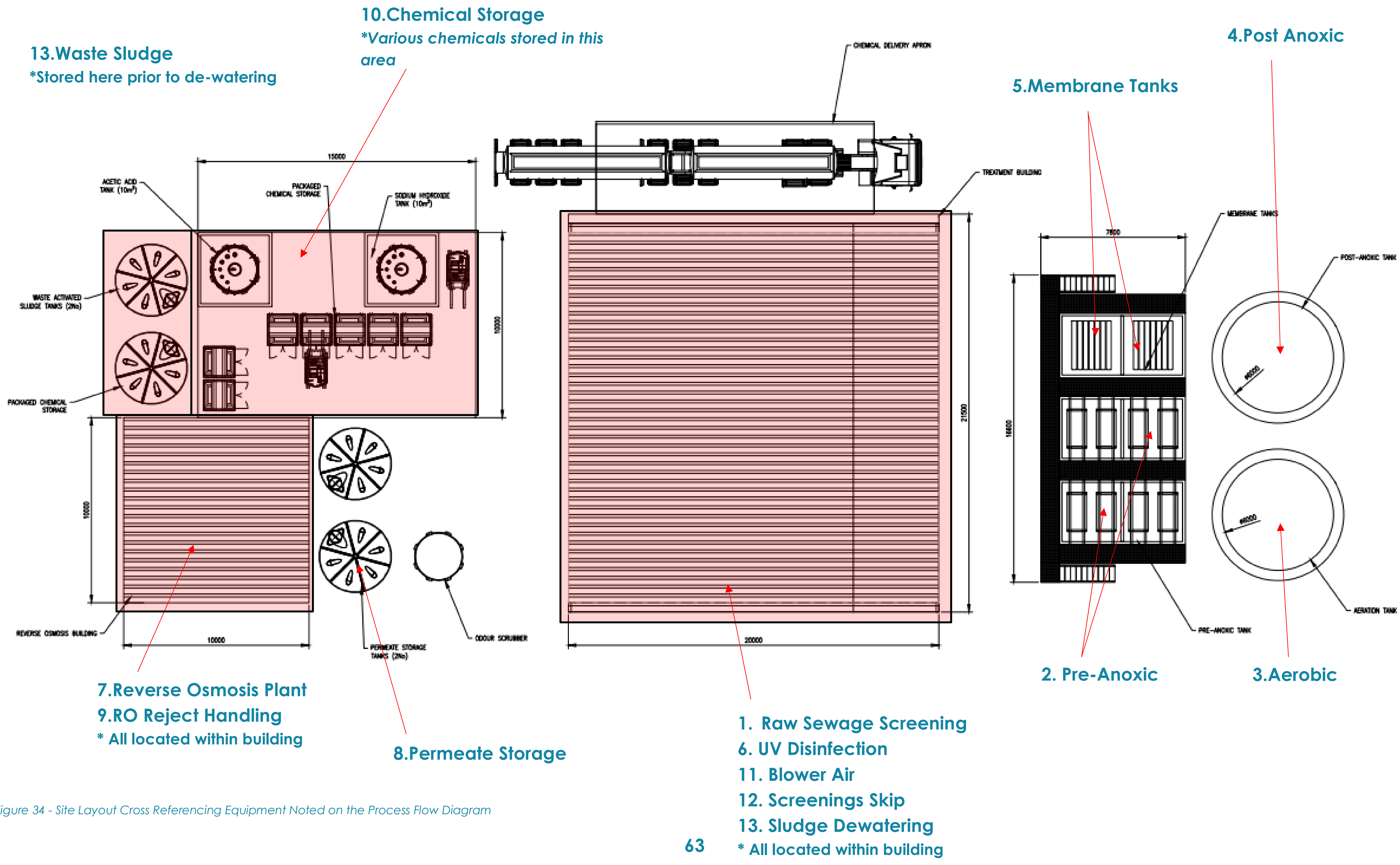


Figure 34 - Site Layout Cross Referencing Equipment Noted on the Process Flow Diagram

BIOWIN MODELLING

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 production and optimisation of the model, the discharge quality can be determined for a range of flow scenarios which allows 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.

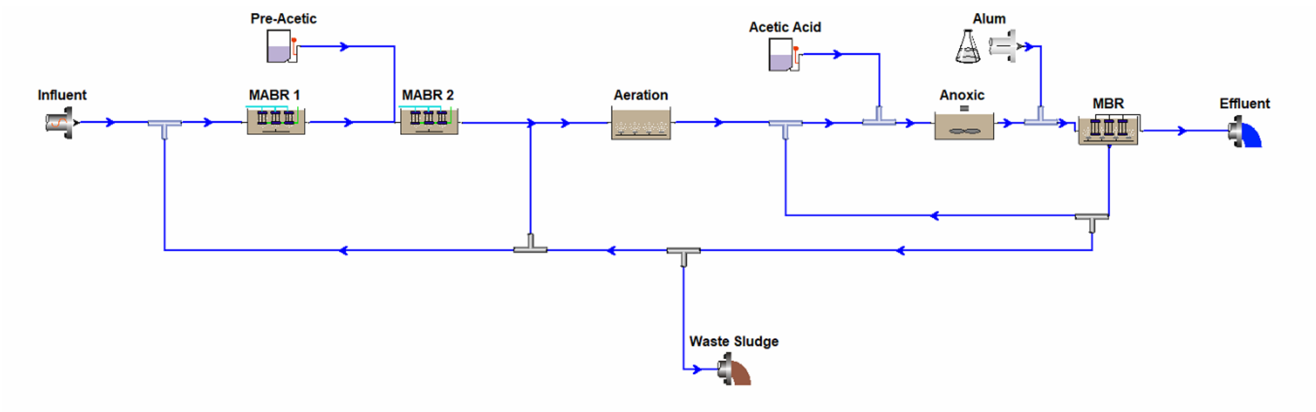


Figure 35 - Biowin Modelling Overview

MAIN UNIT PROCESSES

Headworks Screening

The incoming wastewater from the pumpstation and wet well flows directly into the headworks system. The wastewater enters the tank containing the screw compactor fitted with a fine screen element. As effluent passes through the screen, solids of particle size greater than 2mm are removed in order to protect the membrane system.

As the screen accumulates the removed solids, the upstream water level rises to a pre-set level which is detected by a level sensor installed inside the tank, at which stage a signal is sent to automatically clean the screen.

The screenings are conveyed from the screen zone to the dewatering or pressing zone. During this process, the screenings are washed to reduce organic matter content. The solids collected are held in sealed wheelie bins for collection and removal from site. At full future production, this wheelie bin is expected to need emptying once or twice per month.

The screened effluent then enters the grit sedimentation tank (hopper) where separation of grit particles takes place. The grit settles in the hopper and a horizontal screw conveyor on the hopper base directs the grit into the extraction chamber. An extraction screw lifts, dewaters and washes the grit before being discharged via a chute into the collection bin. Air diffusers are installed inside the sedimentation hopper to enhance separation between organic matter and grit. The solid grit removed by this process is collected in a second sealed wheelie bin for later collection and removal from site. At full future production, this wheelie bin is expected to need replaced once or twice per month.

To ensure all screenings are captured and odour is contained, the wheelie bins are modified so the chute passes through the lid with a tight seal. This captures odour and ensures all screenings enter the bin. The headworks screens are installed indoors to further contain odour and noise from the automatic cleaning system. The wheelie bin used for this purpose is typically fitted with a heavy-duty plastic liner. Figure 36below shows a recent installation of this type of screening system.

This headworks screening process performs the following functions:

- Screening of solids from the incoming wastewater.
- Screenings are washed, conveyed and dewatered prior to discharge to screenings bin.
- Sand and grit separation.
- Lifting and dewatering of the separated grit, which can be discharged to the screenings bin or separate bin.

A coarse and fine inlet screen can be seen in Figure 36below.

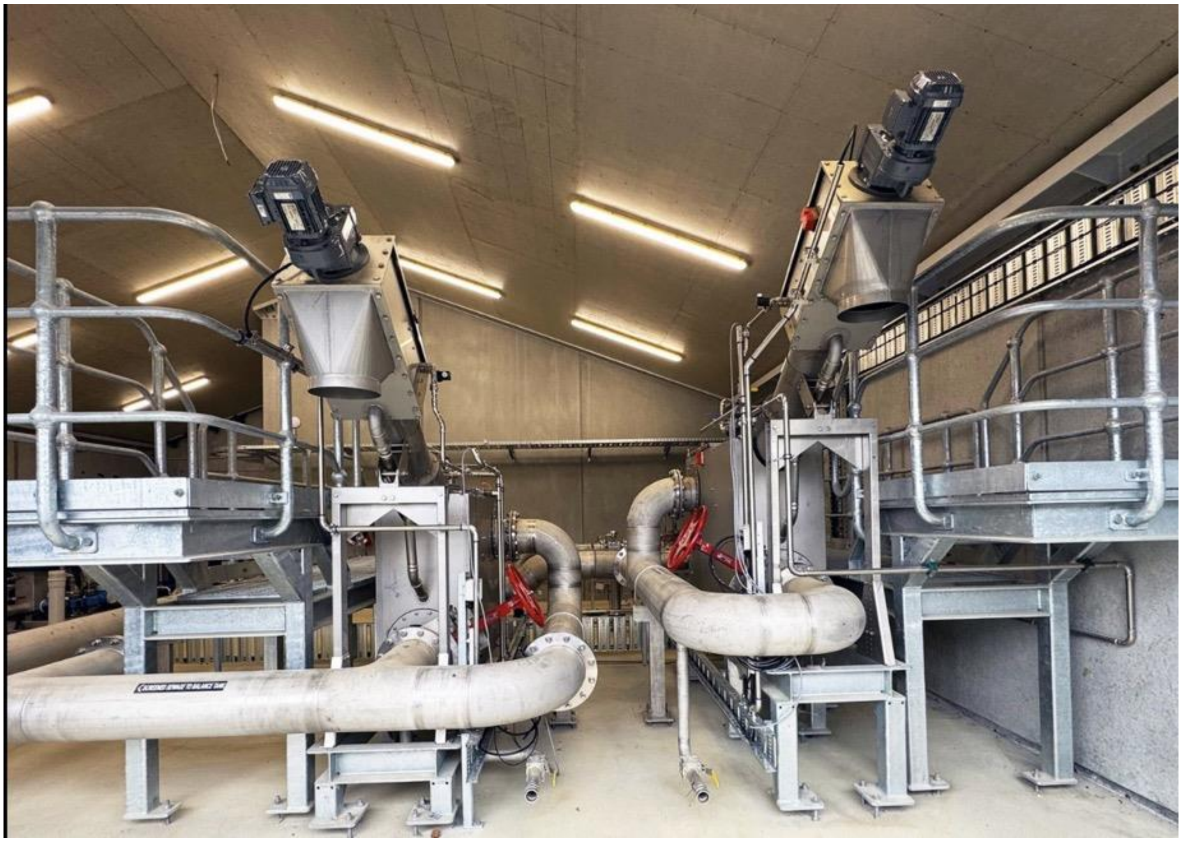


Figure 36 - Fine and Coarse Inlet Screens at a treatment plant designed and built by Apex Water

To reduce operational complexity the screens are elevated to enable the screened sewage to flow under gravity through the screens and into the rest of the process.

Pre-Anoxic Tank

The Pre-Anoxic tank(s) are modular open top stainless-steel tanks sized to be readily road transportable to aid in transportability and modularity. The screened wastewater flows into and through these tank(s) by gravity. These tanks are continuously mixed and operate at a fixed level, overflowing to the next part of the treatment process, which is the aeration tank.

The Pre-Anoxic tank serves as a biological process vessel where a significant amount of the nitrogen containing compounds and organic materials are biologically reacted and released to the atmosphere as carbon-dioxide and nitrogen gas.

Through the addition of MABR membranes into the pre-anoxic tank, a highly efficient simultaneous nitrification-denitrification cycle occurs. This results in the highly efficient and robust removal of nitrogen-based contaminants from the wastewater. The MABR membrane facilitates this by providing a surface on which a biofilm containing large quantities of nitrifying bacteria can grow. In the anoxic MABR tanks oxygen diffusion through the MABR membranes transfers a high concentration of oxygen directly into the biofilm growing on the membranes therefore facilitating nitrification. The nitrate produced then diffuses into the bulk liquid of the tank which provides an oxygen free environment for this nitrate to be removed by nitrification. Combining these processes, which usually occur in separate much larger tanks in a single tank makes the resulting process much smaller and more energy efficient.

The anoxic balance tank contains:

- MABR membrane modules
- Mixer(s) to ensure that bacteria remain suspended and mixed effectively with the incoming contaminants.

Aeration Tanks

From the anoxic MABR tanks, the flow enters the aeration tank, in which naturally occurring bacteria grow and eat the remaining organic contaminants in the wastewater. Residual ammonia below the level that is efficient to remove in the MABR is the main form of nitrogen present in the feed to this tank. The aerobic tanks convert this to nitrate for removal when passed through the final post anoxic tank.

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 is shown in Figure 37 below.

Figure 37 - An Aeration Tank in Action (Large Blue Tank on right) The aeration tank at Milldale will operate in a similar manner to this tank. All other vessels shown are unrelated to the Milldale site.

Air is provided to the process through blowers which are housed in a soundproof plant room. As failure of the aeration system is one of the main avenues through which offensive odours could be discharged from the site, a spare installed blower is included which automatically takes over should a primary blower fail. In addition to this, a back-up generator is installed on site which will automatically activate should power supply to the site fail.

The blowers operate based on continuous measurement of dissolved oxygen in the aeration tank. 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. 8 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

Nitrate rich discharge from the aerobic tank enters the Post-Anoxic tank where it is mixed with highly concentrated biomass recycled from the MBR tanks. This removes any residual nitrate from the wastewater, significantly improving the quality of the discharge.

The continuous supply of nitrate to this Post-Anoxic tank, combined with its very short hydraulic residence time (typically only one to two hours depending on incoming flow rate) prevents anaerobic conditions (and the associated odour risk) from occurring.

When very low concentrations of nitrogen are required in the discharge (such as in this proposal), the wastewater often runs out of the carbon-based contaminants that the bacteria require to remove nitrogen. Therefore, a carbon source is dosed to the Post-Anoxic tank to facilitate scavenging of additional nitrogen.

The recommended supplemental carbon source is 49% acetic acid, as this is a natural product (essentially distilled vinegar), cost effective and relatively safe chemical for use in this application.

To achieve phosphorous removal, Aluminium Sulphate (Alum), a common water treatment chemical, is dosed into the Post Anoxic tank to precipitate dissolved phosphorous out of solution. The solid precipitated phosphorous binds with the sludge in the process and is ultimately removed from the process along with waste sludge.

Membrane Bioreactor

The defining characteristic of a Membrane Bioreactor is the membrane system used to separate bacteria and other solids from the treated water. Because the nominal pore size of the membranes used is smaller than the size of an individual bacteria, these membranes provide a physical barrier to prevent bacterial contamination of the treated water.

This physical separation of bacteria and other solids from the treated water ensures that the Membrane Bioreactors can provide some of the best treated water qualities available among commercially proven sewage treatment plants.

While a typical sewage treatment plant will produce wastewater that varies from 100 – 100,000,000 bacteria per 100mL of treated water measured as Colony Forming Units (CFU/100mL) of E. coli, Membrane bioreactors commonly produce wastewater of less than 5 CFU/100mL. Many MBR treatment plants installed and/or operated by Apex Water regularly achieve undetectable levels of bacterial contamination in the treated water (i.e. <1 CFU/100mL) with no other disinfection processes used.

The membranes proposed to be used in this treatment plant are hollow fibre membranes. To ensure the membranes operate effectively, they are continuously scoured with air during normal operation. The membrane tanks have a high concentration of dissolved oxygen in them which prevents generation of offensive odours.

Supplemental Chemical Dosing

In applications such as this one where a very high level of nitrogen removal is required, the biological reactions in the treatment plant can consume all alkalinity available in the feed water. If this is not controlled by the addition of supplemental alkalinity through chemical dosing, the pH in the treatment plant can drop into a range that is harmful to the bacteria therefore causing the entire treatment plant to fail.

Biological modelling of the proposed treatment plant showed that at the high end of the influent nitrogen concentrations expected, supplemental alkalinity dosing is required to maintain stable plant operation.

Automated dosing of caustic soda into the aeration tank based on continuous measurement of pH is included in the process design for this purpose.

In order to further protect the receiving environment, phosphorus in the wastewater is also actively removed to very low levels. Phosphorus is mainly derived from cleaning chemicals used in the community. This is more easily achieved than with other contaminants as through the simple addition of a small dose of a chemical such as Aluminium Sulphate (Alum) phosphorus dissolved in the water will precipitate so that it can be filtered out by the membrane system in the MBR tank.

The addition of Alum to the system does increase the cleaning requirement of the membranes due to the formation of insoluble compounds which can foul the membranes.

UV Disinfection

As an additional barrier to pathogens in the treated water, water that passes through the membranes is then further disinfected with ultraviolet light ahead of entering the permeate storage tanks or being discharged. High intensity ultraviolet light is used to deactivate microorganisms within the treated wastewater rendering them incapable of reproduction. While passing through a UV reactor, more than 99.9% of the remaining bacteria and viruses are destroyed.

The UV system has multiple individual lamps, failure monitoring, online continuous UV intensity (UVI) monitoring and an automatic wiper system. Clear space beside the UV is provided for easy removal and replacement of lamps and quartz sleeves.

The UV automatically turns on 3 minutes before the discharge flow starts to allow a warmup period and then turns off after flow stops. One benefit of MBR treatment is that the treated water flow tends to be fairly continuous, which enables optimal continuous operation of the UV reactor.

Reverse Osmosis

The treated wastewater that has passed through the membranes of the Membrane Bioreactor and UV is of sufficient quality that is suitable for unrestricted municipal irrigation and other forms of beneficial re-use.

Due to the instream nutrient concentrations within the Waterloo creek being lower than can be achieved through the use of the MABR-MBR treatment process alone, the addition of the Reverse Osmosis membranes is required. At the end of the reverse osmosis treatment step, the wastewater is separated into two streams, a RO reject stream which contains the concentrated nutrients that have been removed and the permeate stream which has passed through the RO membrane which is of exceptionally high quality.

While the permeate stream is suitable for tertiary disinfection prior to discharge into the local environment, the reject stream must be handled and discharged separately.

Permeate Storage

The permeate 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 run through an automated cleaning process requiring high pressure water to be sprayed internally to dislodge and clear accumulated solids. It is proposed that permeate is used in this application and any other cleaning applications on site where there is no risk of potable, non-potable cross-over.

Solids Management

Sludge production is a by-product of the treatment process. The activated sludge primarily contains the bacteria used to facilitate the nutrient reduction processes and is recycled throughout the tanks as required to maintain performance of 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 process. To manage this, a portion of this bacteria in the form of a solids rich waste stream is diverted 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 enclosed storage tanks with a combined volume of approximately 60 m3. The sludge settles and thickens in the WAS storage tanks ahead of dewatering and subsequent removal from site. 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, and waste sludge skip are located inside the plant 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.

Reject Waste Stream Management

The liquid reject stream generated by Reverse Osmosis (RO) filtration is a by-product of all RO process, and in the case of the Milldale site, it is estimated that approximately 30% of the wastewater fed to the process will be produced as RO reject. While this reject stream contains contaminants that are blocked from passing through the RO membrane, it still meets Grade A+ recycled water standards for unrestricted municipal reuse, excluding drinking water applications.

Given that the quality of the RO reject is already higher than that of the effluent produced by the Army Bay Sewage Treatment Plant, this is considered a viable option for managing any surplus reject water. While returning the RO Reject stream to the Watercare network via a bespoke agreement is the preferred options, there are also several re-use and alternate discharge options available for some portion of the reject stream if required, including:

- Dual Reticulation: In this option, the RO reject stream will be distributed across the development for outdoor use, with each property having a dedicated, clearly labelled tap for irrigation or outdoor cleaning purposes.
- Landscape Irrigation: The RO reject stream will be used for irrigation in the development's reserve areas..
- Dust Control and Suppression: In this scenario, the RO reject will be collected in non-potable water tankers and used for dust suppression in subsequent stages of the development during periods of earthworks.

In all these scenarios, the RO reject will be stored on-site in a dedicated tank for either re-use or discharge to the Watercare network, ensuring that the reject stream is handled efficiently and sustainably.

Chemical Systems

The plant will incorporate the chemical systems detailed in Table 7 below.

Table 6 Chemical Systems

Chemical	Purpose / Details	Dose Point	Approx. Consumption
Acetic acid (49%)	Provides a carbon source for nitrogen removal.	Post Anoxic	150 L/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	50 L/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	100 L/month
Citric acid	Utilised for membrane CIP to remove inorganic scaling from the membranes	MBR tanks	100L/month

Treated Effluent Discharge

Options for Dealing with the Treated Wastewater

The wastewater treated by an MABR-MBR treatment plant is of such high quality that it meets World Health Organisation guidelines for bathing water and can therefore be reused for landscape irrigation and similar uses around the development.

While there are few standards in New Zealand for recycled water systems, the proposed system meets the requirements of Queensland Class A+ Recycled water suitable for dual reticulation and unrestricted municipal reuse. One example where treated wastewater is recycled and reused in the local area is at a golf course in the local Wainui where recycled water from an Apex Water MBR wastewater treatment plant is used to spray irrigate.

Discharge Options for the Milldale Wastewater Treatment Plant

Through engagement with local stakeholders and careful consideration of the current and future land uses surrounding the interim plant, FHLD-Woods proposes that the most suitable discharge option is to dose treated wastewater to a constructed land contact infiltration basin receiving only treated wastewater and providing land passage prior to entering the Waterloo creek. A further assessment of the options considered when proposing this solution and considerations can be found in the Assessment of Environmental Effects prepared by Woods supporting the overall resource consent application pack.

The land contact infiltration basin designed for this purpose is not required to achieve the standards outlined above and is proposed as part of consultation with Mana Whenua to 'enhance the Awa' or improve the overall ecology of the Waterloo Stream. The water quality discharged from the treatment plant is to a very high standard and any improvements in quality through the land contact infiltration basin will be marginal but nonetheless of benefit. Figure 38 and Figure 39 below shows the proposed infiltration basin...

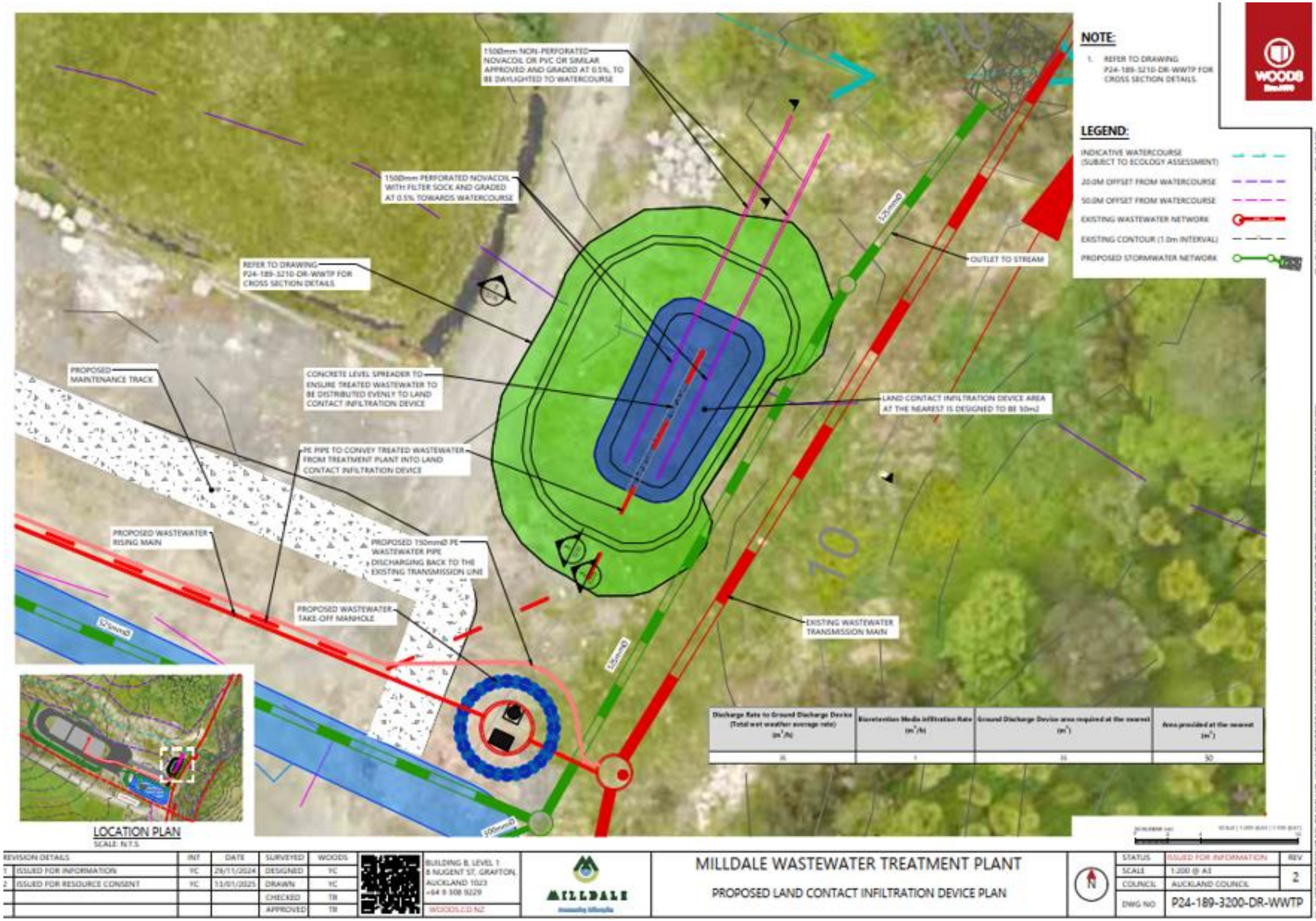


Figure 38 - Layout of the Proposed Land Contact Infiltration Basin

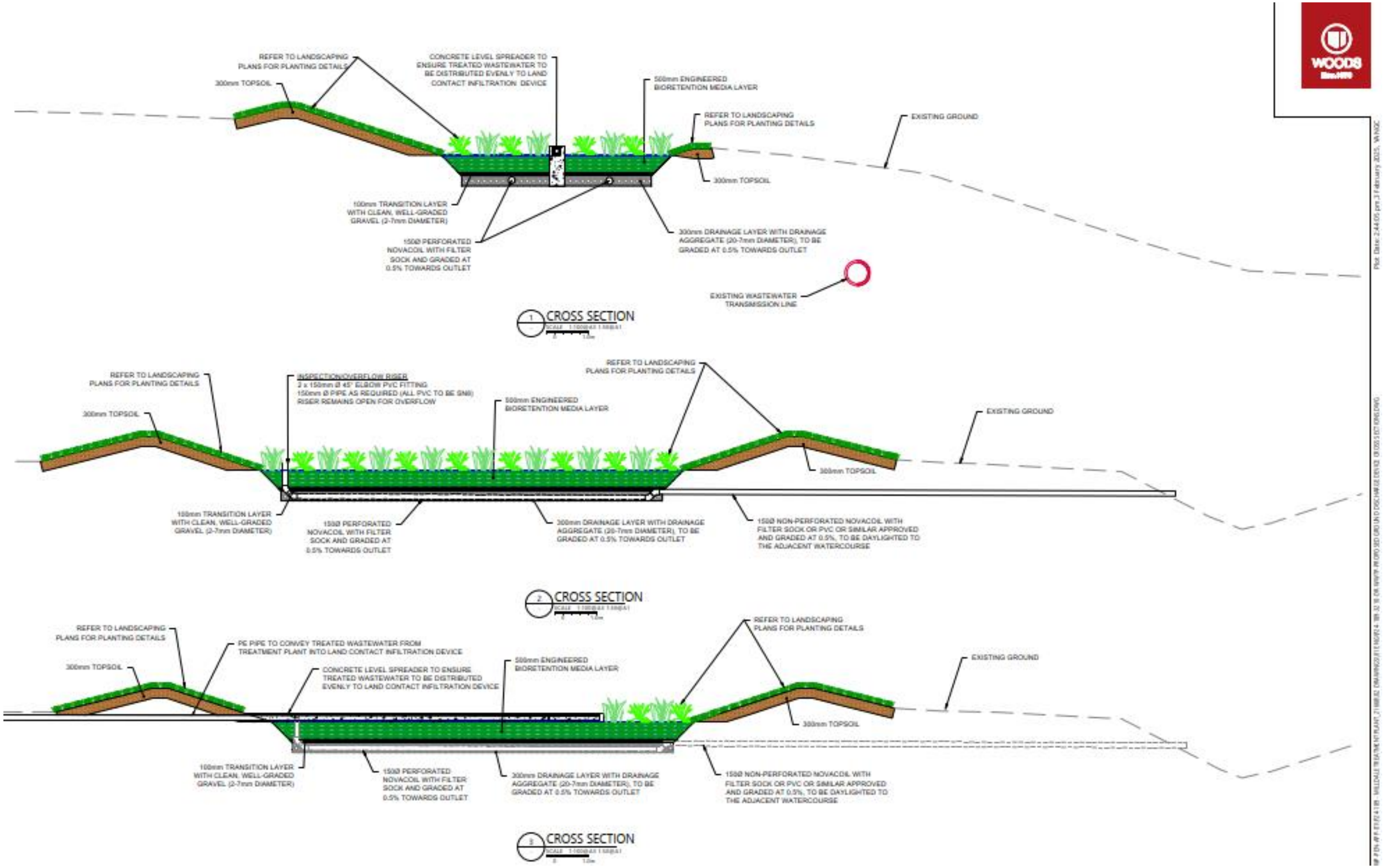


Figure 39 - Cross Section of the Proposed Land Contact Infiltration Basin

Treatment through the Land Contact Basin

It is known that biofiltration devices can play a key role in improving the quality of wastewater discharges through their natural filtration and biological processes. These devices contain ecosystems which can be highly effective at removing contaminants from water, making them an attractive option for stormwater management. Some 108 pond-based wastewater treatment plants with surface water discharges currently operate in New Zealand (Hunt, Walker, O.Neill, & Brockbank, 2021) on a similar basic principle.

While the Land Contact Infiltration basin designed to receive discharges from the proposed facility has not been designed with nutrient uptake or other supplementary processing in mind, it is known that biofiltration devices, containing a number of features in common with the basin proposed can provide additional treatment of discharges. Those with dense vegetation or with subsurface flow through porous media such as gravel provide filtration of suspended solids and particulate matter from the treated wastewater. The plants, such as reeds and cattails filter the water, trapping particles and debris as the water flows through the natural treatment device.

While the MABR-MBR-RO treatment plant proposed provides a permeate which is significantly lower in nutrient concentration than what is achievable from any natural treatment process alone, these systems can also be highly effective at removing excess nutrients, such as nitrogen and phosphorus, which are common in wastewater. They achieve this through the same processes, albeit less effectively that occur in the nitrification/denitrification process central to the MABR-MBR treatment plant.

A graphical representation of how a biofiltration device functions to polish and remove contaminants from wastewater discharges can be seen in Figure 15 below, as taken from the NIWA’s Constructed Wetland Practitioner Guide.

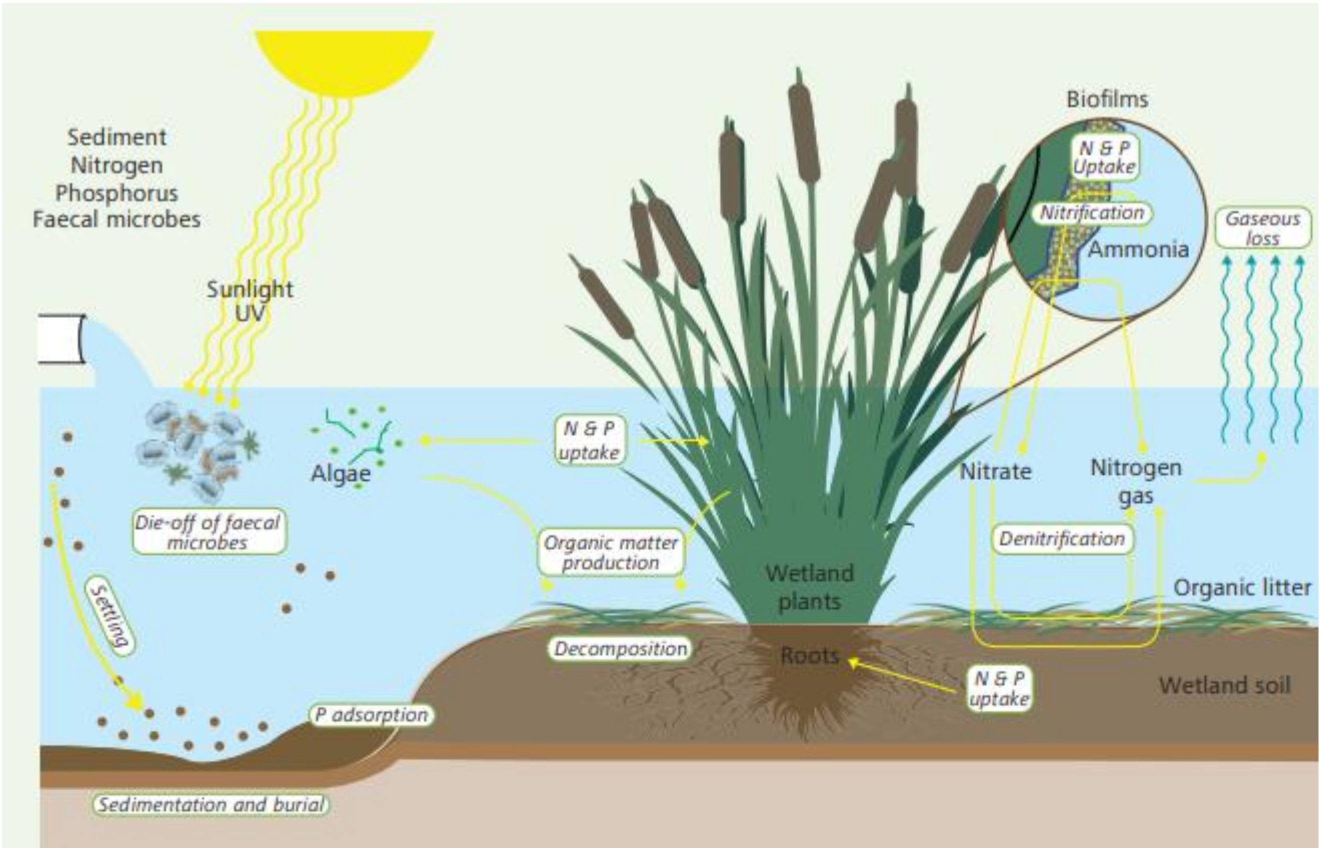


Figure 40 - How a Biofiltration device improves water quality (NIWA, 2022)

As previously detailed, the MABR-MBR-RO treatment process is exceptionally efficient at reducing nutrient concentrations and removing pathogens and solids from wastewater. The treatment process will achieve treated wastewater quality that is orders of magnitude higher than could be achieved by any natural biological-based treatment system. Taking this into consideration, it is unlikely that the land contact infiltration basin receiving the permeate discharged from the treatment process will be providing any further nutrient reduction. As such, it has been assumed as providing no further treatment for the purpose of assessing the effects of the discharge on the receiving environment.

Table 5 - Expected Treated Effluent Concentration

Parameter		Proposed Treated Water Quality Median
$cBOD_5$	mg/L	0.5
TSS	mg/L	4
TN	mg/L	1
TP	mg/L	0.07
AMM-N	mg/L	0.3
E. Coli	MPN/100mL	<4

Cultural Impacts

While the technical environmental impact of discharges from wastewater treatment plants may be able to be managed through the design and operation of state-of-the-art treatment processes, cultural and spiritual impacts may not. This is one of the core tenets of the National Policy Statement for Freshwater Management 2020 (NPS-FM) which takes a holistic approach to the management of freshwater resources in New Zealand. This holistic approach can be seen within the Milldale project settling through the technology selected and the discharge system proposed. While the proposed land contact infiltration basis discharge pathway will have minimal measurable impact on the quality of the final discharge into the Waterloo Creek, the proposal to utilise an infiltration basin which provides land passage and a naturalised discharge into the Waterloo creek has been developed in conjunction with key stakeholders to treat the Waterloo creek and surrounding ecology with the care and respect.

The framework for the management of freshwater resources detailed with the NPS-FM adopts a holistic approach, prioritizing the health of waterways and ecosystems, followed by the needs of people, and finally the social, economic, and cultural well-being derived from these natural resources (Hunt, Walker, O.Neill, & Brockbank, 2021). A key element of this approach is the explicit requirement to manage freshwater in a manner that upholds Te Mana o te Wai. In their report on the NPS-FM 2020, Hunt, Walker, O'Neill, and Brockbank briefly describe Te Mana o te Wai as:

"…a holistic concept that refers to the fundamental importance of water and recognises that protecting the health of freshwater supports the health and well-being of the wider environment." (Hunt, Walker, O'Neill, & Brockbank, 2021)

One of the important distinctions to make in the brief description detailed above is the presentation of the term's 'health' and 'well-being,'. Taking a holistic view of these terms from the perspective of giving effect of Te Mana o te Wai requires an understanding of the deeper and spiritually connected meanings health and well-being hold within Māori world views. To this end, Woods-FHLD have meet and discussed the proposed wastewater treatment plant and discharge system, as well as the broader impact of the development through a number of engagement sessions with local kaitiaki to understand what giving effect to Te Mana o te wai means to impacted iwi in the Milldale project settling and to work collaboratively in providing a solution.

RESULTANT SURFACE WATER QUALITY

An assessment of environmental effects from the treated wastewater discharge has been carried out by Babbage and is presented in the Discharge Assessment Technical Report included in the Assessment of Effect supporting the consent application. This assessment has conservatively assumed that treated wastewater that has passed through the treatment plant will discharge into the land contact infiltration basin where it will permeate through the drainage bed and after land contact will ultimately end up in the Waterloo Creek. 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 conservative representation of summer. In stream flows are naturally reduced due to dry conditions.

Scenario 2 – A representation of average conditions.

Scenario 3 - An extreme representation of winter conditions. In stream flows are naturally higher due to wetter conditions.

A summary of these scenarios and a description of the effects are outlined in Table 7 below.

Table 7 - Summary of Findings of the AEE

Scenario –	In Stream Flow	Treatment Plant Discharge Flow	Description of Effect
1 - A conservative representation of summer	3,974 m3/day	675 m3/day	In all scenarios, the water quality at Waterloo Creek is expected to improve, with concentrations projected to be below or equal to the current Waterloo Discharge site levels or to remain in the same attribute state as before (e.g., for ammonia and nitrate attribute states). Note that TSS and E. coli concentrations decreased, while nitrate, TN, TP, and cBOD5 remain stable.
2 - Average Conditions	4,882 m3/day	675 m3/day	In all scenarios, the water quality at Waterloo Creek is expected to improve, with concentrations projected to be below or equal to the current Waterloo Discharge site levels or to remain in the same attribute state as before (e.g., for ammonia and nitrate attribute states). Note that TSS and E. coli concentrations decreased, while nitrate, TN, TP, and cBOD5 remain stable.
3 – A conservative representation of the winter season	9,504 m3/day	829 m3/day	In all scenarios, the water quality at Waterloo Creek is expected to improve, with concentrations projected to be below or equal to the current Waterloo Discharge site levels or to remain in the same attribute state as before (e.g., for ammonia and nitrate attribute states). Note that TSS and E. coli concentrations decreased, while nitrate, TN, TP, and cBOD5 remain stable.

IMPACTS OF CHANGING LAND USE

Although the potential effects have not been specifically quantified in the technical assessment conducted by Babbage as provided in Assessment of Effects supporting this consent application, it is anticipated that the land use changes associated with the Milldale project in the areas surrounding the wastewater treatment plant will have a net positive impact on the condition and quality of the local surface water environment. Modifications such as the removal of livestock, cessation of supplementary fertiliser application, and clover fixation are expected to reduce nitrogen levels in the soil, thereby decreasing leaching and runoff into nearby surface water sources on the site.

The National Institute of Water and Atmospheric Research (NIWA) highlights on their website, which provides resources and tools for farmers, that the primary source of nutrients and pathogens entering waterways on farms is animal faecal matter and urine…
(National Institute of Weathe and Atmospheric Research (NIWA), 2024). Waterways in New Zealand are highly sensitive to the presence of nutrients and pathogens, which can enter them through direct stock access or during heavy rainfall events. During such periods, rainwater can wash contaminants like faecal matter, urine, and fertiliser directly into waterways. Pathogens can significantly degrade water quality, rendering it unsuitable for recreational activities such as swimming and potentially contaminating downstream food sources. Nutrients like nitrogen can disrupt the ecological balance of these systems, affecting both plant and aquatic life.

Approximately 30% of the nitrogen consumed by dairy cows is converted into milk and meat. While a small portion is lost to the atmosphere, the majority of nitrogen is returned to the soil (DairyNZ, 2013). This nitrogen can potentially enter waterways or groundwater through surface runoff or by leaching through the soil profile. When there is excess nitrogen in the soil and plant uptake is limited, it is converted to nitrate by soil bacteria. Although nitrates are beneficial for plant growth, they are highly soluble and mobile. In surplus, nitrates are prone to leaching below the root zone, potentially reaching groundwater. A simplified representation of the nitrogen cycle is shown in Figure **41**.

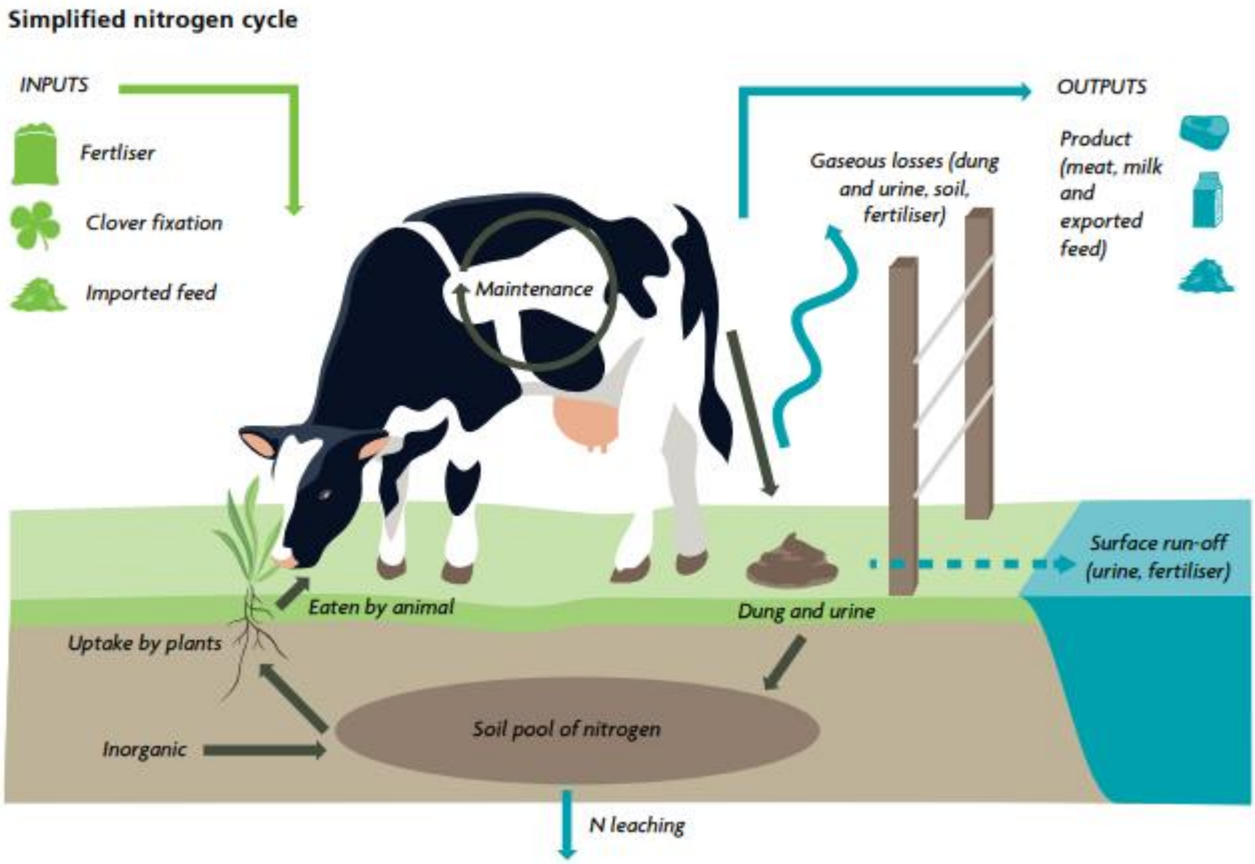


Figure 41 - Nitrogen Cycle (DairyNZ, 2013)

ODOUR MANAGEMENT

ODOUR SOURCES

By virtue of its nature, the wastewater fed into the treatment process has the potential to generate offensive odours. Odour from raw sewage is primarily generated through the decomposition of organic matter by microorganisms in the wastewater. When raw sewage enters the wastewater network, it contains a variety of organic materials, such as food waste, human waste, oils, and other substances. Due to the lack of external sources of oxygen any latent dissolved oxygen with the raw sewage is quickly consumed leaving the breakdown of sewage to occur in anaerobic (oxygen-deprived) conditions.

As organic material decomposes, it produces several gases, some of which are responsible for the foul odour. These gases include:

1. Hydrogen Sulphide (H2S) – Often described as having a rotten egg smell, hydrogen sulphide is produced when sulphur compounds in organic matter are broken down by anaerobic bacteria.

2. Ammonia (NH3) – Ammonia is produced from the breakdown of nitrogen-containing compounds found in human waste and other organic material. It has a sharp, pungent odour.

3. Methane (CH4) – Methane is a colourless, odourless gas, but it can be associated with raw sewage due to the overall decomposition process.

The generation of odour is intensified by long residence times in conveyancing networks, which is compounded by poor ventilation or stagnant conditions. Effective sewage treatment, aeration, and proper system design are essential in controlling and mitigating these odours. While mitigation of the conditions which lead to the generation of offensive odours is not possible in the network leading to the treatment plant, they can be controlled through the treatment steps. 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 8 - Odour Sources and Mitigations

Treatment Process	Potential Odour Source	Mitigation Measure
Headworks screens	Potential of the raw sewage and screenings in this system to release offensive odours due to anaerobic decomposition in the conveyancing network feeding the plant.	The system (including screening bins) is fully enclosed and connected to the odour extraction network. The main site odour extraction network maintains a negative pressure on the headworks system that ensures any odour is captured and transferred to the odour control unit for treatment prior to discharge.
Pre-Anoxic Tank	Raw screened sewage is fed into this tank from the Balance tank	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.
Post Anoxic tank	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 within the wastewater network feeding into the treatment plant cannot be fully controlled, necessitating the installation of infrastructure designed to capture and treat these potential odours. An odour control system is employed to eliminate or neutralise offensive odours and other contaminants extracted from the facility. Air collected from enclosed spaces—such as those housing equipment or liquids with the potential to generate offensive odours—is typically directed to the odour control system. These enclosed spaces are maintained under negative pressure, ensuring that any fugitive odours are extracted and transported to the odour control unit.

A summary of the common odour control technologies used in industrial applications, along with their respective advantages and disadvantages, is provided in Table **9** below.

Table 9 - 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 (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.	• Well-established technology. • Low capital and operating cost.	• Treatment can fail if the moisture and pH of the bark bed is not kept within the optimum range. • Larger biofilters can be 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	• System relies on physical adsorption, so is more robust and reliable than biological oxidation.	• Higher capital and operating costs than a biofilter. • Carbon bed requires replacing every one to three years.

	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.		
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.

ODOUR CONTROL SYSTEM – PROCESS SELECTION

Through an assessment of the advantages and disadvantages of each common odour control system detailed in Table **9** 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 process that is easily designed, constructed and operated.

AIR DISCHARGE ASSESSMENT OF EFFECTS

An Air Discharge Assessment was carried out by Air Matters to investigate the potential impact of any odour generated by the wastewater treatment plant which can be found in the Assessment of Environmental Effect supporting this report. In this assessment of effects Air Matters conclude that:

'Based on the assessment and the design of the WWTP, the potential effects on amenity values on the surrounding land use are considered to be acceptable and remain less than minor for the duration of the consent.'

The air discharge assessment did conclude that while wastewater treatment plants have the potential to generate odours, the generation of these beyond the boundaries of the site is not expected to occur due to the plant design and process mitigations employed as proposed in Table 8, above. The key mitigations proposed include the following:

- An odour control unit of appropriate design that will continuously abstract and treat vapours from areas of the process handling wastewater in potential odorous condition.
- The majority of equipment handling raw wastewater shall be housed indoors, in a treatment plant building whose environment is abstracted to an odour control unit.
- Monitoring of dissolved oxygen concentration or Oxidation-Reduction potential in specific portions of the process to ensure anaerobic conditions which lead to the formation of odorous compounds to not occur
- Duty/Standby aeration blowers, ensuring redundancy in the treatment equipment required to mitigate the formation of odorous conditions
- Back-up generator to be located on site which shall automatically start in the event of a loss of power to ensure that in that aeration and process monitoring can continue uninterrupted.
- Sewer Harvesting from a larger sewer means that there is no requirement for the accumulation of raw sewage on site in the event of a power failure, or during peaking events.

The Air Discharge Assessment was complimented with a site visit to the Watercare operated Meremere Wastewater Treatment Plant, also designed and built by Apex Water. The Meremere site does not have an odour control unit, all equipment handling raw sewage is located outdoors and there is a raw sewage receival tank which is open topped and allows for the accumulation of raw sewage which can transfer odour to the surrounding air. In light of this, due to the design of the plant and the monitoring off process conditions, the odour generated by the Meremere site with none of the mitigations detailed above, as assessed at 45m was described as 'weak; and the frequency was intermittent. These findings are further detailed in the Air Matters report included in the Assessment of Effects supporting this report.

-

OPERATION INTO SERVICE

The commissioning of biological nutrient reduction processes can be complex, requiring expert technical oversight from personnel experienced in both their design and operation. With the core nutrient reduction process being biologically driven, a sufficient concentration of biomass (bacteria) is necessary to consume the contaminants present in the raw wastewater. The generation of biomass can only be developed through the controlled introduction of wastewater, supplementary food sources and maintaining conditions suitable for growth.

The proposed wastewater treatment plant has the benefit of having wastewater of sufficient volume and quality available immediately after being brought into service. This mitigates many of the difficulties associated with commissioning new plants servicing networks with few connections during early stages and hence operating far beneath their design capacities. Based on Apex's experience, it typically takes up to two months, or potentially longer after the initial receipt of wastewater to develop adequate biomass in a seeded and supplementary fed biological treatment process. The exact time required will depend on several factors.

Biomass within wastewater treatment processes thrives under optimal conditions. If these conditions are disturbed, the biological processes may underperform, become stressed, or even fail to effectively remove nutrients from the wastewater. During commissioning, operational adjustments will be made to ensure the correct conditions are maintained to support healthy biomass and promote its growth.

Several factors can influence the health of the biomass, including:

- Insufficient organic matter (carbon-based contaminants) in the raw wastewater to sustain existing biomass and allow for growth. This should not be an issue for this site as wastewater is drawn from an existing network servicing a mature catchment.
- Excessive organic matter in the raw wastewater relative to the available biomass. This will need to be managed carefully during the early stages of commissioning
- Insufficient alkalinity to support required nutrient reduction levels. These will be monitored, and supplementary alkalinity shall be dosed into the system.
- Insufficient dissolved oxygen concentration to support biological processes.

- Inappropriate biomass average residence time within the system, either too high or too low. This will be tightly monitored and controlled and is the key to ensuring the correct level of treatment

Due to the staged and modular nature of the proposed biological treatment process, an increase in plant capacity through future upgrades will require additional engineering oversight to ensure the process can support increased flows and nutrient loading.

Appendix 1 – Draft Environmental Management Plan

Environmental Management Plan

Milldale Wastewater Treatment Plant

PROJECT NUMBER: XXXX

Revision 1
17 March 2025

CONTENTS

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 Fulton Hogan Land Development 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.

Apex Water have been engaged by Fulton Hogan Land Development to design and build the treatment infrastructure, including chemical storage and handling facilities. This letter and the associated Environmental Management Plan appended has been prepared to fulfil Condition XX of consent BUNXXXXXXXXX.

Description of Site Activities

The development of the Milldale Wastewater Treatment Plant has been driven by the need to provide wastewater treatment infrastructure to the Milldale 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)

**- 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 Milldale site entering the local environment.

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

Activity	Pollution Risk	Contaminants
Unloading of chemicals	Spillage	Elevated pH, ecotoxic effects
Storage of chemicals	Spillage	Elevated pH, ecotoxic effects
Use of chemicals in the WWTP	Spillage	Elevated pH, ecotoxic effects
Storage of WAS and dewatered WAS	Spillage	Biochemical oxygen demand, bacterial contamination, ecotoxic effects
Diesel storage within backup generator including refuelling	Diesel spillage	Ecotoxic effects
Disposing of contaminated rainwater in secondary containment systems to sensitive environments	Spillage	Elevated pH, ecotoxic effects

-

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

Figure 3 –Bulk chemical storage locations

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

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

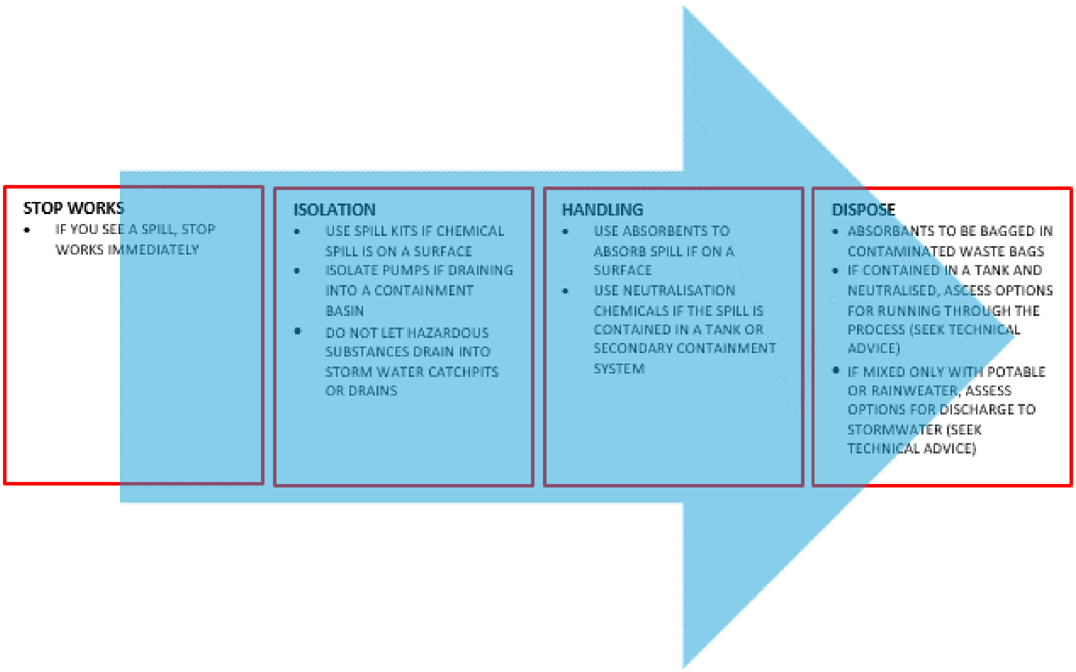
Handling

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

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.

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.

	Spill response plan will be in place, including spill kit provisions on site.			
Hose rupture or spill during delivery of bulk ecotoxic liquids to site	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. Hoses, connections, and fittings associated with hazardous substance delivery are appropriately selected, tested and maintained. 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.	Unlikely	Minor	Low
Fire in diesel generator fuel tank	Emergency Response Plan will be in place with provisions for response including fire extinguishers. Segregated location away from other hazardous substances. Ignition exclusion zone in place to avoid ignition sources in proximity to the generator. Separation of generator location from site boundary, buildings and neighbours.	Unlikely	Minor	Low
Tank overflow or rupture during refilling of diesel generator fuel tank	Tank refilling will be undertaken by trained delivery contractor. Spill response plan will be in place, including spill kit provisions on site.	Unlikely	Minor	Low
Hose rupture during transfer of diesel from stationary tank to generators	Appropriate selection, testing and maintenance of hoses and connections used for transfers. Tank refilling will be undertaken by trained delivery contractor. Spill response plan will be in place, including spill kit provisions on site.	Unlikely	Minor	Low

Appendix A

Appendix C

Appendix 2 – Draft Operations and Maintenance Manual

APEX WATER

OPERATION AND MAINTENANCE MANUAL

MILLDALE WASTEWATER TREATMENT PLANT

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

2 PROCESS OVERVIEW

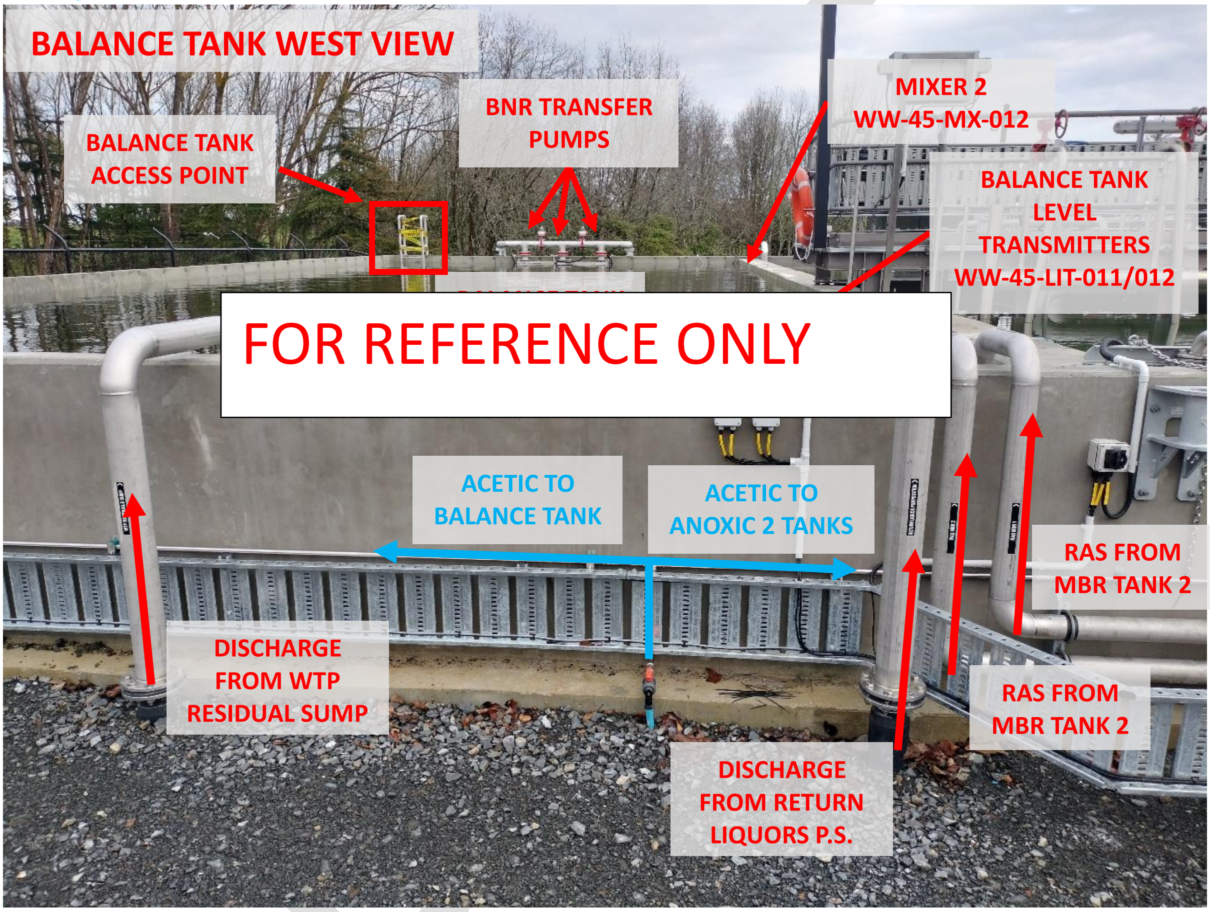
The following provides a brief overview of the control philosophy. Refer to the Functional Description and P&IDs for further detail.

3 PLANT OVERVIEW

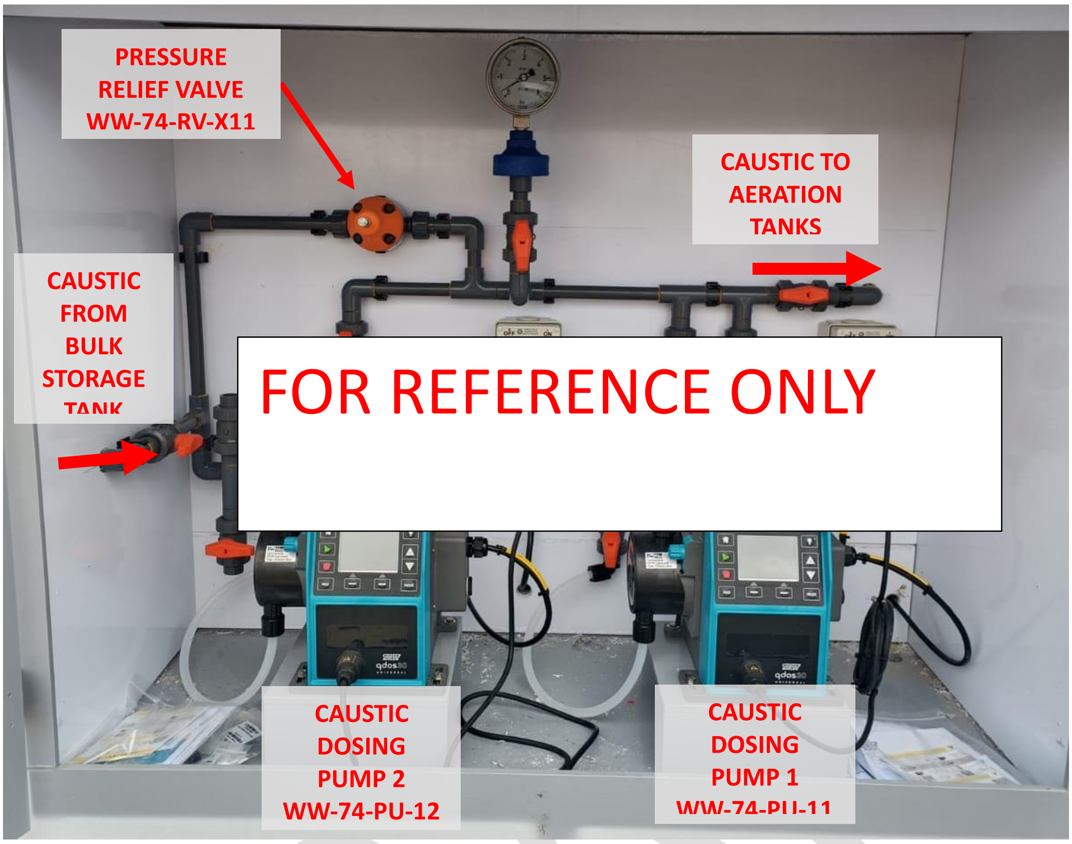
SOME IMAGES HAVE BEEN SHOWN FOR REFERENCE ONLY

Plant inflow:

Biological Treatment Tanks:



Caustic Dosing Cabinet



Acetic Acid Dosing Board

Sodium Hypochlorite (Hypo) Dosing Board:

Chemical Load out Bay:

Site generator:

MCC and switchboard:

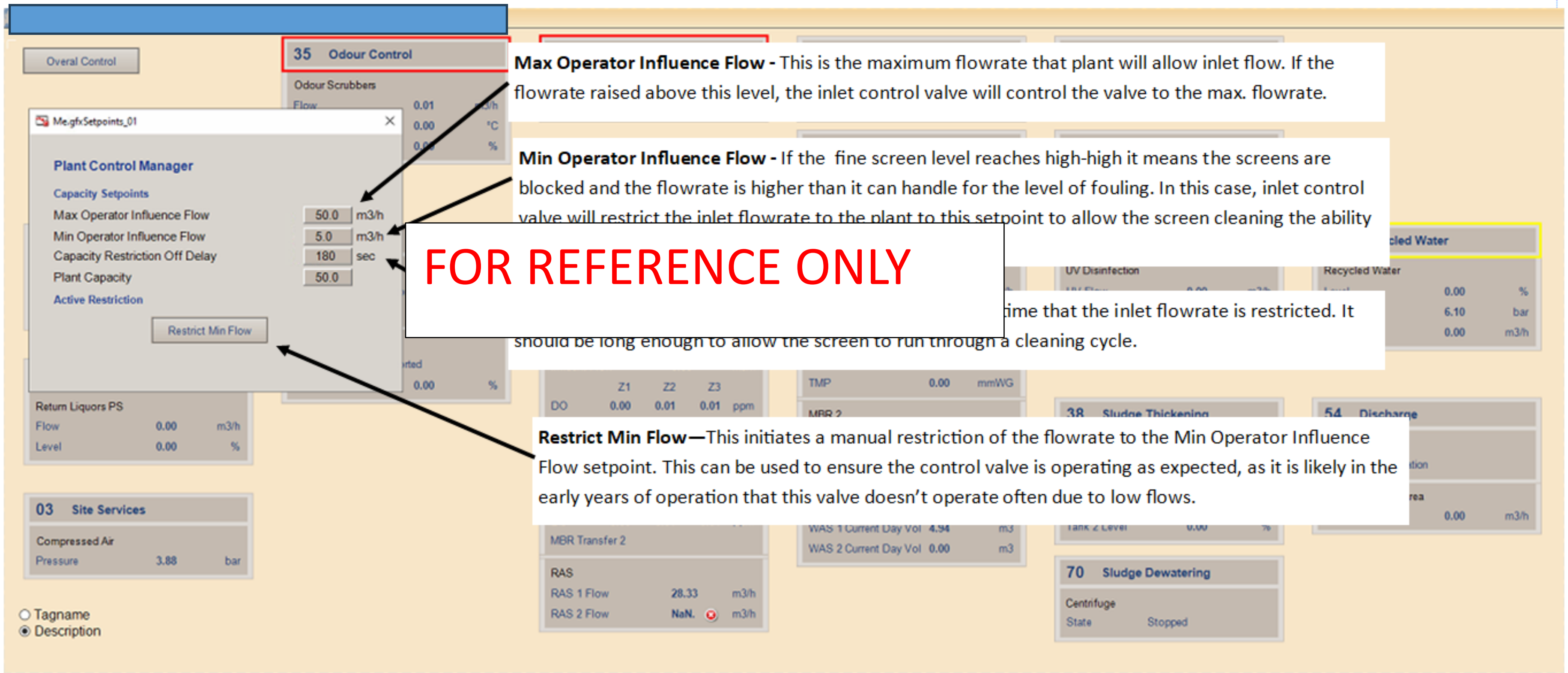
Odour Control:

Navigating the home page:

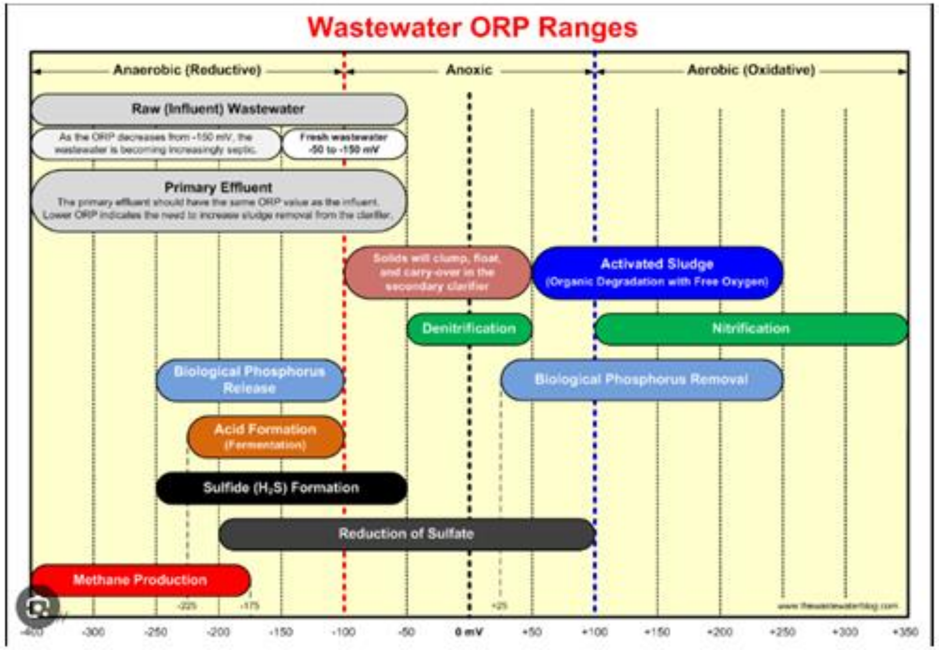
Overall Plant Control Setpoints:

INFORMATION FOR REFERENCE ONLY

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



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:

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

5 FUNCTIONAL DESCRIPTION

- 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.

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
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 __________________

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 ___________________

Task	Description	Checked/Value
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3.	Calibrate the aerobic tanks' DO probes	
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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 ___________________

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
17.	UV unit interlocked.	•
18.	Process water not available (no hose water or water to the screens and sludge decanter)	•

Appendix 3 – Draft Odour Management Plan

Operations and Maintenance Manual – Odour Control

Milldale WwTP

PROJECT NUMBER: XXXXXX

Revision 1
25 March 2025

CONTENTS

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 Fulton Hogan Land Development for the discharge of non-hazardous vapours to the air which are associated with to the operation of wastewater infrastructure.

Apex Water have been engaged by Fulton Hogan to design and build the treatment infrastructure, including odour control infrastructure to remove any odours from resultant discharges to air associated with the operation of the wastewater treatment plant. This letter and the associated Operations and Maintenance Manual – Odour Control appended has been prepared to fulfil Condition XXX of BUNXXXXXXXX.

systems used to support the addition of dissolved oxygen into the process, as well as those to monitor the dissolved oxygen to identify odour generator conditions have been designed with in-built redundancy and failure protection. The main sources of odour generation and release are the handling of raw sewage and the processing of waste activated sludge (WAS).

Raw Sewage Handling

Raw sewage enters the treatment plant from a pump station located adjacent the existing gravity sewer servicing the Milldale community. Due to the length and size of the network and the fluctuating number of households connected to the network, the time that the sewage remains within the network, known as its retention time, will vary over time. When the retention time of the sewage within the network is high, there is more time for dissolved oxygen, or molecular oxygen to be consumed by bacteria. Once the available oxygen levels are low, anaerobic conditions may form, generating odour. For this reason, the wastewater screens which are handling the raw sewage entering the treatment plant are considered an area of having high potential for odour generation.

Waste Activate Sludge Processing

The single most important design and operational parameter effecting the performance of an activate sludge biological process is solid retention time, or the controlled wasting of activated sludge. The Milldale wastewater treatment plant provides the conditions required for the growth of the bacteria which consume nutrients within the waste stream. Optimal performance of the treatment process is typically obtained when the concentration of sludge is maintained at a desired level. This is achieved by the regular removal of bacteria, in the form of sludge. By regularly removing bacteria, the sludge age i.e. the time bacteria can spend reproducing within the process, is limited. The benefits of managing this solids retention time are improved performance, reduced foaming, improved sludge settling characteristics and improved downstream thickening.

The handling and downstream thickening of wasted sludge is considered an area of having high potential for odour generation. The settling of sludge within the WAS tanks provides conditions where through prolonged periods of retention, anaerobic conditions have the potential to form. Similarly to the retention time within the network, this prolonged period of settling could provide the conditions for the complete reduction in dissolved or molecular oxygen and the formation of odour generating anaerobic conditions.

3.2. Potential Odour Sources

Although the main sources of potential fugitive odours are associated to both the handling of raw sewage and the processing of waste activate sludge, there are a number of other areas, which given the right process conditions could become sources of fugitive odour, these include:

- The raw sewage inlet screens
- The skip bins which accumulate screenings from the inlet screens
- The decanter centrifuge
- The skip bin which stores dewatered waste activated sludge
- The return liquor pump station
- The main plant room, housing inlets screens and the decanter centrifuge
- The waste activated sludge settling tanks.
- The biological treatment process
- The odour control unit

Figure 1 – The location of various potential odour sources.

The Main Plant Room

As an additional protection against the escape of fugitive odours from the inlet screens and the decanter centrifuge and their respective skips, and to protect against the accumulation of fugitive odours, the volume of air maintained within the room is regularly turned over by maintaining it at a slight negative pressure. The air removed from the plant room is passed through the Odour Control unit to scrub any potential odorous compounds prior to being discharged. Figure 4 below, shows the location of the plant room.

Figure 4 – The main plant room is highlighted in red.

Waste Activated Sludge Settling Tanks

As outlined above, the principal approach to protecting against the generation of release of fugitive odours from the WAS tanks, is the continued forced aeration of any accumulated sludge. While the nitrification and denitrification of this waste stream is not important, the goal here is only to maintain sufficient aeration to avoid anaerobic conditions. As a secondary protection against the escape of odours, the head space of these tanks are maintained under a negative pressure and are continuously extracted to the Odour Scrubber at a flowrate higher than the rate at which aeration air is introduced. The location of the Waste Activated Sludge tanks can be seen in Figure 1, above.

Biological Treatment Process

The design of the biological process presents various challenges relating to the mitigation of the anaerobic conditions required for the generation of displeasing odours while also maintaining the optimal conditions required for nutrient reduction. The nutrient reduction process is achieved by purposefully creating conditions that provide zones of high levels of dissolved oxygen and low levels of dissolved oxygen, as it is in these conditions that the bacteria which removes nutrients in the wastewater can reproduce. The biological treatment process is split into a number of difference treatment zones, whose conditions are monitored and controlled to ensure optimal treatment and mitigation of anaerobic conditions. These zones and the controls used are:

- Anoxic 1 Stage – Aerated water is continuously recycled from the aeration tank into the Anoxic 1 stage. This maintains levels of dissolved oxygen above those through which anaerobic conditions can form. As the anoxic treatment step purposefully drops these dissolved oxygen levels are a mechanism for nutrient removal, the Oxidation-reduction Potential (ORP) of the Anoxic 1 tank contents are continuously monitored. The ORP measurement of the tank can be used to directly infer the biochemical process which will dominate under the present conditions, and hence this is used to ensure anaerobic processes do not occur.

- Aeration Stage – The wastewater in this portion of the process undergoes forced aeration to provide the required dissolved oxygen levels for optimal treatment. The dissolved oxygen concentration in these tanks is monitored to provide controlled and targeted aeration rates. The control system will not allow the dissolved oxygen concentration in these tanks to drop below levels where anaerobic condition can form.

- Anoxic 2 Stage – The process conditions and controls are a replication of the Anoxic 1 Stage. The ORP of the Anoxic 2 Stage contents are monitored to ensure optimal performance while maintaining above mentioned conditions where anaerobic processes would not occur.

- Membrane Stage – This step is the final treatment step in the Biological Treatment process. The wastewater in these tanks, like the aeration tanks, undergoes forced aeration. This works

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.

3.3. Critical Spares

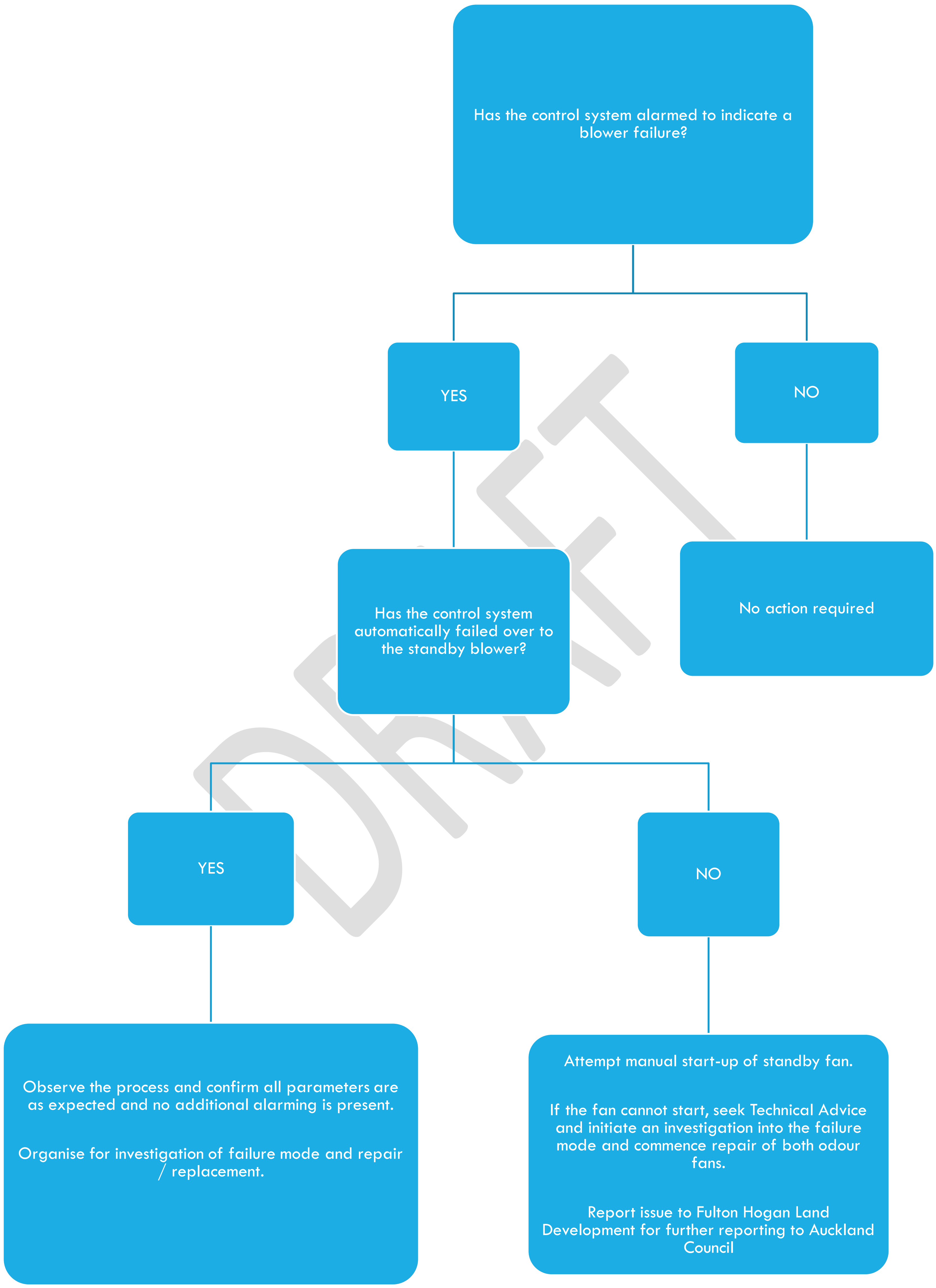
The following items have been identified as critical spares which must be held on site or must be regularly stocked items held by third parties, or by the Apex Water Service and Sales Team. Criticality is qualified by the item being necessary for the operation of any system that protects against fugitive odour generation or emission. Where redundancy has been built into the treatment plant, these items would not be considered critical as a back-up piece of equipment or instrumentation is already available. Where an item of equipment is required for compliance, but isn't required for the operation of the system, it is not considered a Critical Spare. Table 2 below, outlines the critical spares identified.

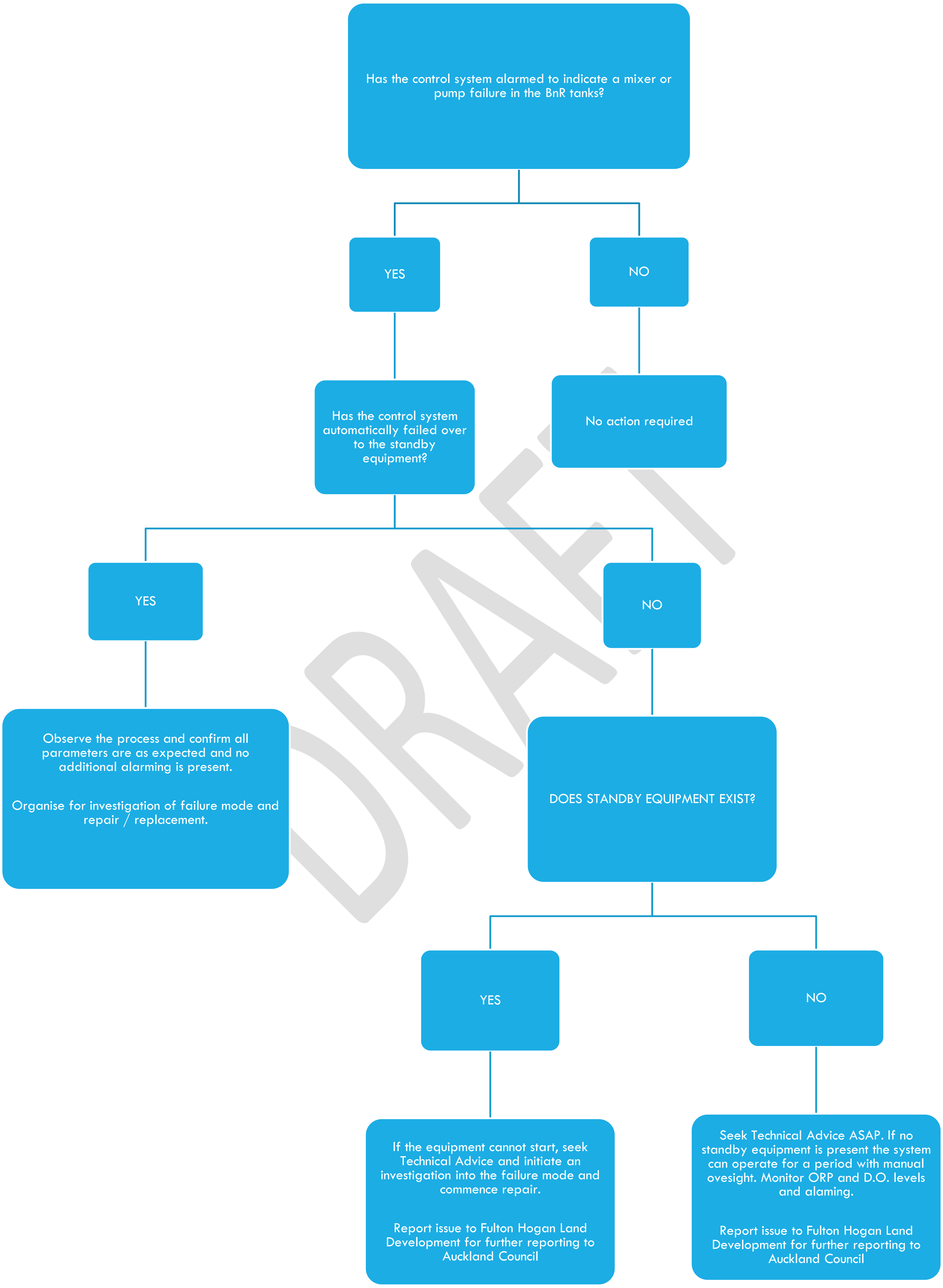
Table 2 – Critical Spares required for Odour Control.

Description	Location	Function	Requirement
Oxidation-reduction Potential probe	For use on either the Anoxic 1 tank	Monitoring of process conditions to ensure anaerobic conditions from occurring.	Spare probe held on site, or with service provider, at all times.

3.4. 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 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 Fulton Hogan Land Development 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 Fulton Hogan Land Development 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 Fulton Hogan Land Development for further reporting to Auckland Council

3.5. 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
		Continuous monitoring of: XXXXXX is carried out by the WwTP. These tags are recorded in SCADA and can be reported through the Query Manager. In addition to this, residence time and flow velocities through the carbon beds are calculated and recorded in the Query Manager for reporting, as required.
		The Oxidation-reduction potential of the anoxic balance tank is continuously monitored with alarming for outside normal parameters. XXXXXXXX The SCADA records the ORP continuously in the anoxic balance tank. Using the Query Manager to provide a history of ORP levels in the anoxic balance tank reflects the conditions. The DO concentration of the aeration tanks is measured, the instruments are linked to SCADA and using the Query Manager, a historical review of DO concentrations can be retrieved to demonstrate compliance.

3.6. Personnel Training and Induction

Personnel operating the wastewater treatment plant on the Milldale 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.

3.7. Responding to Complaints

As a general rule, Apex Water shall not respond to complaints directly. Complaints shall be handled by Fulton Hogan Land Development 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 Fulton Hogan Land Development. 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.

3.8. 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.

3.9. 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 Fulton Hogan Land Development.

APPENDIX B

Appendix 4 – Draft Emergency Response Plan

Emergency Response Plan

Milldale Wastewater Treatment Plant

PROJECT NUMBER:

Revision 1
17 March 2025

CONTENTS

17 May 2024

Lead Compliance Officer – Southern 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 by Fulton Hogan Land Development 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.

Description of Site Activities

The development of the Milldale Treatment Plant has been driven by the need to provide wastewater treatment infrastructure to the Milldale 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)

Emergency Type	Hazard	Scenario	Consequence	Location	Potential Offsite Effects	Control
				Return Liquor Pump Station		**Administrative Controls** Permit to work procedure for confined space entries which includes specific planning (JSA, rescue plan, specialist equipment etc.) Specialist training requirement for entry into, or in support of an entry **Personal Protective Equipment** Personal Protective Equipment available and on site, as prescribed by the MSDS or task assessment.
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*	**Engineering Controls** All potential sources of hydrogen sulphide are covered and kept under negative pressure and extracted to the odour control system. Workspaces containing equipment handling potential sources of hydrogen sulphide are maintained under negative pressure. Online Hydrogen sulphide monitoring is carried out via a gas detector with alarming. **Administrative Controls** Procedures for entering spaces where hydrogen sulphide may exist in the event of alarming. Signage on the entrance to the plant room identifying risks and responses. Induction covering risks, controls and appropriate responses in the event of alarming. **Personal Protective Equipment** Personal Protective Equipment available and on site, as prescribed by the MSDS or task assessment.
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.	Residuals Pump Station, Return Liquor Pump Station	N/A*	**Engineering Controls** Duty/standby pump configuration with automatic fail over to standby pump for both pump stations to minimise the requirement for emergency works. Davit arm with pumps on guide rails, allowing for removal of pump and inspection without entering the tank. **Administrative Controls** Permit to work procedure for confined space entries which includes specific planning (JSA, rescue plan, specialist equipment etc.) Specialist training requirement for entry into, or in support of an entry **Personal Protective Equipment** Personal Protective Equipment available and on site, as prescribed by the MSDS or task assessment.
Injury to Personnel (On-site)	Accumulation of Hydrogen Gas.	Confined Space Entry (Sodium hypochlorite tank).	Harm to personnel with the potential to cause long term injury, disability or death.	Sodium Hypochlorite tank	N/A*	**Engineering Controls** Forced ventilation on the Sodium hypochlorite tank which runs on after a production cycle to ensure the headspace is clear of any gas. **Administrative Controls** Permit to work procedure for confined space entries which includes specific planning (JSA, rescue plan, specialist equipment etc.) Specialist training requirement for entry into, or in support of an entry. **Personal Protective Equipment** Personal Protective Equipment available and on site, as prescribed by the MSDS or task assessment.
Injury to Personnel (On-site)	Accumulation of Hydrogen Gas.	Accumulation in the working areas (OSEC Room).	Harm to personnel with the potential to cause long term injury, disability or death.	OSEC Room	N/A*	**Engineering Controls** Forced ventilation of the OSEC room during the operation of the OSEC unit with run on timer. This ventilation unit has feedback to confirm operation of the ventilation fan which will interlock the unit if not received.

Emergency Type	Hazard	Scenario	Consequence	Location	Potential Offsite Effects	Control
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*	**Administrative Controls** Certificate of Conformity to be issued on the electrical installation. All works on live, open or exposed electrical equipment to be carried out by an electrician. **Personal Protective Equipment** Task specific PPE required as set out within the job safety assessment.
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*	**Engineering Controls** Moving parts on the inlet screen are all contained within the unit, with automatic electrical isolation in the event of a hatch opening. **Administrative Controls** Lock out / tag-out procedure for works on moving equipment. **Personal Protective Equipment** Task specific PPE required as set out within the job safety assessment.
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*	**Engineering Controls** Walkways on site to direct foot traffic to areas with minimal hazards. **Administrative Controls** Induction to brief requirements for traffic movements on site and pedestrian accessways. **Personal Protective Equipment** Site general PPE to be required included high visibility PPE.
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	**Engineering Controls** Certificate of Conformance on the electrical install. Fire alarms located in each space with feedback to the treatment plant PLC, alarming locally and if out of hours sending a message to the operator via SMS. **Administrative Controls** Emergency Response Plan Induction to brief personnel on site of response in the event of a fire.
Environmental Disaster	Earthquake, Tsunami	Environmental Disaster	Harm to personnel with the potential to cause long term injury, disability or death.	Site Wide	N/A*	**Engineering Controls** Importance Level Design 3 for the Wastewater Treatment Plant.

* - Environmental offsite effects covered under the Environmental Management Plan

** - As the presence of Chlorine gas and the ability to pump into the Sodium hypochlorite from anywhere but the Sodium hypochlorite generation unit tank is not present, this has been excluded from any specific Emergency Response Planning. It has been left in this matrix for information purpose only.

- 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 station is for washing down hazardous substances off a person in the event of a chemical spill. There are X safety shower stations located on Milldale 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.

7. RESPONSE PLAN

GENERAL INFORMATION

Designated Emergency Assembly Point:The Main Gate

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.

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 Fulton Hogan Land Development after the emergency. The effectiveness of the emergency plan shall be reviewed. Fulton Hogan Land Development 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 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.

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.

Appendix A

Appendix 5 – Draft Environmental Monitoring Plan

Environmental Monitoring Plan

Milldale Wastewater Treatment Plant

PROJECT NUMBER: XXXX

Revision 1

26 March 2025

CONTENTS

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 Fulton Hogan Land Development for the Discharge of Treated Wastewater at ADDRESS into the receiving environment.

Apex Water have been engaged by Fulton Hogan Land Development to design and build the treatment infrastructure, including provision for the on-going monitoring of the receiving environment in line with Condition XX of consent BUNXXXXXXX . This letter and the associated Environmental Monitoring Plan appended has been prepared to outline the requirements of the consent, broad methodologies for conducting environmental monitoring and appropriate procedures for internal report of result for further actioning.

Monitoring Requirements

The consented requirements for the monitoring of discharges from the wastewater treatment plant, the monitoring receiving environment surface water quality and ecology are detailed below.

DISCHARGE QUALITY MONITORING

Condition 45 – Discharge Sampling

Discharge sampling must be carried out in accordance with the requirements set forth in Condition 45, as detailed below.

The consent holder must continuously monitor treated wastewater discharge flows and volume, with data linked to the WWTP Supervisory Control and Data Acquisition (SCADA) system. In addition, the Consent Holder must take 24-hour flow proportioned samples of the treated wastewater on a fortnightly basis from the treated wastewater compliance monitoring point(s) for the purposes of determining compliance with Condition 40. The parameters tested shall include those detailed within Condition 47. All wastewater quality analyses must be undertaken by an IANZ accredited or equivalent laboratory. All methods used must be appropriate for the wastewater analyses undertaken.

Advice note,

For the purposes of this condition, to determine compliance with consent limits in Condition XXX, no more than 12 samples out of any 24 consecutive fortnightly samples shall exceed the specified limit.

Condition 40 – Discharge Quality

The Discharge quality as sampled in line with Condition 45 must be as detailed in Condition 40, as detailed in the table below.

Parameters	*12-monthly median must not exceed*
Total Nitrogen [mg/L]	*1.0*
Ammoniacal Nitrogen (mg/L)	*0.3*
cBOD5 [mg/L]	*0.5*
Total Suspended Solids mg/L]	*4.0*
Total Phosphorus [mg/L]	*0.07*
Escherichia-coli [CFU/100mL]	*<4.0*
Enterococci [cfu/100mL]	*<4.0*

has resulted from the discharge. Water quality monitoring must be undertaken by a suitably qualified and experienced person, who must provide advice to the Consent Holder if results indicate the water quality has deteriorated because of the WWTP discharge.

Condition 52 – Receiving Environment Surface Water Quality Testing Parameters

The surface water quality must be tested for the parameters detailed in Condition 52, as outlined below.

All surface water quality samples must be tested for the following parameters:

- pH;
- Total Suspended Solids;
- Total ammoniacal nitrogen;
- Nitrate-nitrogen;
- Nitrite-nitrogen;
- Total nitrogen;
- Dissolved reactive phosphorous;
- Total phosphorous;
- Escherichia coli;
- Enterococci; and
- Soluble cBOD5.

ECOLOGICAL MONITORING AND ASSESSMENT REQUIREMENTS

Condition 55 – Ecological Monitoring Frequency

The ecology of the receiving environment must be monitored at the frequency outlined in Condition 55. This provides an on-going assessment of the ecology in the discharge location to monitor any changes over time that may be associated with the discharge, or alternately with change further up the Waterloo Stream catchment.

Following the commencement of the discharge from the WWTP, the Consent Holder must conduct ecology surveys on a yearly basis, during spring, at the same locations within Waterloo Creek immediately upstream and downstream of the discharge point from the Land Contact Infiltration Basin. Once the WWTP has been fully utilised at design capacity for a minimum period of two years, subject to council approval, the in-stream monitoring frequency may be reduced to once every three years if results indicate the ecological community has been unaffected by the discharge. Ecological monitoring must be undertaken by a suitably qualified and experienced person, who must provide advice to the Consent Holder if results indicate the water quality has deteriorated because of the WWTP discharge.

Condition 56 – Ecological Survey Requirements

The ecological surveys must at a minimum report on the items detailed within Condition 56, as detailed below.

All surface water ecology surveys must, as a minimum, meet the following requirements:

(a) Provide an assessment of fish and macroinvertebrate communities, physical habitat quality, macrophytes and periphyton;

(b) Must be undertaken by person(s) suitably qualified in freshwater ecology;

(c) Must not be undertaken within two weeks of a flood event; and

(d) Must report on any significant trends observed over time.

REPORTING AND ESCALATION

Apex Water does not hold consents associated with the operation of the wastewater treatment plant, as such it does not hold the relationship with the regional council for reporting.

Where Apex Water is responsible for the activities of contractors sampling, assessing, testing and reporting all reports and results shall be directed to the Fulton Hogan Land Development compliance contact for further reporting.

Result shall be shared immediately upon receipt with the FHLD compliance contact for review.

Where results require immediate attention, a supporting email or phone call shall be provided to the FHLD compliance contact to discuss the results. A supporting email after an investigation has been carried out shall provide additional information, where required.

Where results do not require immediate attention, whilst these shall be shared immediately with the FHLD compliance contact upon receipt, any comments can be withheld until the next internal compliance meeting which will be formalised for inclusion with the monthly operational report.