Whangārei WWTP Consenting

Master Plan Report

Whangārei District Council

15 October 2021

→ **The Power of Commitment**

GHD Limited [626860]
27 Napier Street, GHD Centre Level 3
Freemans Bay, Auckland 1010, New Zealand
T +64 9 370 8000 | **F** +64 9 370 8001 | **E** aklmail@ghd.comaklmail@ghd.com | **ghd.com**

Printed date	18/10/2021 8:17:00 am
Last saved date	18 October 2021
File name	https://projectsportal.ghd.com/sites/pp02_01/whangareiwwtpconsent/ProjectDocs/Master Plan Report/12528591-REP-Whangarei WWTP Master Plan Report.docx
Author	Danielle Maynard
Project manager	Sarah Sunich
Client name	Whangārei District Council
Project name	Whangārei WWTP Consenting
Document title	Whangārei WWTP Consenting | Master Plan Report
Revision version	Rev 1
Project number	12528591

Document status

Status Code	Revision	Author	Reviewer		Approved for issue		
			Name	Signature	Name	Signature	Date
S4	0 – Draft for client comment	D Maynard	I Ho S Sunich	[signature]	A Kirk	[signature]	7/07/2021
S4	1 – Final Draft for AEE	I Ho	S Sunich	[signature]	A Kirk	[signature]	15/10/2021

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Executive summary

This Master Plan report is a follow-on study of the recent Options Report (GHD 2021d) for the Whangārei WWTP. The purpose of this Master Plan is to present a high-level outline of the likely upgrade works and capital expenditure required over the next ten years at the Whangārei WWTP. These studies are part of the technical assessments supporting the resource consent renewal application, which is due to be lodged in October 2021.

From the Options Report, two possible upgrade pathways were recommended to be carried forward via an Adaptive Pathways Planning approach. This approach provides for a range of future uncertainties and development of flexible long-term strategies that allow for adaptive responses to different plausible futures or outcomes. As such, this Master Plan is a living document where ongoing monitoring and periodic reviews will take place to refine the solutions continually, with the aim to deliver optimal outcomes to the community.

Pathways Evaluation and Summary

The two pathways (1b and 1d) recommended from the Options Report are summarised in the Figure 1 below. A common starting stage for both pathways are proposed "augmentation works", to provide short term capacity increase and improved plant resilience to meet the existing discharge standards. This will be followed by several studies and reviews before pursuing Pathway 1b or 1d (or other pathway if determined through review) for future plant expansion to 82,000 EP over a medium-term timeframe (~ next 10 years) (refer to Table 1).

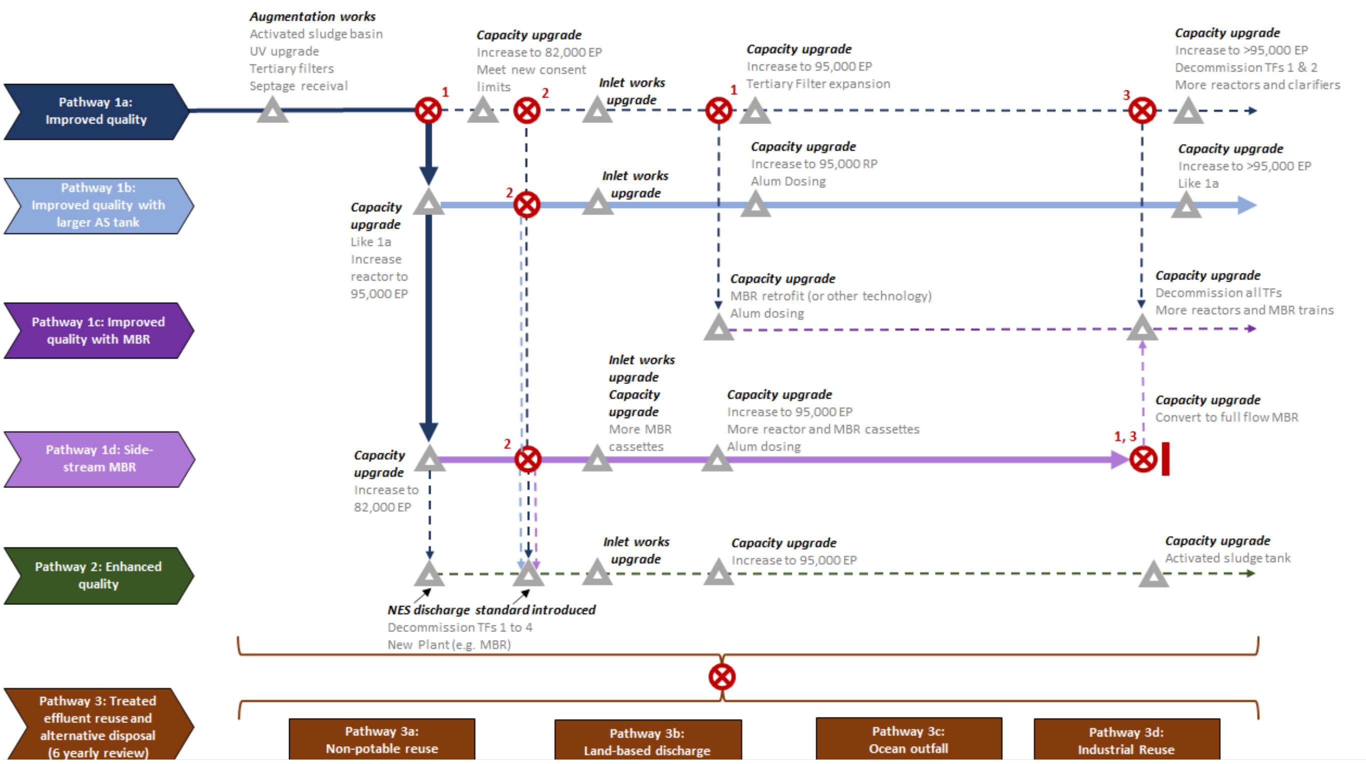


Figure 1 Diagram showing recommended pathways 1b and 1d

Table 1 Upgrade Plan for short-medium term

	Plant Augmentation	Pathway 1b	Pathway 1d
Outline Upgrade Scope for the first 10 years	Tertiary Filters, UV upgrade, Aeration Basin #2 recommissioning, Centrifuge replacement, Bin Covers and EQ Basin operation review	Inlet works upgrade, A large reactor tank to replace TF# 3 and 4, additional secondary clarifier and sludge upgrade	Inlet works upgrade, A reactor tank to replace TF# 2, MBR trains and sludge upgrade
Implementation Timeframe	by 2024-2025	Approx. 2030	Approx. 2030
Est. CapEx	$8 to $13 M	$50 to $75 M	$30 to $50 M

Pathway 4 and 5 Biosolids and Odour Management

The drivers impacting the wastewater treatment processes also impact the biosolids and odour management on site. They are summarised in the diagram below.

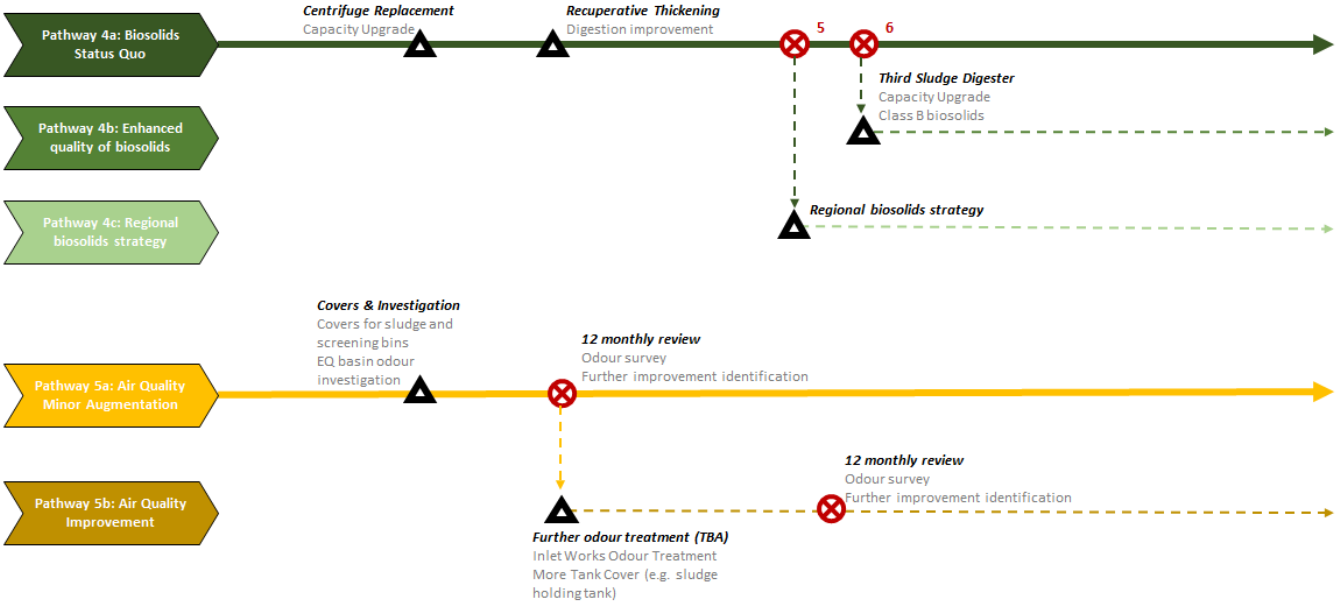


Figure 2 Diagram showing Biosolids pathway (Pathway 4a) and Odour pathway (Pathway 5a)

Ongoing Review of Drivers and Triggers

A key feature of this Master Plan implementation, with Adaptive Pathway Planning principles, is the continuous loop of ongoing monitoring, review and adjustment to solutions as better understanding and new drivers emerge. Hence, this Master Plan aligns with other technical assessments, ongoing reviews and other WDC's documents, as shown in the Figure 3 below.

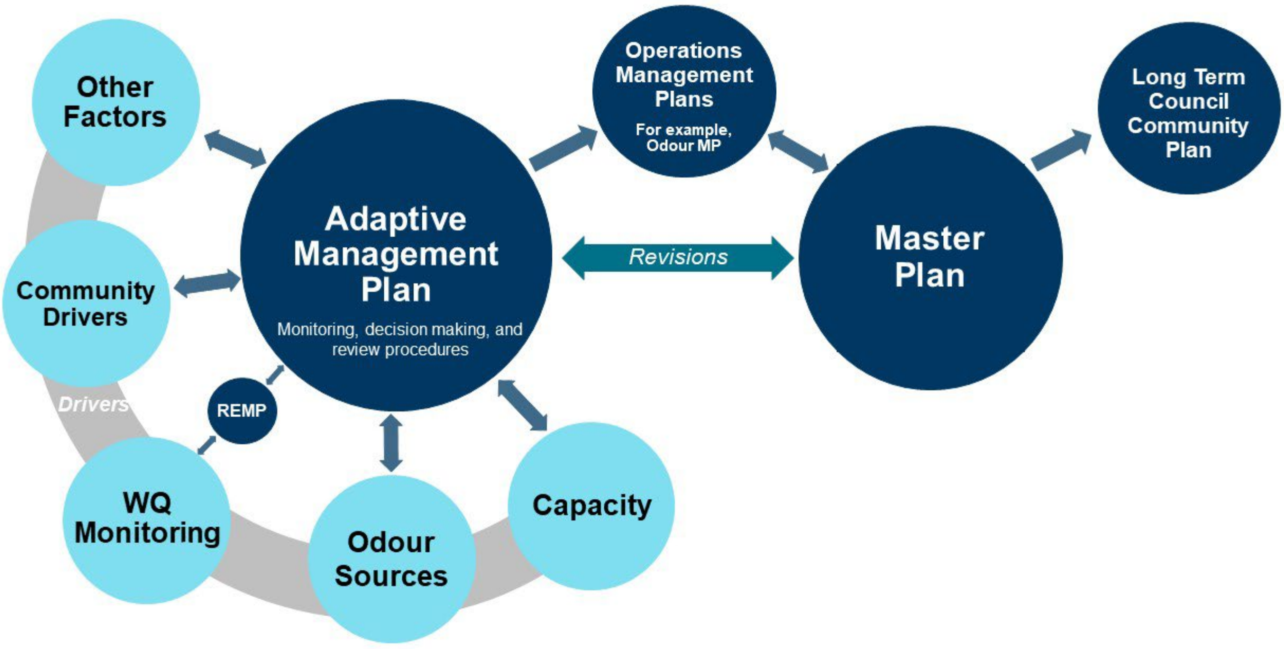


Figure 3 Adaptive management implementation

The following table summarises the ongoing review and monitoring of triggers and drivers. It should be noted additional drivers could be added over time.

Table 2 Monitoring of Triggers and review of Drivers

Period	Monitoring of Triggers and Review	Related Drivers
From 2022 onwards	Receiving environment monitoring – refer to Water Quality assessment (GHD 2021b) for details	Receiving environment Improved plant performance
	6 monthly odour review and independent survey – refer to Air Quality assessment (GHD 2021a) for details	Odour mitigation
	Review of population growth/forecast – allow 2 to 3 years lead-in time for design and construction	Population Growth Alternative Technology and innovation
From 2026 onwards	Every 6 yearly review (TBC – new consent condition) to examine the best practicable option (BPO) with the latest performance, regulations/standards, community aspiration and other factors	Alternative Treatment Effluent Disposal Climate Change Carbon Neutrality Contaminants of Emerging Concern Landfill capacity and restriction Alternative Technology and innovation
From 2024 onwards	Monitor other potential governance or significant changes, e.g. Regional solids waste or biosolids strategy, Water Reform	Regulation and Governance Changes Industrial reuse opportunities Regional solids waste and biosolids strategies

Master Plan Implementation for the next 10 years

The diagram below summarises the implementation steps of this Master Plan over the next 10 years.

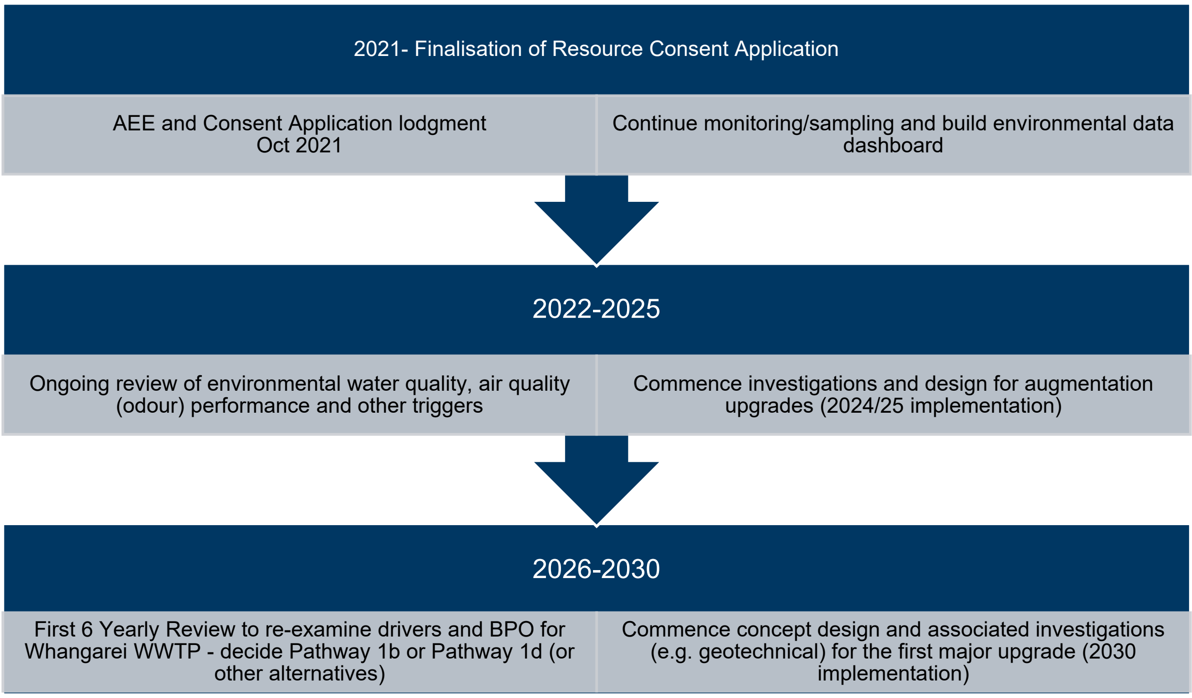


Figure 4 Master Plan Implementation

Glossary

Abbreviation	Term
AGS	Aerobic Granular Sludge
AOP	Advanced Oxidation Process
AS	Activated Sludge
BOD_5	5-day Biochemical Oxygen Demand
CAPEX	Capital Expenditure
CEC	Contaminants of Emerging Concerns
CEPT	Chemically Enhanced Primary Treatment
CIP	Clean in Place
DAPP	(Dynamic) Adaptive Pathways Planning
EP	Equivalent Population
EQ Basin	Equalisation Basin
I&I	Inflow and Infiltration
IBC	Intermediate Bulk Container, 1000 litres in volume
kW	Energy/power unit - KiloWatts
m^3/day	Flow unit - Cubic Meters per Day
MABR	Membrane Aerated Biofilm Reactor
MBR	Membrane Bioreactor
MfE	Ministry for Environment
mg/l	Milligrams per Litre
ML	Volume unit - Mega Litres
ML/d	Flow unit - Mega Litres per Day, 1 ML/d = 1000 m^3/day
MLE	Modified Ludzack-Ettinger, a form of activated sludge tank configuration
NES	National Environmental Standard
P&G	Preliminary and General
PACl	Polyaluminium Chloride solution
PNRP	Proposed Northland Regional Plan
RAS	Return Activated Sludge
TF	Trickling Filter
TN	Total Nitrogen
TP	Total Phosphorus
UV	Ultra-Violet
WAS	Waste Activated Sludge
WDC	Whāngarei District Council
WWTP	Wastewater Treatment Plant

1. Introduction

The Whangārei wastewater treatment plant (Whangārei WWTP) services the urban Whangārei area. The treatment process comprises trickling filters, an aeration basin, and UV disinfection which discharges effluent through constructed wetlands prior to discharge to Limeburners (Hāhā) Creek. The catchment population growth is forecast to increase from 65,000 to 95,000 people, by 2056.

The current resource consent for discharge of treated effluent into Limeburners – Haha expires on 30th April 2022. To support Whangārei District Council (WDC) with the renewal of the Whangārei WWTP resource consent, GHD have completed an assessment of the capacity and process bottlenecks of the existing WWTP treatment process and an options assessment. The resulting Plant Assessment Report (GHD, 2021c) and Options Report (GHD, 2021d) are attached to this report as Appendix A and B respectively.

It was decided that a traditional static approach to the options assessment (identifying a single best practicable option) did not provide for the uncertainty regarding the current and upcoming regulation changes, discharge requirements and the needs of the Whangārei community. To accommodate this uncertainty, an Adaptive Pathways Planning approach to assessing and defining upgrade options (pathways) was proposed. As part of the Adaptive Pathways Planning approach, current and future drivers for upgrades to the WWTP have been identified. A series of actions or upgrades to be undertaken over time which respond to these potential future needs have been developed.

By exploring different pathways and considering path-dependency of the actions required, an adaptive plan has been prepared that includes short-term actions to be undertaken, while maintaining flexibility in the selection of a number of long-term options.

1.1 Purpose of this report

This report contains a high-level overview of the likely works and capital expenditure required over the next ten years at the Whangārei WWTP based on the Options Report (GHD, 2021d). The Options Report recommended two pathways, Pathway 1b and Pathway 1d to be taken forward as follows:

– Pathway 1b – Keep the existing plant configuration with a large bioreactor (sufficient for 95,000 EP).
– Pathway 1d – Construct a side-stream Membrane bioreactor (MBR) process for blending final effluent (sufficient for 82,000 EP in first stage expansion, followed by another capacity expansion in future).

This recommendation receiving endorsement by WDC and verbal agreement from those present at the May 2021 Wastewater Working Group (representatives from key stakeholders) hui.

This report also provides a high-level overview of the existing facility, the project drivers considered when developing the adaptive pathways, and the options assessment undertaken.

The Master Plan is a living document, which will be reviewed periodically (e.g. every 6 years) or at a time where trigger points are reached that drive the need for other upgrades or investigations. For example, a different treatment technology may emerge over the next few years where it offers significantly better attributes than those considered in this current version of the Master Plan.

1.2 Report Scope

The scope of this report is to:

– Provide an overview of the existing facility and capacity pinch points (Section 2).
– Summarise the drivers and of which are been considered in this master plan (Section 3).
– Overview of pathways/options considered, an extract from the Options Report (Section 4).
– A high-level capital works plan (Section 5).
– Master Plan Implementation (Section 6).

1.3 Limitations

This report: has been prepared by GHD for Whangārei District Council and may only be used and relied on by Whangārei District Council for the purpose agreed between GHD and Whangārei District Council as set out in section 1.1 of this report.

GHD otherwise disclaims responsibility to any person other than Whangārei District Council arising in connection with this report. GHD also excludes implied warranties and conditions, to the extent legally permissible.

The services undertaken by GHD in connection with preparing this report were limited to those specifically detailed in the report and are subject to the scope limitations set out in the report.

The opinions, conclusions and any recommendations in this report are based on conditions encountered and information reviewed at the date of preparation of the report. GHD has no responsibility or obligation to update this report to account for events or changes occurring subsequent to the date that the report was prepared.

The opinions, conclusions and any recommendations in this report are based on assumptions made by GHD described in this report (refer section(s) 1.4 of this report). GHD disclaims liability arising from any of the assumptions being incorrect.

GHD has prepared this report on the basis of information provided by Whangārei District Council and others who provided information to GHD (including Government authorities), which GHD has not independently verified or checked beyond the agreed scope of work. GHD does not accept liability in connection with such unverified information, including errors and omissions in the report which were caused by errors or omissions in that information.

GHD has prepared the indicative cost estimate set out in section 5 of this report ("First 10 Years Capital Works Programme") using information reasonably available to the GHD employee(s) who prepared this report; and based on assumptions and judgments made by GHD as specified in Section 1.4.

The Cost Estimate has been prepared for the purpose of presenting rough order capital costs for various pathways presented in this Master Plan and must not be used for any other purpose.

The Cost Estimate is an indicative estimate only. Actual prices, costs and other variables may be different to those used to prepare the Cost Estimate and may change. Unless as otherwise specified in this report, no detailed quotation has been obtained for actions identified in this report. GHD does not represent, warrant or guarantee that the project can or will be undertaken at a cost which is the same or less than the Cost Estimate.

Where estimates of potential costs are provided with an indicated level of confidence, notwithstanding the conservatism of the level of confidence selected as the planning level, there remains a chance that the cost will be greater than the planning estimate, and any funding would not be adequate. The confidence level considered to be most appropriate for planning purposes will vary depending on the conservatism of the user and the nature of the project. The user should therefore select appropriate confidence levels to suit their particular risk profile.

1.4 Assumptions

The following assumptions were made when developing this report:

– Drivers for current and future upgrades to the Whangārei WWTP identified in workshops with WDC and the wastewater working group (representing key stakeholders), represents at the time of writing this version of the Master Plan, a list of possible triggers that would likely lead to a need to improve WWTP performance. Regular review of the Adaptive Plan for the Whangārei WWTP should be carried out to identify new drivers and associated understanding.
– Population projections are based on figures from the Whangārei Draft Growth Strategy (2019).
– Technical assumptions related to estimating future wastewater infrastructure requirements:
  - The future upgrade works described in this Master Plan are an outline only and will require scope confirmation through concept and preliminary design phases.
  - The historical wastewater characteristics for the screened wastewater will stay relatively similar in future scenarios, that is, no new significant trade waste dischargers in the catchment have been confirmed at the time of writing.

- Recent wastewater characteristic data (summarised in Options Report Section 3.6 see Appendix B) of primary clarifier effluent and trickling filter effluent have been used as input for process calculations.
- The wastewater network inflow and infiltration reduction strategy is ongoing with the aim to achieve a future reduction in the ratio between peak daily flow and average daily flow.
- Steady state spreadsheet calculations have been used to estimate the capacity, bottlenecks and trigger points of the existing treatment process. The calculation results and assumptions should be confirmed through future BioWin modelling.
- Existing digester mixing and biogas systems have been assumed adequate for future use, and no provision for upgrade has been allowed in the master plan. The adequacy and relevant standard compliance of these systems will need to be reviewed as part of the future asset condition survey and preliminary design.

– Assumptions related to cost estimates presented in this master plan report:

- The costing included in this report is for the purposes of master planning only and requires further assessment in future design phases. Cost figures are presented at today's rate, and no inflation has been allowed. For WDC budgeting purpose, appropriate construction inflation index is to be applied.
- Cost estimate accuracy would be in the order of -20 to +30%, and the figures contained in this report have factored in this accuracy range.
- There is reasonable ground condition for future structure construction. Geotechnical field work is highly recommended to confirm this assumption, particularly against landslide risk as new tanks will be constructed in a sloped area. We anticipate this will be undertaken as part of the concept design of the future plant expansion.
- The existing main plant building will be re-purposed by converting the existing operator area to additional switchrooms. A new operator room will be built near the site entrance.
- Electrical cost is assumed to be 20% of civil and mechanical items.
- Contractor's Preliminary and General (P&G), onsite and offsite overheads are assumed to be amounted to 40% to the physical works cost.
- Contingency sum and professional fees for design and investigation are assumed to be 20% and 15% of the physical works respectively. These could be reduced once more information becomes available in the subsequent design stages.

2. Existing facility and capacity pinch points

Figure 5 presents a schematic of the process flow for the current treatment plant as a schematic. For detailed background information, refer to the Whāngarei WWTP Plant Assessment Report (GHD, 2021c) attached as Appendix A to this report. The plant assessment report documents an assessment of the existing facility and the plant's current operation. Table 1 below is adapted from the Plant Assessment Report and summarises the capacity issues experienced at the WWTP, highlighting wastewater and sludge treatment 'pinch points'.

Odour related issues were excluded at the time of the plant assessment and have since been addressed as a separate workstream as part of an air quality assessment that will be used to inform the consent renewal process (GHD, 2021a).

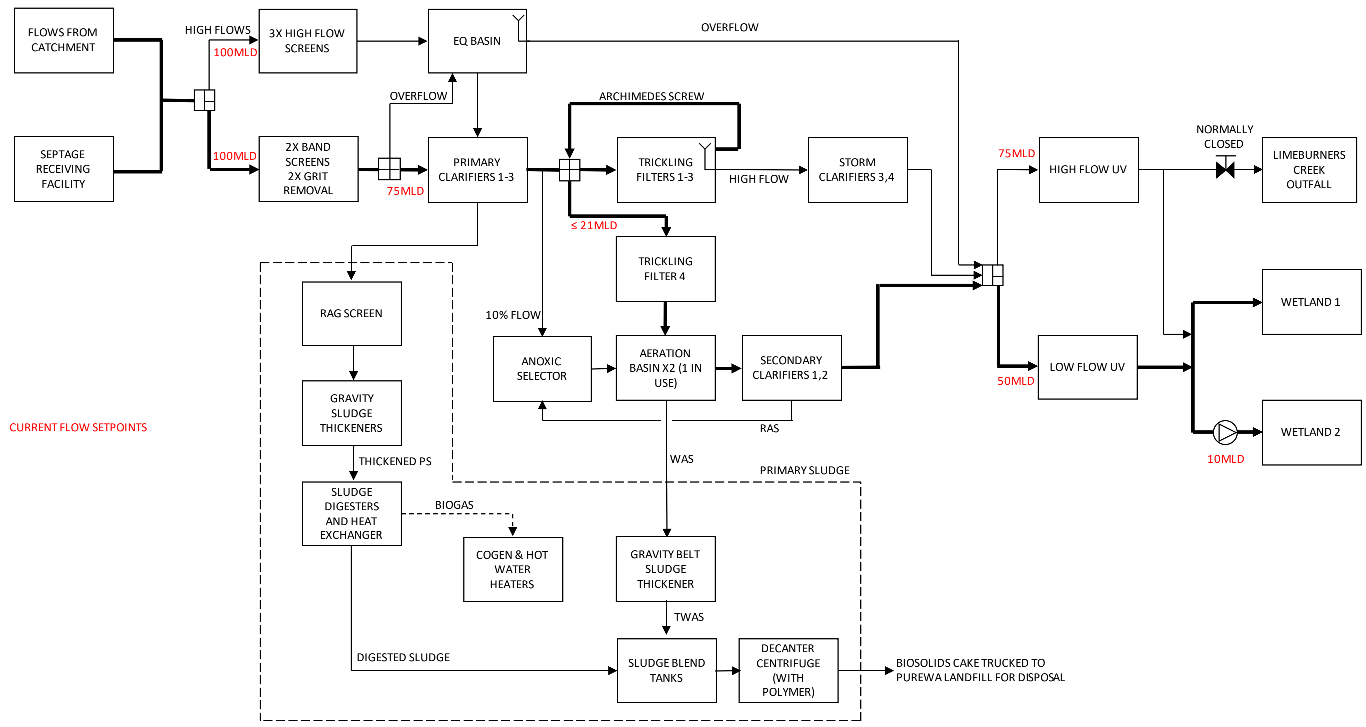


Figure 5 Whangārei WWTP process flow schematic

Table 3 Whangārei WWTP process pinch points (extracted from the Plant Assessment Report)

Process	Priority	Comments
Capacity Issues Required Immediate Attention		
Activated Sludge Basin		*Additional aeration basin/capacity required.*
Normal Flow UV		*Low UV dose issue requires attention*
Centrifuges		*Centrifuge in operation over 30+ years. Limited by truck transport capacity*
Primary Clarifiers		*Capacity likely limiting in peak flow condition, but ample capacity during normal flow condition.*
Storm Clarifiers		*Additional peak weather capacity required in future flows*
Inlet Works		*Additional capacity required as Band Screens and Vortex Grit are limited to 100 ML/d.* *Blinding often observed immediately after septic truck deliveries*
Capacity Issues likely to be experienced in future		
Power Supply / Backup Power		*Backup generator recommended for additional resilience*
Trickling Filters – normal flow		*Stage 2 trickling filter loading rate is moderately high.*
Trickling Filters – high flows		*Additional capacity required as future peak flow increases*
Anoxic Selector		*Poor sludge settling requires attention*
Secondary Clarifiers		*Poor sludge settling requires attention*
Gravity Thickeners		*Hydraulic loading rate is high, possibly can be resolved by thicker primary sludge stream through primary clarifier sludge withdrawal.*
Gravity Belt Thickeners		*Single unit at present, second unit will be required.*
Sludge Digesters		*Digester retention time is close to borderline.*
Items have sufficient capacity in the foreseeable future		
High Flow UV		*Room for capacity expansion, compliance issue to be investigated*

Process	Priority	Comments
Items not assessed		
Polymer Dosing	--	*Not reviewed*
Recycled Water	--	*Not reviewed*
Biogas Storage and Flare	--	*Not reviewed*
Digester Mixing	--	*Not reviewed*
Odour Control	--	*Not reviewed*

Colour legend: Orange – Capacity issue observed, Yellow – likely capacity bottleneck in future, Green – spare capacity available

The Whangārei WWTP Consenting Options Report (GHD, 2021d) (Appendix B) includes an overview of the plant performance, comparing historical (data collected from Jul 17 to Nov 19) to recent data (Oct 20 to Dec 20). The data indicated a deterioration of plant performance in the later part of 2020. The plant operations team has advised that the plant was severely impacted by the July 2020 flood. Nonetheless, the treatment plant has performed well throughout the past few years, particularly with respect to “medium” (21,000 to 30,400 m^3/day) and “high flow” conditions (30,400 to 57,400 m^3/day) described in the past resource consent monitoring reports by NRC.

From the recent plant performance data and discussion with WDC operations team, the following immediate improvements have been identified (referred to later in this report as “augmentation works”):

1. Tertiary filtration to minimise solids spikes and improve UV performance.
2. Additional biological capacity (e.g. re-commissioning of second aeration basin) to cater for projected short term growth.
3. Separate septage receiving station for septic tank trucked waste to avoid screen blinding.
4. Centrifuge replacement due to aging infrastructure.

3. Project drivers

Drivers for current and future upgrades to the Whangārei WWTP were identified during workshops with WDC and the wastewater working group (with representatives of key stakeholders in October 2020; November 2020 and May 2021) summarised in the Options Report (GHD, 2021d) (see Appendix B). The drivers are very diverse and some of which are more known and certain, while others could have a major impact in future, but require further understanding.

Key drivers have been identified and used to inform the Adaptive Pathways Planning, with a number of less certain drivers identified but to be considered in more detail in future as more information regarding these becomes available. As such, regular review should be carried out to identify and update the understanding of these drivers and the impact on the Master Plan.

Below is a summary from the Options Report of several selected drivers:

– **Improving plant performance** – from the plant assessment and recent plant data review, augmentation and optimisation works have been recommended to focus on stabilising ammonia concentrations and improved removal of suspended solids and pathogens.
– **Population growth** – Under the high growth scenario, the connected population could increase from 65,000 to 95,000 EP by 2056. The corresponding average wastewater flow to be treated by the Whāngarei WWTP would increase from 18 ML/d to 27 ML/d, requiring a significant capacity upgrade.
– **Prevention of further degradation to the receiving environment** – the Master Plan considers two future discharge quality scenarios: Improved Quality (in line of the intention of the Proposed Northland Regional Plan, PNRP – appeal version) and potential National Environmental Standard (NES) for coastal wastewater discharges. Details and timeframes of the latter is yet to be confirmed, indicative discharge standards were

developed as part of the Options Reporting. The current understanding of the PNRP requirements will require the plant discharge mass loads to be maintained.

– **Reuse opportunities** – WDC has obtained a short-term resource consent for suppling recycled water to parks and reserves. The Options Report also considered potential standards for other reuse opportunities including open-space irrigation, land-based application in forest blocks and dual reticulation. These potential opportunities will be reviewed continually over time.
– **Landfill capacity and restriction** – Currently only primary sludge is treated by the digesters at the Whangārei WWTP. This might change in future, if Purewa landfill specifies a higher sludge treatment standard (e.g. Class B stabilised). In this situation, the secondary sludge will also require to be processed by sludge digestion on site.
– **Regional solids waste and biosolids strategy** – We understand WDC is considering a solids waste management strategy and possibly a regional biosolids management approach. Timeframe and scope of this is unknown.
– **Odour Mitigation** – Plant upgrades would need to consider any adverse impact or improvement of odour mitigation measures.
– **Changing Discharge and Environmental Standard** – In addition to new regional and national discharge standards, contaminants of emerging concerns (CECs) or national greenhouse gas emission targets could have a significant impact. However, further technical studies are needed to inform these two particular examples.
– **Regulation and Governance Changes** – The upcoming Water Reform will likely significantly reshape the water industry across New Zealand by consolidating into larger, multi-regional water entities. It is unclear of the extent on how WDC's water assets will be affected at the time of writing.

Table 4 below presents how each driver listed above has been considered.

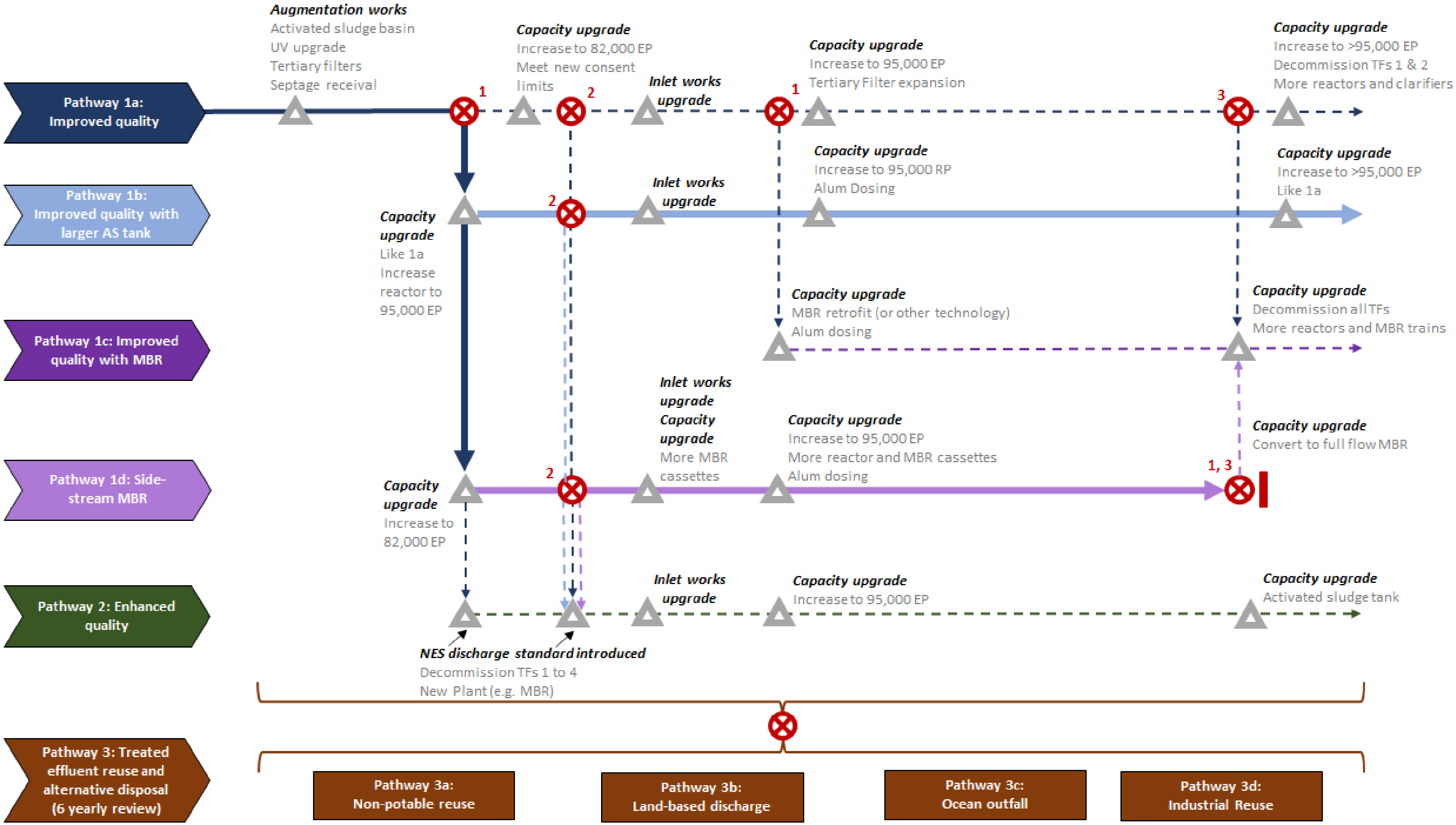
Table 4 Drivers considered in this Master Plan

Included as proposed upgrade works in the current Master Plan	Incorporated as part of ongoing monitoring and review	Excluded in the current Master Plan
Improved plant performance. Prevention of further degradation to the receiving environment Population growth. Recycled water for parks and reserves. Odour mitigation.	Changing Discharge and Environmental Standard. Impact of Climate Change. Alternative Treated Effluent Disposal. Landfill capacity and restrictions. Alternative Technology and Innovation. Contaminants of Emerging Concerns.	Regulation and Governance Changes. Industrial reuse of recycled water. Regional solids waste and biosolids strategies. Satellite scheme. National greenhouse gas targets. Plant structure and remaining asset life.

4. Options assessment

4.1 Pathways Outline

The Whangārei WWTP Consenting Options Report (GHD, 2021d – attached in Appendix B) details the Adaptive Pathway Planning approach which proposed a set of actions to be undertaken in response to the drivers outlined in Section 3. These actions were then developed into an Adaptive Plan of possible upgrade pathways for the plant as replicated below in Figure 6.



Pathway 1a: Improved quality
Pathway 1b: Improved quality with larger AS tank
Pathway 1c: Improved quality with MBR
Pathway 1d: Side-stream MBR
Pathway 2: Enhanced quality
Pathway 3: Treated effluent reuse and alternative disposal (6 yearly review)
Augmentation works
Activated sludge basin
UV upgrade
Tertiary filters
Septage receival
Capacity upgrade
Increase to 82,000 EP
Meet new consent limits
Inlet works upgrade
Capacity upgrade
Increase to 95,000 EP
Tertiary Filter expansion
Capacity upgrade
Increase to >95,000 EP
Decommission TFs 1 & 2
More reactors and clarifiers
Capacity upgrade
Like 1a
Increase reactor to 95,000 EP
Inlet works upgrade
Capacity upgrade
Increase to 95,000 RP
Alum Dosing
Capacity upgrade
Increase to >95,000 EP
Like 1a
Capacity upgrade
MBR retrofit (or other technology)
Alum dosing
Capacity upgrade
Decommission all TFs
More reactors and MBR trains
Capacity upgrade
Increase to 82,000 EP
Inlet works upgrade
Capacity upgrade
More MBR cassettes
Capacity upgrade
Increase to 95,000 EP
More reactor and MBR cassettes
Alum dosing
Capacity upgrade
Convert to full flow MBR
1, 3
Inlet works upgrade
Capacity upgrade
Increase to 95,000 EP
Capacity upgrade
Activated sludge tank
NES discharge standard introduced
Decommission TFs 1 to 4
New Plant (e.g. MBR)
Pathway 3a: Non-potable reuse
Pathway 3b: Land-based discharge
Pathway 3c: Ocean outfall
Pathway 3d: Industrial Reuse

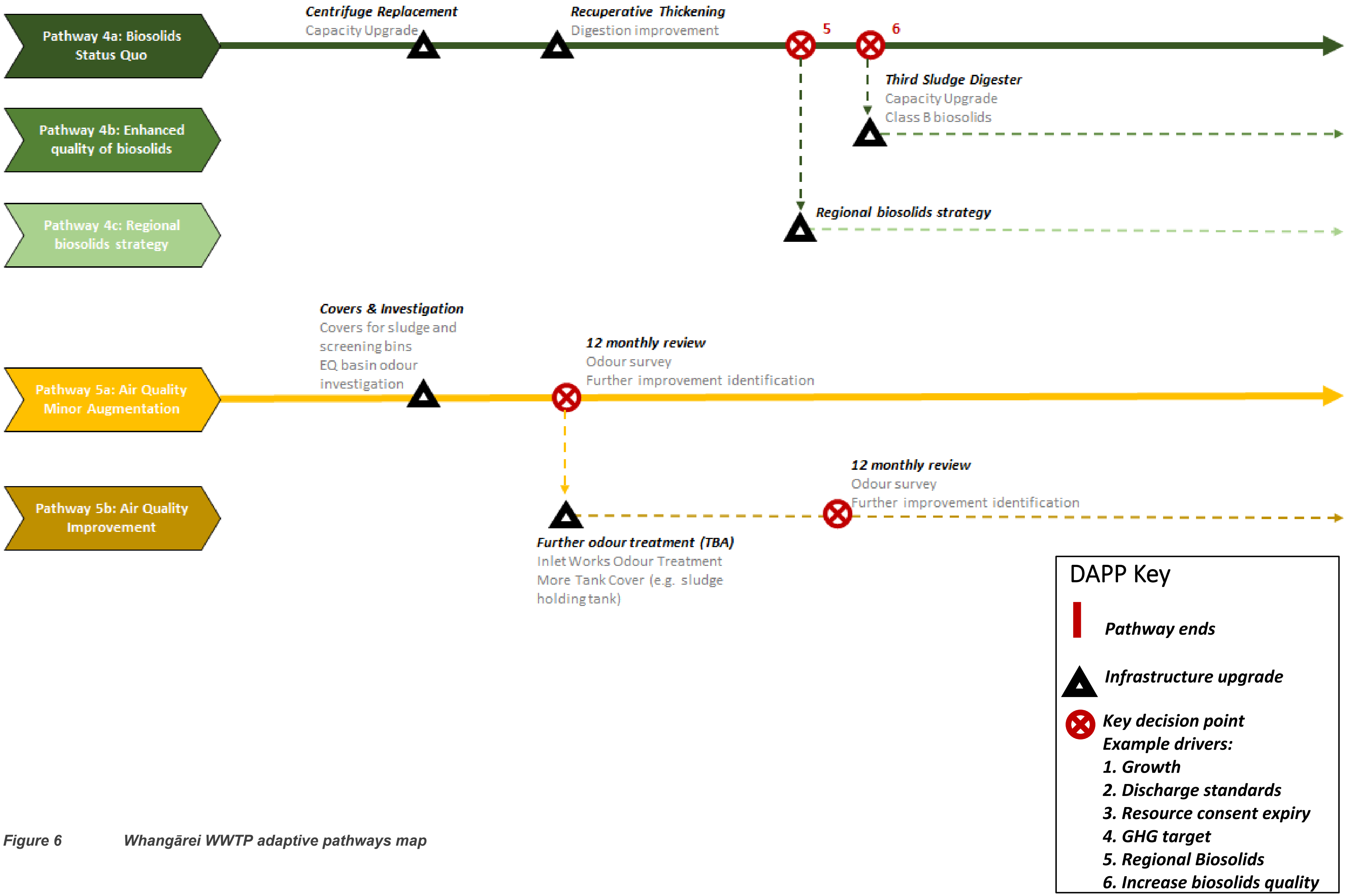


Figure 6 Whangārei WWTP adaptive pathways map

Existing plant augmentation

The existing plant augmentation works are common to all the proposed pathways. These works are required to increase plant capacity for the short term and improve plant resilience to meet existing consent discharge standards. Specifically, these works address elevated spikes in ammonia, E. coli, and suspended solids observed at times.

Key infrastructure includes:

- New septage receiving station specific for septic tank trucked wastes
- New aerators and re-commissioning of aeration basin #2
- Tertiary Filters
- Normal flow UV replacement (for larger capacity)

Pathway 1: Improved quality

Pathway 1 considers the long-term capacity upgrades required to maintain the quality of the receiving environment to prevent further degradation. At the same time, the treatment plant will undergo significant capacity upgrade to accommodate the forecasted 2056 population of 95,000 EP. This will be achieved by improving treatment of BOD_5, suspended solids, E coli and a gradual reduction of nitrogen and phosphorous concentrations to maintain the current mass loads discharged to the Limeburners – Haha.

Key infrastructure includes:

- Inlet Works upgrade.
- Modified operation of the existing primary clarifiers.
- Additional secondary and tertiary treatment capacity.
- Biosolids upgrades – e.g. recuperative thickening, third digester tank (refer to Pathway 4).

Four sub-pathways under Pathway 1 have been defined, which consider different timing and infrastructure sizing for two different types of secondary treatment technologies: an activated sludge plant (similar to the existing plant technology) and Membrane Bioreactor (MBR) (or other technology). These sub-pathways are as follows:

- Pathway 1a: Gradual capacity expansion via adding activated sludge tanks in 10 year increments.
- Pathway 1b: Significant increase of plant with a larger activated sludge plant sufficient for 2056 population (95,000 EP).
- Pathway 1c: Implement MBR (or other technology) to increase quality of treatment.
- Pathway 1d: Side-stream MBR with existing trickling filter/activated sludge process capped at 15-18ML/d.

Pathway 2: Enhanced quality

Pathway 2 considers a potential future scenario where the total nitrogen and total phosphorus limits would need to be reduced beyond those in Pathway 1. Triggers for this pathway could include a future resource consent review or new wastewater discharge regulations. The site footprint does not have adequate room for constructing larger reactor tanks and clarifiers, hence an alternative process intensification (e.g. MBR) would be required.

Key infrastructure required is similar to Pathway 1, except the entire process would be switched to a MBR process. MBR has been selected as a benchmark technology for this study and a further review of the appropriate technology would be carried out closer to the time.

As part of a chemical dosing upgrade for phosphorous removal, a review of the expected biosolids volume would be required to determine if any solids handling upgrades would be required (e.g. longer centrifuge hours to handle increase solids).

Pathway 3: Treated effluent reuse and alternative disposal

Pathway 3 considers the use of recycled effluent or alternative disposal options. It is proposed that this pathway is reviewed every 6 years in line with the Ruakaka ocean outfall feasibility and consent reviews.

Three sub-pathways under Pathway 3 have been defined and are as follows:

- Pathway 3ai: Effluent reuse for public space irrigation or other restricted access irrigation. This pathway can occur in parallel with other pathways, as the recycled water infrastructure requirements are downstream of the UV reactors and can be installed regardless of the upstream WWTP configuration.
- Pathway 3aii: Industrial reuse opportunities for recycled effluent.
- Pathway 3b: Land-based disposal as a complement to the existing Limeburners (Hāhā) Creek and wetland disposal.
- Pathway 3c: Combined ocean outfall with Ruakaka WWTP.

Pathway 4: Biosolids Management

Pathway 4 considers future solids handling upgrades, accounting for possible future requirements that all biosolids have to be stabilised.

Two sub-pathways under Pathway 4 have been defined and are as follows:

- Pathway 4a: Biosolids status quo, with replacement of existing centrifuges (reaching end of life), addition of recuperative thickening to help increase the sludge retention time of the two digesters resulting in better digestion efficiency and likely deferral of a third digester construction.
- Pathway 4b: Enhanced quality of biosolids requiring all sludge to achieve Class B stabilisation, which requires the addition of a third digester to treat the secondary waste sludge.

The upgrade of the biosolids management system can occur in parallel with the other pathways, dependent on other liquid stream processes.

Pathway 4c considers the possibility of Whangārei WWTP being converted to a regional biosolids centre. The timeframe, the sludge volume and the scope of requirements are unclear. Hence, it has not been considered in any detail in this Master Plan.

Pathway 5: Odour Mitigation Management

Pathway 5 considers air quality management. Six-monthly independent odour surveys in conjunction with review of odour complaints will be used to determine at which point further improvements to odour management may be required.

Two sub-pathways under Pathway 5 have been defined and are as follows:

- Pathway 5a: Air quality minor augmentation, including covers for sludge and screening bins and an EQ basin odour investigation.
- Pathway 5b: Air quality improvement considers further odour treatment (ie inlet works odour treatment, more tank covers, etc)

4.2 Preferred Pathway Selection

Three workshops with the wastewater working group have been held to date as part of engagement with representatives from key stakeholders. The latest workshop held on the 1st of June 2021 was to update the group on the environmental investigations and baseline monitoring results, and to seek endorsement for pursuing the Adaptive Pathway 1. Minutes from this workshop are attached as Appendix C.

Those present in the workshop generally endorsed the Adaptive Pathways Planning approach being taken and agreed in principle to further evaluation of Pathways 1b and 1d as part of the master planning, for the following reasons:

- Pathway 1b will require one major expansion within the consent period (unless NES trigger occurs).
- The larger bioreactor in 1b can accommodate the uncertainty around population growth better than 1a . Whilst Pathway 1a has lower initial capital expenditure, it also has the advantage of being more disruptive to plant operation as requires the construction of two reactors 10 years apart.
- Costing for 1b can be easily adapted for 1a, if a lower initial capital expenditure is desired.
- The upfront capital expenditure for 1b is lower than that of Option 1c, as Option 1c will require demolition of most existing trickling filters and construction of additional new reactor tanks in their place.

– Pathway 1d provides an alternative pathway to 1a/1b, as it allows WDC to sweat the existing trickling filter assets to the end of useful asset life by gradually replacing the older trickling filters with a more compacted Membrane Bioreactor (MBR) process.

5. Initial ten years capital works programmes

This section presents indicative capital expenditure and an overview of upgrade works involved in both the plant augmentation works, and the subsequent capacity upgrade.

The augmentation works consider what is required to meet existing consent discharge standards, specifically to address elevated ammonia, E. coli and suspended solids. These works are based on augmenting the existing process to increase capacity and accommodate the current consent limits without any major changes to the process.

Pathways 1b and 1d consider the capacity upgrades required to maintain the receiving environment quality by improving effluent quality in terms of BOD_5, suspended solids, E coli and maintaining the discharged mass loads of nitrogen and phosphorous.

These pathways also include other upgrades from other pathways (e.g. biosolids and odour management).

5.1 Plant augmentation (2022-2025)

The plant augmentation works centre around upgrades to a new septage reception facility, re-commissioning of the second activated sludge basin, upgrades to the Ultra-violet (UV) disinfection system and addition of tertiary filters. Upgrades to the sludge processing plant are also included in the plant augmentation scope, however it is likely these will be completed after the initial treatment augmentation works.

Figure 7 Proposed plant augmentation configuration

Table 5 Plant Augmentation Summary Table – Physical Works, Risks identified and Investigation/Design

	Preliminary Treatment	Primary Treatment	Secondary Treatment	Tertiary Treatment	Biosolids Processing	Other Upgrades
What will be upgraded?	Septage receiving station for trucked septic tank waste. Improved Plant Inflow Management.	Primary clarifier sludge withdrawal optimisation – increase sludge consistency.	A selector north of the existing one. Aeration replacement (55kW x 4) in the two aeration basins.	Two tertiary filters in existing concrete structure (where decommissioned filters were). Normal flow UV capacity upgrade.	Centrifuge replacement. Self levelling sludge bins. Odour treatment for sludge bins.	Covers for screening and grit bins. Permanent emergency generator. Recycled water tanks and chemical dosing for trucked recycled water supply.
Reasons for Upgrade Works	a/ Minimise sludge blinding of inlet screens by thick septic tank sludge discharges. b/ Improve flow management around the plant.	a/ Reduce hydraulics (primary sludge volume) to gravity sludge thickeners, by increasing thickening within the thickeners.	a/ Additional biological treatment capacity and more stable ammonia removal.	a/ Reduce solids spikes in the final effluent. b/ Capacity increase for normal flow UV and improve disinfection performance.	a/ Centrifuges near or at the end of asset life. b/ Eliminate odour generating source.	a/ Eliminate odour generating source. b/ Additional resilience against unplanned power outages. c/ Make use of recent consent to supply recycled water for parks and reserves via water trucks.
High level capital cost estimates	$8-13M (incl Contractor's P&G, margins, 20% contingency, design)					

Period	Lead-in Investigations and Plant Design	Risks and Proposed Mitigations (not already covered in drivers)
2021/22	WWTP plant performance monitoring. BioWin model construction (additional parameters needed).	Lack or outdated existing services and as-built information– *as-built survey and drawings update.* Tertiary Filter concrete structure condition – *asset condition surveys.* Centrifuge condition – *asset condition surveys.*
2022 to 2023	Preliminary and detailed design of augmentation work for 2024 implementation.	
2024 to 2025	Preliminary and detailed design of sludge centrifuge replacement and odour treatment for 2025/26 implementation (or sooner subject to asset conditions)	

5.2 Pathway 1b (TF/AS with bioreactor)

Pathway 1b continues the current TF/AS configuration with the following key upgrade stages:

– 72,000 EP: Replace trickling filters 3 & 4 with large activated sludge tank (8000 m^3), and a secondary clarifier.
– 82,000 EP: Construct an additional clarifier, and additional tertiary filter.
– Beyond 2056, above 92,000 – 95,000 EP: Replace trickling filters 1 & 2 with activated sludge tank (not considered in this master plan as growth beyond 30 years is highly uncertain).

Figure 8 Proposed Pathway 1b configuration

Table 6 Pathway 1b Summary Table – Physical Works, Risks identified and Investigation/Design

	Preliminary Treatment	Primary Treatment	Secondary Treatment	Tertiary Treatment	Biosolids Processing	Other Upgrades
What will be upgraded in the next 10 years?	Inlet Screen Upgrade – replace band screen and civil structure. New flow split structure and pipelines	Install chemical dosing for chemically enhanced primary treatment at peak flow conditions.	Replace TF#3 and 4 with an 8 ML bioreactor tank, add a blower room, and a 26m dia secondary clarifier. Alum/PACl dosing.	N/A	Recuperative thickening.	Additional Transformer. New Operator Building and extending the security fence.
Reasons for Upgrade Works	a/ Inadequate capacity of existing band screens and close to end of asset life. b/ Improve flow management around the plant.	a/ Enhance primary treatment capacity during wet weather flows and mitigate the need of the fourth primary clarifier.	a/ Increase secondary treatment capacity and maintain mass loads of nitrogen and phosphorus. b/ Alum/PACl dosing for additional phosphorus removal.	a/ Capacity upgrade and/or end of asset life of existing tertiary filter.	a/ Enhance anaerobic digestion efficiency. b/ Add resilience when 1 digester is offline for maintenance or process upset.	a/ Meet power supply requirements. b/ Convert existing operator and electrical building as fully-purposed electrical switchroom. c/ Operator building near the entrance.
High level capital cost estimates in 2030	$50-75M (incl Contractor's P&G, margins, 20% contingency, design)					

Period	Lead-in Investigations and Plant Design	Risks and Proposed Mitigations (not already covered in drivers)
2026	First review of triggers and drivers for this master plan and the receiving environment	Wastewater composition changes – *ongoing wastewater monitoring* Geotechnical/poor ground condition risk – *detailed field investigation and interpretative report in 2026* *Asset condition of trickling filters and primary clarifiers may result in scope creep/change – asset condition survey* *Community consultation about New Operator Building – early engagement starts in 2026* Complex construction and likely disruption of existing treatment process – *detailed construction planning and sequencing in 2027 as part of the concept design*
2027-29	Concept design and detailed engineering of the upgrade scope for 2030/31 implementation. The lead-in time is approximately 3 years, approximately 12-18 months design and 18 months construction.	
2038 (or around 78,000 EP)	Technology review for the capacity upgrade to 95,000 EP followed by concept design and detailed engineering.	
Upgrades beyond 2030	At 82,000 EP (~2040): Fourth Secondary Clarifier and additional tertiary filter. Potential: third digester if all sludge to landfill/disposal needs Class B stabilisation and a recycled water plant for supplying recycled effluent	

5.3 Pathway 1d (side-stream MBR)

Pathway 1d considers implementation of a side-stream MBR or similar technology, initially 3,500 m^3 with a second reactor of the same size added later to accommodate further population growth. The existing trickling filter and activated sludge process would be capped at 15-18 ML/d on average. The remaining flow treated by a new side-stream MBR would have a target effluent TN of 8 to 10 mg/L and TP of 2 to 3mg/L for blending.

This option negates the need to put more flow through the existing trickling filter/activated sludge process, does not require the addition of more secondary clarifiers, and has a more compact footprint than Pathway 1b.

The key upgrade stages for Pathway 1d are as follows:

- 72,000 EP: Build the first side-stream bioreactor with MBR (or other similar technology).
- 82,000 EP: Add the second bioreactor, with additional MBR cassettes, and chemical dosing for phosphorus removal.

It is envisaged that by consent expiry (~95,000 EP), the existing trickling filters and aeration basins would be decommissioned, new bioreactors and additional MBR trains would be installed to effectively treat the entire flow.

Figure 9 Proposed pathway 1d configuration

Table 7 Pathway 1d Summary Table – Physical Works, Triggers Monitoring and Investigation/Design

	Preliminary Treatment	Primary Treatment	Secondary Treatment	Tertiary Treatment	Biosolids Processing	Other Upgrades
What will be upgraded in the next 10 years?	Inlet Screen Upgrade – replace band screen and civil structure. New flow split structure and pipelines.	Install chemical dosing for chemically enhanced primary treatment at peak flow conditions.	Replace TF#2 with a 3.5 ML bioreactor tank, add a blower room, a MBR structure (5 trains of 3 cassettes), CIP chemical store (IBCs) and provision of alum/PACl dosing.	N/A	Recuperative thickening. Possible – third digester if all sludge needs to be stabilised.	Additional Transformer. New Operator Building and extending the security fence.
Reasons for Upgrade Works	a/ Inadequate capacity of existing band screens and close of end of asset life. b/ Improve flow management around the plant.	a/ Enhance primary treatment capacity during wet weather flows and mitigate the need of the fourth primary clarifier.	a/ Increase treatment capacity and maintain mass loads of nitrogen and phosphorus through side-stream MBR. b/ Alum/PACl dosing for additional phosphorus removal.	N/A	a/ Enhance anaerobic digestion efficiency. b/ Add resilience when 1 digester is offline for maintenance or process upset.	a/ Meet power supply requirements. b/ Convert existing operator and electrical building as fully-purposed electrical switchroom. c/ Operator building near the entrance.
High level capital cost estimates in 2030	$30-50M (incl Contractor's P&G, margins, 20% contingency, design)					

Period	Lead-in Investigations and Plant Design	Risks and Proposed Mitigations (not already covered in drivers)
2026	First review of triggers and drivers for this master plan and receiving environment.	Wastewater composition changes – *ongoing wastewater monitoring.* Geotechnical/poor ground condition risk – *detailed field investigation and interpretative report in 2026.* *Community consultation about New Operator Building – early engagement starts in 2026.* Complex construction and likely disruption of existing treatment process – *detailed construction planning and sequencing in 2027 as part of the concept design, a lower risk than Pathway 1b*
2027-29	Concept design and detailed engineering of the upgrade scope for 2030/31 implementation.	
2038 (or around 78,000 EP)	Technology review for the capacity upgrade to 95,000 EP followed by concept design and detailed engineering.	
Expansion beyond 2030	Between 72,000 to 82,000 EP (~2040): Increase number of MBR cassettes. At 82,000 EP (~2040), replace TF#1 with a second 3.5 ML tank with additional blower(s) and MBR cassettes (indicative sizing: 5 trains of 5 cassettes each). Potential: third sludge digester and a recycled water plant, similar Pathway 1b.	

5.4 Adaptive Management for Master Plan

As described in the above sections, augmentation of the Whangārei WWTP will provide improvements to meet current treatment expectations regarding the discharge. Subsequent to this, further expansion upgrades will be implemented over time in line with those project drivers outlined in Section 3 or drivers not yet identified.

As part of the Adaptive Pathways Planning Approach, this Master Plan will have linkages to a number of other key documents, such as a proposed Adaptive Management Plan and the Operations Management Plan (both yet to be developed and are envisaged to be prepared in accordance with conditions of the new resource consent) as depicted in Figure 10.

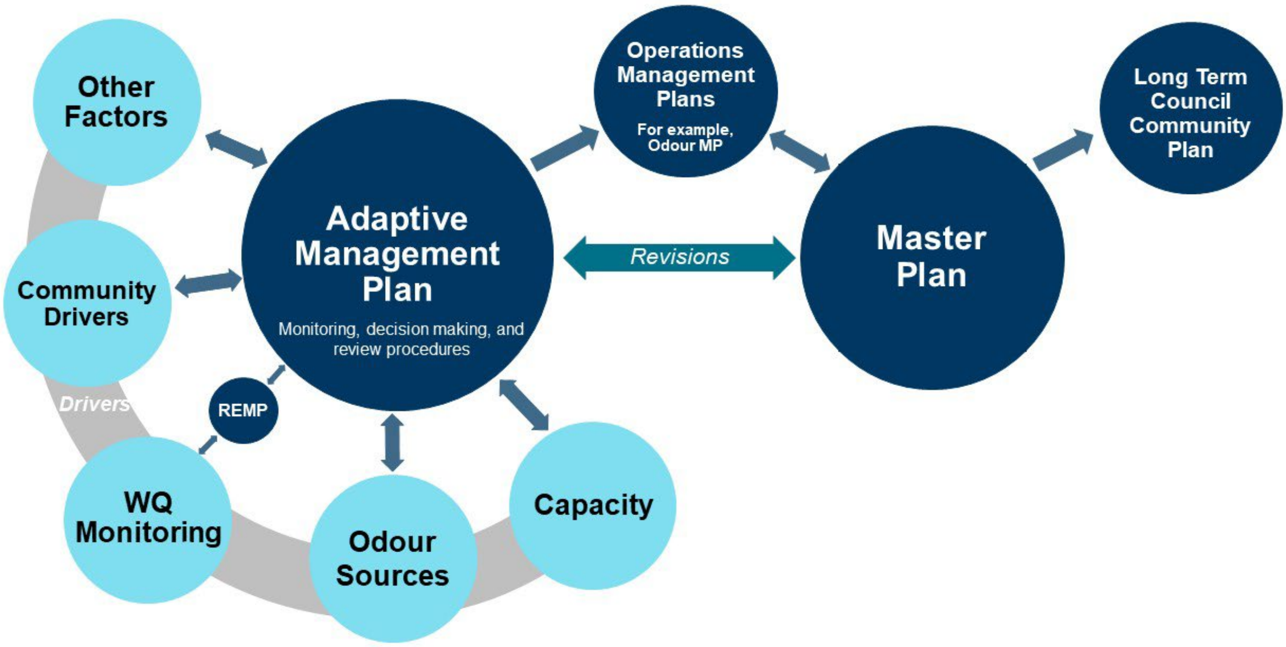


Figure 10 Adaptive Management Overview

The Adaptive Management Plan, is considered to be the "how to guide" to implementing the Adaptive approach and will define a suite of triggers, detail the programmes/procedures for monitoring those triggers, and procedures to be followed if triggers are met and thus the decision-making process for updating the Master Plan and/or Operations Management Plan is required. The Operations Management Plan will describe the operational procedures to be carried out at the plant to avoid, remedy and mitigate effects on the environment in line with the resource consent, including roles and responsibilities, matters regarding training and notification/reporting procedures. These document links and the continuous loop of ongoing monitoring/review and refining of options/solutions will be important in delivering an optimal outcome to the community.

The current version of the Master Plan will be subjected to ongoing review to understand the status of environmental, cultural and community drivers throughout the term of the consent, as outlined in Table 8 below.

Table 8 Adaptative Management Approach to monitor and review triggers

Period	Monitoring of Triggers and Review	Related Drivers
From 2022 onwards	Receiving environment monitoring – refer to Water Quality assessment (GHD 2021b) for details.	Change in receiving environment
	6 monthly independent odour survey and annual review – refer to Air Quality assessment (GHD 2021a) for details.	Odour
	Review of population growth/forecast – allow 2 to 3 years lead-in time for design and construction	Population Growth Alternative Technology and innovation

Period	Monitoring of Triggers and Review	Related Drivers
From 2026 onwards	Every 6 yearly review (TBC – new consent condition) to examine the best practicable option (BPO) with the latest performance, regulations/standards, community aspiration and other factors	Alternative Treatment Effluent Disposal Impact of Climate Change Carbon Neutrality Target Contaminants of Emerging Concerns Landfill capacity and restriction Alternative Technology and innovation
From 2024 onwards	Monitor other potential governance or significant changes, e.g. Regional solids waste or biosolids strategy, Water Reform Frequency: *as it happens*	Regulation and Governance Changes Industrial reuse opportunities Regional solids waste and biosolids strategies

6. Master plan implementation

The immediate implementation steps of this master plan is summarised in the diagram below.

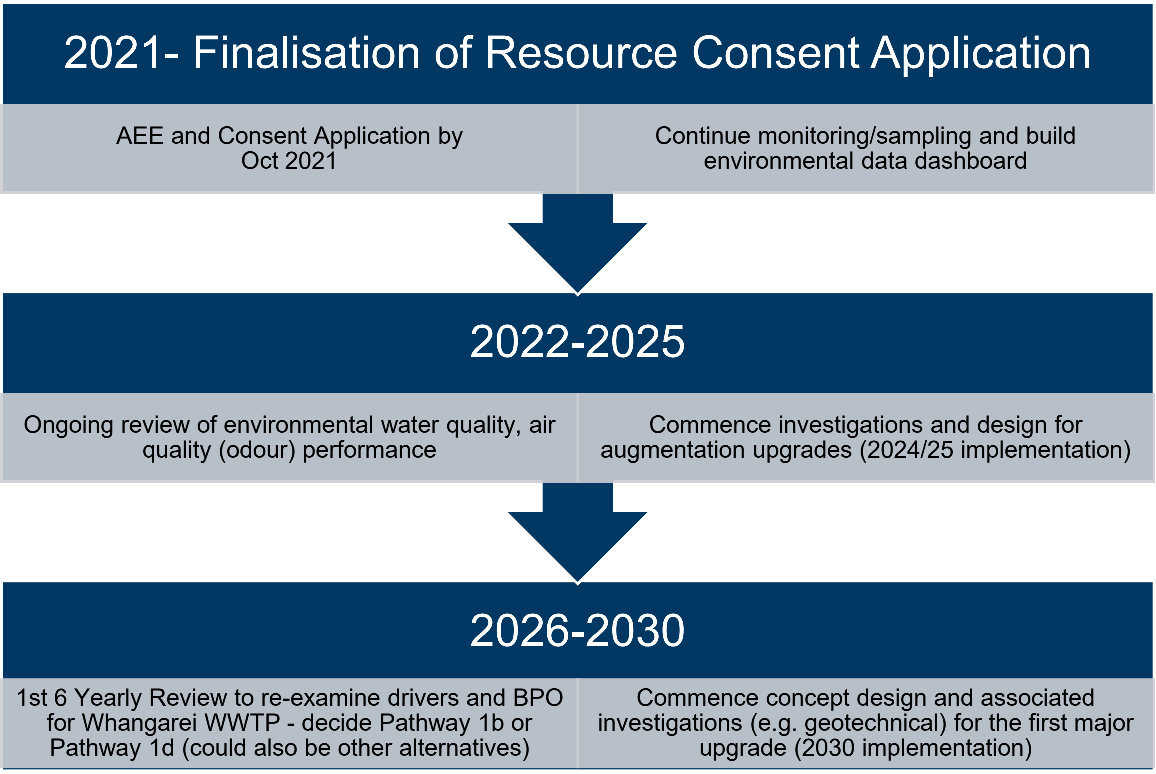


Figure 11 Master Plan Implementation Steps (2021 to 2026)

This Master Plan and the associated implementation steps align with the circular nature of the Adaptive Pathways Planning framework as shown in Figure 12. The Master Plan in conjunction with the Adaptive Management Plan discussed in Section 5.4 represents the top right quadrant of the framework, a “how to” guide of implementations through investigations, physical upgrades and ongoing review. The ongoing monitoring, review and lessons learnt sharing will feed back to the Definition phase as better understanding of various drivers emerge with more information and feedback from the community. Ultimately this will lead to a continuously better outcome.

Figure 12 Adaptive Pathways Planning Framework – the top right quadrant (Evaluation and Implementation)

7. References

GHD (2021a) Whāngarei WWTP Consenting - Air quality (odour) assessment, Revision 1, Final, prepared for Whāngarei District Council, August 2021.

GHD (2021b) Whāngarei WWTP Consenting – Water quality and public health assessment, Revision 1, Final Draft, prepared for Whāngarei District Council, July 2021.

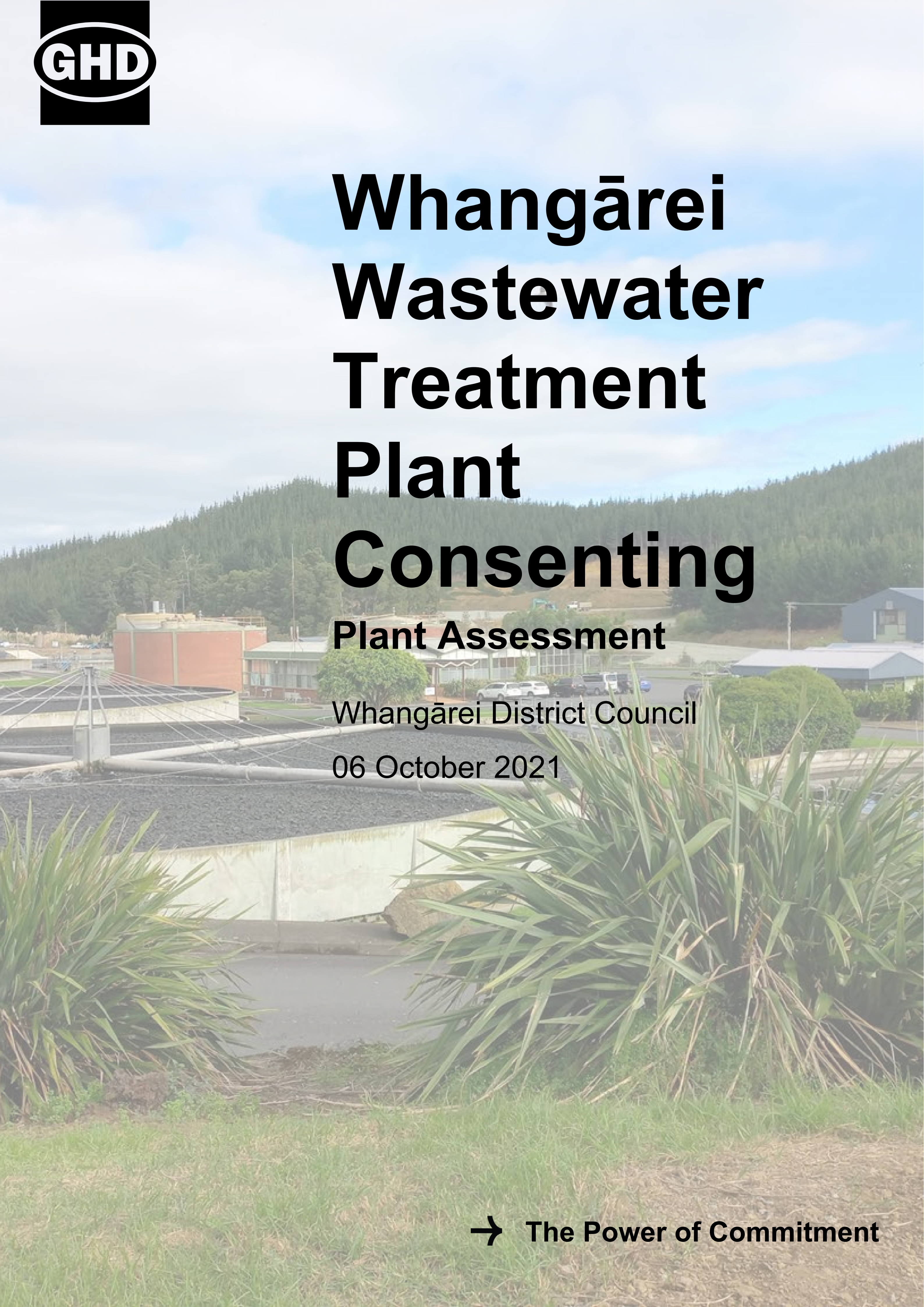
GHD (2021c), Whāngarei WWTP Plant Assessment Report, Revision 2 for consent application, prepared for Whāngarei District Council, October 2021.

GHD (2021d), Whāngarei WWTP Consenting – Options Report, Revision 3 Final Version, prepared for Whāngarei District Council, October 2021

Appendices

Appendix A

Plant Assessment Report



Whangārei Wastewater Treatment Plant Consenting

Plant Assessment

Whangārei District Council

06 October 2021

→ The Power of Commitment

GHD Limited
27 Napier Street, GHD Centre Level 3
Freemans Bay, Auckland 1010, New Zealand
T +64 9 370 8000 | **F** +64 9 370 8001 | **E** aklmail@ghd.com | **ghd.com**

Printed date	7/10/2021 10:09:00 am
Last saved date	07 October 2021
File name	https://projectsportal.ghd.com/sites/pp02_01/whangareiwwtpconsent/ProjectDocs/WWTP Plant Assessment/12528591-REP_Whangarei WWTP consenting - Plant Assessment - For consent application.docx
Author	Ian Ho
Project manager	Sarah Sunich
Client name	Whangārei District Council
Project name	Whangārei WWTP Consenting
Document title	Whangārei Wastewater Treatment Plant Consenting | Plant Assessment
Revision version	Rev 02
Project number	12528591

Document status

Status Code	Revision	Author	Reviewer		Approved for issue		
			Name	Signature	Name	Signature	Date
S4	Rev 0 - for client comment	I Ho D Maynard	I Ho J Gallo	Digitally signed by Ian Ho Date: 2020.07.03 09:19:20 +12'00'	A Kirk S Sunich		03/07/2020
S4	Rev 1 – Final draft	I Ho	S Sunich		A Kirk		20/08/2020
S4	Rev 2 – For consent application	I Ho	S Sunich		A Kirk		6/10/2021

Executive summary

Scope and Purpose:
This desktop assessment identifies capacity and process bottlenecks of the existing treatment process. This forms the baseline for the subsequent Best Practicable Option (BPO) assessment and master plan report to support the consent renewal application. Refer to Section 1 for details on scope, limitations and assumptions

Plant Assessment Summary
Desktop plant assessment identified two types of issues:

1. **Process bottlenecks** – Orange = no/little headroom, Yellow = future capacity upgrade likely needed. Upgrade
2. **Immediate attention/augmentation –** Red = augmentation recommended for consent compliance

	Likely Pinch Point	Require Immediate Attention
Inlet Works	Orange	
Primary Clarifiers	Orange	
Normal Flows		
Trickling Filters – normal flow	Yellow	
Anoxic Selector	Yellow	Red
Activated Sludge Basin	Orange	Red
Secondary Clarifiers	Yellow	Red
Normal Flow UV	Orange	Red
Wet Weather Flows		
Trickling Filters – high flows	Yellow	
Storm Clarifiers	Orange	
High Flow UV	Green	Red
Sludge Processing		
Gravity Thickeners	Yellow	
Gravity Belt Thickeners	Yellow	
Digesters	Yellow	
Centrifuges	Orange	
Site Services		
Power Supply / Backup Power	Yellow	Red

Population Growth Pressure
The connected population of Whangārei WWTP is expected to increase from 65,000 to 92,000 people in the next 30 years. This represents significant service demand for the existing wastewater treatment facility, requiring capacity upgrades.

Nutrients in Receiving Environment
WDC is undertaking further environmental studies to quantify the nutrient load to Limeburners (Hāhā) Creek and the Hātea River. Based on initial discussions with NRC we anticipate the mass loads will need to be maintained at current levels in order to protect the receiving environment, despite significant growth being forecasted.

Draft Long List Option Themes
Four themes have been proposed as a draft for discussion with WDC, before further options assessment being undertaken. They include:

- **Alternative Effluent disposal**– this eliminates or reduces the quantity of treated wastewater into the harbour through land or deep bore injection.
- **Satellite Plant** – this requires construction of a new plant as well as some upgrades to the existing site.
- **Additional Process Trains** – this requires construction of additional tanks and clarifiers within the limited space on site.
- **Process Intensification** – this introduces new technologies to maximise utilisation of existing space and tanks on site.

Immediate Actions for WDC to undertake

- Commence BPO investigation after this review.
- Confirm future service demands and peak wastewater flows to WWTP
- Update current plant sampling/testing plan.
- Commence minor plant augmentation for recent non-compliance issues.

Short Term Investigations recommended:

- Additional intensive sampling at the plant may be required if the BPO identifies the need to update the existing process model (which has not been updated for years).
- A review of previous odour assessment.

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1. Introduction

1.1 Purpose of this report

This report summarises a desktop assessment of the Whangārei wastewater treatment plant (WWTP) in terms of process unit capacity and current consent compliance. A draft long list of options for the upcoming resource consent renewal process is presented for further discussion with the project stakeholders.

The purpose of this report is to form a baseline for evaluating the current process capacity and performance of the existing Whangārei WWTP prior to the development of the long list options for treatment improvement and alternative disposal options.

1.2 Scope and limitations

This report: has been prepared by GHD for Whangārei District Council and may only be used and relied on by Whangārei District Council for the purpose agreed between GHD and Whangārei District Council as set out in section 1.1 of this report.

GHD otherwise disclaims responsibility to any person other than Whangārei District Council arising in connection with this report. GHD also excludes implied warranties and conditions, to the extent legally permissible.

The services undertaken by GHD in connection with preparing this report were limited to those specifically detailed in the report and are subject to the scope limitations set out in the report.

The opinions, conclusions and any recommendations in this report are based on conditions encountered and information reviewed at the date of preparation of the report. GHD has no responsibility or obligation to update this report to account for events or changes occurring subsequent to the date that the report was prepared.

The opinions, conclusions and any recommendations in this report are based on assumptions made by GHD described in this report (refer section(s) 1.3 of this report). GHD disclaims liability arising from any of the assumptions being incorrect.

GHD has prepared this report on the basis of information provided by Whangārei District Council and others who provided information to GHD (including Government authorities), which GHD has not independently verified or checked beyond the agreed scope of work. GHD does not accept liability in connection with such unverified information, including errors and omissions in the report which were caused by errors or omissions in that information.

1.3 Assumptions

Several specific assumptions and exclusions were included as part of the methodology for this desktop plant assessment:

– Typical process unit loading rates are used to establish the indicative process capacity of the major process units, in conjunction with the operator’s field experience;
– Minor process equipment such as transfer pumps, mixers, and augers are not included in this assessment;
– This desktop assessment does not include a review or assessment of asset condition, health and safety, or plant operation practice;
– This report does not include a plant hydraulic assessment;
– This report does not include a review and update of BioWin models.

2. Information Review

A review of the information supplied by WDC was completed to identify any gaps in knowledge of the WWTP requiring further investigation. A technical summary of the gap analysis is provided in an Information Review memorandum in Appendix A.

3. Existing Plant and Current Consent Compliance

3.1 Site Location

The Whangārei WWTP located on Kioreroa Road and understood to have a process capacity treating wet weather flow of up to 125 ML/d (125,000 m^3/d) based the rated process capacity of the UV system. The current resource consent (AUT 004352.01 – 05) enables the discharge of up to 140 ML/d of treated wastewater.

The current WWTP was originally constructed as a Trickling Filter and Clarifier plant in 1966, and was doubled in size and capacity in the early 1980’s. Following that upgrade, the treatment capacity was considerably enhanced through the addition of an activated sludge process, disc filters (now decommissioned) and Ultra-Violet (UV) disinfection of effluent under normal flow conditions. More recent upgrades occurred between 2012 and 2014, including further upgrades to the UV disinfection system (i.e. the addition of high-flow UV) to allow all flows to be UV treated.

Treated effluent is discharged through two treatment wetlands and a dense mangrove forest into Limeburners Creek or Hāhā awa as known to local hapu (referred as “Limeburners (Hāhā) Creek hereafter) before being ultimately discharged into the Hātea River at Port Road Bridge.

Limeburners (Hāhā) Creek, is located in the upper reaches of the Whangārei Harbour and drains a watershed area of 1,280 hectares[1], southwest of the Whangārei City Business District.

There are no direct discharges to Limeburners (Hāhā) Creek via the existing Bypass Overflow Outlet. This outlet is manually isolated by a closed valve and padlock. However, this facility has been retained in the event where flows to the wetland system are not practical, such as:

- The unlikely failure of infrastructure between the treatment plant and wetland.
- Unplanned or unforeseen events that otherwise affects the discharges from the treatment plant to the wetlands. This could include unusual hydraulic conditions that pose a risk to the treatment facility, infrastructure, or public health.

Figure 1 outlines the plant aerial photograph and Figure 2 provides the process flow diagram of the unit processes.

[1] Information sourced from NRC and WDC Whangārei Harbour Water Quality Improvement Strategy (2012)

Figure 1 - Whangārei WWTP and surrounding environment

3.2 Connection Population and Wastewater Flows

Table 1 summarises the current population and wastewater flows from the Information Review memo (Appendix A).

Table 1 - Population and Wastewater Flows

	Values	Comments
Connected Population	65,000	*WDC confirmed the current connected population is between 65,000 to 66,000.*
Average Dry Weather Flow (ADWF)	13,348 m³/d	*Estimated based on Median Flow to the plant.*
Annual Daily Flow (ADF)	15,250 m³/d	*The average plant discharge flow is 18,491 m³/day, WDC advised that the plant inlet flow readings are less reliable than the UV discharge volume.* *This assessment uses 15.2 ML/d to estimate the available capacity "headroom".*
95th percentile flow	26,036 m³/d	*The plant discharge volume is 37,441 m³/d*
Peak Daily Flow	100,084 m³/d	*WDC operators indicated that the peak daily flow has reached 125 ML/d before, not shown in the recent flow data.*

In addition to the above wastewater flows, the plant also receives septage waste via trucks. The waste includes septic tank sludge, landfill leachate and industrial and dairy factory wastewater. The septage waste adds approximately 13.5% Carbonaceous Oxygen Demand (COD) loads, 9% Total Suspended Solids (TSS) loads and 6% Total Kjeldahl Nitrogen (TKN) load.

3.3 Existing Plant Set-up

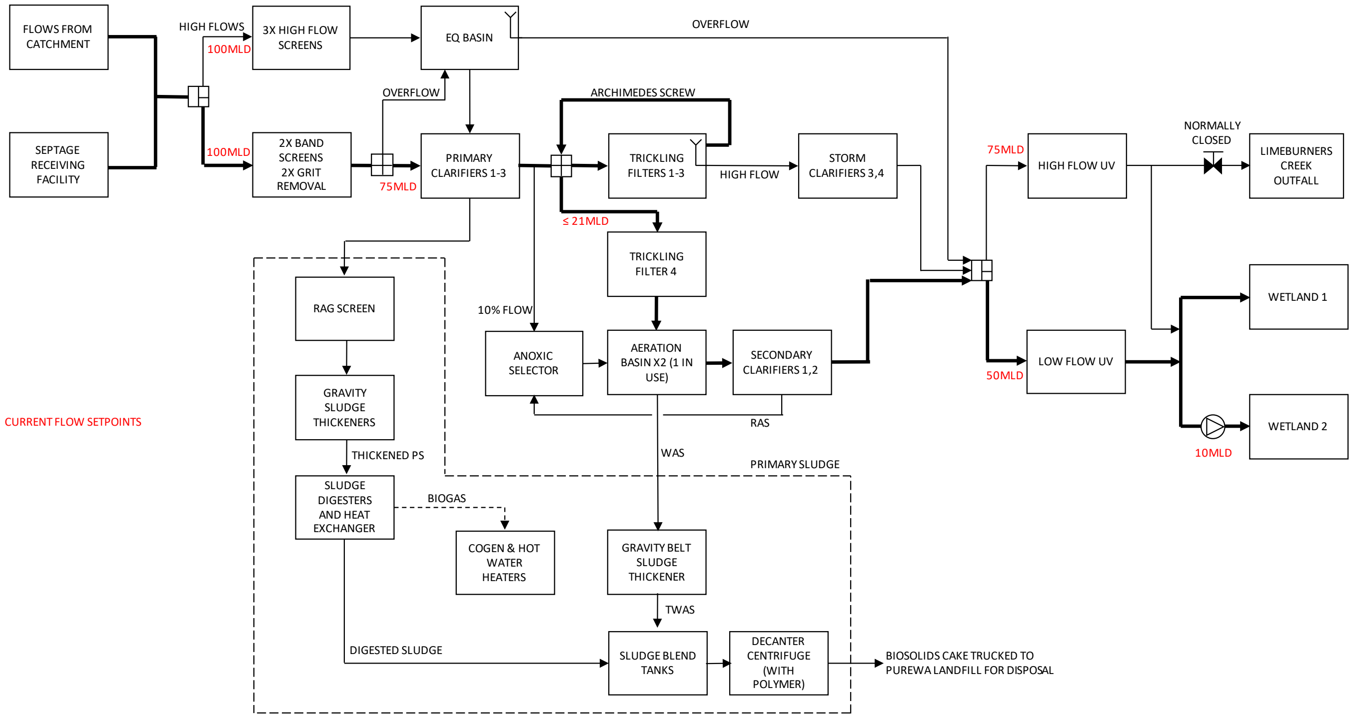


Figure 2 - Whangārei WWTP Process Flow Schematic (Top) and Plant Photo (Bottom)

As shown in the above process flow schematic, the treatment process comprises of the following treatment steps:

- Influent enters an inlet chamber from both the network, and a septage receiving facility.
- The main preliminary treatment consists of 2x band screens and 2x vortex grit removal; if the incoming flow exceeds the band screen capacity, excess flows are diverted to a high-flow inlet works comprising 3x inclined screw screens and an equalisation basin.
- The high flow equalisation basin has an overflow weir to discharge to the high-flow UV system when there is no capacity in the treatment train (primary clarifiers, trickling filters and activated sludge basin) at very high incoming flows.
- Flow from the preliminary treatment inlet works is then treated in three primary clarifiers, which operate in parallel.
- Primary clarifier effluent passes through the trickling filters, which are arranged in a semi two-stage configuration:
  - Under normal flows (<21,000 m^3/day), flow is directed to trickling filters no. 1 – 3 (operating in parallel) and trickling filter no. 4 acts as a second stage trickling filter. Trickling filter no 1- 3 operate with a recirculation back to the trickling filter flowsplitter.
  - During high flows, effluent from trickling filters no. 1 to 3 is directed to secondary clarifiers 3 and 4, via a weir. Recirculation flow via the Archimedes screw is stopped during high flow.
- Downstream of trickling filter no. 4, there is an activated sludge process in an aeration basin (currently only one of two in operation), before passing through secondary clarifiers 1 and 2, low-flow UV treatment, and then discharge to:
  - Wetlands 1 (floating type) via gravity.
  - Wetlands 2 (surface flow type) via pumping, limit to 10 MLD flow.
- Wastewater in secondary clarifiers 3 and 4 (storm clarifiers) are diverted into the high-flow UV treatment system, and discharge to the wetlands.

The sludge treatment train consists of the following process steps:

- Screenings are washed, compacted and transported to landfill.

- Primary clarifier sludge is screened, then thickened by two gravity thickeners.
- Thickened primary sludge then passes through heat exchangers, upstream of two digesters operated at mesophilic temperature (approximately 35-37°C). Biogas from the digesters is used for a co-generation engine and hot water heating.
- Digested sludge is then blended with thickened Waste Activated Sludge (WAS), which has been thickened via a gravity belt thickener.
- Blended sludge is transferred to a sludge holding tank prior to being centrifuged and finally carted offsite to the Purewa landfill, about 10 km south of Whangārei.

3.4 Resource Consent Compliance Performance Summary

Refer to Appendix A Information Review Memo for the current wastewater flows, plant performance, and consent compliance. Current discharge consents cover two stages of upgrades for the WWTP. At this point, the more stringent Stage 2 consent conditions apply after the Stage 2 upgrades were completed in 2015. Below is a summary of the February 2020 consent compliance:

- Final effluent does not comply in terms of the median TSS limit for normal flow conditions (18 mg/L compared to 15 mg/L for flows up to 21,000 m^3/day)
- Final effluent is close to median ammoniacal nitrogen limits for normal flow conditions (4.2 mg/L compared to 5 mg/L, when discharge volume <21,000 m^3/day).
- Final effluent generally complies with the discharge standards for both medium (21,000 to 30,400 m^3/day) and high flow conditions (30,400 to 57,400 m^3/day).
- Final effluent generally complies with microbial discharge conditions, with lower UV-dose occasionally recorded at the normal flow condition.
- There has been no record of non-compliance issues in Limeburners (Hāhā) Creek relating to:
  - Production of conspicuous oil, grease films, scums, foams, floatable, or suspended materials
  - Emission of objectionable odour
  - Discharge of offensive, objectionable, noxious, and/or dangerous contaminants (i.e. dust and odour)

It should be noted that the April 2019 compliance report has recorded offensive odour outside the boundary and along with Kioreroa Road at the time of Northland Regional Council (NRC) staff inspection.

Information Review Memo (Appendix A) contains a summary table of the WWTP's consent compliance over the previous few years, from 2017-2019 as its appendices (Appendix 2). Common issues are regarding insufficient UV dosing, insufficient sampling to determine plant flow rates, low dissolved oxygen levels in Limeburners (Hāhā) Creek, and microbial and TSS non-compliance for the final effluent.

4. Plant Assessment

4.1 Inlet Works

4.1.1 Description

Inlet works consist of an inlet chamber (combining flows from the network and the septage receiving facility), three flow control channels, 2x band screens and grit removal (for normal flows), and 3x inclined screw screens (for high flows). A manual bar screen was initially installed but has been decommissioned and blocked off.

Figure 3 - Inlet Works – view towards the Band Screens

4.1.2 Capacity Assessment – Band Screens (Normal Flows)

Table 2 - Band Screens Capacity Assessment

	Current Loading	Supplier Information	Comments
Number of Band Screens	2	--	
No of screen in operation at peak flows	2	--	
Inlet Screen Peak Flows	100 ML/d total	579 L/s ea 100 ML/d total	*Current loading rate quoted by operator*
Number of Grit	2	--	
Grit Removal Peak Flows	Same as screens	Same as screens	

- Band screens are rated by the supplier at a combined 100 ML/d total, which is similar to the peak daily wastewater flow recorded to the plant of 100 ML/d (2015 to April 2020).
- The operator observes that the band screens and the grit removal are able to meet this 100 ML/d capacity.
- The operator also observes the plant receives 125 ML/d during very high wet weather events, hence part of the inflow is diverted to the High Flow Screens at times.
- The hydraulic limitations of the band screens channel have not been evaluated but are assumed to be also limited to 100 ML/d as stated in MWH (2012) report[2].

4.1.3 Capacity Assessment – High Flow Screens

Table 3 - High Flow Screen Capacity Assessment

	Current Loading	Supplier Information	Comments
Number of Screens	3	-	
No of screen in operation at peak flows	3	-	
Inlet Screen Peak Flows	-	100 ML/d total	*Hourly flow data not provided*

[2] MWH (2012), Hydraulic Control of Screens - Section 5.2

– The plant peak hourly inflow data was not provided.
– In the absence of peak hourly flow data, this assessment was based on the operator's observation that the peak flow screens generally handle the excess high flows that can't be treated by the band screens. However, the Equalisation Basin is used relatively frequently to store diurnal peak flows.
– The hydraulic limitations of the high-flow inlet works structure has not been assessed. The 2012 MWH report estimated that 140 ML/d can be passed using both band screens and high flow screens.

4.1.4 Septage Receiving

The treatment plant receives tanker waste from a number of sources:

– Landfill leachate.
– Industrial waste (e.g. Puhoi Valley Cheese process waste).
– Septic tank waste.

A reception facility is located at the eastern end of the plant, to allow tanker waste to be discharged to the inlet works via gravity. There is no flow equalisation or septage balancing and therefore all tanker waste discharges directly enter the inlet works.

Figure 4 - Septage Receiving Facility

– The operator advises that there are no operational issues related to this facility. It is understood that the inlet grab samples exclude any tanker waste discharge.
– Whilst the tanker waste represents a 0.8% increase in plant inflow, the waste streams increase the plant loading significantly. The percentage estimates are based on average daily volume received at the plant, hence the actual increase on a diurnal or hourly basis will be higher:
  - COD: 13.5%
  - TKN: 6%
  - TSS: 9%

4.1.5 Equalisation Basin

An open top concrete equalisation basin (EQ basin) is located next to the inlet works to provide temporary upfront flow storage during high flow events, particularly when there is no additional capacity at the Primary Clarifiers. EQ basin also provides diurnal flow buffering at times.

An odour measurement study conducted in January and February 2019 indicated that strong odour was detected at the surface of the basin. Further odour assessment was conducted as part of the 2021 AEE work.

Figure 5 - Equalisation Basin and surface aerator

– The operator advises that there are no recent operational issues related to the Equalisation Basin. The operator also informed that the surface aerator is switched on most of the time and this might have contributed to better odour mitigation since the 2019 odour measurements.

4.2 Primary Clarifiers

4.2.1 Description

There are three uncovered primary clarifiers, all operating in parallel, which take the flow from the inlet works and the equalisation basin. They are desludged intermittently, one at a time.

4.2.2 Capacity Assessment

Table 4 - Primary Clarifier Capacity Assessment

	Current Loading	Typical Loading Rate	Comments
Number of Clarifiers	3	-	*24.6 m diameter.*
Average Daily Flow (m^3/d)	15,250		*Recent average influent flow.*
Peak Daily Flow (m^3/d)	75,000		*Operator Peak Flow Setpoint (usual setpoint), occasionally increase to 90ML/d.*
Average surface overflow rate (m^3/m^2d)	10.7	30-50[3]	*Average daily loading rate acceptable and below typical design range.*
Peak flow surface overflow rate (m^3/m^2d)	52	80-120	*Based on 90 ML/d Peak Daily Flow Throughput typically set by the operator.*
Weir Loading Rate (m^3/m d)	72 – Avg 351 – Pk Day	125-500[3]	*Peak weir loading rate is within the upper limit at 75ML/d.*
Detention Time	6.7 hours	1.5-2.5	*On Average Flow condition.*
Current Performance			
TSS reduction	75%	65%	*Results from grab samples.*
$cBOD_5$ reduction	50%	30%	

[3] WEF Manual of Practice No.8 Chapter 12

- The loading rates are relatively low during the current average flow of 15 ML/d. However, the clarifiers appear to be close to typical maximum loading rates when there is a peak daily flow setpoint of 75 ML/d. This aligns with the operator's field experience, detailed below.
- Operator observes that hydraulically the clarifiers are capable of processing 90 ML/d, however they are usually limited to 75 ML/d. The equalisation basin is then used as a storage and a primitive clarifier for the remaining 50 ML/d (with 125 ML/d of peak daily volume).
- The primary clarifier performance (in terms of TSS and $cBOD_5$ reduction) may be over-estimated due to samples at the inlet being grab samples. However, the operator observes that the primary clarifiers generally work well, with the primary effluent $cBOD_5$ and TSS being relatively stable.
- As part of the monitoring programme update, influent samples are now collected as composite samples from October 2020.

4.3 Trickling Filters

4.3.1 Description

There are four uncovered trickling filters onsite, and they are arranged in a semi two stage configuration. Primary clarifier effluent enters a measuring flume upstream of the trickling filter distributor chamber, which also receives the effluent from Trickling Filter No. 1 to 3.

The distributor chamber splits the flow into approximately four equal paths, one to each trickling filter. Trickling Filters No. 1 to 3 are operated as a first stage trickling filter, with an Archimedes Screw Pump to return the trickling filter effluent to the distributor chamber. Trickling Filter No. 4 receives 25% of the flow, and its effluent then passes through a snail removal facility.

The distribution arms of all trickling filters are hydraulically driven, and under dry flow condition only two of the four arms will be used. When high flows occur, the return flow from the Archimedes Screw Pump will be reduced. When the flow to the Trickling Filter No. 1 to 3 exceeds the return flow by the Archimedes Screw Pump, the excess trickling filter effluent flow will be diverted to Secondary Clarifiers No. 3 and 4 via an overflow weir.

Figure 6 - Trickling Filters

Figure 7 - Trickling Filters – outlet launder

4.3.2 Capacity Assessment – Trickling Filters #1 to 3

Table 5 - Trickling Filter No 1 to 3 Capacity Assessment

	Current Loading	Typical Loading Rate	Comments
Number of Trickling Filters	3 in parallel	-	*35m diameter.*
Average Flow to TF #1 to 3 (m^3/d)	11,440		*Based on 75% of average flow (15,250 m^3/d).*
Peak Flow to TF#1 to 3 (m^3/d)	56,000		*Peak hourly flow data not provided, basis of 75% of 75 ML/d peak flow to primary clarifiers .*
Dry Weather hydraulic loading rate (m/d)	4	4-40	*Recirculation flow excluded.*
Wet Weather hydraulic loading rate (m/d)	20	14-88[4]	
Average Organic loading rate ($kg/m^3.d$)	0.22	0.32-0.96[4]	*Based on Primary effluent BOD of 102 mg/L.*
Current Performance			
TSS reduction	No data		*To add to Op's sampling programme.*
$cBOD_5$ reduction		60%	
AmmN reduction		20%	

– Dry weather hydraulic loading appears to be at the low end of the typical loading rate, however this does not include the recirculation flow by the Archimedes screw. There is no media drying observed during the site visit, thus the low hydraulic loading rate is not a major concern.

– The organic loading rate appears to be at the lower end of typical loading rate for similar carbon oxidising trickling filters. It should be noted that the rock media trickling filters are rarely loaded above 1.0 $kg/m^3.d$.

– An assessment of trickling filter 1-3 actual performance could not be made. Sampling has historically been conducted prior to the trickling filter distributer and after trickling filter 4 and so encapsulates the entire

[4] WEF, Manual of Practice No. 8 Chapter 13, Carbon-oxidising trickling filters and nitrifying trickling filters

trickling filter system. The recommendation in the August 2020 version of this report for inclusion of trickling filter 1-3 effluent has been adopted since October 2020.

4.3.3 Capacity Assessment – Trickling Filter #4

Table 6 - Trickling Filter No 4 Capacity Assessment

	Current Loading	Typical Loading Rate	Comments
Number of Trickling Filters	1	-	
Average Flow to TF #4	15,250 m^3/day	-	
Peak Flow to TF#4	21,000 m^3/day	-	
Average hydraulic loading rate (m/d)	16	4 to 10 m/d	35 m diameter, slow rate trickling filter.
Peak hydraulic loading rate (m/d)	22	14 to 28 m/d	
Average Organic loading rate (kg/m^3.d)	0.35	0.1-0.25[2]	Assume first stage trickling filter removes 80% $cBOD_5$
Current Performance			
TF 4 effluent TSS	No data		*To add to Op's sampling programme*.
TF 4 effluent cBOD5	44 mg/L		Avg value 2017-19
TF 4 effluent AmmN	25 mg/L		Avg value 2017-19

– The operator observes that the trickling filter generally functions without issue.
– The $cBOD_5$ loading rates appear to be high for a combined carbon oxidising and nitrifying trickling filter.
– The hydraulic loading rates appear to be at the upper end of the typical range for a second stage intermediate trickling filter.
– The $cBOD_5$ concentration in Trickling Filter No. 4 effluent is between 15 and 90 mg/L over the past 3 years, with an average value of 44 mg/L.
– The ammoniacal nitrogen concentration in the trickling filter effluent varies between 1 to 90 mg/L over the same 3 year period, with an average value of 27 mg/L.
– The variability observed in trickling filter effluent $cBOD_5$ and ammoniacal nitrogen can be attributed to variable wastewater flows (15,000 to 21,000 m^3/day), and elevated organic and hydraulic loading rates.
– Trickling Filter #4 outlet TSS analysis has been added to the operational monitoring programme since October 2020.

4.4 Aeration Basins

4.4.1 Description

An Aeration basin is in place to treat wastewater from Trickling Filter No. 4. The basin is equipped with two 45 kW surface aerators to provide aeration. A pump station is located downstream of the aeration basin, with four activated sludge pumps and two waste activated sludge (WAS) pumps. The activated sludge pumps are configured in parallel, to lift the mixed liquor into the Secondary Clarifiers No. 1 and 2 for clarification. WAS pumps are configured in a duty/standby arrangement to transfer excess biological sludge to the Gravity Belt Thickener (GBT).

An anoxic selector is located upstream of the aeration basin, in which return activated sludge (RAS) from the secondary clarifiers is mixed with a bypass stream of primary clarifier effluent (approximately 10% of plant flow). The anoxic selector is fitted with a submersible mixer to maintain sludge in suspension. The purpose of this anoxic selector was to improve the sludge settling properties through minimising filamentous growth.

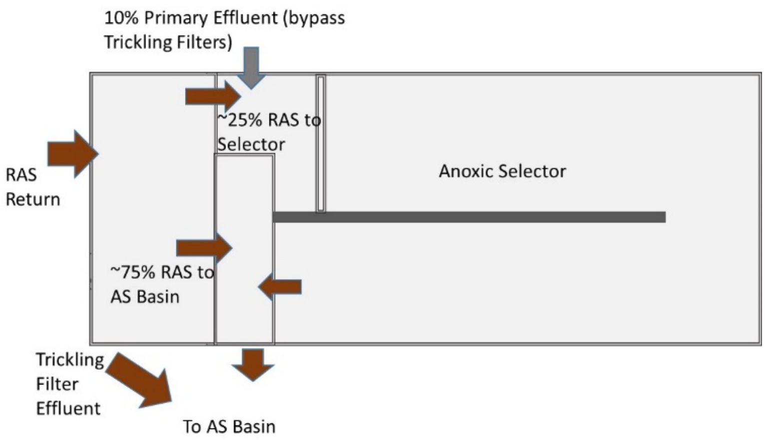


Figure 8 - Anoxic selector Flow Schematic

Figure 9 - Aeration basin

Figure 10 - Anoxic selector

4.4.2 Capacity Assessment

Table 7 - Activated Sludge Basin Capacity Assessment

	Current Loading	Typical Loading Rate	Comments
Number of AS Basin	1	-	
AS Basin Volume (m^3)	1500	-	*Source: WDC Op.*
BOD5 Loads (kg/d)	671	-	*Average Flow of 15,250 m^3/day and Trickling Filter Effluent of 44 mg/L.*
SRT (days)	6.5	8 – 10 days	*WDC Op Record.*
HRT (hours)	2.4 hours	2 – 4 hours	
MLSS (mg/L)	2600	1500 – 3000	*WDC Op Record.*
F/M Ratio (kgBOD/kgSS.d)	0.17	0.08-0.1	
Sludge settling volume (SSV)	314 mL/L		*Average record 2015-18.* *2018 Jan - June Average: 541 mL/L (sampling ceases after this date).*
Sludge Volume Index (SVI)	154 mL/g		*Average record 2015-19.* *2018-19 Average: 231 mL/g.*
Anoxic selector volume	150 m^3		1 partition.
Anoxic selector organic loading rate (kgBOD/kgMLVSS.d)	0.17	3-6[5]	*10% Plant Flow Primary Eff ~ 1525 m^3/d.* *RAS ~ 7500 mg/L.* *Assume RAS VS/TS ~ 0.8.*
RAS return ratio	100%	75-150%	
DO Set points	2		*WDC Op info (site visit).*
Estimated AOR (kg/hr)	108		*WRC aeration coefficients.* *No Denitrification oxygen credit allowed.*
Surface Aerators (kW)	90		
Current Performance (2017-19 Average Values)			
Effluent cBOD[5]	23	--	*Secondary Clarifier outlet.*
Effluent AmmN	5.5	--	*UV Outlet.*
Effluent TN	28	--	*Wetland inlet.*
Effluent TP	3.5	--	*Wetland inlet.*

– From the site visit on 21st May 2020, the feed pumps from the Activated Sludge Basin to the Clarifiers are understood to be operated based on the level in the pump well and operate in parallel.

– The operating MLSS was generally between 2500 to 3500 mg/L. However, there was significant fluctuation in RAS concentrations, indicating the RAS ratio is not constant.

– The WDC operation record indicated the activated sludge basin is operated at 6.5 days sludge age, which is at the lower end necessary to achieve complete nitrification.

– The F/M ratio is estimated to be 0.17 kgcBOD_5/kgMLSS.day, which also seems to be at the upper limit of typical nitrifying activated sludge systems. This is supported by variable ammonia concentrations observed in the final effluent (average: 5.5 mg/L and 95th percentile: 13.7 mg/L).

5 Davoli et al (2002), Testing the effect of selectors in the control of bulking and foaming in full scale activated sludge plants. Water Science and Technology Vol 46 No 1-2, pp 495-498.

– The anoxic selector organic loading rate is lower than typically observed in other facilities.[3] Moreover, the existing selector only takes 25% of RAS return flow. These factors are likely to adversely affect sludge settling characteristics.
– The aeration basin appears to be just sufficient to treat the current wastewater loads, as indicated by relatively good removal of $cBOD_5$ and ammoniacal nitrogen. Considering the sludge age and MLSS the plant is already close to the upper end of the typical design envelope, it is likely that the second aeration basin will be required to treat higher wastewater flows from the projected population increase.

4.5 Secondary Clarifiers 1 & 2 (Normal Flows)

4.5.1 Description

The two uncovered secondary clarifiers are in parallel (26 m diameter each), with RAS pumped into the clarifiers and returned to the anoxic selector via gravity.

Figure 11 - Secondary clarifier launder

4.5.2 Capacity Assessment

Table 8 - Secondary Clarifiers #1 & 2 Capacity Assessment

	Current Loading	Typical Loading Rate	Comments
Number of Clarifiers	2	-	
Clarifier Area (m^2)/clarifier	530.9		*26 m diameter.*
Depth (m)	5		*Tank height.*
Average surface overflow rate (m^3/m^2d)	14	18-24	*2 clarifiers in parallel at 15,250 m^3/day.*
Peak surface overflow rate (m^3/m^2d)	20	40-60	*2 clarifiers in parallel at 21,000 m^3/day.*
Average solids loading rate ($kg/m^2.h$)	3.1	4-6	*RAS Ratio of 100%, MLSS at 2600 mg/L.*
Current Performance (2017-19 Average Values)			
Effluent TSS - Average	20		
Effluent TSS – 90%tile	32		

– The estimated current hydraulic and solids loading rates are within typically accepted industry practice.
– There are a few significant spikes in secondary clarifier effluent TSS content (>50 mg/L). Secondary clarifier effluent TSS should ideally be less than 15-20 mg/L*, c.f. median consent limits of 15 and 25 mg/L respectively for Normal and Medium flow conditions.*
– Elevated TSS in the secondary clarifier effluent can be attributed to poor sludge settling. This is supported by operator's temporary coagulant dosing system to aid sedimentation to reduce TSS spikes. It should be noted coagulant dosing should only be a temporary measure as it introduces additional solids loading to the activated sludge basin and secondary clarifiers.
– The SSV and SVI curves shown in the Information Review memo (Appendix A) that the sludge settling characteristics have deteriorated significantly since 2018.

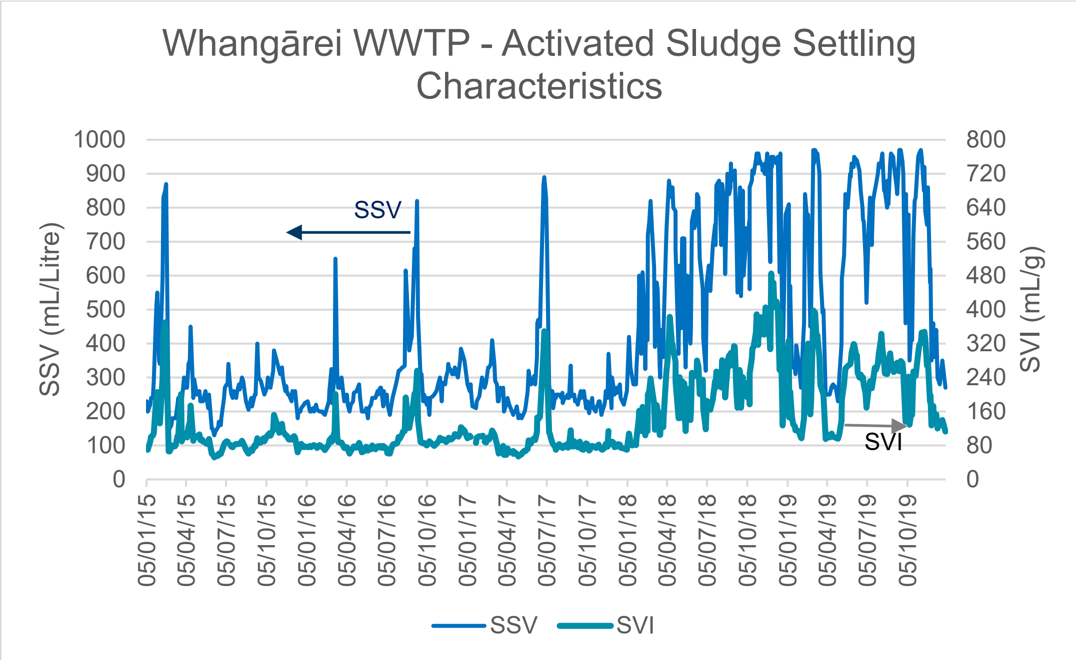


Figure 12 - Sludge Settling Characteristics Data

– This issue of elevated TSS in the plant effluent has been highlighted in the NRC compliance reports, notably in the February 2020 report. Whilst there is a temporary alum dosing system to assist sludge settling in the secondary clarifiers, further optimisation is deemed to be necessary. Some ideas may include:
  - Jar testing to evaluate effectiveness of alternative coagulants and dose rate;
  - Increase primary effluent bypass ratio to the anoxic selector;
  - RAS chlorination;
  - Provision of a tertiary filter system.
– The Plant Manager informed that previous effort to improve sludge settlability included increase of primary effluent bypass to the anoxic selection and RAS chlorination, but neither has resulted in significant improvement in sludge settling characteristics.

4.6 Storm Flows Secondary Clarifiers (#3 and 4)

4.6.1 Description

There are two uncovered clarifiers in parallel which receive weir overflow from the trickling filters. They have a shallower depth compared to the secondary clarifiers #1 and 2 (tank depth of 3 m).

4.6.2 Capacity Assessment

Table 9 - Storm Flow Clarifiers Capacity Assessment

	Current Loading	Typical Loading Rate	Comments
Number of Clarifiers	2	-	
Clarifier Area (m^2)	491 ea		
Peak Daily Flow (m^3/d)	54,000		*75MLD minus 21 MLD*
Peak surface overflow rate (m/d)	55	40-60	*Typical rate for Humus Tanks*
Current Performance (2017-18)			
Effluent TSS (mg/L) - average	3		*High Flow UV Outlet, likely already blended with Normal Flow treatment*
Effluent TSS (mg/L) - peak	10		
Effluent $cBOD_5$ (mg/L)	No data		*To add to Op's sampling programme*
Effluent AmmN (mg/L)	No data		*To add to Op's sampling programme*

- Operator observes that the storm flow clarifiers generally function well without issue.
- Peak hydraulic loading rate seems to be at the upper end of typical trickling filter effluent clarification.
- There was no specific monitoring for the outlet of these storm flow clarifiers – they were added into the revised operations monitoring programme from October 2020.

4.7 UV Disinfection

4.7.1 Description

Effluent from the secondary clarifiers and storm clarifiers is combined upstream of a buried flow splitter located upstream of the normal flow and high flow UV disinfection systems. The normal flow UV disinfection system has a nominal capacity of 50,000 m³/day. Excess flow from the flow splitter combines with the overflow from the equalisation basin and is treated by the high flow UV disinfection system (installed in 2015).

Additional UV lamps can be installed in the high flow UV treatment facility, as shown in the picture below. The expandable channel area is currently blocked off and unable to receive flows.

Figure 13 – High Flow UV treatment facility

4.7.2 Capacity Assessment – Normal Flow UV

The current consent specifies the Normal Flow UV is to comply with the minimum dose at the following flow range:

- <30,400 m³/day – minimum UV dose of 30 mWs/cm²;
- >30,400 m³/day – minimum UV dose of 40 mWs/cm²;

As highlighted in the Information Review memo (Appendix A) and the recent NRC compliance reports, there have been non-compliance with the minimum UV dose at times, particularly during the normal flow condition.

Table 10 - Normal Flow UV Capacity Assessment

		Current Loading	Typical Loading Rate	Comments
Number of UV Channels		1	-	
Unit process capacity		46 ML/d	50 ML/d	*Vendor information*
Current Performance				
UV Transmissivity (%/1cm)		45.6%	50%	*Last 2 years average.* *Vendor advised the design UV-T is 50%.*
UV Dose (mWs/cm2)	Average	40.1	44	*Last 2 years average, c.f. Vendor original design value.*
	Minimum	14.4[6]	Consent limit: >30	
E coli (MPN/100mL) – median (2015-19)		1180	-	*Wetland inlet data.*

- Operator observes that the normal flow UV unit is capable of 50 MLD, which aligns with the vendor design information[7].
- As highlighted in NRC compliance reports, the consented minimum UV dose of 30 mWs/cm^2 has not been achieved at times. It is understood from the WDC operation team that the low UV dose are caused by mis-reading and the online UV transmittance analyser being dirty.
- The online UV transmittance is also on the lower end of typical secondary effluent, with only 45.6% per cm. This is below the original design UV-T value by the UV vendor when this system was expanded in 2016. The design UV-T and effluent TSS were 50% and <10mg/L respectively. This can be improved by a tertiary filtration system upstream.
- The UV achieves reasonably good disinfection, considering E. coli at the wetland inlet is around 1,000 MPN/100mL between 2015 to 2019.
- There is a large period in January 2020 where there are instances of either no dosage recording or 0 mWs/cm² dosage being recorded, despite flow passing through the normal flow UV unit. Therefore, the minimum dosage measurement is taken as the minimum above a dosage of 5 mWs/cm². This recorded dosage of 14.4 mWs/cm² still falls well below the consent limit. We understand from the operation team that this is caused by communication issues between the UV system, plant SCADA and historian, likely over-reporting of under dosage issue. This should be addressed by future investigations.

4.7.3 Capacity Assessment – High Flow UV

The current consent specifies a number of compliance conditions related to the High Flow UV operation:

- Minimum UV dose of 40 mWs/cm²;
- Median E. coli concentration <1,000 cfu/100mL post UV prior to the wetlands.
- 90th percentile E. coli concentration <3,000 cfu/100mL post UV prior to the wetlands.

[6] WDC Plant Manager informed that there have been occasions where the UV dose charts have been mis-read. Low dose occurrences could also be attributed to difficulty to keep the online UV-T analyser clean.
[7] Email from Trojan NZ to GHD, dated 14th August 2020.

– At least 1.5 log reduction in F-specific bacteriophage and culturable rotovirus concentration compared to influent.

Table 11 - High Flow UV Capacity Assessment

		Current Loading	Typical Loading Rate	Comments
Number of UV Channels		4, only 2 in use	-	
Unit process capacity		80 ML/d	75 ML/d	
Current Performance				
UV Transmissivity (%/1cm)		53.6	Vendor: 35%	Vendor Design TSS <35mg/L.
UV Dose (mWs/cm2)	Average	226	Consent: >40	
	Minimum	33.7		
E coli (cfu/100mL) - median		1868.5	Consent: 1000	
E coli (cfu/100mL) – 90%tile		13634	Consent: 3000	

– Operator observes that the high flow UV unit is capable of 70 ML/d, which is similar to the vendor specification of 75ML/d.
– It is unclear why UV-T passing through the High Flow UV is higher than that in the Normal Flow UV system. Further investigation is recommended.
– It seems that E. coli concentrations do not comply well with the consent limits.

4.8 Wetland

4.8.1 Description

Treated effluent from normal flows is split between two constructed wetlands. Wetland 1 has a floating media plantation and is gravity fed from the plant, with a volume of 14,330 m^3 in pond 1, and 5,100 m^3 in pond 2. Wetland 1 was upgraded around 2015 to accommodate a higher hydraulic capacity up to 140 MLD[8]. The upgrade included desludging, rehabilitation of pipework and plant vegetation, and introduction of floating wetlands.

Wetland 2 also has a floating media plantation and receives plant effluent via a pump station, with a volume of 6,800 m^3 in pond 1, 6,640 m^3 in pond 2, and 1,940 m^3 in pond 3. It is understood that Wetland 2 has not been desludged. From the monitoring data, wetland 2 seems to be performing well, with an average TSS of 3.6 mg/L at the outlet.

4.8.2 Observations

From a visual inspection during the site visit (May 2020), the wetlands look to be in an acceptable condition. WDC has engaged WaterClean to undertake regular maintenance of the floating wetland such as plantation trimming/harvest.

[8] AWT, Whangārei Wastewater Treatment Plant: Application for Change to Consent 200904352 Supporting Application. April 2014.

Figure 14 - Wetland 1

4.9 Emergency Outfall to Limeburner Creek

There is an emergency outfall to Limeburner Creek, which is manually isolated at all times. This was the main disposal route prior to the construction of the wetlands. Opening the manual isolation valve requires authorisation from the Plant Manager to permit the discharge of treated effluent via this emergency outfall.

Figure 15 - Emergency outfall isolation valve (with manual padlock)

4.10 Gravity Sludge Thickener for Primary Sludge

4.10.1 Description

Primary sludge is sent to two picket-fence uncovered gravity thickeners, each produce an average of 45 m^3/day thickened sludge prior to feeding into the digesters. There is an upstream screen to remove rags from the primary sludge – these screenings are taken to landfill.

Supernatant from the thickeners is diverted into an emergency basin, near the old UV building, before it drains into a supernatant return pump station.

Figure 16 - Primary sludge gravity thickener

4.10.2 Capacity Assessment – Gravity Sludge Thickener

Table 12 - Gravity Sludge Thickener Capacity Assessment

	Current Loading	Typical Loading Rate	Comments
Number of Thickener	2	---	
Thickener area (m^2)	28 m^2 each	---	Source: operator info
Thickener loading rate – hydraulic (m^3/m^2.d)	30	<33	
Current Performance			
Thickened Sludge consistency (%DS)	5.0	3-5%DS	

– The gravity thickener appears to work satisfactorily, considering that the loading rate and thickened sludge consistency are within typical range.

4.11 Gravity Belt Thickener for WAS

4.11.1 Description

Waste activated sludge (WAS), pumped out from the aeration basin, passes through a polymer dosing injection manifold prior to a housed gravity belt sludge thickener (GBT). Thickened WAS is transferred to the blend tanks, whilst the GBT filtrate is pumped back into the plant inlet via a supernatant well chamber.

Figure 17 - WAS gravity belt thickener

4.11.2 Capacity Assessment – Gravity Belt Thickener

Table 13 - Gravity Belt Thickener Capacity Assessment

	Current Loading	Typical Performance	Comments
Number of Thickener	1	-	
Current Performance			
Thickened WAS consistency (%DS)	~4.5%	3-5%DS	
Solids Capture ratio	Not measured	90%	

– The operator advised that the GBT works satisfactorily, and no major operating issues are reported.

– This is a critical piece of equipment to provide a relatively consistent sludge feed to the blending tank and the centrifuges downstream.

4.12 Digesters

4.12.1 Description

Thickened primary sludge is pumped into two covered mesophilic anaerobic digesters. The digester feed passes through two heat exchangers (in parallel) prior to discharge into the digester tanks. Each digester tank is fitted with a pump recirculation loop for mixing with the digester content and the feed stream. Digested sludge is discharged into the blending tank.

Biogas generated from the digesters is stored temporarily in the repurposed secondary digester tank. Biogas is then distributed to an onsite co-generation engine and two hot water heaters, with excess being flared off.

Figure 18 - Digester Tanks and Gravity Thickeners (buried foreground)

4.12.2 Capacity Assessment – Sludge Digesters

Table 14 - Sludge Digesters Capacity Assessment

	Current Loading	Typical Loading Rate	Comments
Number of Digesters	2	-	
Digester configuration	Parallel	-	*Based on P&ID set-up.*
Total Digester volume (m³)	960 m^3 each 1920m^3 total	-	*Source: Operator info, WDC asset register incorrect volume.*
Digester VS loading rate (kgVS/m^3.d)	1.9	1.9-2.5[9]	*VS: 3.7% (max: 7.4%, not use for calculation).* *Thickened PS feed: 97 m^3/d.*
Digester retention time (days)	20	15-25	
Current Performance			
Volatile solids reduction	67%	>38%	*Digested Sludge VS 1.2%.*
Biogas production	No data		

- The retention time and volatile solids loading rate to the digesters indicate the digesters have some capacity to handle more primary sludge flow.
- Mixing efficiency may need to be examined.

If a significant treatment plant upgrade is identified as the preferred option from the BPO, it is possible that the existing digester tanks may require a capacity upgrade (e.g. third digester or small thermal hydrolysis) to handle the additional sludge volume (e.g. thickened waste activated sludge stream, TWAS). Further assessment is therefore required, e.g. mixing and heating.

Moreover, the proposed increase of landfill levy from the current rate of $10 to $60 per tonne by 2023 may present an opportunity to explore land-based reuse of biosolids in the region, and possibly lead to a potential regional biosolids processing centre at the Whangārei WWTP. There are four other smaller high rate wastewater treatment plants in the Northland Region (Mangawhai, Kerikeri, Hihi and Russell) and some of the other ponds may be converted into high rate treatment processes when their respective resource consents are renewed. However, this will only be a consideration during the BPO stage.

[9] WEF, Manual of Practice No. 8, Chapter 25 Mesophilic Digestion

4.13 Sludge Blending and Centrifuge Dewatering

4.13.1 Description

Digested sludge is blended with thickened WAS in a DEFAC holding tank. The blended sludge is then transferred to a large open top holding tank. From the holding tank, the blended sludge is fed to one of the two centrifuges. Polymer is injected upstream of the centrifuge to assist dewatering, and the dewatered sludge cake drops into a bin before it is taken offsite for disposal at the Purewa landfill.

Centrate is returned to the inlet works for re-processing. It should be noted that post-digester centrate often contains elevated levels of nitrogen and COD, and potentially contribute a load increase to the secondary treatment processes, e.g. trickling filters and aeration basin.

4.13.2 Capacity Assessment – Centrifuges

Table 15 - Sludge Centrifuges Capacity Assessment

	Current Loading	Supplier Information	Comments
Number of Centrifuges	2	-	
Centrifuge configuration	1 at a time	-	
Centrifuge loading rate (m3/hr)	5.4	<10	Vendor information indicative info[10]
Centrifuge feed solids (%DS)	1-2%	~2%	
Centrifuge loading rate (kgDS/hr)	54-108	<290	
Current Performance			
Dewatered cake dryness (%DS)	18.6%	18-22%DS	Depending on polymer dose rate.
Solids capture ratio	Not measured.	>95%	Centrate solids test to be done.

- The current capacity headroom of the centrifuge cannot be determined as vendor information and centrifuge feed solid levels are not available. This was subsequently addressed by the revised operations sampling programme in October 2020.
- The operator has indicated that the sludge dewatering capacity is limited by logistics and truck transport between the WWTP and the landfill.
- The centrifuges are understood to be operated 4 days per week and up to 10 hours per run.

4.14 Biogas System

Biogas from the digesters is stored in a holding tank, which was converted from a decommissioned digester. Biogas is used on site, including the warm water heater and co-generation engines.

A capacity assessment of the biogas system has not been conducted.

4.15 Electrical System

The site power supply is via a transformer, located in the main plant building. Two air compressors are located adjacent to the transformer. The electrical room is also used for storing spare parts of plant equipment.

[10] Alfa Laval provided indicative sizing and loading rates based on current centrifuge models (ALDEC-45 or G3-45) as the existing centrifuges were installed in 1985 and the model AVNX-418 have been discontinued for a number years. Alfa Laval indicated that they will continue to support these two older centrifuges.

Figure 19 - Electrical Room

Several high level recommendations have been made:

- We agree with the Plant Manager that the plant should have a backup generator to operate critical plant equipment.
- Equipment spare parts should be stored in other locations on site.
- The site-wide electrical single line diagram will need to be updated (this was not provided as part of the plant assessment).

A detailed electrical capacity assessment is recommended during future plant augmentation upgrade.

5. Assessment Summary

5.1 Process Bottlenecks Summary

The table below summarises the process capacity analysis of this report and highlights the aspects regarding the wastewater and sludge treatment performance which require urgent attention. Odour related issues have not been examined in this plant assessment.

A colour scheme is used in the "Likely Pinch Point" column to highlight the likely capacity headroom: Red = under capacity, Orange = no/little extra capacity, Yellow = possible future capacity issue, and Green = light loading. The capacity of individual process units will be examined in detail as part of the next phase options assessment.

Red cells in the "Require Immediate Attention" column identify that short term remedial actions are needed to address process pinch points or consent compliance issues. We understand that WDC will commence further investigation on process improvements to address such issues.

Table 16 - Whangārei WWTP Process Pinchpoint

	Likely Pinch Point	Require Immediate Attention	Comments
Inlet Works			*Additional capacity required as Band Screens and Vortex Grit are limited to 100 MLD*
Primary Clarifiers			*Capacity likely limiting in peak flow condition*
Normal Flows			
Trickling Filters – normal flow			
Anoxic Selector			*Poor sludge settling requires attention/*
Activated Sludge Basin			*Additional aeration basin/capacity required.*
Secondary Clarifiers			*Poor sludge settling requires attention*
Normal Flow UV			*Low UV dose issue requires attention*
Wet Weather Flows			
Trickling Filters – high flows			
Storm Clarifiers			*Additional peak weather capacity required*
High Flow UV			*Room for capacity expansion* *Compliance issue to be investigated*
Sludge Processing			
Gravity Thickeners			*May require expansion for future pop*
Gravity Belt Thickeners			*Critical equipment*
Digesters			
Centrifuges			*Limited by truck transport capacity*
Polymer Dosing	--	--	*Not reviewed*
Site Services			
Power Supply / Backup Power			*Backup generator recommended* *Current full site single line diagram needed*
Recycled Water	--	--	*Not reviewed*
Biogas Storage and Flare	--	--	*Not reviewed*
Odour Control	--	--	*Not reviewed*

5.2 Likely Impacts from Accommodating Future Growth

For the purpose of this assessment, the current estimated population connected to the Whangārei WWTP network is 65,000 EP. According to the high growth model, the overall (i.e. connected and non-connected) population is expected to increase to 92,000 people by 2051.

The growing population will put pressure on the treatment plant and the high inflow and infiltration (I&I) received by the plant limits the capacity of several key process units which are hydraulically driven (i.e. inlet works and screens, primary clarifiers, storm clarifiers, UV units) due to the influx of stormwater into the network and subsequent treatment system. It is important to have a reliable understanding of how current and future I&I and any remedial works will affect the design wastewater flows and loads to be treated at this treatment plant, and thereafter disposal.

As such, we recommend WDC to provide information regarding the interaction between wastewater network expansion and wastewater I&I correction programme with the treatment plant, this may include a wastewater network model update.

5.3 Likely Impacts from Changing Planning and Environmental Standards

GHD have been undertaking two other investigations in parallel to this plant assessment:

1. Planning review; and
2. Nutrient budget of Limeburners (Hāhā) Creek and Hātea River.

The preliminary findings of these two investigations and recent liaison between GHD, WDC and NRC has indicated that there are two possible pathways the consenting could take, subject to further water quality assessments of Limeburners (Hāhā) Creek and Hātea River:

a. **Maintain nutrients mass loads** – under this scenario, the treatment plant will be upgraded to cater for significant growth (from 65,000 EP to 92,000 EP in 2051) whilst discharging similar mass loads of nutrients to the receiving environment. The Whangārei WWTP will undergo upgrades to achieve partial denitrification and phosphorus removal. Plant upgrades may be implemented in stages in line with the increase of wastewater flows and loads to be treated at the plant.
b. **Reduce nutrient mass loads** – under this scenario, the treatment plant not only will be upgraded for capacity increase to accommodate population growth, but also target a reduction in nutrient mass loads to the receiving environment. The Whangārei WWTP will undergo major changes to become a biological nutrient removal plant, likely requiring the trickling filters to be decommissioned or re-purposed.

It is GHD's understanding that NRC and WDC agrees to pursue the "Maintain nutrient mass loads" for the next phase of the Best Practicable Option assessment.

6. Draft Long List Options

Table 17 below summarises the draft long list options for the future management of Whangārei City's wastewater to be discussed with WDC.

Table 17 - Draft Long List Options

Theme of Long List Options	Advantages	Potential Constraints
Land Treatment of Whangārei WWTP – Full or partial	*Potentially perceived to be more culturally favourable*	*Land area required for effluent treatment is likely to be significant and cost of acquisition prohibitive.*
Deep well injection of treatment plant effluent	*Less land area required than Land Treatment option*	*Technical suitability uncertain, capital cost likely to be high.*
Relocation of Whangārei WWTP	*Avoid the issue of encroaching development around the WWTP site*	*Uncertainty around land availability, major changes to wastewater network, and very likely cost prohibitive.*
Construction of a new satellite WWTP to service growth, e.g. northern end of the city (two treatment plants in total for Whangārei)	*Existing plant requires less upgrade, less brownfield upgrade.* *A satellite plant to be built with possible land treatment.*	*Uncertainty about land availability and regulatory requirements for new scheme.* *More complex operation and likely re-configuration of wastewater networks.*
Additional Process Trains (e.g. additional clarifiers and activated sludge basins)	*Operation already familiar with the treatment processes*	*Space constraint of existing site.* *More complex construction and additional earthworks (e.g. south and north of the existing plant).*
Process Intensification (e.g. MBR, IFAS, MBBR or MABR retrofit, and use of compact filters in lieu of primary clarifiers)	*Less expansion of existing plant footprint*	*New processes would be introduced.*

We understood that WDC is considering adding a small recycled water facility to provide recycled water to park facility. If implemented, this facility will be compatible to the long list options.

In addition to the above, a future regional biosolids strategy could impact the operation and sizing of existing sludge digesters and dewatering facilities.

7. Next Steps

We recommend the following steps to be carried out in due course as a result of this assessment.

Immediate Actions to be undertaken (implemented during September 2020)

1. WDC to review the draft long list options, and commence the Best Practicable Option (BPO) investigation. Completed as of August 2020.
2. WDC to revise the current treatment plant sampling program, to close the information and data gaps identified in this plant assessment and/or Information Review Memo. Completed as of October 2020.
3. WDC to confirm how the future growth will be serviced by the wastewater network. It is also important for the BPO study to understand how the future wastewater flow will be pumped and conveyed to the treatment plant, as well as provision of future peak wastewater flows.
4. WDC to implement minor augmentation and optimisation works to address issues highlighted in the recent consent non-compliance issues (highlighted red in table 16). A plant optimisation study with a focus on optimising the performance of the trickling filters, aeration basin, clarification and disinfection will assist WDC to develop augmentation measures in the short term. This plant optimisation study must work very closely with the BPO investigation so that the proposed augmentations can be incorporated in the future scheme. Plant augmentation scope commenced in October 2021.

Short Term Investigation (in the next 3 to 6 months) to support the BPO study and Consent Renewal application

1. Assuming the options of “Additional Process Trains” and “Process Intensification” are selected to take forward through to the shortlisted options assessment, an update or revision of the BioWin model for the Whangārei WWTP is recommended. A 6 to 8 week intensive sampling regime should be undertaken to collect the current wastewater data and fractionations for the model update. This is incorporated as part of plant augmentation for a simplified version of process modelling, for aeration basins and secondary clarifiers.
2. Beca has previously designed odour treatment upgrades for Whangārei WWTP. However, the WDC operation team have some different ideas and there has been only one odour complaint between August 2017 and Feb 2020 to NRC. No significant offensive odour was noted during the site visit for this assessment. It is noted however that future reverse sensitivity issues will need to be addressed as part of the re-consenting. Hence, a review of the work carried out by BECA is recommended as part of the next phase of BPO assessment. Completed as of August 2021 as part of the GHD Air Quality Assessment.
3. An update of the wastewater network model may be required as supplementary technical information to demonstrate improvements being made by WDC not only at the treatment plant (the BPO study), but also across its wastewater network. This is part of WDC ongoing work.

Appendix A

Information Review Memo

Memorandum

20 August 2020

To	Whangarei District Council – Hai Nguyen and Sarah Irwin		
Copy to	Sarah Sunich and Anthony Kirk		
From	Ian Ho and Danielle Maynard	**Tel**	+64 9 370 8000
Subject	Whangarei WWTP Information Review (Revised)	**Project no.**	12528591

1	20/05	Draft issue before site visit
2	30/06	Final – revision after new data from WDC
3	20/08	Updated Final – WDC corrected population forecast data and WDC feedback on Plant Assessment Report

1. Introduction

This technical memo presents a summary of the information reviewed to enable the plant assessment for the Whangārei Wastewater Treatment Plant (WWTP). The plant assessment will commence following the approval of this memo by Whangārei District Council (WDC).

The following information were reviewed:

1. Population and Forecast
2. WWTP Wastewater Flow Record
3. WWTP Wastewater Sampling Data – Influent, Effluent and Inter-Stage
4. WWTP Plant Drawings

In parallel to this information review, a planning review and a preliminary nutrient balance of the receiving environment are being undertaken. The respective key findings of these two parallel investigations will be incorporated during the development of the long list options.

2. Current Population and Future Forecast

The catchment for the Whangārei WWTP consists of both domestic and industrial sources. It is the main treatment plant for Whangārei, and treats wastewater from the city, including Onerahi and the Whangārei Heads area.

The city/urban areas of Whangārei are taken to be those areas as shown in **Figure 1,** from the Whangārei District Growth Strategy Draft, 2019. The District Growth Strategy also specifies that the Whangārei Heads area includes: McLeod Bay, Reotahi, Pataua, McGregors Bay, Taurikura, Urquharts Bay, and Ocean Beach.

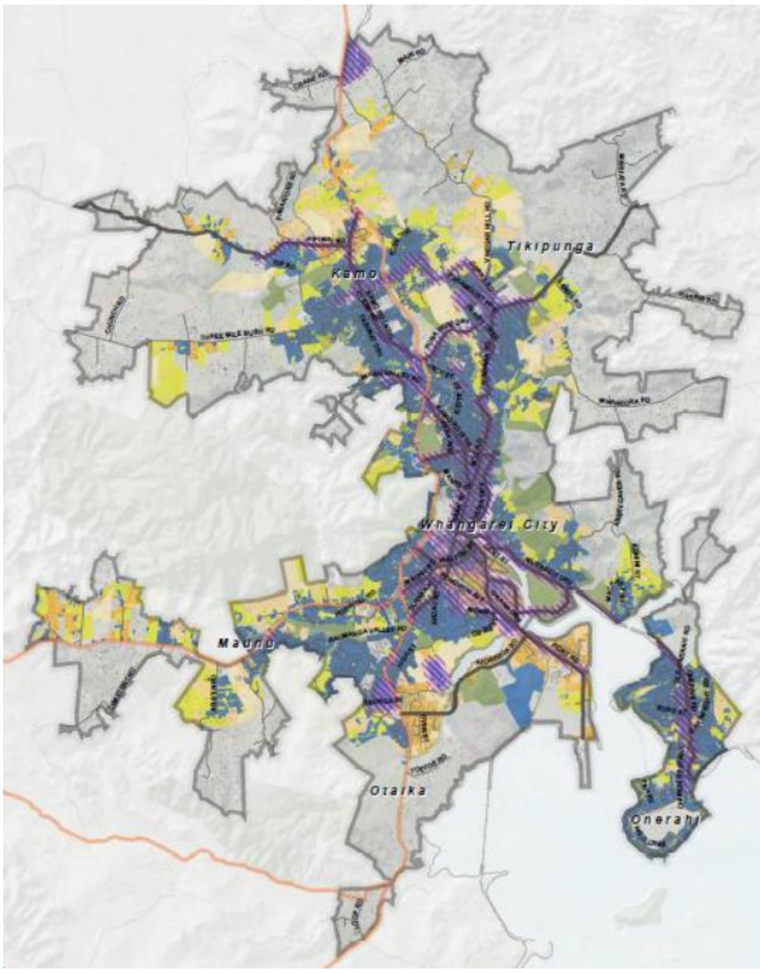


Figure 1 - From Whangārei District Growth Strategy Draft, WDC 2019

Figure 2 below is a wastewater network schematic, of how wastewater is conveyed to the treatment plant. Okara PS is the main terminal pump station of the catchment, and since 2010-11 (circa) has a duplicate rising main to the WWTP resulting in a significant increase of conveyance capacity.

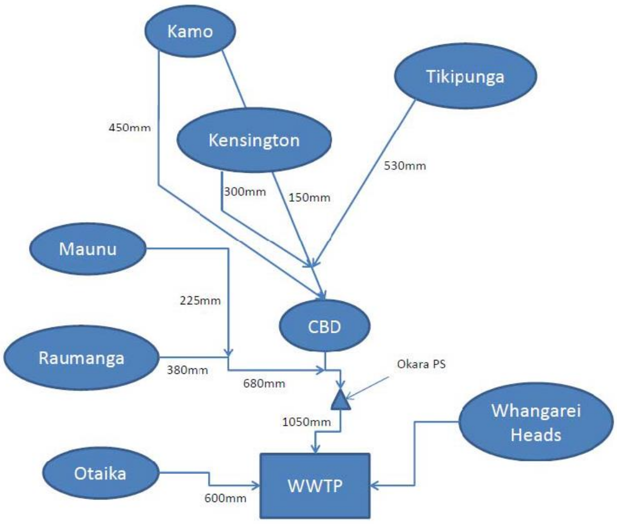


Figure 2 - Whangārei Wastewater Network - Whangārei Wastewater Master Plan, WDC July 2013 (Note: the duplicate rising main from Okara PS to the WWTP is not shown)

From the Whangārei District Growth Strategy Draft (WDC, 2019), the current population in the Whangārei WWTP catchment is estimated to be between 65,000 and 66,000 people, and is expected to increase to over 91,000 people by 2051 (high growth model), as depicted in **Figure 3**. The current connected population was confirmed by WDC in July 2020[1].

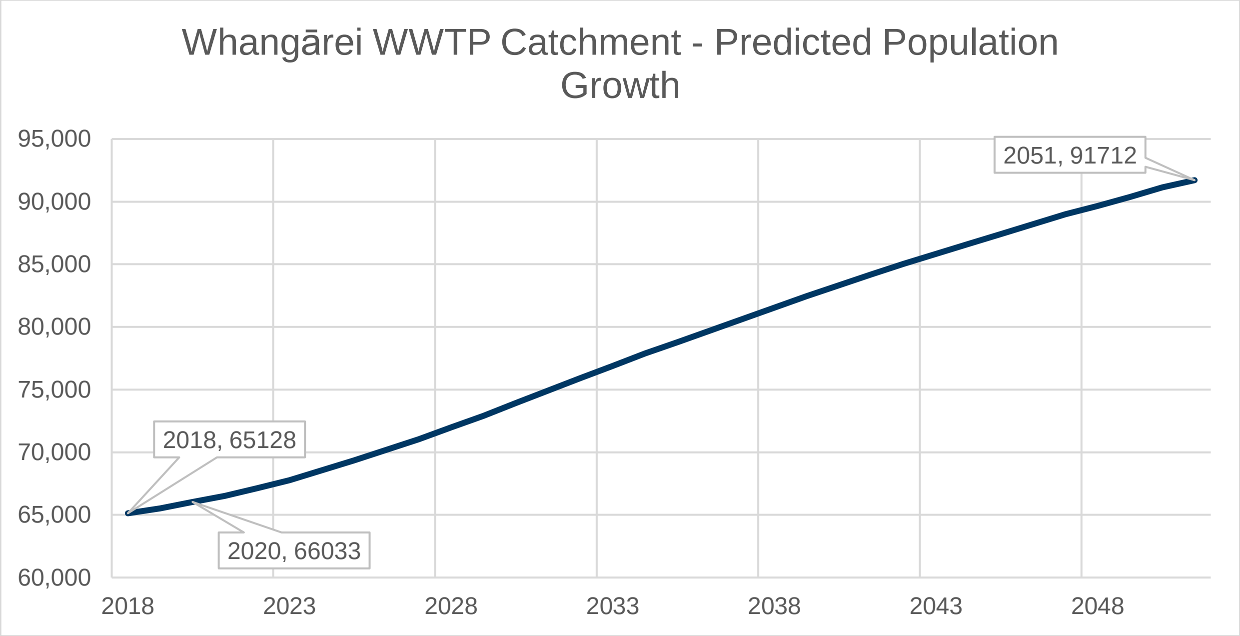


Figure 3 - Predicted Whangarei WWTP Catchment Population Growth [High Growth Scenario]

3. Wastewater Flows

This section presents a summary of the current wastewater flows monitored at the treatment plant.

3.1 Wastewater Daily Flows

Figure 4 below presents the daily wastewater influent flows from 1st January 2015 to 30th April 2020. Peaks in daily rainfall (readings taken from Whangārei Airport) shown in **Figure 5,** correlate to peaks in the WWTP inlet flow.

A wastewater flow percentile plot was also generated as **Figure 6** to assist analysis of the wastewater flow distribution.

From the inlet flow percentile curve, the majority of wet weather events appear to exist above the 90th percentile, with a range from 20,817 to 100,080 m^3/day.

[1] Email from Sarah Irwin (15th July 2020)

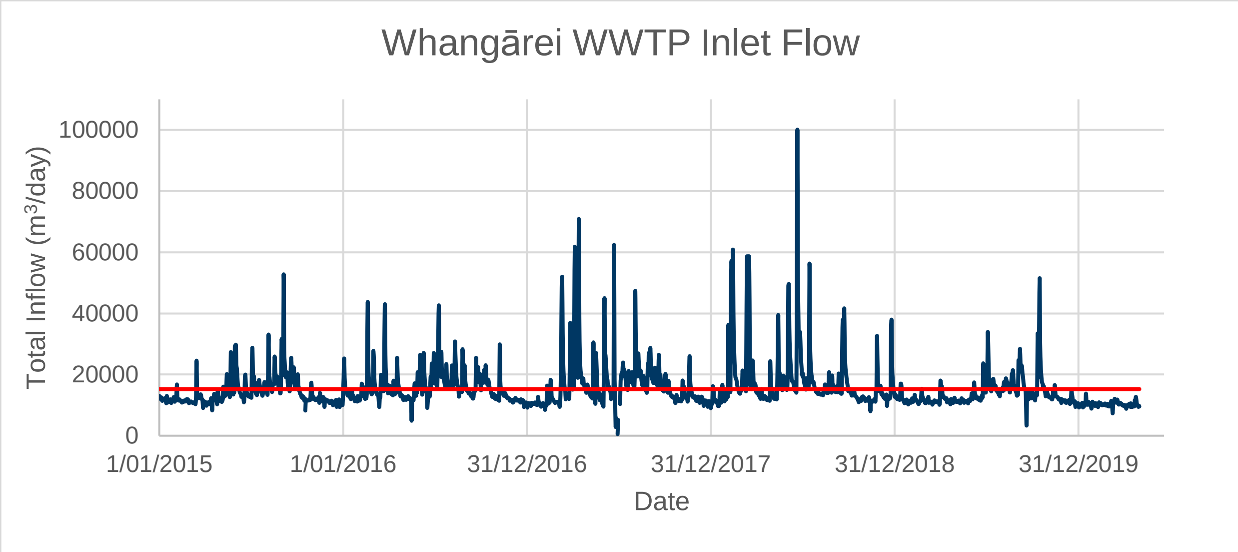


Figure 4 - Whangārei WWTP Inlet Flow (Jan 2015 to April 2020), Red line showing average wastewater flow

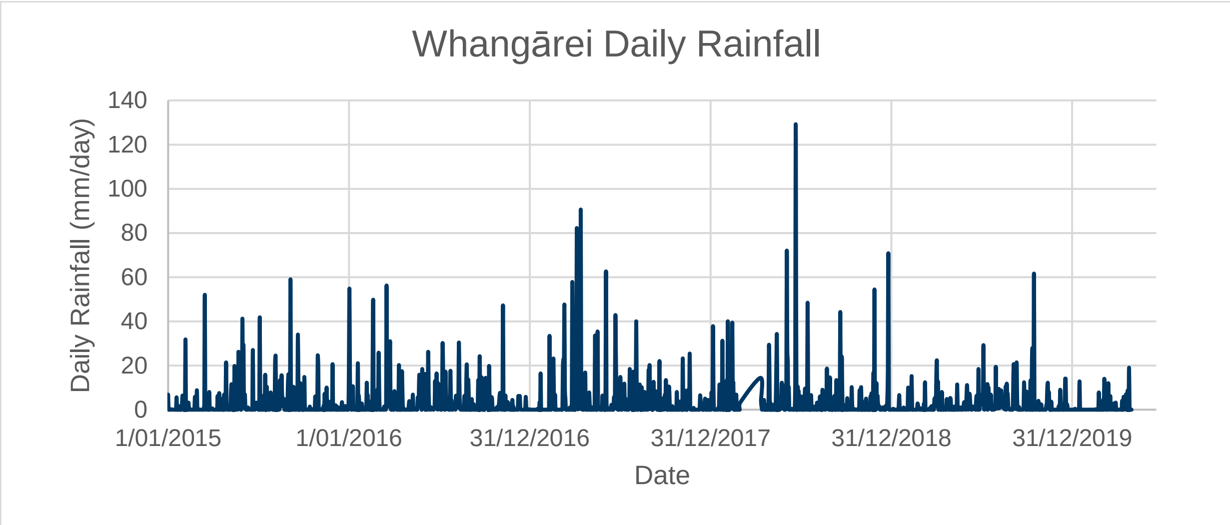


Figure 5 - Whangārei Daily Rainfall (Jan 2015 to April 2020), sourced from the NIWA data

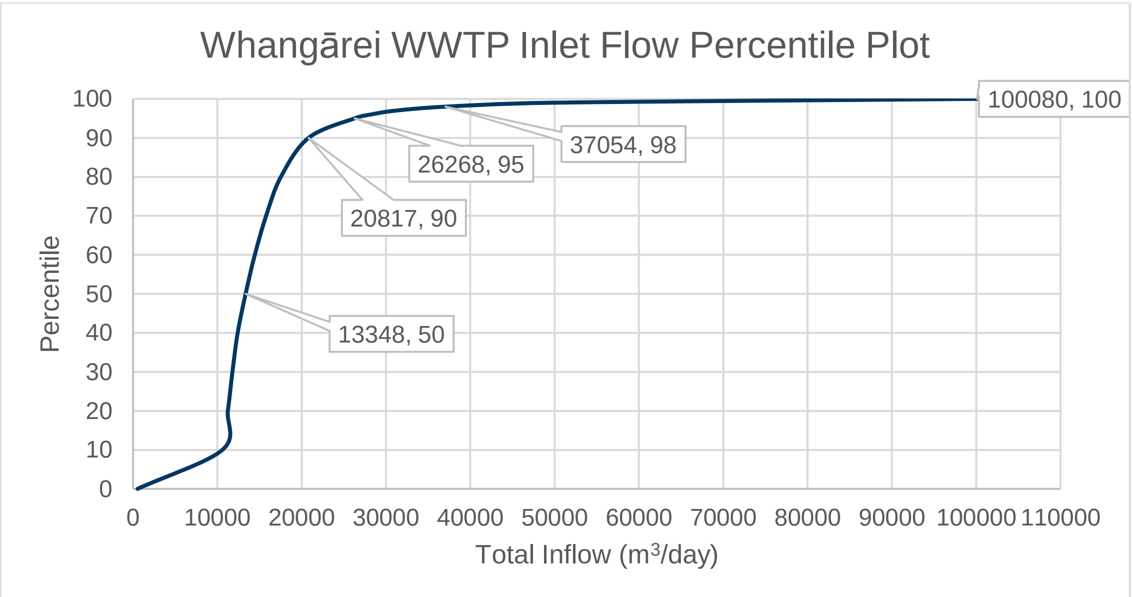


Figure 6 - Whangārei WWTP Inlet Flow Percentiles

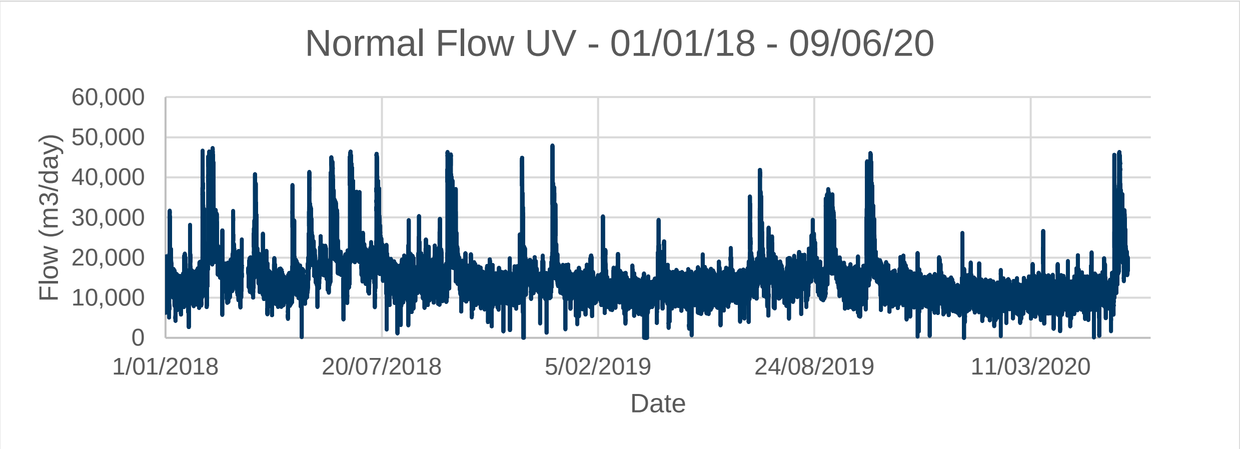
The wastewater inflow data shows the following characteristics:

- Current dry weather flow (ADWF) is approximately 13,000m³/day, or 200 litres/day per EP[2].
- Average wastewater flow (AAF) is approximately 15,250m³/day, or 235 litres/day per EP.
- Maximum daily flow in the period was 100,080m³/day; the corresponding ratio of MDF/AAF ~ 6.5x.
- Wastewater flow volume is highly influenced by the intensity of the rainfall.
- The resource consent normal wastewater flow is <21,000m³/day, which should cover 90% of the wastewater flow scenario.

3.2 Effluent Discharge Flows

Refer to Figure 7 for recent UV flows, and observations are as follows:

- Normal UV flows can reach up to 45,000 m³/day, which is within the stated capacity of UV unit.
- High Flow UV data is 15 minutes interval.
- The day of the peak plant influent flow (100,080 m³/day) in June 2018 closely resembles the average daily flow through both UV units on that same day (99,703 m³/day).
- For the majority of the time, there is no flow through the high flow UV unit, with flow only being treated in this unit on particular wet weather events, as shown in the graph below.
- There are instances of very low flow (~20m³/day) passing through the high flow UV unit with zero dosage being applied. It is unclear whether this is a flowmeter error when there is neligible flow through the UV channel, or the UV lamps are switched off as part of low flow protection.



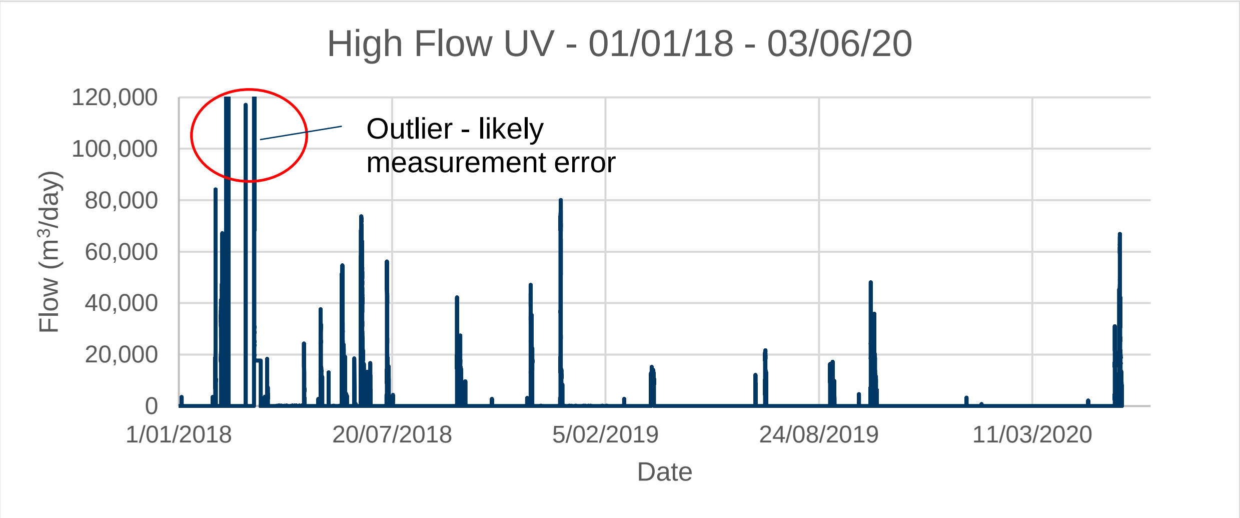


Figure 7 - Whangārei WWTP Flow through Normal UV (Top) and High Flow (Bottom)

[2] Flow per capita is estimated based on a current population of 65,000 people.

Table 1 presents a comparison of the plant inlet flow and discharge volume.

Table 1 - Comparison of Whangarei WWTP Inlet and Discharge Volume (2015 to 2020)

	Daily Inlet Flow (m^3/day) Jan 15 to Apr 20	Discharge Volume (m^3/day) 2nd Oct 15 to 22nd Nov 19	UV Volume (m^3/day) 1st Jan 18 – 9th Jun 20
# of data points	1,941 (daily data)	352 (WQ sampling dates)	85048 (15 minute intervals)*
Average	15,250	18,491	14,507.2*
Median	13,348	15,632	-
95th percentile	26,036	37,441	-
Maximum	100,080	88,544**	99,703**

**Average UV volume data is taken only from the UV channel (not also including the high flow UV channel) – quantity of data and difference in interval size between the two data sets creates complexity in doing a combined analysis. The difference between the average daily inlet and average UV daily outlet flows is likely due to the omission of this high flow data in the latter.*

***From the UV flow data, the maximum daily flow through both the UV and the high flow UV channels is 99,703 m^3/day. This figure more closely correlates to the maximum daily inlet flow (measured on the same day as the maximum daily outlet flow) of 100,080.4 m^3/day.*

As seen from the above comparison, the plant effluent discharge volume is **noticeably different** to the plant inflow measurements. WDC advised that the UV discharge volume is a more accurate representation of the daily wastewater flow treated by the plant.

We recommend WDC investigate the discrepancy of the plant inlet and outlet flow measurements.

3.3 Inter-Stage Wastewater Flows

WDC has provided the following flowmeter data:

– Primary Sludge Flow/Daily Volume;

– Return Activated Sludge (RAS) Flows (Flowmeters 1 and 2);

– Waste Sludge (WAS) Flow;

In examination of the treatment plant process flow diagrams (PFD) and P&IDs, there are several additional flowmeter data which will be useful for plant assessment. They include:

1. Archimedes Screw Pump Flow – *this measures the recirculation flow around the trickling filters. WDC confirmed at site visit on 21/05 that there is no flowmeter installed in this line;*
2. Primary Effluent Bypass – *this measures the primary effluent directly treated by the AS Basin. WDC Plant Manager confirmed this is normally 10% of the PST effluent flow;*
3. Thickened PS Feed – *this measures the ratio of primary sludge to the digesters. WDC has provided this data for the plant assessment;*
4. Centrifuge feed and Centrate flows – *these values help to estimate centrifuge solids capture performance. WDC confirmed that centrifuge feed pump rate is normally set at 10L/s and centrate flow is not monitored.*

4. Wastewater Sampling Data

4.1 Influent Wastewater

Table 2 below is a summary of the influent samples, collected as grab samples.

Table 2 - Influent Wastewater Quality Summary (Jan 2015 to Dec 2019)

	Average	Median	Minimum	Maximum	No. of Samples
pH	7.42	7.40	6.3	8.6	478
Alkalinity (mg/L)	281	2834	29*	525.2	109
TSS (mg/L)	427	349	75	4,213*	476
$cBOD_5$ (mg/L)	283	267	60	1,525*	246
COD (mg/L)	734	638	63	4,716*	477
AmmN (mg/L)	48.1	48.5	0.4*	108.8*	464
DRP (mg/L)	8.11	8.15	2.74	14.19	37
TP (mg/L)	8.52	7.50	4.4	13.5	21

* - these values are assessed to be outliers.

Observations of the above data are as follows:

– Wastewater characteristics are similar to those typically observed in municipal data;

– In particular, $cBOD_5$ and AmmN are similar to typical municipal wastewater;

– TKN was not included in the supplied data;

– Based on a typical AmmN/TKN ratio of 0.7 (commonly varies between 0.6 to 0.8, as catchment specific), the influent TKN is approximately 68mgN/L.

Table 3 below presents a comparison of the influent loads (based on an average flow of 15,250m^3/day) and the per capita load contribution (based on 65,000 EP).

Table 3 - WWTP Incoming Loads and Per Capita Generation Rates

	Average Load (mg/L)	Per Capita Rate (g/EP/d)*	Typical Range (g/EP/d)
TSS	427.26	100.24	65-90
$cBOD_5$	282.74	66.34	65-80
COD	733.74	172.15	100-160
AmmN	48.07	11.28	10-12
TP	8.52	2.00	2-2.5

*Assuming a population of 65,000EP (2019), and an average flowrate of 15,250 m^3/day.

The above estimation indicates that the majority of the per capita contaminant load generation rates are within the typical range. However, TSS and COD are both above the typical range. This can be attributed to the uncertainty of the wastewater flow and connected population figures, as well as grab samples at the plant inlet.

As shown in the table below, the treatment plant also receives septage waste via tankers from various sources, information provided by WDC operation team.

Table 4 - Septage discharge summary (Source: WDC Operation)

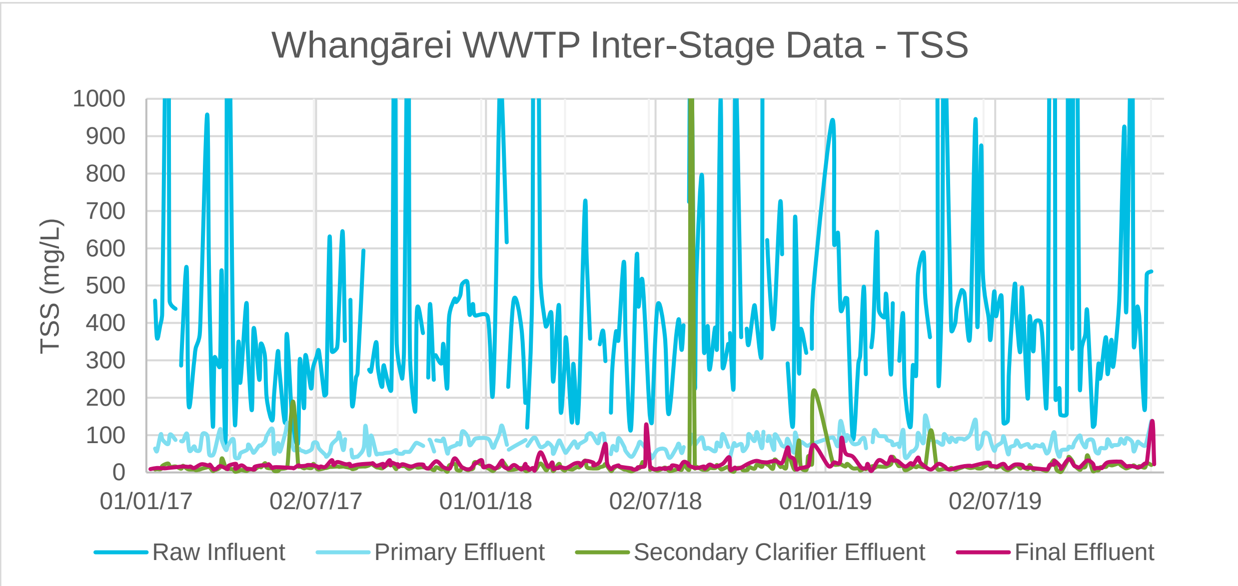
Type	Average volume/day (m3)	Average COD (kg/m3)	Average TKN (kg/m3)	Average TSS (kg/m3)
Septic tank sludge	31.42	25	0.5	15
Lightly contaminated wastewater	10.28	0.8	0.3	0.05
Puwera landfill leachate	60.51	9.1	0.7	1.2
Dairy wastewater	18.19	8	0.2	1.3
Total Mass load	**120 m³/d**	**1490kg/d**	**65 kg/d**	**568kg/d**

Whilst the tanker waste represents 0.8% increase of plant inflow, but this waste stream represents noticeable increase in loads to the treatment plant:

– COD: 13.5%
– TKN: 6%
– TSS: 9%

4.2 Inter-Stage Data

4.2.1 Total Suspended Solids (TSS)



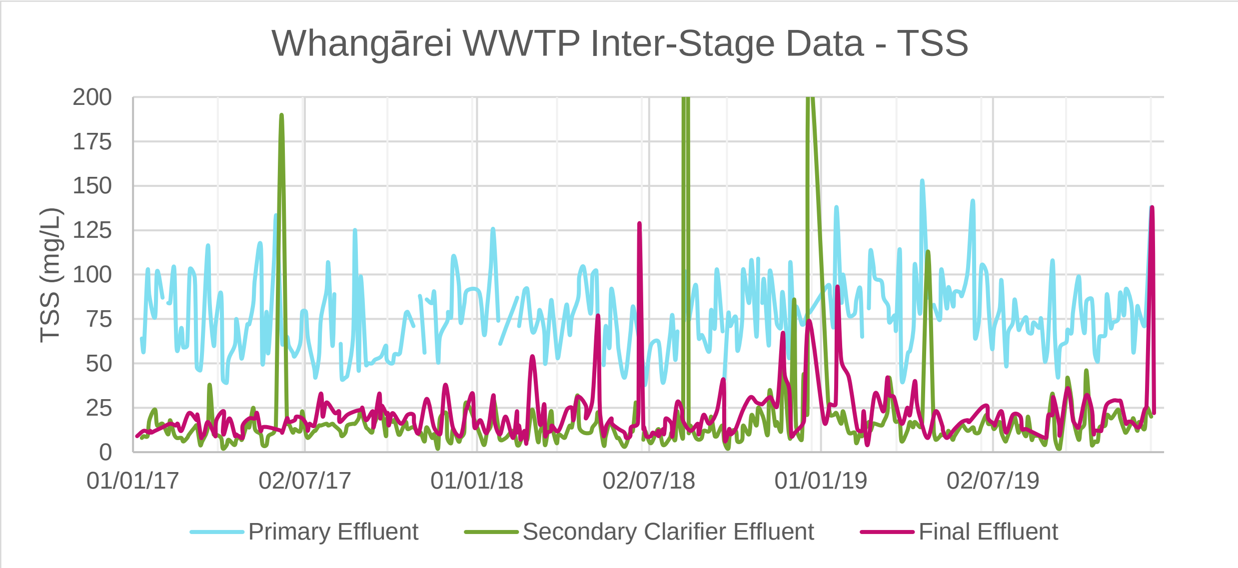
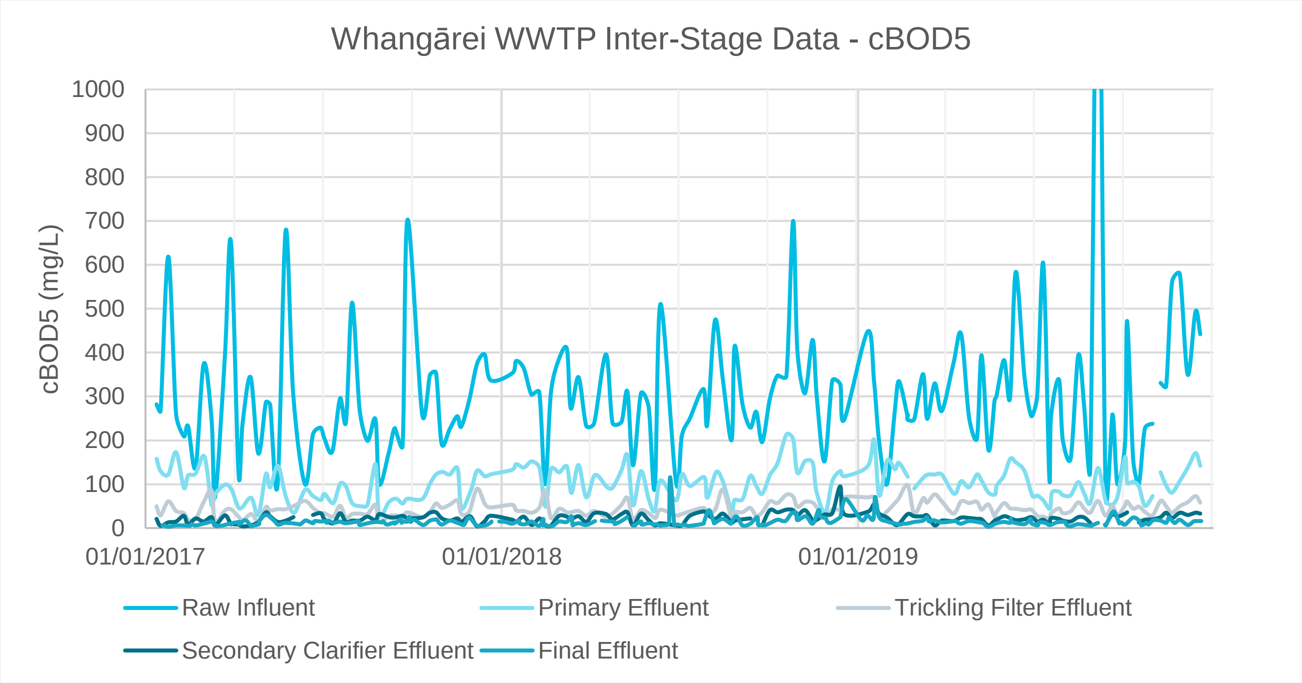


Figure 8 - Whangārei WWTP TSS Profile

Observations noted:

– TSS data not available for trickling filter effluent;
– Wide fluctuation of raw influent TSS is due to grab sample regime. It is more desirable to adopt a 24 hour time composite sample regime to get a more accurate representation of "daily average" influent characteristics;
– Primary clarifier effluent TSS is relatively stable, <120mg/L; Primary Clarifier TSS removal is generally around 75%, better than typical performance of 60-65%;
– Secondary clarifier and final effluent TSS are relatively similar, this is expected as the discfilter is no longer in operation;
– There are a few significant spikes in secondary clarifier effluent (>50mg/L). Secondary clarifier effluent TSS should ideally be less than 20mg/L, *c.f. median consent limits of 15 and 25mg/L respectively for Normal and Medium flow conditions*;
– The final effluent is understood to be sampled based on 24 hour composite samples.

4.2.2 $cBOD_5$



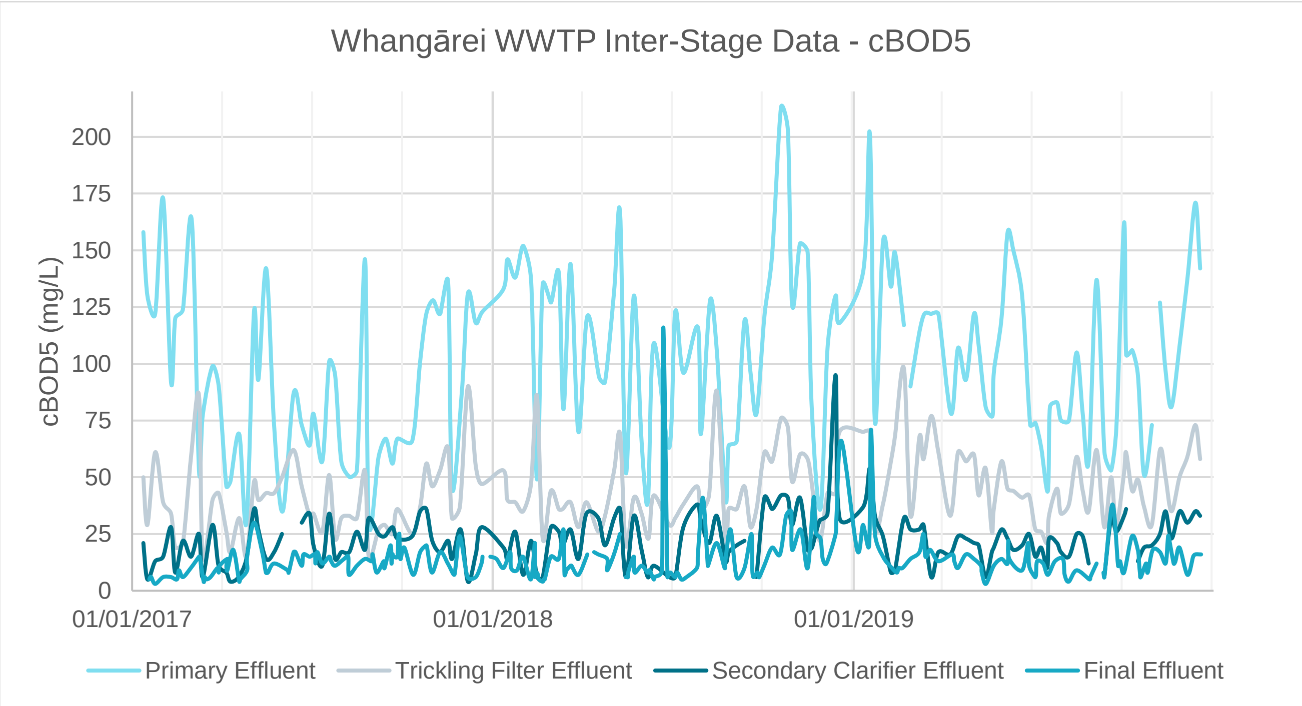


Figure 9 - Whangārei WWTP $cBOD_5$ Profile

Observations from the $cBOD_5$ data:

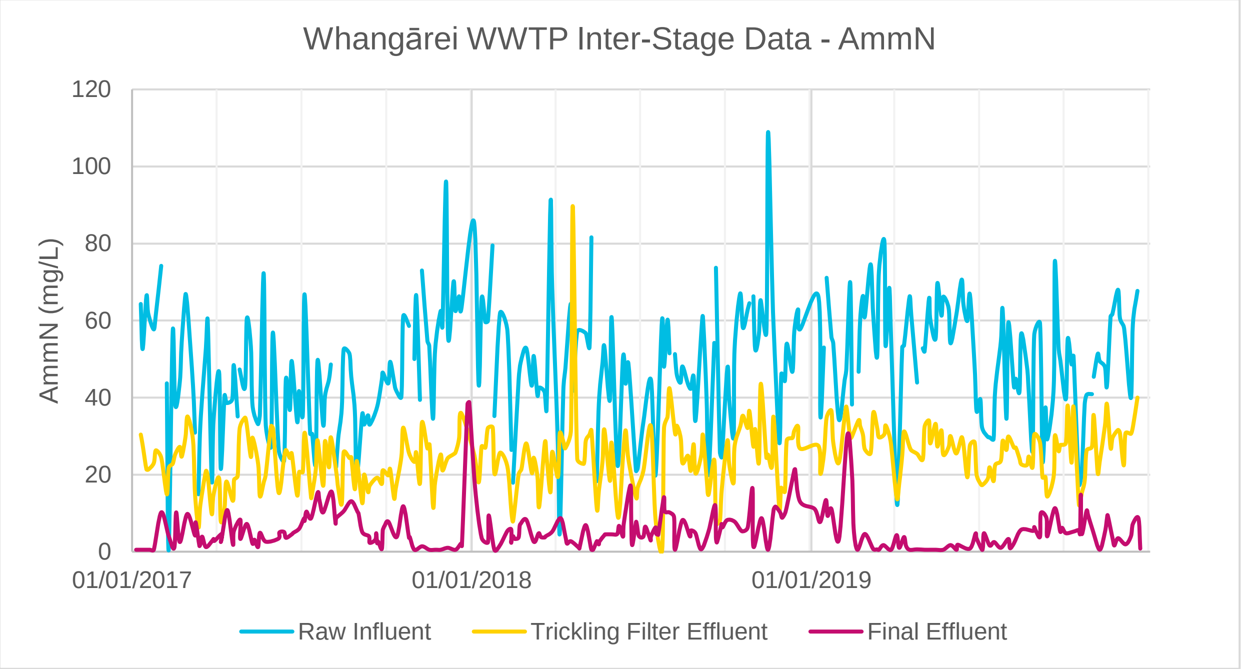
– Sporadic distribution of raw influent $cBOD_5$ is attributed to grab samples.

– Primary clarifier effluent $cBOD_5$ has been relatively stable between 100-175mg/L.

– Trickling filter effluent $cBOD_5$ was generally between 30 to 80mg/L.

– Similar to the Final effluent TSS profile, there have been some significant spikes in final effluent $cBOD_5$ Ideally the final effluent $cBOD_5$ should be less than 15-20mg/L, c.f. *median consent limits of 15 and 20mg/L respectively for Normal Flow and Medium Flow Conditions.*

4.2.3 Ammoniacal-Nitrogen (AmmN)



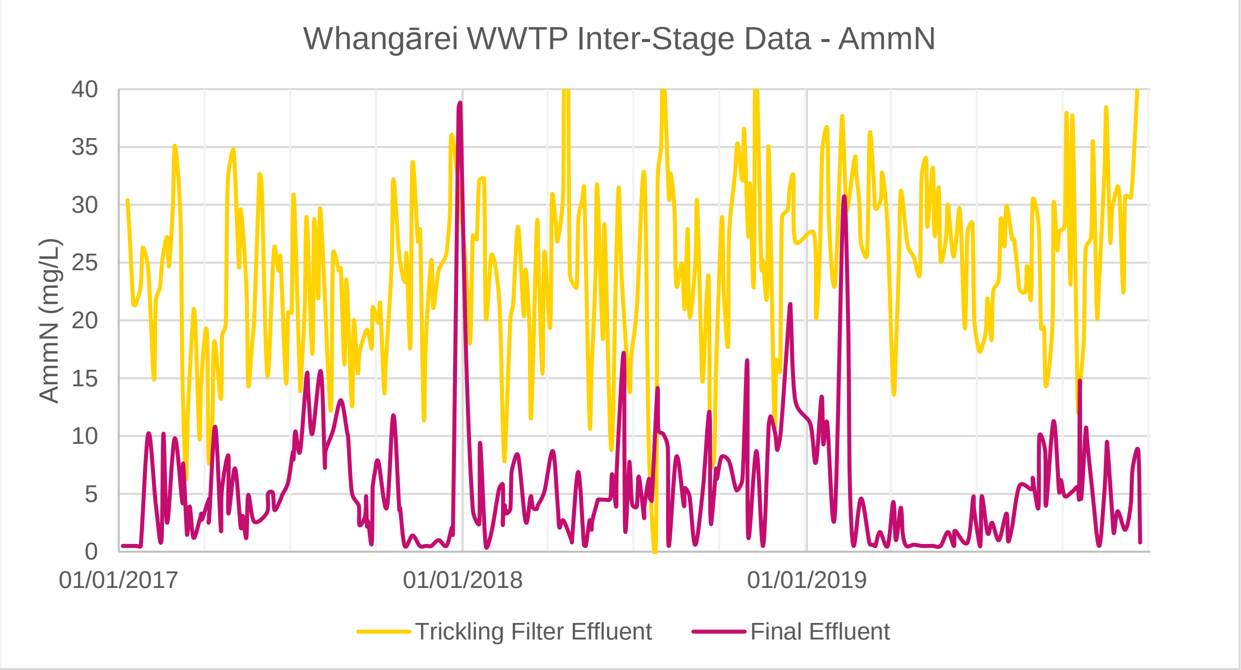


Figure 10 - Whangārei WWTP Ammoniacal Nitrogen Profile

Observations from the AmmN data:

- AmmN data not monitored at primary clarifier outlet and secondary clarifier outlet;
- Sporadic distribution of raw influent AmmN is attributed to grab samples, especially for the unusually high values (i.e. >60mg/L);
- Trickling filter effluent AmmN generally varied between 15 to 35mg/L (as N), indicating partial nitrification at the trickling filters;
- Final effluent AmmN generally varied between 2 to 10mg/L, with a noticeable number of samples exceeding 5mg/L (the normal flow median consent limit). The cause of spikes will be investigated further in the plant assessment.

4.2.4 Activated Sludge Basins

Mixed Liquor Suspended Solids (MLSS) and Return Activated Sludge (RAS)

MLSS is a measure of the quantity of biomass in the activated sludge basin.

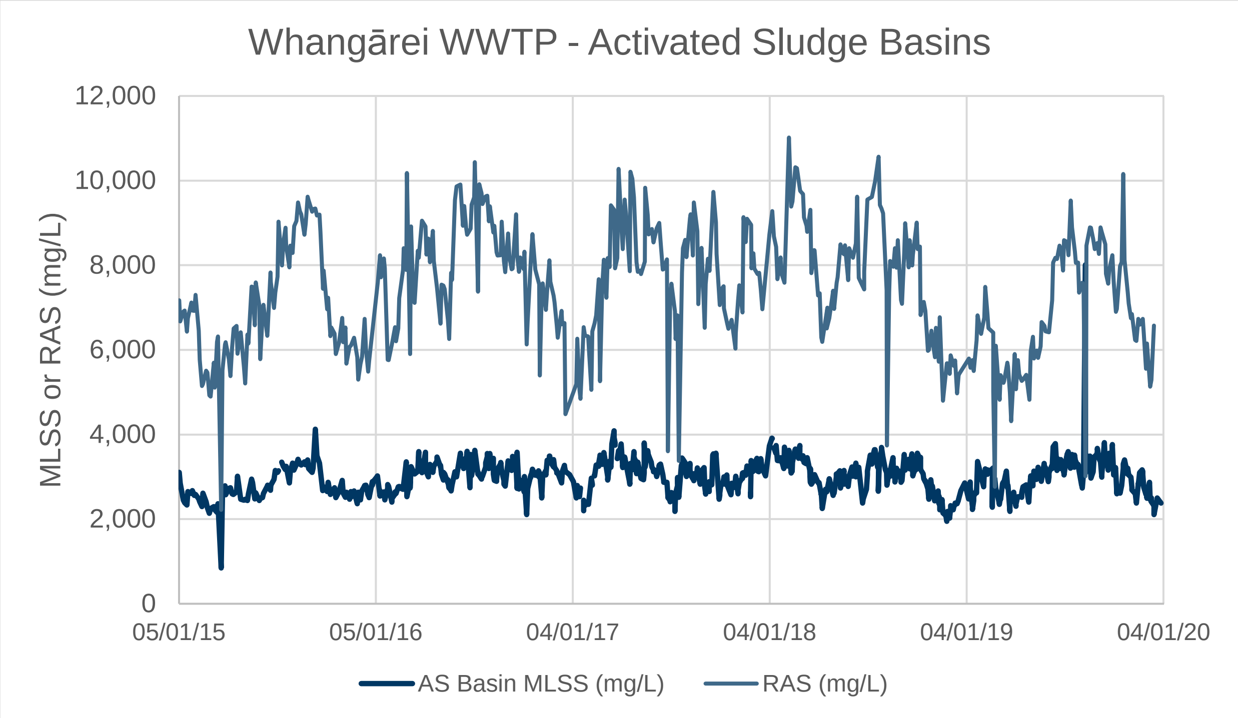


Figure 11 - Whangārei WWTP MLSS Profile

The operating MLSS was generally between 2500 to 3500mg/L. However, there was significant fluctuation in RAS concentrations, indicating the RAS ratio was adjusted continually.

From the site visit on 21st May 2020, the feed pumps from the Activated Sludge Basin to the Clarifiers are understood to be operated based on the level in the pump well and operated in parallel.

Sludge Settling – Sludge Settling Volume (SSV) and Sludge Volume Index (SVI)

SSV and SVI are measurements to quantify/characterise the settling characteristics of the mixed liquor/biomass in the activated sludge basin.

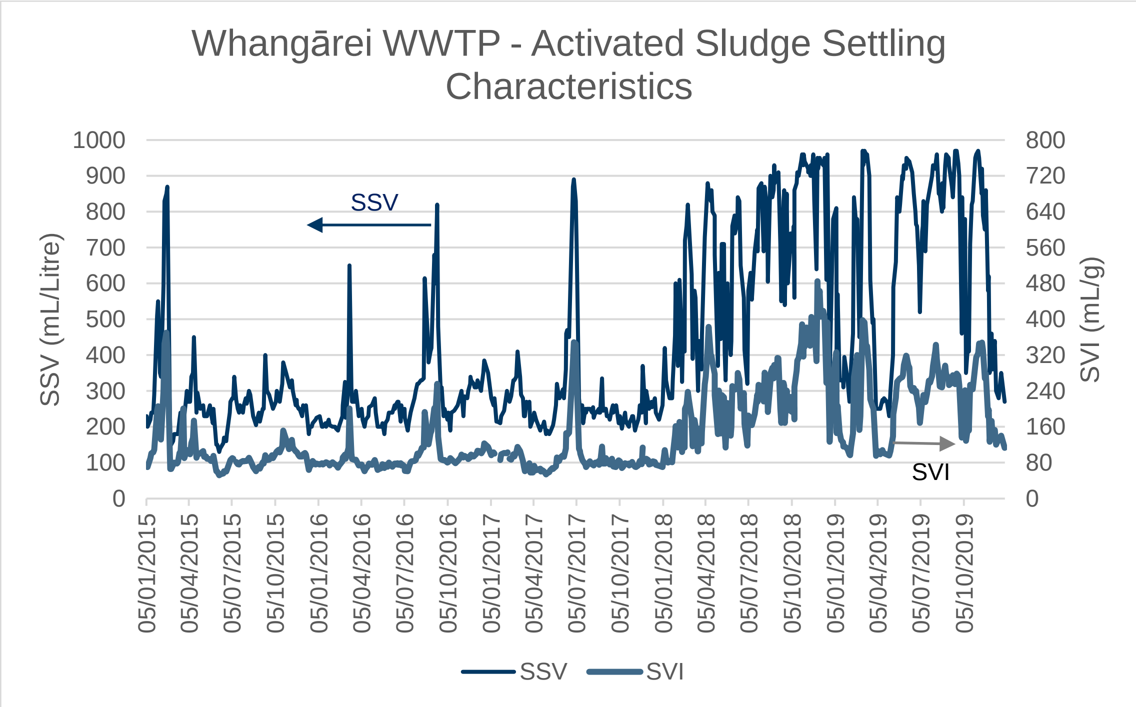


Figure 12 - Whangārei WWTP Sludge Settling measurements

The above SSV and SVI curves indicated that the sludge settling characteristics have deteriorated significantly since 2018. SVI values exceeding 160mL/g are considered to be poor settling sludge, and this reflected in the SSV measurements (i.e. after 30 minutes, 1 litres of mixed liquor only generates 100mL of clear supernatant).

Poor sludge settling seems to be an issue requiring immediate attention. This was also identified in the February 2020 consent compliance report, which says "*The median consent limit for Total Suspended Solids is consistently exceeding for flows up to 21,000m^3/day. Please provide an explanation detailing the reason for the reoccurring exceedance and what action is being taken to prevent it from reoccurring.*"

Further discussion with the plant operation was held on 21st May to understand the possible causes and mitigation measures, but didn't identify any major cause of poor settling other than having only 25% of RAS pass through the selector. More details will be covered in the plant assessment report.

4.3 Plant Effluent and Consent Compliance

This section presents a comparison of the final effluent quality data against the discharge standards prescribed in the resource consent.

4.3.1 Consent Discharge Conditions

The current discharge consents cover two stages of upgrades for the Whangārei WWTP. Stage 1 of the upgrades carried its own set of discharge conditions and were applicable between 06/07/2015 to 06/07/2017. After this point, the Stage 2 upgrades should have been completed.

The quality of the treated wastewater from the Stage 2 upgraded treatment system, measured prior to it entering the wetlands, shall not exceed the following limits. These consent limits are applicable between 07/07/2017 to 30/04/2022:

Table 5 - Stage 2 Consent Discharge Conditions (July 2017 - May 2022)

	Conditions based on Daily Discharge Volume		
Determinand	Up to 21,000 m^3/day	21,000 to 30,400 m^3/day	30,400 to 57,400 m^3/day
BOD_5 (mg/L) - 50%ile	15	20	25
BOD_5 (kg/day) - 50%ile	300	-	-
BOD_5 (kg/day) - 90%ile	500	-	-
TSS (mg/L) - 50%ile	15	25	25
TSS (kg/day) - 50%ile	300	-	-
TSS (kg/day) - 90%ile	500	-	-
AmmN (mg/L as N) - 50%ile	5	10	15

Table 6 summarises the plant performance data under Normal Flow Condition (<21,000m^3/day)

Table 6 - Normal flow conditions – up to 21,000 m^3/day,157 samples (Jul 17 to Nov 19)

Determinand	Consent Limit		WWTP Monitoring Data	
	Median	90%tile	Median	90%tile
BOD5 (mg/L)	15	-	12	25
BOD5 (kg/day)	300	500	178	340
TSS (mg/L)	15	-	18	32
TSS (kg/day)	300	500	274	483
AmmN (mg/L as N)	5	-	4.2	11.1

As seen from above, the final effluent does not comply in terms of median TSS limit. It is also close to the 90th percentile TSS mass load. This can be attributed to poor sludge settling characteristics. Elevated TSS level in the final effluent may also impact the UV disinfection efficiency, e.g. a 90th percentile of 32mg/L is considered high for UV disinfection.

In addition, the final effluent median concentration of ammoniacal nitrogen (AmmN) is very close to the median consent limit of 5mg/L (as N).

Table 7 summarises the plant performance data under Medium Wet Weather Flow Condition (21,000 to 34,000 m^3/day)

Table 7 - Medium flow conditions - 21,000 to 30,400 m^3/day, 25 samples (Jul 17 to Oct 19)

Determinand	Consent Limit (median)	WWTP Monitoring Data	
		Median	90%tile
BOD5 (mg/L)	20	8	16
BOD5 (kg/day)	-	219	386
TSS (mg/L)	25	13	26
TSS (kg/day)	-	299	679
AmmN (mg/L)	10	4.8	12.2

The above data indicates that the final effluent generally complies with the discharge standards under this flow condition.

Table 8 summarises the High wet weather Flow Condition (30,400 to 57,400 m^3/day).

Table 8 - High flow conditions - 30,400 to 57,400 m³/day, 18 samples (Aug 17 to Oct 19)

Determinand	Consent Limit (median)	WWTP Monitoring Data	
		Median	90%tile
BOD5 (mg/L)	25	12	26
BOD5 (kg/day)	-	497	1,354
TSS (mg/L)	25	16	35
TSS (kg/day)	-	725	1,807
AmmN (mg/L)	15	4.6	7.7

The above data indicates that the final effluent generally complies with the discharge standards under this flow condition.

4.3.2 Microbial Compliance

Consent Condition 9 specified minimum UV doses, measured at 10-minutes intervals in lieu of microbiological sampling/analysis.

– When the discharge flow is less than 30,400 m³/day, the minimum UV dose should not be less than 30 mWs/cm².
– When the discharge flow exceeds 30,400 m³/day, the minimum UV dose should not be less than 40 mWs/cm²

Consent condition #10 specified the following microbial discharge standards particularly applicable to treating the extreme wet weather flows for the High-Flow UV unit:

– Median E. coli concentration <1,000cfu/100mL
– 90th percentile E. coli concentration <3,000cfu/100mL
– At least 1.5 log reduction in F-specific bacteriophage and culturable rotovirus concentration compared to influent
– Minimum UV dose of 40 mWs/cm²

According to the Monitoring Report for Resource Consent – February 2020, the WWTP was fully compliant for this condition, with UV disinfection achieving a log 3 reduction in the concentration of F-specific bacteriophage. A summary of the last 3 years compliance report is presented as Appendix 2

While there are limited samples taken, wetland influent data supports this assessment, as shown in the table below.

Table 9 - Wetland Inlet and Outlet E. coli concentration (from 2015 to 2019)

	No. samples	**Median E. coli (MPN/100mL)**	**90th percentile E. coli (MPN/100mL)**	**Minimum UV Dose**
Normal Flow UV Outlet	83844 (Dose)	No data	No data	14.4 mws/cm²*
High Flow UV Outlet	45 (E. coli) 126709 (Dose)	1868.5	13634.1	33.7 mws/cm²
Wetland Influent	14	1179.5	51678.9	N/A
Wetland 1 – effluent	17	209	886	N/A
Wetland 2 - effluent	3	364	1751	N/A

* Average UV dose is 40.1 mws/cm². There is a large period in January 2020 where there are instances of either no dosage recording or 0 mws/cm² dosage being recorded, despite flow passing through the normal flow UV unit, therefore minimum is taken as the minimum above a dosage of 5 mws/cm².

- Due to limited data available, for the wetland influent and effluent there is no specific divide between E. coli concentration for normal and wet weather flows – the data displayed is an overall combination. There is also no data available for the normal flow UV E. coli performance – it is recommended to sample for this to determine the individual performance of the normal flow versus the high flow UV treatment units.
- Elevated levels of E coli in the wetland influent sample points indicate more intensive tracking of the UV performance is needed.
- It is observed from the data that E. coli concentration generally performs well following the wetlands, where there is a marked improvement in E. coli concentration.

4.3.3 Monitoring Report for Resource Consent

A summary of the NRC consent compliance monitoring reports from June 2017 – February 2020 is provided in Appendix 2. Key areas of concern include:

- **Condition 9** – Normal Flow UV dose was found to be insufficient meeting the minimum dose of 30mWs/cm^2 in a number of reports. Elevated ammoniacal nitrogen and suspended solids were also mentioned in several reports, including February 2020.
- **Condition 10** – High Flow UV dose was found to be insufficient meeting the minimum dose requirements. Non-compliance to microbiological criteria was noted in April and July 2018 reports.
- **Condition 15** – There are a number of occasions where the DO readings in the Limeburner Creek did not meet the targets.
- **Condition 21** – Out of 11 reports since June 2017, the April 2019 report recorded offensive odour was detected at the time of NRC inspection.

5. Plant Drawings and Reports

5.1 Information Received

Table 10 below summarises the plant documentation provided by WDC. It should be noted this table only highlights those matters with particular relevance to the plant assessment and future Best Practicable Option (BPO) investigation

Memorandum

Table 10 - Summary of received plant documentation

Documentation	Date	Key Summary/Findings	Relevance to 2020 Plant Assessment and Options Investigation
Whangarei WWTP Site Water Reticulation Indicative Layout	*11/14*	*Indicative potable water and recycled water reticulation layout around the WWTP*	*Plant GA and indicative pipe route for potable water and recycled water lines.*
Whangarei WWTP Site Stormwater	*1/12*	*Indicative stormwater pipe reticulation around the WWTP*	*General reference information*
WWTP Waste and Drainage Kiorerea High Flow Paths (14-84520)	*Unknown*	*Plant configuration showing the flow paths of normal flow (<21MLD) and high flow (up to 69MLD) scenarios.* *At Higher Flow, TF#1 to 3 will be used to treat before secondary clarifiers 3 &4*	*Important information for plant assessment*
SOLVIT Plant Process High Level Summary, 1-WR-WTP, Rev 0	*05/2020*	*A mammoth diagram showing the network of most flow streams across the WWTP.* *Nominal Flow Treatment Capacity shown in key flowpaths. This shows the design flow split between various operation regimes.* *Explanation of Drawing Notes not included.* *Some connections may have errors.*	*Flow path complexity and loops across the whole site.* *Flowmeter location shown – to be checked against data and during site inspection.* *This flow sheet will be examined/inspected during the site visit, prior to plant assessment commencement.*
SOLVIT Main Sewage Treatment Process, Process Block Diagram, PBD-01, Rev D1	*07/2018*	*Process block diagram of liquid stream, showing pump location and some design flow rates.* *Some operational notes were included as Drawing Notes*	*Important information for plant assessment*
SOLVIT Sludge Treatment and Dewatering Units, Process Block Diagram, PBD-02, Rev C1	*07/2018*	*Process block diagram of solids stream, including thickening, digesters (primary sludge only?) and dewatering.* *Sludge from Clarifiers 3 and 4 not known.* *CHP operated on surplus gas? To check*	*Important information for plant assessment*

Documentation	Date	Key Summary/Findings	Relevance to 2020 Plant Assessment and Options Investigation
WDC Main Treatment Process Process Flow Diagram, 1-WR-WTP, SHT01 Rev B	*1/2012*	*Process block diagram of the liquid stream, including some design min and max flows. The decommissioned disc filter was part of the train. A lot easier to read/understand than the SOLVIT version.*	*Important information for plant assessment. The Anoxic Selector Bleed appears to be OFF, to be checked at site inspection.*
WDC Sludge Treatment Process Process Flow Diagram, 1-WR-WTP, SHT02 Rev A	*12/2009*	*Process block diagram of the solids stream.* *This drawing contradicts the SOLVIT drawing in terms of TWAS digestion.*	*Important information for plant assessment. To confirm at site inspection about TWAS stream passes through the digesters or not.*
WDC Process Flow Scheme 1-WR-WTP Rev A to C	*6/2013* *1/2012*	*Rev C Drawings include Okara Inlet update in 2013* *Rev B Drawings for all other drawings* *P&ID drawings*	*Important information for plant assessment to identify what valve and instrumentation set-up. Some key features (e.g. bypass and instruments) will be confirmed at the site walkover.*
WDC Plant Asset Register		*Asset register* *Not asset properties have been populated*	*Important asset information for plant assessment and subsequent options assessment.*
Whangarei Wastewater Master Plan – High Level Options (Final)	*11/2012*	*An options investigation to identify infrastructure requirements to achieve 80% reduction in overflow for 2041 population during a 1 yr ARI storm event.* *Three options were examined: (1) Increased conveyance and plant capacity; (2) New Treatment Plant to the north of Whangarei; (3) Increased conveyance capacity with new treated off-load sites.* *This master plan recommended Option 3, constructing storm flow treatment facilities at different places of the wastewater network.*	*Several offload sites (Hatea PS and Tarewa PS) have been constructed, and their efficacy is important to the overall consent strategy. They will be viewed during Site visit on 21st May.* *Option 2 (a new smaller WWTP in North Whangarei) can be included in the draft Long List Option.*
Whangarei Wastewater Master Plan (Draft)	*07/2013*	*This master plan focused on network upgrades to reduce untreated spill volume.*	*Little relevance to the current study, as the master plan focused on wastewater network improvement only.* *We will seek clarification with WDC on the current programme of further network improvements. They may lead to reduction of peak I&I flows in future.*
Whangarei WWTP AEE 2014	*04/2014*	*This AEE sought a condition variation to increase the maximum discharge volume from 57.4MLD to 140 MLD, from the wetland system.* *WDC consultation with Iwi/Hapu and other interested parties identified a strong desire for all wastewater to flow through the wetlands before being discharged into Limeburner Creek.*	*Relevant information to understand community's desires as well as a background report for the recent UV upgrade works.*

Documentation	Date	Key Summary/Findings	Relevance to 2020 Plant Assessment and Options Investigation
		Wetland 1 upgrade was proposed to accommodate the higher discharge flow. A High Flow UV system was subsequently installed in 2015.	
Whangarei WWTP Hydraulic Control of Screens	*02/2012*	*A hydraulic model of the normal flow band screens and the peak flow inclined screw screens. This was only theoretical, not a calibrated hydraulic model.* *Modelled peak instantaneous flow of 140MLD (1620L/s)*	*Inlet Works design capacity – to check with WDC Op experience*
NRC Monitoring Whangarei WWTP Feb 2020	*11th Feb 2020*	*NRC review of plant compliance performance Oct to Dec 2019, and a NRC officer visit on 8th Jan* *UV dosage was not met on 88 occasions (10 mins interval), of which 83 occasions happened between 30.4 to 57.4MLD* *Elevated TSS and AmmN observed at Normal Flow situation (<21MLD)*	*A review of most recent plant performance* *Consent application will need to benchmark the recent performance against historical performance.*
Whangarei WWTP Odour Control – Design Report (Beca)	*09/2019*	*A detailed design report and drawings for proposed odour treatment at these process units: Equalisation Basin, Centrifuge Feed Sludge Tanks and Inlet Works (which is partially covered)*	*Proposed plant augmentation for odour emission mitigation, particularly relevant for long term upgrade option involving existing infrastructure.* *Details will be looked at during shortlisted options stage. Cost estimates may need to be revised.*
Whangarei WWTP Summary of Odour Emission Testing	*03/2019*	*This technical memo presented odour monitoring undertaken on site. A comparison was made against the 2014 odour monitoring data.*	*Important background to understand the hotspots of odour emission within the treatment plant.* *A high level review might be needed in the Shortlisted Option stage to determine if additional monitoring is necessary, particularly if an interim plant augmentation upgrade is proposed.* *Location of odour emission hotspots will be considered when developing the concept design layout for the long term upgrade option, to be put forward as part of consent application.*

Memorandum

5.2 Major Process Unit Information Summary

A table of key process equipment parameters extracted from various drawings and plant documentations is appended in Appendix 1 to this memo.

5.3 Information Gaps Summary

Table 11 below present the current information gaps.

Table 11 - Information Gap

Information Gaps Identified	Recommended Actions	Resolution
Current connected population clarification	To discuss with Hai on 21/05	Clarified, 65,000EP.
Wastewater Flowmeter Discrepancy clarification	21/05 - Andy advised	Use effluent data.
Influent sampling – TKN not included	To confirm with Lois on 21/05	No available data – recommend to be included in future program.
Effluent sampling – TIN and DRP not included	To confirm with Lois on 21/05	
UV-Transmissivity values of Low Flow and High Flow Effluent streams	To confirm with Lois on 21/05, for assessing current effluent is still within UV design specification	Online data received on 09/06/20, incorporated in the memo revision.
Blended sludge sampling – TS and VS	To confirm with Lois on 21/05, for digester loading estimation	WDC provided a formula to convert organic matter values into Thickened PS volatile solids concentrations. Information incorporated in the Plant Assessment Report.
Centrate sampling – TSS and VSS	To confirm with Lois on 21/05	Not monitored, centrifuge solids capture ratio cannot be estimated.
Plant Hydraulic Profile As-Built AWT, 1006-HP-001 & 002 (2013)	WDC to provide a copy – to understand the design flow split between process units	Received
Process Flow Diagram, As-Built AWT, 1006-PFD-001	WDC to provide a copy – to understand the design flow split between process units	WDC commissioned GHD to create a simplified PFD for consent application.
P&ID As-Built (AWT, 2013 upgrade) 1-WR-WTP-204 Rev C 1-WR-WTP-209 Rev C 1-WR-WTP-211 Rev A 1-WR-WTP-301 Rev C	WDC to provide a copy	Yet to be provided, low priority item.
Process Equipment Dimensions (some data gaps and information confirmation required)	To discuss with Hai and Andy on 21/05 Refer to Appendix 1	Refer to site notes.

Current and future peak hourly flow estimates	To discuss with Hai on 21/05	Hourly inflow not provided.
Daily Flow Data (not requested in RFI#01): Archimedes Screw Pump Flow, Thickened PS Feed, Centrate Flow, Blended Sludge Pump Flow (to digesters)	To discuss with Hai and Andy on 21/05	FM of thickened PS used for digester capacity assessment.
GBT and Centrifuge performance data (not requested in RFI#01) – solids capture and polymer dose	To discuss with Hai and Andy on 21/05	Capture rates cannot be estimated as centrate and filtrate not sampled. WDC operations are satisfied with GBT and centrifuges.
Current O&M Manual	Low priority outstanding information	Yet to be provided.

Appendices

Appendix 1 Major Process Equipment Information Summary (Rev2)

Appendix 2 Consent Compliance Reports Non-compliance Summary

Whangarei WWTP - Existing Asset Information Summary

Inlet Screens		**Sources**
Band Screen Capacity L/s	579 L/s per unit	Model Hydrodyne 26550-01/02 MWH 2012 Screen Hydraulic Report – model basis of 100MLD (579 L/s per unit) (This is higher than SOLVIT Block Diagram of 75MLD) Andy informed the capacity based on field experience.
Grit Removal Capacity L/s	579 L/s per unit	Assumed the same flow rate as Band Screens
Peak Flow Screen Capacity L/s	100MLD total, instant capacity	CST SF7 Andy informed the capacity based on field experience.
Band Screen Dimensions		Inlet Works Upgrade Drawings
Peak Flow Screen Dimensions		No data
Peak Hourly Flow		Request data from WDC
Primary Clarifiers		**Sources**
# of units	3	
Clarifier diameter	24.6	Asset Register
Depth	3	Asset Register, full depth
Weir/Launder length	No data	Not shown on drawings, to assume
Equalisation Basin		
Volume	4000m3	
Trickling Filters		
# of units - dry	TF 1 to 3 as Stage 1, TF as Stage 2	
# of units - wet	No recirculation	
TF diameter	35	Asset Register, ext or int diam?
TF Height	1.8m (Op data)	
TF Recirculation Flow (Archimede screw pump)	55kW pump	Asset Register, Flow capacity not known
AS Basin and Selector		
Selector Tank Volume / zones	150m3 (Op data)	Asset Register
Selector Mixers	2x 1.5kW	Asset Register
Aerators (2x)	S&L FGMA-60 45kW	Asset register
AS Basins (2x) – PE lined basin	40m L x 26m W x Depth? TWL? 3m	WDC As-Built Drawing 8822 4876 Sheet 8 of 41 1988 Andy informed the volume is 1500m3
AS Pumps (4x to Clarifiers)	No Flowmeter	Asset Register – Flygt 3202
WAS Pumps (2x)	WAS FIT	Asset Register – Flygt 3102
No. of AS Basin in use?		
Secondary Clarifiers		
Clarifier #1 and 2 diameter	26	Asset Register, water depth?
Clarifier #1 and 2 depth	5m	Asset Register, water depth?
Clarifier #1 and 2 weir length	No data	Not shown on drawings, to assume
Clarifier #3 and 4 diameter	25	Asset Register
Clarifier #3 and 4 depth	3m	Asset Register, shallower original Humus Tank
Clarifier #3 and 4 weir length	No data	Not shown on drawings, to assume
Tertiary Filter OFFLINE		

UV Disinfection		
Low Flow UV Design Capacity (Trojan)	Capacity of 50MLD and UV dose of 30mWs/cm^2	2014 AEE Require Vendor documentation on UV-T? Process and Hydraulic Flow? (WDC Info?) No expandable
High Flow UV Design Capacity	Capacity of 90MLD and UV dose of 40mWs/cm^2	2014 AEE Require Vendor documentation on UV-T? Process and Hydraulic Flow? (WDC Info?) Expandable, by another 30 to 50%
Wetland		
Wetland 1 Volume	Pond 1: 14330m^3 Pond 2: 5100m^3	2014 AEE
Wetland 2 Volume	Pond 1: 6800m^3 Pond 2: 6640m^3 Pond 3: 1940m^3	Not visited on site, not desludged
Gravity Sludge Thickener (2x)		
Thickener tank diameter	7.2m	Asset Register . Andy informed surface area is **28m2**.
Thickener tank depth	4.42m	Asset Register, tank depth, no as-built
Gravity Belt Thickener	**1 unit**	
Vendor design loading - hydraulic		Asset Register – no data
Vendor design loading - solids		Asset Register – no data
Sludge Blend Tank	55m3	Asset Register
Sludge Digesters	**2 units in parallel**	
Digester Tank diameter	12.8m	Asset Register
Digester Tank depth	9.9m	Asset Register – tank height or TWL?
Digester Tank Volume	2547kL each	Andy informed surface area is **960m3** ea
Monitor – Temp and Feed		
Heat Exchanger rating	XXX kW	Asset Register, custom-built units
Sludge Dewatering		
Blending Tank (DEFAC)	14m x 13m x 3m 546kL	Asset Register
Centrifuge Feed Pumps	No data	
Centrifuge (2x) design loading - hydraulic	No data	Asset Register, Alfa-Laval
Centrifuge (2x) design loading - solids	No data	
Biogas Storage & Cogen		
To gather as site photos, understood some upgrades recently occurred.		Not part of plant assessment
Recycled Water Tank		
To gather as site photos		Not part of plant assessment

Appendix 2 - Consent Compliance Reports Non-compliance Summary

	2017		
	June	**August**	**December**
Condition 5	-	Three sets of missing data occurred in June 2017	Instantaneous flow data was not recorded for extended periods in the compliance quarter which ran from 1 July to 30 September 2017.
Condition 9	Insufficient samples have been collected to officially assess compliance for **flow rates** between 30,400 and 57.400 m^3/day during the compliance quarter which ran from 1 January 2017 to 31 March 2017. However the samples that have been collected indicate that wastewater treatment was meeting consent standards required. Insufficient **UV doses** have been applied on several occasions during the compliance quarter which ran from 1 January 2017 to 31 March 2017.	Insufficient samples have been collected to officially assess compliance for **flow rates** greater than 21,000 m^3/day for the compliance quarter 1 April 2017 to 30 June 2017. However the samples that have been collected indicate that wastewater treatment was meeting consent standards required. Insufficient **UV dose** was applied to flow rates greater than 30,400 m^3/day on several occasions during the month of June 2017. The discharge was non-compliant in regards to **total suspended solids** concentration limits for flow rates being less than 21,000 m^3/day with a median value of 16 mg/L for the compliance quarter 1 April 2017 to 30 June 2017 exceeding the limit of 15 mg/L.	Insufficient samples have been collected to officially assess compliance for **flow rates** greater than 21,000 m^3/day, however the samples that have been collected indicate that wastewater treatment was meeting consent standards required. Insufficient **UV dose** was applied to the discharge on several occasions during the compliance quarter. It is believed that these errors are a data error and do not reflect non-compliant UV dose. Water quality limits specified were not complied with for the compliance period 1 July to 30 September. **Total suspended solids** and **ammoniacal nitrogen** results caused non-compliance for the above compliance quarter. This has resulted in non-compliances of the median values of 21 mg/L and 6.7 mg/L respectively; the consent limits are 15 mg/L and 5 mg/L respectively. Additionally, non-compliances were seen in the median and ninetieth percentile values for total suspended solids daily load with values of 358 kg/day and 502 kg/day respectively; the compliance limits are 300 kg/day and 500 kg/day respectively. At the time of writing this report, water quality data for October 2017 had been received. This data showed a continuation of the high total suspended solids concentrations and also increased concentration of biochemical oxygen demand concentrations. Ammoniacal nitrogen concentrations had decreased in this month. On 29 November 2017, the cause for the non-compliance and actions taken was reported by WDC. It was also shown that final effluent suspended solids and ammoniacal nitrogen concentrations had reduced at that time.
Condition 10	-	**Flow through the UV** system was recorded throughout the compliance quarter at times when extreme weather bypass should not have been operating.	-
Condition 24	**Discharge structures** in wetland two were non-complaint at the time of the inspection due to scour of the downstream environment. This scour is associated with the discharge of treated wastewater from the structures.	-	**Discharge structures** in wetland two were non-complaint with of the consent at the time of the inspection due to scour of the downstream environment. No significant increase in scour was identified at the time of the inspection.

	2018			
	February	**April**	**July**	**December**
Condition 9	Median **total suspended solids** quality limits specified for flows <21,000 m^3/day exceeded the limit of 15 g/m^3, with the result being 16 g/m^3	During the compliance quarter, the correct **UV dose** was not received on one occasion at flow below 30,400 m^3/day and on 8 occasions at flow above 30,400 m^3/day.	Insufficient **UV dose** was delivered on 38 occasions during the compliance quarter.	**UV disinfection** failed to achieve the reduction in determinands at flows less than <21,000 m^3/day. On 79 (10-minute interval) occasions the UV disinfection system failed to treat flows with the correct **dosage**.
Condition 10	-	The samples taken on 19 February 2018 showed that a log reduction of 1.08 was achieved, less than the required 1.5 order of magnitude (i.e. 1.5 logarithm) reduction in the concentration of **F-specific bacteriophage** and culturable **rotavirus** when compared to untreated wastewater that enters the plant. The extreme flow UV treatment failed to deliver the required **UV dose** on 31 occasions during the compliance quarter, this is based on detected flow greater than 120 m^3/day,	At flow greater than 57,400 m^3/day the high flow UV treatment failed to achieve the reduction in **E. coli** concentration required. The E. coli concentration post UV treatment has been consistently rising during the preceding 12 months and has now reached a median of 10,430 MPN and a 90th Percentile of 19,560 MPN.	-
Condition 15	-	-	-	**Dissolved oxygen** levels at Limeburners Creek were significantly lower (< 40%) than the daily minimum (≥ 80%).
Condition 24	**Discharge structures** in wetland two were non-complaint at the time of the inspection due to scour of the downstream environment. No significant increase in scour was identified at the time of the inspection	-	-	-

	2019			2020
	February	**April**	**July**	**February**
Condition 9	UV disinfection failed to achieve the reduction in determinands at flows less than <21,000 m^3/day. On 79 (10-minute interval) occasions the UV disinfection system failed to treat flows with the correct **dosage**.	UV disinfection failed to achieve the reduction in determinands at flows less than <21,000 m^3/day. On 139 (10-minute interval) occasions the UV disinfection system failed to treat flows with the correct **dosage**.	UV disinfection failed to achieve the reduction in Total Suspended Solids at flows less than <21,000 m^3/day. *[This is a typo in the NRC report as UV does not reduce suspended solids in the discharge effluent]* On 1 (10-minute interval) occasion the UV disinfection system failed to treat flows with the correct **dosage**.	UV disinfection failed to achieve the reduction in Total Suspended Solids and Ammoniacal Nitrogen at flows less than <21,000 m^3/day. *[This is a typo in the NRC report as UV does not reduce suspended solids in the discharge effluent]* On 88 (10-minute interval) occasions the UV disinfection system failed to treat flows with the correct **dosage**.
Condition 15	**Dissolved oxygen** levels at Limeburners Creek were lower (<40%) than the daily minimum (≥ 80%) Dissolved oxygen levels at Limeburners Creek were lower (73.5%) than the daily minimum (≥ 80%). Dissolved oxygen levels at Limeburners Creek were lower (73.5%) than the daily minimum (≥ 80%).	**Dissolved oxygen** levels at Limeburners Creek were lower (73.5%) than the daily minimum (≥ 80%) Dissolved oxygen levels at Limeburners Creek were lower (73.5%) than the daily minimum (≥ 80%) Dissolved oxygen levels at Limeburners Creek were lower (73.5%) than the daily minimum (≥ 80%)	-	-
Condition 21	-	Offensive **odour** was detected outside the boundary and along Kioreroa Road at the time of inspection.	-	-

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Appendix B

Options Report

Whangārei Wastewater Treatment Plant Consenting

Options Report

Whangārei District Council

08 October 2021

→ The Power of Commitment

GHD Limited [626860]
27 Napier Street, GHD Centre Level 3
Freemans Bay, Auckland 1010, New Zealand
T +64 9 370 8000 | **F** +64 9 370 8001 | **E** aklmail@ghd.com | **ghd.com**

Printed date	4/11/2021 8:58:00 am
Last saved date	04 November 2021
File name	https://projectsportal.ghd.com/sites/pp02_01/whangareiwwtpconsent/ProjectDocs/BPO Options/12528591-REP_Whangarei WWTP Options Report - Oct 2021 Final.docx
Author	D Maynard
Project manager	Sarah Sunich
Client name	Whangārei District Council
Project name	Whangārei WWTP Consenting
Document title	Whangārei Wastewater Treatment Plant Consenting | Options Report
Revision version	Rev 3
Project number	12528591

Document status

Status Code	Revision	Author	Reviewer		Approved for issue		
			Name	Signature	Name	Signature	Date
S4	Rev 1 – Draft Issue	D Maynard B Asquith	I Ho J Gallo S Sunich		A Kirk		4/3/2021
S4	Rev 2 – Final Draft	D Maynard	I Ho A Kirk		A Kirk		6/4/2021
S4	Rev 3 – Final	I Ho	S Sunich		A Kirk		8/10/2021

Whangārei WWTP Options Report Executive Summary

This report is subject to, and must be read in conjunction with, the limitations set out in section 1.4 and the assumptions and qualifications contained throughout the Report.

Background

The Whangārei wastewater treatment plant (Whangārei WWTP) resource consent will expire in April 2022. To support the consent renewal application, a plant capacity assessment was completed in Aug 2020 followed by a long list options assessment in Oct 2020.

This report describes Adaptive Pathway Planning approach to assess drivers and options for the Whangārei WWTP over the next 35 years.

Project Drivers

From the consultation with key stakeholders, a range of drivers have been identified. Significant drivers that impact future planning include:

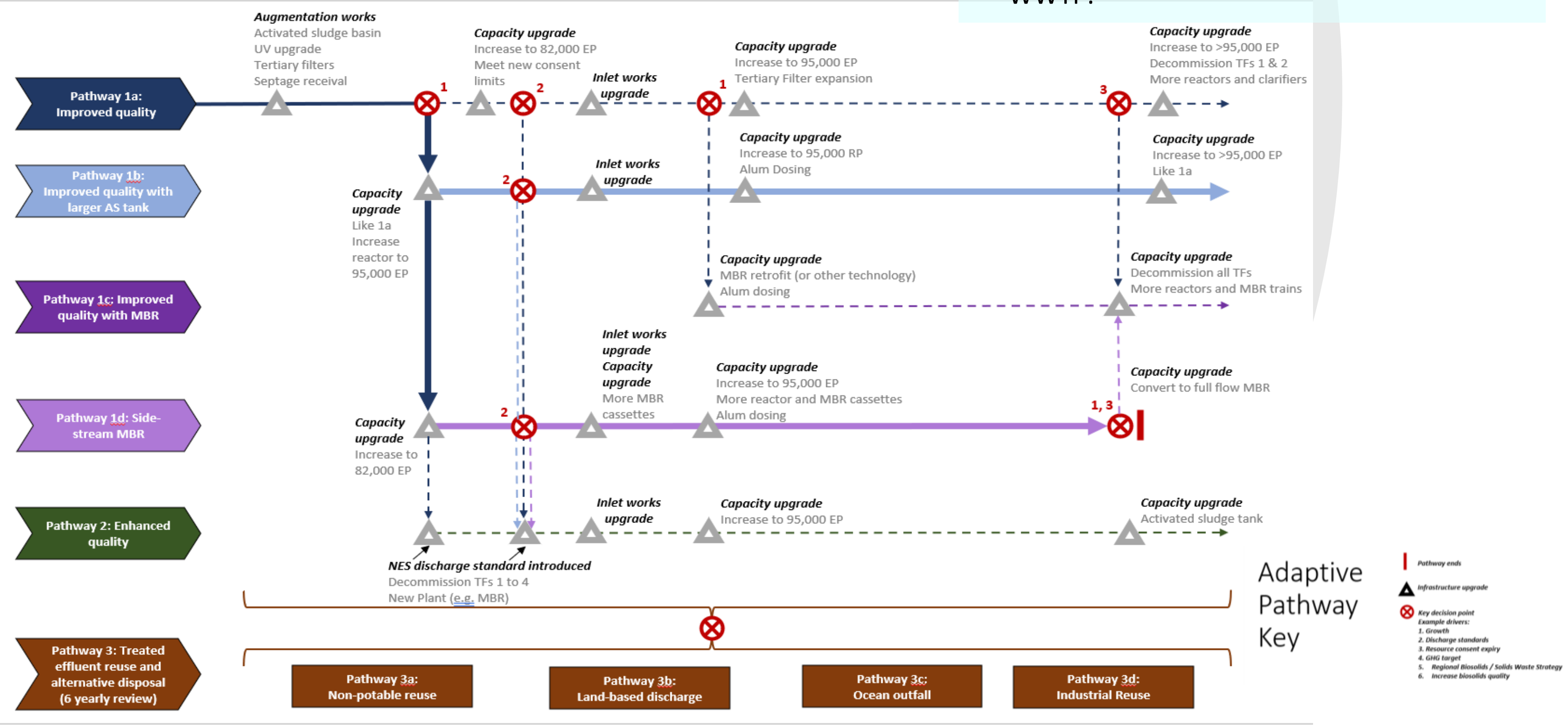
1. Population growth from 65,000 to 95,000
2. Receiving Environment protection
3. Ongoing changes in regulations
4. Climate resilience e.g. recycled water, frequency and intensity of rainfall events

Why Adaptive Pathway

Adaptive pathways planning is a practical planning approach that has been developed in recent years in response to the need to plan for long term and potentially uncertain futures. This approach helps embed adaptive responses into the short-medium actions that need to be taken, and leaves options open for the future if needed. This approach leads to an adaptive and flexible plan to change as the future unfolds, and avoid redundant infrastructure being built.

Pathways considered

- **WWTP Augmentation** – this achieves improvement in ammonia, suspended solids and disinfection performance.
- **Pathway 1** – this is based on preventing further degradation of the receiving environment over the next 35 years. This splits into 4 sub-pathways.
- **Pathway 2** – this responds to a potential future scenario tighter coastal discharge standards may come into effect. Timing of this is not known.
- **Pathway 3 Reuse and Alternative Disposal** – this considers the use of recycled effluent in public space irrigation for the interim, and ongoing exploring/review of alternative effluent disposal routes.
- **Pathway 4 and 5** for biosolids and odour management.



Next Steps

- **Stakeholder Consultation** – Engage with key stakeholders to endorse a pathway to move forward, Pathway 1b and 1d were supported.
- **Master Plan –** Complete the master planning based on Pathway 1b and 1d.
- **Resource Consent Application** – Prepares AEE for the consent renewal application.
- **Make Adaptive Pathway Plan a living document** – Ongoing review and update of this Adaptive Pathway Planning for Whangārei WWTP.

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Glossary

ADF	Average Daily Flow
ADWF	Average Dry Weather Flow
AS/ASP	Activated Sludge / Activated Sludge Plant
BOD_5	Five day Biochemical Oxygen Demand
CEPT	Chemically Enhanced Primary Treatment
COD	Chemical Oxygen Demand
dia.	Diameter
EP	Equivalent Population
EQ Basin	Equalisation Basin
Kg/d	A measurement of mass loads, in kilograms per day
Kg/m2.h	A measurement of solids loading rate, in kilograms per metre squares per hour
Km	Kilometre
L/s	Litres per second
MBR	Membrane Bioreactor, a form of biological treatment coupled with membrane filtration
MCA	Multi-Criteria Assessment
mg/L	milligrams per litre
ML/d	Megalitre per day (1,000 L/d = 1 ML/d)
MLSS	Mixed Liquor Suspended Solids
mWs/cm^2	A measurement of UV dose, in milli-Watts second per centimetre square
NES	National Environmental Standard
NRC	Northland Regional Council
no.	Number
PNRP	Proposed Northland Regional Plan
PST	Primary Settling Tank / Primary Clarifiers
PWWF	Peak Wet Weather Flow
RAS	Return Activated Sludge
SiD	Safety in Design
SRT	Solids Retention Time
TF	Trickling Filter
TKN	Total Kjeldahl Nitrogen
TN	Total Nitrogen, comprise of TKN, nitrate and nitrite
TP	Total Phosphorus
TSS	Total Suspended Solids
TWAS	Thickened Waste Activated Sludge
UV	Ultra-violet light
WAS	Waste Activated Sludge
WDC	Whangarei District Council
WWTP	Wastewater Treatment Plant

1. Introduction

1.1 Options Assessment Background

The Whangārei Wastewater Treatment Plant (Whangārei WWTP) services the urban Whangārei area. The treatment process comprises trickling filters, an aeration basin, and UV disinfection which discharges effluent through constructed wetlands prior to discharge to Limeburners (Hāhā) Creek. The catchment population growth is forecast to increase from 65,000 to 95,000 people, by 2056.

The current resource consent for discharge of treated effluent into Limeburners (Hāhā) Creek expires on 30th April 2022. The Whangārei area network consent is to be processed separately.

To support Whangārei District Council (WDC) with the renewal of the Whangārei WWTP resource consent, GHD have completed an assessment of the capacity and process bottlenecks of the existing WWTP treatment process (GHD, 2021b). Following the plant assessment, an options assessment was completed and is attached to this report as Appendix A.

A traditional static approach to assessing upgrade options for a WWTP aims to identify a single option (the best practicable option) which will provide for the long-term plant requirements. However, over the Whangārei WWTP planning horizon considerable uncertainty associated with regulations, discharge requirements and Whangārei city needs have been identified, with these influencing the ability to plan effectively for the long-term needs of the treatment plant. For example, uncertainty exists regarding the future National Environmental Standard (NES) for coastal discharge of treated wastewater, future Whangārei growth, climate change outcomes, demand for recycled water and requirements for stabilised biosolids. A traditional static options assessment approach was initially applied to the Whangārei WWTP but was not considered to provide an effective and cost-efficient means of responding to such uncertainty.

To accommodate this uncertainty, an Adaptive Pathway Planning approach to assessing and defining upgrade options has been proposed. As part of the Adaptive Pathway Planning approach, current and future triggers (drivers) for upgrades to the WWTP have been identified. A series of actions or upgrades to be undertaken over time (pathways) which respond to these potential future needs have been developed. By exploring different pathways and considering path-dependency of the actions required, an adaptive plan has been prepared that includes short-term actions to be undertaken, while maintaining flexibility in the selection of a number of long-term options.

The adaptive pathway plan is to be subject to regular review in order to identify when the next step of a pathway should be implemented, whether to change or remove pathways, or whether additional drivers or pathways should be added through reassessment.

The Adaptive Pathway Planning approach and implementation of the resulting adaptive plan for the Whangārei WWTP is intended to provide WDC direction in how it responds to changing conditions. The approach is also beneficial in that it requires ongoing consideration of the appropriateness of the actions being undertaken and how these may influence future decision making. Additionally, greater contribution by stakeholders over the course of implementing the plan is required, providing greater clarity and focus on issues considered important to the community.

With improved monitoring of plant performance and environmental outcomes, the Adaptive Pathway Planning approach is considered to provide significantly better community and environmental outcomes than would result from a traditional static options assessment approach.

1.2 Long-list Options Assessment Summary

Ten long list options were considered for the Whangārei WWTP best practicable option (BPO) assessment. These included combinations of different wastewater treatment and effluent discharge options, with a detailed explanation of each option shown in the Long List Options Summary Memorandum (GHD, 2020) attached as Appendix A.

A long list options wastewater working group workshop was held on 22 October 2020 to discuss the options and carry out a Multi-Criteria Assessment (MCA) with participants from the Department of

Conservation, Northland District Health Board, representatives from Te Parawhau and Rewarewa D Block, Northland Fish and Game, WDC, and GHD, with apologies from Northland Regional Council (NRC) and no response received from Forest and Bird.

Table 1 outlines the long list options, with their scoring and reasoning as to why several options were ultimately excluded from being scored.

In light of the discussions held with stakeholders on 22 October 2020, it was agreed with WDC at a teleconference on 3rd November 2020 to continue the options assessment via an Adaptive Pathways Planning approach. The minutes of the October workshop are attached as Appendix B.

Table 1 Long-list options evaluation results summary

No.	Option title	MCA scoring	Carry forward?
1	Existing Discharge - Plant Expansion	2	*Yes*
2	Existing Discharge - Process Intensification	1	*Yes*
3	Existing Discharge plus a Satellite Plant (North Whangārei)	-	*No, considered difficulty to complete the necessary investigations within the pre-consent timeframe. Could be investigated as part of future consent review and may not be limited to North Whangārei.*
4	Existing Discharge plus a Satellite Plant (Whangārei Head)	-	*No, fatal flaw – caters for small flow only and increased complexity.*
5	Ocean Discharge - Relocate Whangārei WWTP	-	*No, significant hurdles associated with consent and construction of pipeline and outfall.*
6	Ocean Discharge - Existing WWTP and pump to ocean	-	*No, significant hurdles associated with consent and construction of pipeline and outfall although could be investigated as part of future consent review in line with Ruakaka WWTP upgrades.*
7	Land-based Discharge (dry weather) - Existing WWTP site	-	*No - fatal flaw around land availability and land costs but could be investigated as part of future consent review.*
8	Existing Discharge supplemented with reuse and/or partial summer land-based discharge regime.	3	*Yes*
9	Deep Bore Injection - Existing WWTP site	-	*No - fatal flaw around aquifer impact, aquifer recharge necessity, cost, and consent uncertainty.*
10	Lower harbour discharge - Existing WWTP	-	*No - fatal flaw around no/lack of support from Tangata whenua.*

1.3 Purpose of the Report

This report details the Adaptive Pathway Planning assessment carried out and presents the resulting adaptive plan for consideration by WDC. Works contributing to this and discussed within this report include:

- A review of the Whangārei WWTP existing capacity and process bottlenecks.
- A workshop with WDC and the wastewater working group held on 26 November 2020 (workshop minutes attached in Appendix B) to confirm the Adaptive Pathway Planning approach and identify current and potential future drivers for upgrade of the Whangārei WWTP. Attendees at the workshop included representatives from the Department of Conservation, Northland District Health Board, Northland Fish and Game, WDC, and GHD, with apologies from representatives of Te Parawhau and Rewarewa D Block, NRC and Forest and Bird.

– An Adaptive Pathway Planning assessment for the Whangārei WWTP, to provide upgrade pathways and identify pathway dependencies and interactions.
– Consolidation of drivers and pathways into the adaptive plan for the Whangārei WWTP, outlining likely upgrade works and responses to changing conditions.
– A draft version of this report was then presented at a stakeholder workshop on 1 June 2021 following which the WWTP Master Plan was prepared and which provides an outline of the short term upgrade works recommended for the plant, associated investigations and direction for programming future works.

This report is also intended to support the application for renewal of the Whangārei WWTP resource consent by providing details of the options assessment and subsequent Adaptive Pathway Planning assessment undertaken which lead to determining the best practicable option for the WWTP over the short to medium.

1.4 Scope and Limitations

1.4.1 Report scope

The scope of this report is to:

– Describe the Adaptive Pathway Planning approach (Section 2).
– Summarise the background information including the plant assessment report findings (Section 3).
– Describe the Whangārei WWTP upgrade drivers (Section 4), with greater detail provided in the attached technical memo (Appendix A).
– Present the adaptive plan for the Whangārei WWTP developed using an Adaptive Pathway Planning framework (Section 5 and 6).

1.4.2 Limitations

This report: has been prepared by GHD for Whangārei District Council and may only be used and relied on by Whangārei District Council for the purpose agreed between GHD and the Whangārei District Council as set out in section 1.3 of this report.

GHD otherwise disclaims responsibility to any person other than Whangārei District Council arising in connection with this report. GHD also excludes implied warranties and conditions, to the extent legally permissible.

The services undertaken by GHD in connection with preparing this report were limited to those specifically detailed in the report and are subject to the scope limitations set out in the report.

The opinions, conclusions and any recommendations in this report are based on conditions encountered and information reviewed at the date of preparation of the report. GHD has no responsibility or obligation to update this report to account for events or changes occurring subsequent to the date that the report was prepared.

The opinions, conclusions and any recommendations in this report are based on assumptions made by GHD described in this report. GHD disclaims liability arising from any of the assumptions being incorrect.

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1.5 Assumptions

The following assumptions were made when developing this report:

- The historical wastewater characteristics for the screened wastewater will stay relatively similar in future scenarios, i.e. no new significant trade waste dischargers in the catchment.
- Recent wastewater characteristic data of primary clarifier effluent and trickling filter effluent have been used as input for process calculations.
- Steady state spreadsheet calculations have been used to estimate the capacity, bottlenecks and trigger points of the treatment process. The calculation results and assumptions should be confirmed through future BioWin modelling.
- Process assumptions are described in Appendix D.
- Reasonable ground condition and space for construction.
- The existing main control building and switchroom will remain in its current location.
- The wastewater network inflow and infiltration reduction strategy is ongoing with an aim to achieve a future reduction in the ratio between peak daily flow and average daily flow.
- Drivers for current and future upgrades to the WWTP, identified in workshopping with WDC and the wastewater working group, represents a complete list of potential triggers for needing to improve WWTP performance. Regular review of the adaptive plan for the WWTP should be carried out to identify and correct deviation from this assumption.

2. Adaptive Pathway Planning

2.1 Adaptive Pathways Planning Concept

Over the planning horizon of this project there is uncertainty associated with regulations and discharge requirements, future growth, demand for recycled water and requirements for stabilised biosolids. This is in addition to a wider range of unknowns associated with societal perspectives, cultural values, politics, technology, and the economy.

Adaptive Pathways Planning provides guidance on how to develop a future plant that is adaptive and flexible to change as the future unfolds, and avoid redundant infrastructure being built. This approach helps embed adaptive responses into the short-medium term actions that need to be taken, and leaves options open for the future if needed. Adaptive Pathways Planning is a practical planning approach that has been developed in recent years in response to the need to plan for long term and potentially uncertain futures.

2.2 Adaptive Pathways Methodology

The general Adaptive Pathways Planning methodology, which is circular in nature with continuous monitoring and review points resulting in the continuous refinement of pathways over time is illustrated in Figure 1.

In developing the pathways for upgrade into an adaptive pathway plan a graphical representation is shown of the key concepts in Figure 2 and summarised in Table 2.

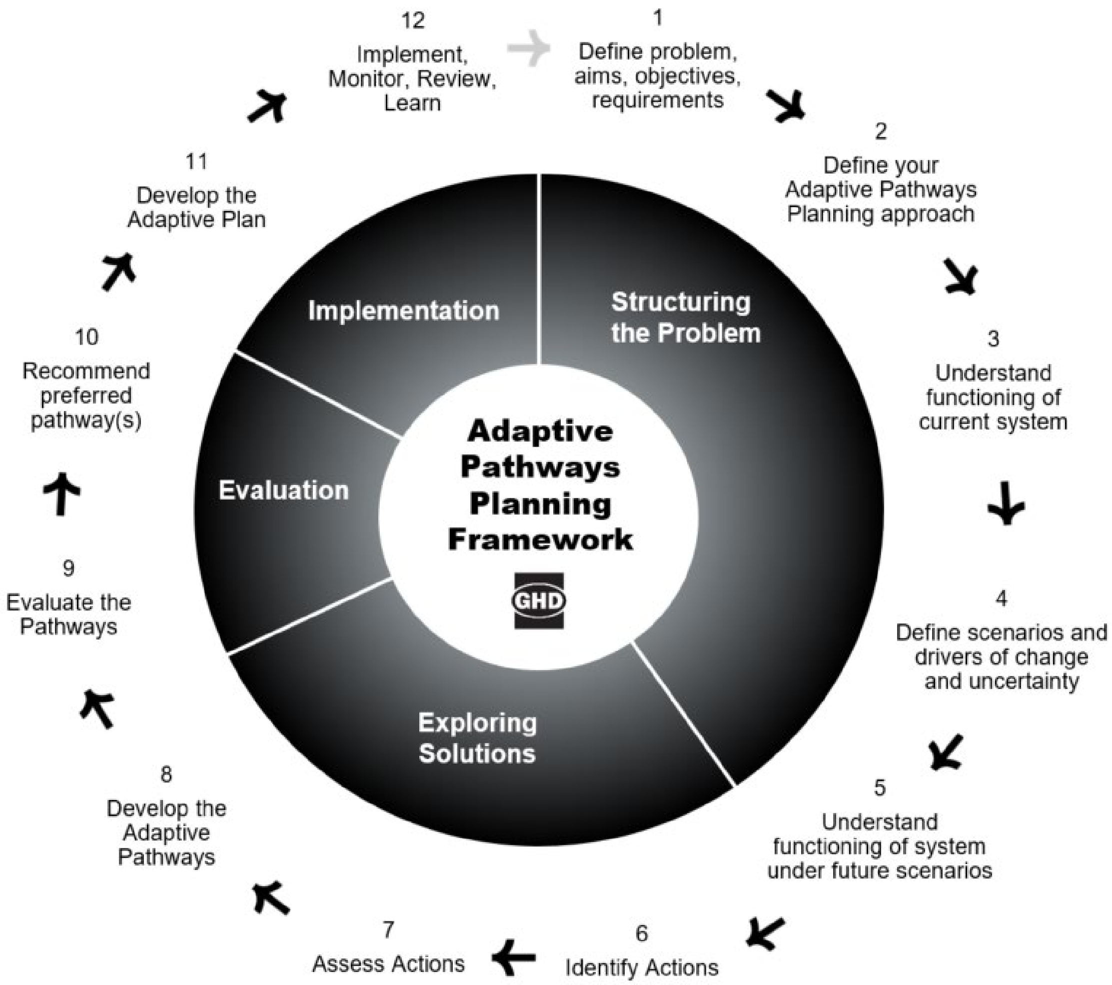

Figure 1 Adaptive pathway planning framework

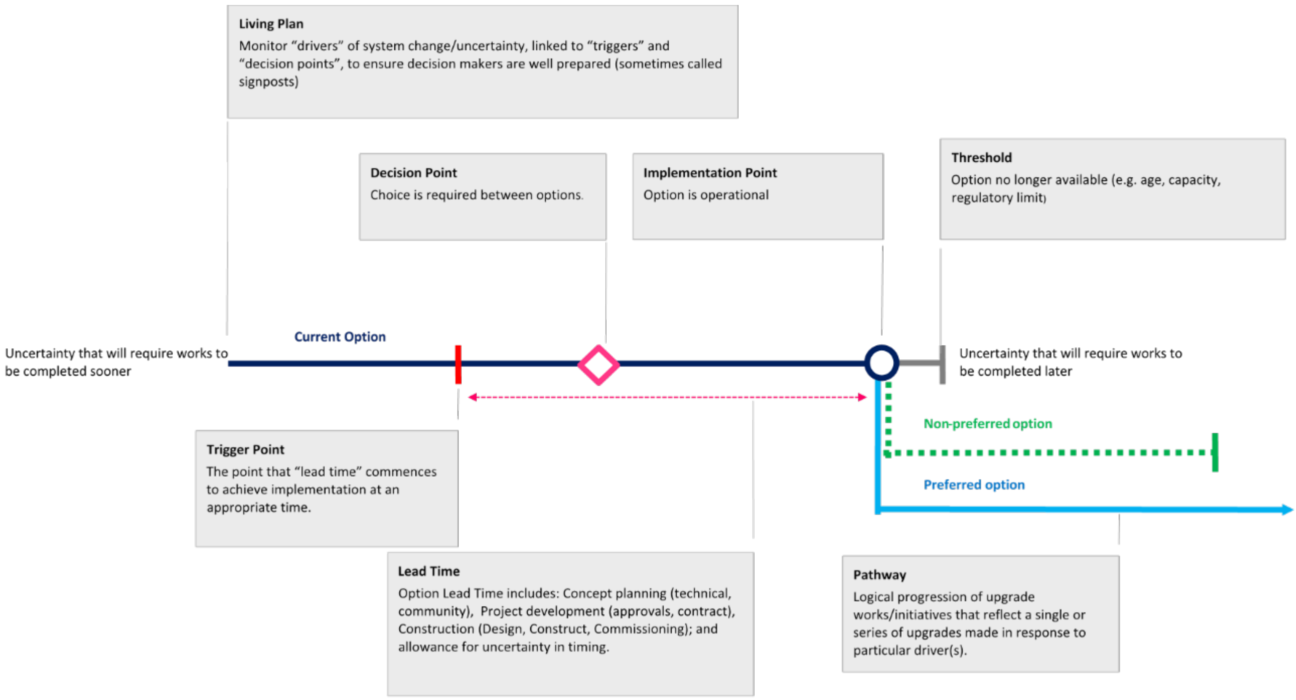

Figure 2 Timeline showing key discussion points from the adaptive pathways planning approach

Table 2 Adaptive planning key concepts

Concept	Description	Example
Living Plan	A live document requiring ongoing monitoring of triggers and periodic review of decisions/options	
Driver	A factor that has a significant influence on the need for WWTP upgrade works.	*NES Standard introduction*
Implementation point	The point at which upgrade works are predicted to be required in response to a driver.	*New primary clarifier required when population reaches 70,000 EP (PWWF > 1,320 L/s).*
Lead time	The time prior to the implementation point required for final concept preparation, construction and commissioning work, considering uncertainty once a decision has been made.	*Primary clarifier may take five years to design, construct and commission.*
Trigger point	The point that "lead time" commences in order to achieve implementation at an appropriate time. Determined in relation to a particular driver/s.	*The PWWF is approaching 1,320 L/s and may exceed this limit in five years.*
Uncertainties	Uncertainties may require the works to be completed sooner or later.	*Additional or lower than expected growth in the catchment resulting in higher or lower PWWF.*
Pathway	Logical progression of upgrade works and initiatives that reflect a single or series of upgrades made in response to particular driver/s. Pathways Consider: • The benefits of the preceding works. • Next step for WWTP upgrade/augmentation.	*MBR upgrade to the activated sludge plant after new aeration tanks have been constructed.*

The Adaptive Pathway Planning approach applied has typically considered:

– Population size which will trigger the need for future works, based on projected trends.
– The combined effect of future "disruptors" that could result in the works being brought forward in time, delayed, or the preferred high-level strategic pathway being changed.

Section 4 discuses in more detail the Drivers for Change and Uncertainty.

3. Current WWTP Overview and Performance

3.1 Overview

This section provides a brief outline of the Whangārei WWTP. Figure 3 shows the process flow diagram for the current process. For detailed background information, refer to the GHD Plant Assessment Report (GHD, 2021b).

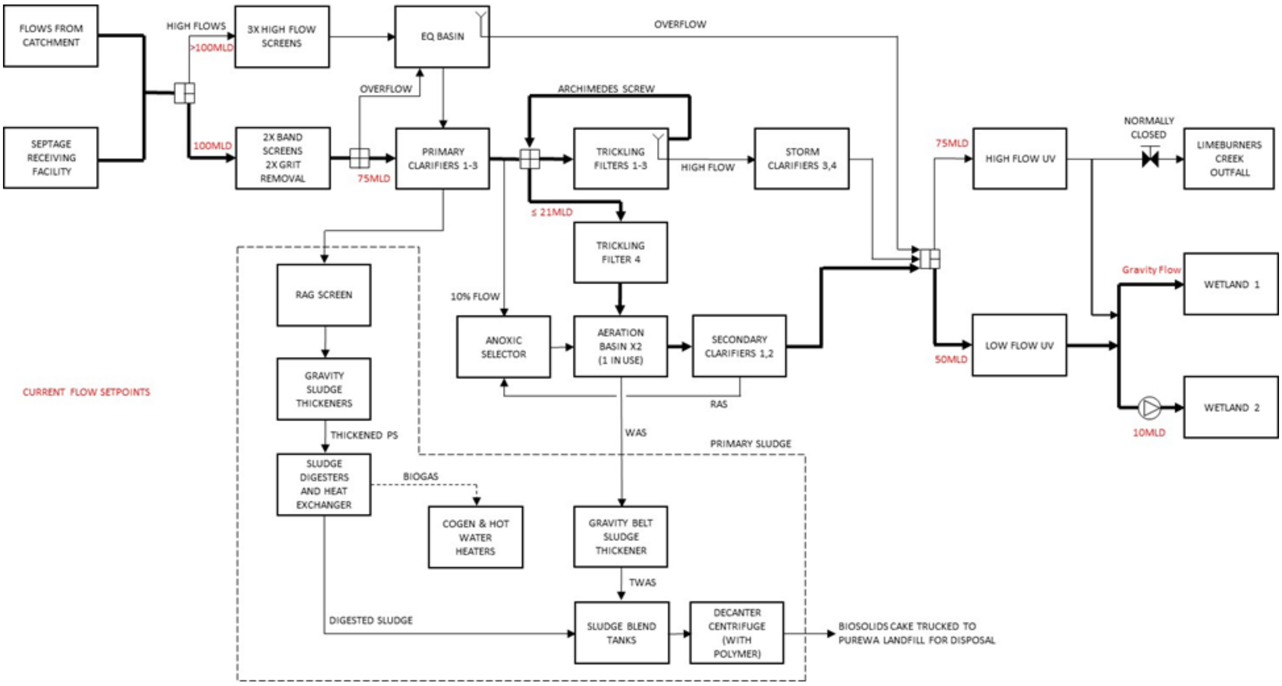

Figure 3 Process flow diagram – Whangārei WWTP current process

3.2 Liquid Treatment

The existing treatment process comprises of the following treatment steps:

- Influent enters an inlet chamber from both the network, and a septage receival facility.
- The main preliminary treatment consists of two (2) band screens and two (2) vortex grit removal; if the incoming flow exceeds the band screen capacity, excess flows are diverted to a high-flow inlet works comprising three (3) inclined screw screens and an equalisation basin (referred to as the EQ basin).
- The high flow equalisation basin has an overflow weir to discharge to the high-flow UV system when there is no capacity in the treatment train (primary clarifiers, trickling filters and activated sludge basin) at very high incoming flows.
- Flow from the inlet works is then treated through three primary clarifiers, which operate in parallel.
- Primary clarified effluent passes through the trickling filters, which are arranged in a two-stage configuration during dry weather conditions:
  - Under normal flows (< 21 ML/d), flow is directed to trickling filters no. 1 – 3 (operating in parallel) and trickling filter no. 4 acts as a second stage trickling filter. Trickling filters no 1- 3 operate with a recirculation back to the trickling filter flow-splitter via the Archimedes screw.
  - When flows exceed 21 ML/d, effluent from trickling filters no. 1 to 3 is directed to secondary clarifiers 3 and 4, via a weir. Recirculation flow via the Archimedes screw is reduced and eventually stopped.

– Downstream of trickling filter no. 4, flows less than 21 ML/d (normal flows) receive treatment through an activated sludge (AS) basin (currently only one of two in operation), before passing through secondary clarifiers 1 and 2, followed by low-flow UV treatment.
– Secondary clarifiers 3 and 4 (storm clarifiers which receive weir overflow from the trickling filters in wet weather) are diverted into the high-flow UV treatment system.
– Downstream of the UV treatment, the final effluent is discharged to:
  - Wetland 1 via gravity. Wetland 1 consists of two ponds covered with floating wetland, with volume of 14,300 and 5100 m^3 respectively;
  - Wetland 2 via pumping, limited to 10 ML/d flow. Wetland 2 is a surface flow type, with a total volume of 15,400 m^3.

3.3 Solids Treatment

The sludge treatment train consists of the following process steps:

– Screenings are washed, compacted, and transported to landfill.
– Primary sludge is screened and thickened through two gravity thickeners.
– Thickened primary sludge then passes through heat exchangers and two digesters operated at mesophilic temperature (approximately 35-37°C). Biogas from the digesters is used for a co-generation engine and hot water heating.
– Digested sludge is blended with thickened Waste Activated Sludge (WAS), which has been thickened via a gravity belt thickener.
– Blended sludge is transferred to a sludge holding tank prior to being centrifuged and finally carted offsite to the Purewa landfill, about 10 km south of Whangārei.

3.4 Discharge Consent Conditions

The current resource consent has a maximum discharge volume limit of 140,000 m^3/day.

The quality of the treated wastewater from the treatment system, measured prior to it entering the wetlands, shall not exceed the limits outlined in Table 3:

Table 3 ***Existing Discharge consent conditions***

	Conditions based on Daily Discharge Volume			
	Up to 21,000 m^3/d	**21,000 to 30,400 m^3/d**	**30,400 – 57,400 m^3/d**	**>57,400 – 140,00 m^3/d**
BOD_5 (mg/L) - 50%ile/Median	15	20	25	
BOD_5 (kg/day) - Median	300	-	-	
BOD_5 (kg/day) - 90%ile	500	-	-	
TSS (mg/L) - Median	15	25	25	
TSS (kg/day) - Median	300	-	-	
TSS (kg/day) - 90%ile	500	-	-	
Ammonia (mg/L as N) - Median	5	10	15	
Minimum UV dose (mWs/cm^2) – 10 minutes average	30	30	40	40
E.coli (cfu/100mL) – Median E.coli (cfu/100mL) – 90th%ile				1,500 3,000

The current consent does not have specific discharge limits for total nitrogen or total phosphorus.

3.5 Current Plant Performance

Table 4 outlines the historical performance (Jul 17 to Nov 19) when operating below 21,000 m^3/day and compares this to more recent sampling carried out between October and December 2020 as part of a new sampling plan developed by GHD and WDC in October 2020[1]. The consent compliance is based on collection of 15 samples for every 3 months.

Table 4 Comparison of Latest and historical plant performance

Determinant	Current Consent Limit @ Flows <21MLD		Historical Performance Jul 17 to Nov 19		Recent Plant Effluent Results Oct to Dec 20 (7 weeks)
	Median	**90%tile**	**Median**	**90%tile**	**Median**
BOD_5 (mg/L)	15	-	12	25	**19**
BOD_5 (kg/day)	300	500	178	340	239
TSS (mg/L)	15	-	**18**	32	**38**
TSS (kg/day)	300	500	274	483	**432**
AmmN (mg/L as N)	5	-	4.2	11.1	**9.0**
TN (mg/L as N)	-	-	30*	37.2	31*
TP (mg/L as P)	-	-	3.6**	4.2	4.4**

** Number of TN samples between 2017 to 2019 and Oct to Dec 2020 were 25 and 6 respectively.*

*** Number of TP samples between 2017 to 2019 and Oct to Dec 2020 were 4 and 6 respectively.*

As seen in Table 4, the recent plant results in late 2020 did not meet the median consent concentration limits of BOD_5, TSS and Ammoniacal nitrogen. It is understood from WDC Operations staff that the plant performance was affected by the significant storm event in July 2020 and a subsequent event of illegal dumping around December 2020. Elevated BOD_5 can also be attributed to solids spikes in the final effluent. There was also a similar incident in 2018; these incidents were reported to NRC. It is recommended that a method for tracking these incidents is developed.

Moreover, WDC Operations have indicated that the biological treatment was also recovering since the extreme wet weather event in July 2020.

Nonetheless, the treatment plant has performed well throughout the past few years, particularly with respect to “medium” (21,000 to 30,400 m^3/day) and “high flow” conditions (30,400 to 57,400 m^3/day) described in the 6 monthly resource consent monitoring reports prepared by NRC over this period. Refer to the Information Review memo, an appendix to the GHD Plant Assessment Report (GHD, 2021b) for details.

3.6 Inter-Stage Monitoring Results

The below sections outline the current wastewater quality at key stages of the treatment process, particularly used for estimating future upgrade requirements.

Some of these parameters were only sampled after the implementation of the new sampling plan developed by GHD and WDC in October 2020, and therefore there are fewer samples available which may impact the confidence of the assumptions made.

While they are still key stages in the treatment process, as the effluent quality from the AS basin and the UV treatment are not used in the sizing calculations they are excluded from this summary.

3.6.1 Primary clarifier effluent

Table 5 below shows the average concentration in the effluent from the primary clarifiers 1-3. The operator advised that hydraulically, the clarifiers are capable of processing 90 ML/d, however they are usually limited to 75 ML/d. The data has shown the primary clarifiers are performing very well in terms

[1] The new sampling plan has built on the existing consent sampling requirements to better understand the performance of key stages of the treatment process to inform future upgrade requirements.

of removing BOD_5 and suspended solids, attributed to low hydraulic loading during the dry weather condition.

Table 5 Primary clarifier effluent (primary clarifiers 1-3)

Parameter	Average concentration (mg/L)	Sampling date range	No. samples
TSS	75	1/12/14 – 1/12/20	534
BOD_5	97	1/12/14 – 1/12/20	297
COD	273	1/12/14 – 1/12/20	532
AmmN*	40	25/10/20 – 4/12/20	9
TKN*	41	25/10/20 – 4/12/20	8
TP*	4.7	25/10/20 – 4/12/20	4

** Parameter from new sampling plan, implemented in October 2020 (fewer than 10 samples available)*

3.6.2 First stage trickling filter effluent

Sampling of first stage trickling filter effluent (trickling filters 1-3) has only been implemented since October 2020, therefore limited data is available. The performance of the first stage trickling filter effluent will be revisited when implementing the Master Plan.

Table 6 Trickling filter stage 1 effluent

Parameter	Average concentration (mg/L)	Sampling date range	No. samples
TSS*	67	25/10/20 – 4/12/20	5
BOD_5*	38	25/10/20 – 4/12/20	5
COD*	163	25/10/20 – 4/12/20	5
AmmN*	24	25/10/20 – 4/12/20	5
TKN*	26	25/10/20 – 4/12/20	3
NOxN	Not monitored	-	-
TP*	4.4	25/10/20 – 4/12/20	4

** Parameter from new sampling plan, implemented in October 2020 (fewer than 10 samples available)*

The removal of BOD and TSS across these trickling filters is within the range of typical expected performance.

3.6.3 Second stage trickling filter effluent

Table 7 below shows the average concentration in the effluent from the second stage trickling filters (Trickling Filter 4).

When compared to trickling filter stage 1 effluent (noting this data has only been collected from October to December 2020) there is no observable change in ammonia and a slightly increased COD, indicating the second stage trickling filter (Trickling Filter 4) may not provide nitrification.

This is likely due to moderately high loading on the filter (~0.35 kg/m³/day, GHD plant assessment report 2021b).

Table 7 Trickling filter stage 2 effluent

Parameter	Average concentration (mg/L)	Sampling date range	No. samples
TSS*	68	25/10/20 – 4/12/20	4
BOD_5	43	1/12/14 – 1/12/20	296
COD	181	1/12/14 – 1/12/20	568
AmmN	24	1/12/14 – 1/12/20	569
NOxN*	11	25/10/20 – 4/12/20	6
TP*	6.3	25/10/20 – 4/12/20	4
DRP*	4.1	25/10/20 – 4/12/20	3

** Parameter from new sampling plan, implemented in October 2020 (fewer than 10 samples available)*

3.6.4 Plant effluent

Table 8 below presents the plant effluent results collected between October and December 2020. The long term historical performance was described in Table 4.

The data indicated recent deterioration of plant performance, and the plant operations team has advised that the plant was severely impacted by the July 2020 storm event.

Table 8 Plant effluent (Oct to Dec 2020 results)

Parameter	Average concentration (mg/L)	Sampling date range	No. samples
TSS	38	27/10/20 – 17/12/20	13
BOD_5	20	27/10/20 – 18/12/20	13
AmmN	7.7	25/10/20 – 17/12/20	13
TN	31	29/10/20 – 9/12/20	11 – *composite and grab samples*
TP	4.6	29/10/20 – 9/12/20	6
Faecal coliform	Median - 8727	29/10/20 – 17/12/20	11

3.7 High Level Capacity Review

As reported in GHD's Plant Assessment report (GHD, 2021b), the table below summarises the process capacity of the WWTP and highlights wastewater and sludge treatment 'pinch points' (odour related issues have been excluded).

Table 9 Process 'pinch points'

Process	Pinch Point	Comments
Inlet Works		*Additional capacity required as Band Screens and Vortex Grit are limited to 100 ML/d.*
Primary Clarifiers		*Capacity likely limiting in peak flow condition.*
Normal Flows		
Trickling Filters – normal flow		*Stage 2 trickling filter loading rate is moderately high.*
Anoxic Selector		*Poor sludge settling requires attention.*
Activated Sludge Basin		*Additional aeration basin/capacity required.*
Secondary Clarifiers		*Poor sludge settling requires attention.*
Normal Flow UV		*Low UV dose issue requires attention.*
Wet Weather Flows		
Trickling Filters – high flows		*Additional capacity required as future peak flow increases.*
Storm Clarifiers		*Additional peak weather capacity required.*
High Flow UV		*Room for capacity expansion.* *Compliance issue to be investigated.*
Sludge Processing		
Gravity Thickeners		*Hydraulic loading rate is high.*
Gravity Belt Thickeners		*Single unit.*
Digesters		*Digester retention time is close to borderline.*
Centrifuges		*Centrifuge in operation over 30+ years. Limited by truck transport capacity.*
Polymer Dosing	--	*Not reviewed.*
Site Services		
Power Supply / Backup Power		*Backup generator recommended.* *Current full site single line diagram needed.*
Recycled Water	--	*Not reviewed.*
Biogas Storage and Flare	--	*Not reviewed.*
Odour Control	--	*Not reviewed.*

***Colour legend**: Orange – Capacity issue observed, Yellow – likely capacity bottleneck in future, Green – spare capacity available*

4. Drivers for Change and Uncertainty

This section introduces the drivers for current and future upgrades to the WWTP which were identified during workshops with WDC and the wastewater working group. The degree of uncertainty in these drivers would influence the scope, the timing and the need for upgrades.

Several drivers have been identified as key drivers and taken through to inform the Adaptive Pathways Plan, with the more uncertain drivers identified to be considered in more detail in the future as more information regarding these becomes available. Regular review of the Adaptive Plan for the WWTP should be carried out to identify and correct deviation from this assumption.

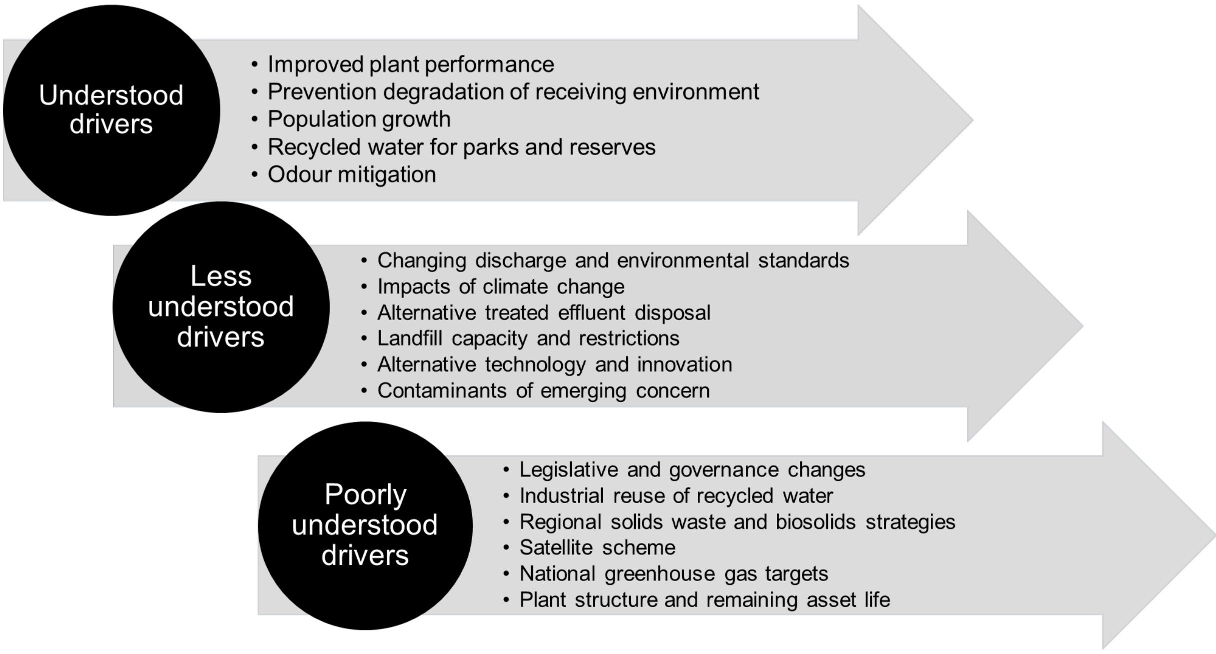

Figure 4 Whangārei Wastewater Scheme Drivers Summary

4.1 Current Consent Compliance

Parameter representing driver: current consent compliance requirements

The Plant Assessment (GHD, 2021b) identified areas of the plant which require immediate attention to address process pinch points or consent compliance issues, these are also summarised in Section 3.7 above.

4.2 Population Growth

Parameter representing driver: Equivalent Population

The current and projected total flows to the plant are outlined below in Table 10. The 2056 flows were extrapolated from the 2051 population and flow forecast provided in the WDC high growth model. A growth of 46 % is forecast over the next 35 years which is considered reasonably significant.

Incoming loads to the plant are outlined below and include both municipal network flows and trucked waste. This data has been used as the design basis when considering future options. When available, findings from the network modelling underway will contribute to the future daily peak flow and inlet works capacity upgrade assessment.

Table 10 Current and future wastewater flows - Whangārei WWTP[2]

	2020/Current	2051 (WDC forecast)	2056 (Extrapolated)
Population (EP, equivalent population)	65,000	91,000	95,000
Average Daily Flow (m^3/day)	18,500*	25,900	27,000
Maximum Daily Flow (m^3/day)	99,700**	139,600***	140,000***
% Average Daily Wastewater Flow Increase	N/A	40%	46%

** WDC advised that the plant inlet flow readings are less reliable than the UV discharge volume. Thus, the plant outflow average reading (Oct 15 to Nov 19) is presented.*

***We have not included the July 2020 "1 in 500-year rainfall event", >220 mm of rain, resulting in excess of 140 ML/d being received by the plant. This was significantly higher than the next highest flow event of 100 ML/d.*

**** Future peak flow volumes will be confirmed by ongoing wastewater network flow gauging and network modelling. In the absence of the network model, it is assumed that the new consent will retain the current consented maximum discharge volume of 140 ML/d.*

Increased flows to the plant mean an increased loading on various stages of the plant. Table 11 presents the current and predicted loading rates for the WWTP influent, and current trucked waste mass load. Due to the difficulty in predicting any change in industry in the area, only current trucked waste mass loads are presented to demonstrate the relative ratio to the current municipal loading that the future design needs to take into account. The combination of the increase in incoming mass load and more stringent future discharge requirements reflects the need to upgrade the treatment process to maintain the mass loads at the discharge.

Table 11 WWTP average incoming loads (municipal and trucked waste)[3]

	2020 Municipal WW Mass Load (kg/d)	2056 Municipal WW Mass Load (kg/d)	2020 Septage Mass Load (kg/d)
TSS	7,900	11,600	570
BOD_5*	5,228	7,640	No data
COD	13,567	19,900	1490
AmmN*	888	1,300	No data
TP*	157	230	No data
TKN**	933	1370	65

**Septage loading unknown.*

***TKN taken after implementation of sampling plan in October 2020 (thus fewer than 10 samples)*

As seen in the table above, it is acknowledged that the gaps in the septage sampling data have resulted in a likely under-estimation of total mass load calculations. As part of the revised sampling programme, influent sampling has switched from grab samples to composite samples collected from downstream of the inlet screen as of mid-October 2020 and thus a more comprehensive suite of data will be available to inform future design work. Moreover, the technical assessment of future upgrade requirements is based on the combination of flow increase and current wastewater characteristics data at different treatment processes.

[2] As reported in GHD's Plant Assessment report (GHD, 2021b).
[3] As reported in GHD's Plant Assessment report (GHD, 2021b).

4.3 Discharge Standards

Parameter representing driver: future discharge standards

The future discharge consent conditions are likely governed by two documents:

- Proposed Northland Regional Plan (PNRP – appeal version) and future revisions.
- A potential National Environmental Standard (NES) for wastewater discharges.

It should be noted that the discharge limits applied in the following sub-sections are preliminary figures, for the purpose of developing the future treatment plant upgrade requirements.

4.3.1 Proposed discharge standards (PNRP)

Under this scenario, the discharge standards are based on the WWTP's contribution to the state of the Hātea River's water quality being maintained and thus avoiding further degradation in water quality in line with the water quality standards prescribed in the Proposed Northland Regional Plan (PNRP). This assumes that the current mass loads of nutrients (nitrogen and phosphorus) are maintained with improvements in pathogen and suspended solids removals.

The two underlying principles within this discharge standard are:

- Improving pathogen treatment , suspended solids and BOD_5 to achieve improvements in public health risk in the broader Hātea River and Whangārei Harbour (refer to Water Quality and Public Health Risk Assessment (GHD, 2021c)).
- Maintaining the mass discharge of nitrogen, phosphorus and other contaminants. As outlined in GHD's long list options memo (see Appendix A), the current average total nitrogen mass load at the wetland inlet is approximately 574 kg/day (based on average flow of 18.5 ML/d and average TN of 31 mg/L at wetland inlet). The current average total phosphorus load is approximately 81 kg/day (based on average TP at wetland inlet of 4.4 mg/L measured between October to December 2020). Further quantification of mass discharge at the wetland outlet will be established with future ongoing monitoring.

With a mass load constraint on the discharge, any future increase in flow as a result of population growth will require improved treatment i.e. if flow is doubled the concentration of treated wastewater constituents must halve to maintain the equivalent mass load.

Table 12 below presents the effluent discharge quality targets assuming a 2x current average flow scenario for the purpose of developing future upgrade options.

4.3.2 Potential future discharge standards (NES)

Further to these proposed discharge consent conditions, a future National Environmental Standard (NES) may stipulate higher effluent quality requirements. Some indicative targets based on overseas jurisdictions were described in a report for the Department of Internal Affairs (GHD, 2019).

The report indicates discharge standards for Total Nitrogen under a "poor dilution" category (i.e. inner waterway discharge) could be as low as 5 mg/L. However, further review has identified that reasonable mixing of the treated effluent within the Whangārei Harbour exists, hence we have revised this future Total Nitrogen limit to 15 mg/L (at this discharge standard, constant dosage of supplementary carbon for nitrogen removal would be an unlikely requirement).

Table 12 below presents the effluent discharge quality targets under this scenario, for the purpose of quantifying the likely upgrade works.

Table 12 Proposed indicative discharge quality targets to meet PNRP and potential future NES (flow limit up to 2x average flow)

Parameter	Unit	Limit type	Proposed limits to meet PNRP	Assumed limits to meet future NES
BOD_5	mg/L	Median	15	10
TSS	mg/L	Median	15	10
Ammonia	mg/L	Median	3	2
TN	mg/L	Median	20*	15**
TP	mg/L	Median	3.0***	2.0
E coli	cfu/100 mL	Median	100	10
E coli	cfu/100 mL	90%tile	1000	100
Enterococci	cfu/100 mL	Median	50	50

** A mass load total nitrogen limit of 570kg/day is proposed, and 20mg/L median concentration value is derived based on the estimated flow for Year 2056 (27 ML/d). Note that recent plant effluent TN average was about 31mg/L.*

***The nitrogen limit is based on achieving low nitrogen levels without supplementary chemical dosing.*

**** The recent phosphorus results indicated the plant effluent level is 81kg/day, equivalent to 3.0 mg/L in 2056 flow. Note that recent plant effluent TN average was about 4.4mg/L.*

***** It is noted that there may be risks associated with basing the consent limits on limited data.*

4.4 Reuse Opportunities

Parameter representing driver: Water scarcity/climate change, E. coli count, community/industry support

NIWA (2018) has predicted a hotter climate for the Northland region, which may at times exacerbate the drought condition previously experienced in the Whangārei area. Hence, recycled effluent may become a viable option to supplement the valuable potable freshwater source.

Reuse opportunities may present themselves in the form of land-based irrigation, park/reserve irrigation, industrial reuse, or domestic non-potable reuse (i.e. toilet flushing and gardens). Improvement of pathogen treatment generally enables more options for reuse, however specific industries may have differing requirements (i.e. not just reduced pathogen content). Table 13 below presents some of the possible reuse opportunities, based on reclaimed water guidelines from the Queensland Urban Utilities (QUU)[4].

The exact quality requirements will require a risk-based evaluation approach based on exposure, buffer distance and operational requirements closer to the time.

Table 13 Recycled Effluent typical quality parameters (Source: Queensland Urban Utilities)

Water Reuse	E coli (cfu/100mL)	Processes
Land-based irrigation	<100	Good tertiary filtration and disinfection
Aboveground open space irrigation and nurseries	<10	MBR + UV, <u>or</u> additional tertiary filtration and chlorination
Dual reticulation (toilet flushing, domestic garden use and fire-fighting)	<10 Virus removal >6 log	MBR + UV + Chlorination <u>or</u> AS + Microfiltration + UV + Chlorination

Cultural sensitivities around water reuse also need to be considered.

[4] Queensland Urban Utilities (QUU), Fact Sheet – Recycled Water Information Sheet, accessed online

4.5 Odour

Parameters representing driver: Odour surveys and complaints

The Whangārei WWTP Air Quality (Odour) Assessment (GHD 2021d) recommended several immediate improvements related to odour containment such as covers for screening and grit bins and cover/lid for sludge bins. In particular, the current open-top sludge bins would be replaced by enclosed self-levelling bins.

Ongoing odour surveys will determine what other improvement measures might be required, such as odour extraction and treatment for key components of the plant.

4.6 Climate Change Adaptation

Parameters representing driver: Flooding risk mitigations, Wet weather treatment capacity and Greenhouse gas emission/carbon neutrality targets

Flooding risk mitigations

Northland Regional Council (NRC) coastal flood hazards mapping[5] provides a broad assessment of the flooding risks in the vicinity of the wastewater treatment plant. Based on the information, the existing wetlands may be affected in future major flood and severe sea level rise events. This requires ongoing monitoring.

Wet Weather Treatment Capacity

Climate change will increase the frequency and intensity of severe wet weather events, which could result in higher wastewater flows into the wastewater network, which eventually requires treatment and discharge. WDC is currently undertaking a wastewater network strategy study, which the findings will need to be incorporated into future treatment plant master plan updates.

Greenhouse gas emission/carbon neutrality targets

The Climate Change Response (Zero Carbon) Amendment Acts 2019 sets a national goal to achieve net zero carbon emission by 2050 (except for biogenic methane). For wastewater treatment, carbon emission comes in three different forms namely, process emission (Scope 1), power and consumables (Scope 2) and embodied carbon (Scope 3).

Based on a high-level estimate of WWTP emission on a national scale[6], Scope 1 emission is understood to be significantly higher than Scope 2. A general approach to achieve carbon neutrality often entails energy efficiency measures and co-digestion of organic/food wastes.

Detailed methodology to accurately quantify Scope 1 process emission from wastewater treatment processes is currently being developed and more research in this area is needed. Many widely used emission reporting protocols apply single factors for nitrous oxide and methane emission from secondary treatment processes which make it extremely difficult and highly subjective to compare emission from different types of treatment processes. This is particularly due to the fact that there is a general lack of international consensus of these emission factors.

A New Zealand specific emission reporting/estimation guideline is currently being developed, and the initial step would be to undertake a baseline carbon emission estimation once the guideline is adopted by the industry and consideration of this be given in future master plan reviews.

4.7 Land-based effluent application or ocean outfall

Parameters representing driver: E. coli count, prolonged drought conditions, community support

[5] Northland Regional Council (NRC), Coastal Hazards Map Portal, accessed online
[6] Ministry for Environment (MfE) Wastewater Sector Report (2020) – Figure 88

Alternatives of treated effluent discharge including land application and harbour/ocean outfall were examined as part of the options investigation. An alternative discharge can have the potential to reduce the nutrient loads discharged to the Limeburners (Hāhā) Creek. However, these alternatives do not appear to be acceptable and viable at this time of writing (October 2021). It is proposed that alternative treated effluent discharge is to be re-examined periodically.

4.8 Landfill Capacity and Restrictions

Parameter representing driver: landfill levy, biosolids quality requirements for landfill

Currently only primary sludge is treated by the digesters at the Whangārei WWTP.

This practice may be required to change because of a potential increase in landfill levy or higher biosolids quality requirements by the Purewa landfill (i.e. Class B stabilised). In this situation, the digesters will have to accommodate the secondary sludge, which will require additional digesters, and/or additional sludge treatment process such as recuperative thickening.

An upgrade of the co-generation engines will likely be required to handle higher biogas volume.

4.9 Contaminants of Emerging Concerns (CECs)

Parameters representing driver: Water quality monitoring and National Environmental Standards

CECs have been very topical for several; decades, and more information is being discovered and reported on a regular basis. Removal of these contaminants can be achieved via (1) source diversion or (2) treatment, the latter is often difficult and expensive to construct and operate. Whilst these contaminants have not been prescribed in any current/recent discharge standards, this may yet to be incorporated in future discharge standards triggered by new regulations and/or environmental standards. This may also act as a driver to seek or dissuade from a particular alternative effluent disposal means (e.g. land, harbour, ocean etc).

This is proposed to be part of the periodic review of treatment options and receiving environment. For instance, endocrine disruptor compounds can be treated by advanced oxidation processes (AOP), which could entail hydrogen peroxide dosing into a high-power UV system (typically UV dose will be 4 times or higher than what’s required for disinfection purposes).

4.10 Alternative Technology and Innovation

Parameters representing driver: Technology Review

There has been significant acceleration in wastewater treatment technology in the past few decades. For instance, membrane bioreactor (MBR) was once considered to be uneconomical and now is considered part of standard treatment options. There are a number of new wastewater treatment technologies emerging into the market including Aerobic Granular Sludge (AGS), Membrane Aerated Biofilm Reactor (MABR), Sludge drying and pyrolysis package plants and many others. Over time, these new and emerging technologies will become more established and their long term reliability will be better understood, and may be considered suitable for Whāngarei WWTP.

4.11 Regulatory and Governance Changes

Parameters representing driver: Water Reform

The upcoming Water Reform will likely significantly reshape the water industry across New Zealand by consolidating into larger, multi-regional water entities. It is unclear how WDC will be affected at the time of writing. For instance, if a new entity is formed, the funding priority for the Whāngarei WWTP may change, this would then impact the proposed works timeframes outlined in this Master Plan or the options/solution may change.

4.12 Industrial reuse opportunities

Parameters representing driver: E. coli count, water scarcity/climate change, community support

There may be current and future industries open to use recycled effluent to reduce their dependence on freshwater sources. At the time of writing, it is not possible to establish the approximate future demand for this application. This should be monitored and considered in future master plan reviews.

4.13 Regional Solids Waste and Biosolids Strategy

Parameters representing driver: Solids waste management strategy, Landfill capacity and Regional biosolids management strategy

We understand WDC is considering a solids waste management strategy and possibly a regional biosolids management approach to provide a more holistic wastewater management approach for addressing stakeholder concerns and providing greater surety in planning. Both can have significant bearings on the Whangārei WWTP future expansion plan, in terms of loadings from the return streams (e.g. centrate) and space for expansion.

If Whangārei WWTP becomes a regional biosolids facility, it may accept sludge from other WWTPs such as Mangawhai and Kerikeri in the Far North region. The timeframe and details of these potential sludge streams coming to this facility is yet to be determined.

Furthermore, adding organic waste from the municipal waste stream will significantly boost biogas production, it may assist the plant towards energy neutrality.

Both will increase the sludge volume to be processed at the Whangārei WWTP, requiring larger digester volume. However, there is insufficient data available to enable early quantification of the impact on the Whangārei WWTP, it is recommended that the implication is to be addressed as a separate study.

4.14 Satellite Wastewater Schemes

Parameters representing driver: Population growth and spatial planning

Satellite wastewater schemes were considered in the initial long list options evaluation but was not considered suitable within the current consent application timeframe. Nonetheless, establishing satellite wastewater schemes could be viable and appropriate in future, subject to actual population growth and spatial planning of this growth. This should be monitored and considered in future master plan reviews.

4.15 Asset Conditions and Remaining Asset Life

Parameters representing driver: Asset condition survey

The existing treatment plant assets have been built over an extended period in the past 40 to 50 years. Some of the assets could reach the end of asset life in the foreseeable future, examples include primary clarifiers, trickling filter #1, centrifuges and the normal flow UV unit.

Smaller assets such as pumps and mechanical equipment would be typically replaced under a “like for like” regime. Nonetheless, these assets would also be replaced to increase process capacity or the level of treatment standards.

An asset condition survey is recommended to more accurately characterise the remaining asset life, to inform the next master plan review.

5. Adaptive Pathways for Whangārei WWTP

The section below provides the graphical adaptive plan for the WWTP, presenting the proposed upgrade pathways, the reasons for each upgrade pathway and a summary of the required infrastructure. Additional details are provided in Appendix C (indicative layout) and Appendix D, (process assumptions).

As demonstrated by the adaptive plan, following the augmentation works which are common to all pathways there is flexibility in when to switch pathways and which pathway to switch to in response to the various drivers; a decision made for the plant infrastructure for the next 10 years does not solidify the long-term future of the plant.

As there is uncertainty with regards to the timing and influence of the change drivers, decision points as to when a different pathway can be followed are based not on specific dates but on the population (for capacity increase), resource consent compliance monitoring outcomes or periodic reviews of the adaptive pathway plan (for other drivers).

5.1 Possible Actions to respond to drivers

Table 14 summarises the range of possible actions to respond to drivers identified in Section 4.

Table 14 Possible Actions to respond to drivers

Possible Actions	Drivers addressed	Triggers / timeframe
Immediate Plant Augmentation	• Current consent compliance improvement • Population growth	*Improvement needs for consent compliance and capacity constraints – immediate (<5 years)*
Treatment Plant Capacity Upgrade	• Prevent further degradation of receiving environment (PNRP) • Population growth	*Capacity exceeded or consent compliance – medium term (5 to 10 years)*
Conversion into MBR treatment or other treatment technology	• Higher discharge quality standards stipulated by future NES roll out (timeframe uncertain) • Population growth • Alternative treatment • Climate change adaptation • CECs	*Resource consent condition changes and/or NES roll out – medium to long term* *Alternative treatment processes – ongoing monitoring and review to identify the best upgrade options closer to the time*
Supply recycled water for parks/reserves and other potential applications, ranging from indirect potable, non-potable and industrial uses	• Climate change adaptation (drought mitigation, alternative water source for non-potable activities) • Community aspiration	*Parks/reserves – current consent lapses in 2023* *Other reuse opportunities – medium to long term*
Alternative treated effluent disposal and investigate satellite wastewater schemes	• Prevent further degradation of receiving environment (PNRP) • Community aspiration • Climate change adaptation • Population growth	*Periodic ongoing review – medium to long term* *Ruakaka ocean outfall construction – long term ongoing monitoring every 6 years*
Bin covers and odour treatment	• Population growth • Odour	*Complaints and odour surveys - Short to medium term*
Early replacement or repurposing of plant assets	• Population growth • Remaining asset life • Higher discharge quality standards	*Asset condition survey – short term*

Possible Actions	Drivers addressed	Triggers / timeframe
Additional Biosolids treatment capacity or/and increase of sludge treatment level	• Population growth • Odour • Landfill capacity and restrictions • District solids waste strategy • Regional biosolids management strategy	*Additional capacity – short to medium term* *Increase sludge treatment level – medium to long term driven by future strategies of solids waste and regional biosolids management*

5.2 Adaptive Pathways Summary

Table 15 provides a summary of the upgrade pathways and other key actions (augmentation works, biosolids management) for the Whangārei WWTP, including triggers, advantages, and risks. The pathways are also shown graphically in Figure 5, 6 and 7 with estimated triggers for the different upgrades.

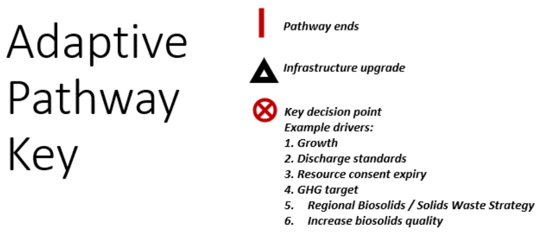

Figure 5 Adaptive pathway plan key

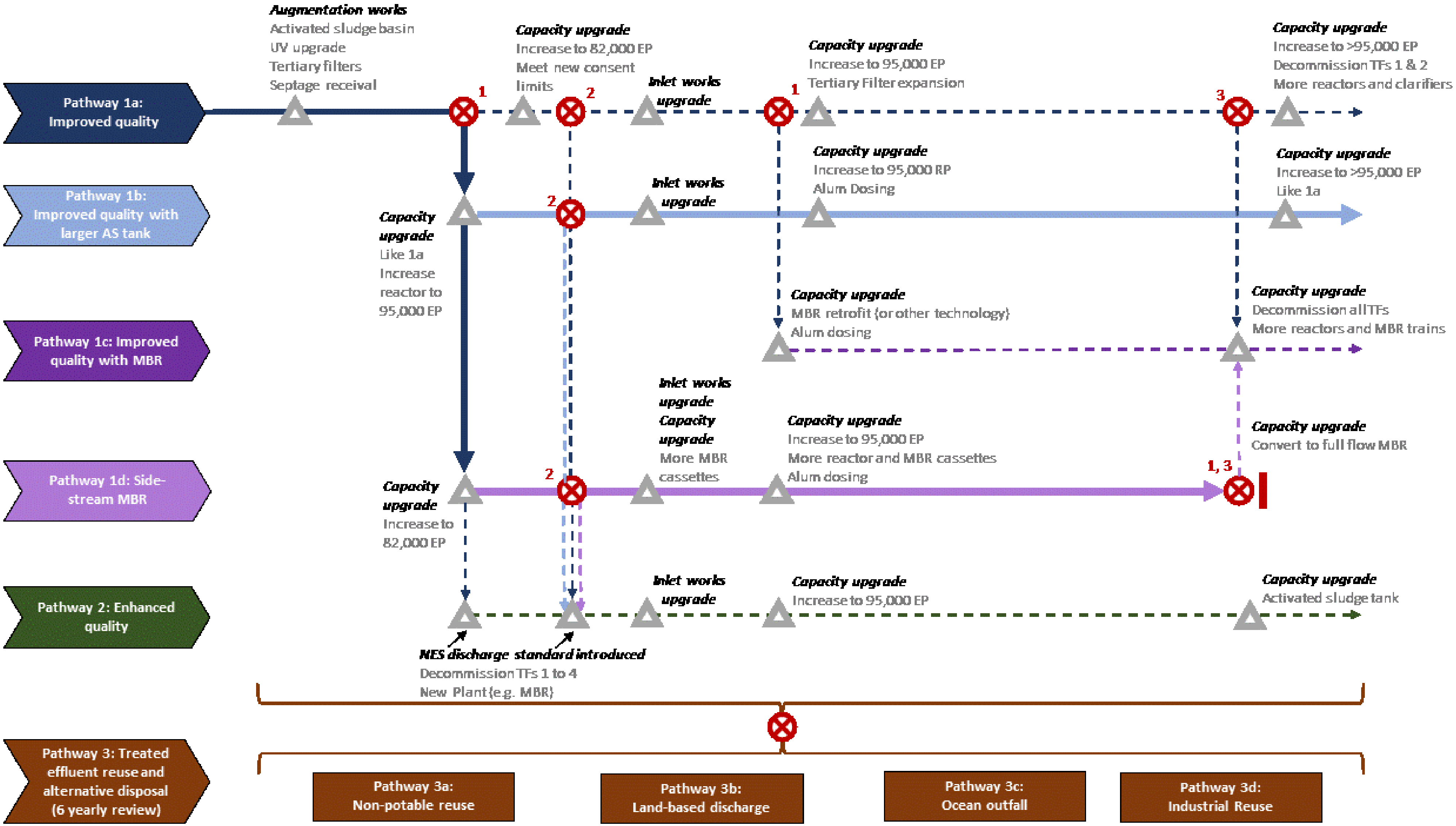

Figure 6 Whangārei WWTP Adaptive Pathway – liquid streams

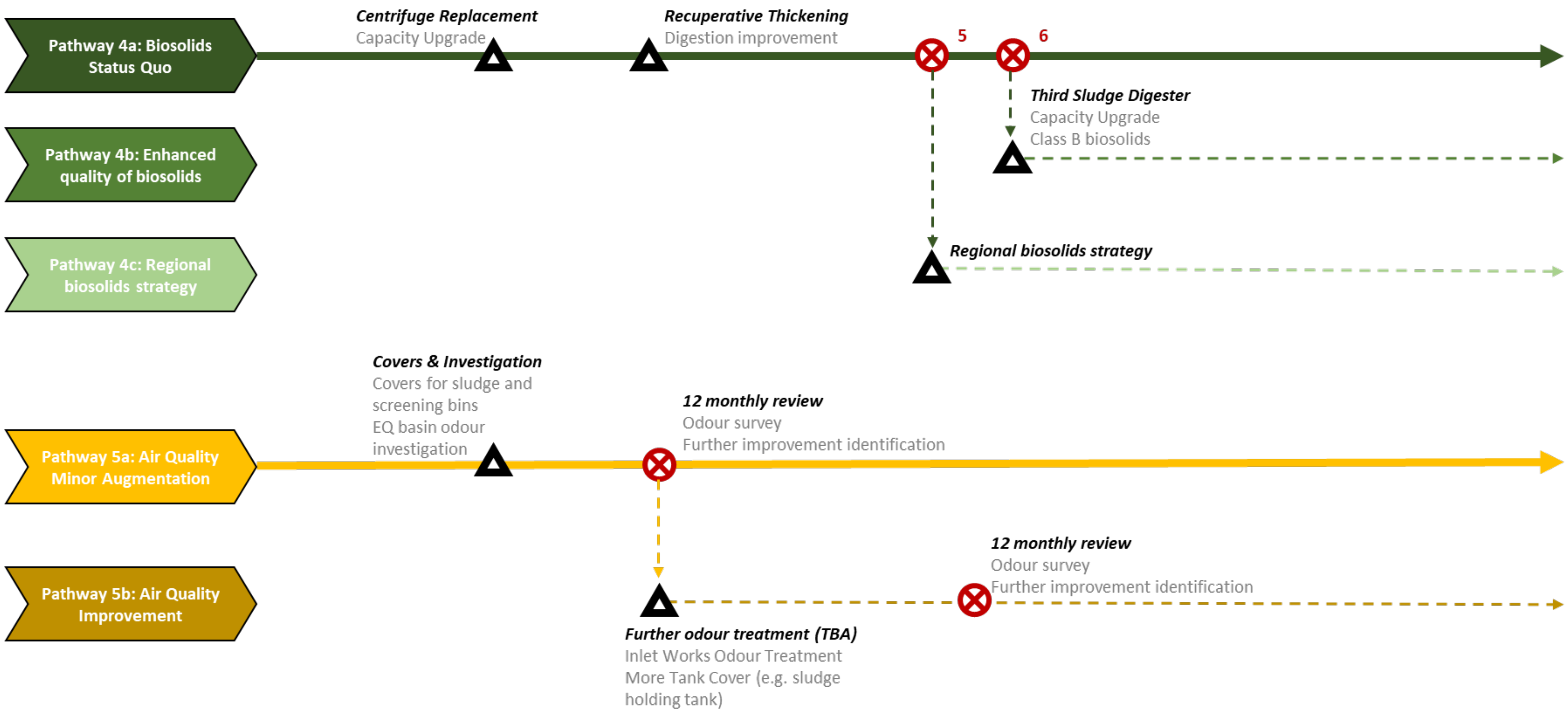

Figure 7 Whangārei WWTP Adaptive Pathway – Biosolids and Odour Management

Table 15 Strategic pathway and key actions summary

Pathway	Overview	Triggers	Advantages	Risks
Existing plant augmentation	Upgrades to existing plant infrastructure: • Inlet works • New Anoxic selector • Activated sludge basin • UV disinfection • Tertiary filters	**ASB:** Ammonia in effluent > current consent **UV:** Existing UV inconsistent with current consent **Tertiary filters:** Elevated TSS in effluent	Addresses several existing capacity and compliance issues	Tertiary filters may not be needed if: • Secondary clarifier performance improves. • MBRs are subsequently installed in future.
Pathway 1a – Improved Quality	Expand capacity of activated sludge plant with capacity for additional 10 years.	• Plant unable to meet new consent conditions and capacity demand, i.e. environmental monitoring triggers reached. • Primary clarifier exceeds capacity. • Secondary clarifier exceeds capacity.	• Staged approach to decommissioning trickling filters and installing new activated sludge tanks	• Constructability issues when staging removal of trickling filters 3 & 4 and constructing new activated sludge tanks. • Clarifier 4 location is in the same location as the anoxic tank/ • Suitability of re-purposing secondary clarifiers as membrane tanks require investigation if Pathway 1c and 2 is selected in distant future.
Pathway 1b – Improved Quality	Expand capacity of activated sludge plant with capacity for additional 20 years.		• Expands plant capacity for a longer design horizon, offsets further upgrades.	• Decommissioning of both trickling filters 3 & 4 required simultaneously prior to construction of new activated sludge tank. • Similar comments to Pathway 1a regarding secondary clarifiers.
Pathway 1c – Improved Quality	Retrofit activated sludge tanks with MBR (or other technology) to increase capacity.		• Process intensification of new infrastructure to reduce footprint. • Eliminates the need for tertiary filtration to meet suspended solids consent limits.	• Activated sludge tanks must be designed to accommodate retrofitting, and MBR technology may be less suitable at the trigger point.

Pathway	Overview	Triggers	Advantages	Risks
Pathway 1d – Improved Quality	Side-stream MBR with existing trickling filter/activated sludge process capped at 15-18ML/d.		• More compact footprint than Pathways 1a, 1b, 1c. • No need for earthworks behind existing anoxic tank to create a civil platform to construct secondary clarifier 3 and 4 (in other Pathway 1a, 1b, 1c). • TF1 and TF2 are more accessible for construction than TF4.	• Higher O&M cost related to MBR cassette replacement, chemical dosing, etc. • Wet weather flow management is critical.
Pathway 2 – Enhanced Quality	MBR upgrade to expand capacity and meet tighter consent limits.	• Tighter TN and TP discharge limits by NES introduction or review of PNRP water quality standards or required by receiving environment triggers being met.	• Process intensification of new infrastructure to reduce footprint. • Eliminates the need for tertiary filtration to meet suspended solids consent limits.	• New bioreactors to be designed for long term capacity requirements and further tightening of discharge standards.
Pathway 3 – Treated Effluent Reuse and Alternative disposal	Treated effluent reuse and alternative disposal.	• Sufficient demand for recycled water. • Ruakaka WWTP ocean outfall construction (periodic review) • Periodic review of land-based discharge / industrial reuse	• Provide recycled water to reduce potable water demand in drought. • Reduce volume and loads of treated effluent into the Limeburners (Hāhā) Creek.	• Uncertainty about future recycled water demand and quality requirements. • Uncertainty about whether ocean outfall will be constructed. • Uncertainty about land availability for land-based discharge.
Pathway 4 - Biosolids management	Increase capacity to solids handling process and stabilised biosolids, including: • Recuperative thickening • Dewatering upgrade • Gravity belt thickener • Third anaerobic digester	• Recuperative thickening: Digester SRT < 15 days. • Dewatering upgrade: End of asset life. • Gravity belt thickener: Single point of failure mitigation. • Third anaerobic digester: Landfill requirement changes.	• Recuperative thickening maximises existing anaerobic digesters capacity • Additional gravity belt thickener increases process redundancy	• Additional digester volume will be required if this facility is selected as the Northland regional biosolids processing centre. Limited space for further expansion. • Construction of Digester #3 will reduce available space around the digester tanks, GBT building, potentially restricting site vehicle

Pathway	Overview	Triggers	Advantages	Risks
				movements, e.g. crane access for digester lid maintenance.
Pathway 5 – Odour Management	Implementation of bin covers and EQ basin optimisation investigation Odour treatment system installation	• Odour survey. • Future Odour complaints.	• Address intermittent odour issues by relative straight forward plant modifications. • Deferral and possible elimination of major expenditures (e.g. EQ basin and primary clarifier covers).	• Require more periodic odour survey to be undertaken.

5.3 Pathway 1: Improved Quality

A consent application for the renewal of resource consents associated with the Whangārei WWTP will be lodged with NRC in early 2022.

Pathway 1 considers the capacity upgrades required to improve effluent quality to meet the proposed discharge criteria for BOD_5, suspended solids, E coli, nitrogen and phosphorous (refer section 4.3.1 - Proposed discharge standards (PNRP) and Table 12). These limits would be met by maintaining the existing nutrient mass loads in the plant discharge as the influent increases with increasing population, up to 95,000 EP, which is the current forecast for 2056. This pathway also includes other upgrades required to meet the expected increase in flow and loads (i.e. inlet works and solids handling upgrades).

Timeframe/Trigger: 72,000 EP

– The key infrastructure for pathway 1 includes:
  - New primary clarifier (or modified operation of the existing primary clarifiers).
  - Increased aeration tank capacity for the activated sludge plant.
  - Additional secondary clarifier.
  - Decommissioning of trickling filters.
  - Biosolids upgrades – e.g. recuperative thickening, third digester tank;

Details of infrastructure are provided in Appendix D.

Four sub-pathways under Pathway 1 have been defined, which consider different timing and infrastructure sizing for the activated sludge plant and MBR (or other technology).

5.3.1 Pathway 1a

– 72,000 EP: Replace trickling filter 4 with activated sludge tank, and a secondary clarifier.
– 82,000 EP: Replace trickling filter 3 with activated sludge tank, an additional secondary clarifier and chemical dosing for phosphorus removal.
– 92,000 – 95,000 EP (consent expiry): Replace trickling filters 1 & 2 with activated sludge tank.

5.3.2 Pathway 1b

– 72,000 EP: Replace trickling filters 3 & 4 with larger activated sludge tank, and a secondary clarifier.
– 82,000 EP: Construct an additional clarifier, and chemical dosing for phosphorus removal.
– 92,000 – 95,000 EP (consent expiry): Replace trickling filters 1 & 2 with activated sludge tank.

5.3.3 Pathway 1c

– At any point along pathway 1a or 1b, retrofit new activated sludge tanks with MBR (or other technology) to increase capacity. Adoption of this option would require additional planning works to be completed during the design of the activated sludge tank to allow for future conversion.
– If pathway 1a diverges to pathway 1c after the construction of a single MBB tank, the total activated sludge reactor volume is expected to provide sufficient biological treatment capacity to 2056.
– If either pathway 1a or 1b diverge to pathway 1c once the activated sludge plant reaches capacity in approximately 2056, a new activated sludge tank would be required. This may coincide with the decommissioning of trickling filters 1 & 2 due to the end of their asset life.

5.3.4 Pathway 1d

– Following augmentation works, a side stream MBR (or other technology) can be built to run alongside the existing trickling filter and activated sludge process which will be capped to 15-18ML/d on average.

- The side-stream MBR treatment will aim to achieve a final effluent TN of 10mg/L for blending. This option negates the need to put more flow through the existing trickling filter and activated sludge process, does not require additional clarifiers, and has a more compact footprint.
- 72,000 EP: Build side-stream MBR (or other similar technology).
- 82,000 EP: Add an additional reactor, with additional MBR cassettes, chemical dosing for phosphorus removal
- 92-95,000 EP (consent expiry): Add additional reactors, with additional MBR trains, this converts into a full MBR process

5.4 Pathway 2: Enhanced Quality

This pathway considers a potential future scenario where the total nitrogen and total phosphorus limits would be reduced beyond those in pathway 1 (refer Section 4.3.2 and Table 12). Triggers for this pathway could include a future resource consent review or new wastewater regulations.

The key infrastructure for pathway 2 is described in Appendix D and includes:

- New primary clarifier (or modified operation of the existing primary clarifiers).
- MBR tank and associated infrastructure (MBR is selected as a benchmark technology for this study. Technology selection is to be carried out closer to the time).
- Increased aeration tank capacity for the activated sludge plant.
- Chemical dosing to achieve a lower effluent total phosphorus concentration.
- Decommissioning of trickling filters.

As part of a chemical dosing upgrade for phosphorous removal, a review of the expected solids generation would be required to determine if any solids handling upgrades are required (e.g. longer centrifuge hours to handle increase solids).

5.5 Pathway 3: Treated Effluent Reuse and Alternative Disposal

5.5.1 Pathway 3a: Effluent Reuse

This scenario considers the use of recycled effluent for public space irrigation or other restricted access irrigation. At recent workshops, key stakeholders expressed interest to understand this scenario further. Potential recycled effluent users are yet to be identified, however WDC has a short-term resource consent to supply recycled water to Council owned gardens, trees and sports fields, during times when water restrictions apply, as a “trial”.

This pathway can occur in parallel with other pathways, as the recycled water infrastructure requirements are downstream of the UV reactors and can be installed regardless of the upstream WWTP configuration.

Short term recycled effluent

One of the improvement drivers desired by the stakeholder representatives is to increase reuse of recycled water. As noted above, WDC obtained a short-term resource consent (NRC file no: 41633) in March 2020 to facilitate supply of treated effluent to irrigate Council owned gardens, trees and sport fields. The chlorine dosing system prescribed in the consent is yet to be built, as the consent was applied to provide emergency use of treated wastewater to relieve the pressure on potable water supply during severe drought in summer 2019/20. This consent has not yet been enacted as drought conditions passed soon after the consent was granted, and the consent will expire in February 2023.

Medium to Long Term Future recycled effluent

Owing to the uncertainty around demand and future uses of recycled effluent in Whangārei, the treatment process of the recycled effluent plant cannot be established at this point. Example criteria in Queensland are presented in Table 13 (Section 4.4). Nevertheless, space provision at the treatment plant site has been allowed for recycled water infrastructure and future tanks.

A summary of the pathway 3a infrastructure requirements is provided in Appendix D.

5.5.2 Pathway 3b: Land-based Disposal

As a compliment to disposal to Limeburners (Hāhā) Creek through the wetlands, land-based disposal of treated effluent can also be considered. This will involve long term, ongoing monitoring and identification of potential sites. It should be noted that the long list option assessment considered the option of full land application and found the area required is non-feasible. Hence, the future focus would be placed on partial land application during summer conditions, where the receiving waters are more sensitive.

Land based disposal infrastructure can be constructed in stages as land becomes available to match the growing population and flows. This will be part of the ongoing review/update of the Adaptive Pathway Plan.

5.5.3 Pathway 3c: Ocean Outfall

WDC have a resource consent authorising the construction, occupation and use of a new ocean outfall structure in Bream Bay for the Ruakaka WWTP (NRC file no: 21532).

Consideration of a combined ocean outfall from the Whangārei WWTP with the Ruakaka WWTP has been considered, and it is recommended that the feasibility of this option is reviewed every 6 years in line with the Ruakaka ocean outfall feasibility and consent review requirements of the Ruakaka WWTP consent (Condition 32). This will be part of the ongoing review/update of the Adaptive Pathway Plan.

5.6 Pathway 4 Biosolids Management

5.6.1 Pathway 4a: Current Practice

This scenario assumes continuation of the current practice where thickened primary sludge is treated in the anaerobic digesters prior to blending with thickened waste activated sludge (TWAS) in the sludge holding tank, immediate upstream of the centrifuges.

Centrifuges have been operating beyond the usual asset life and should be replaced with larger capacity units to accommodate higher sludge volumes in future.

The proposed recuperative thickening will improve the digester performance and capacity by increasing the sludge retention time in the existing digesters. This will involve installation of a sludge recirculation loop with drum thickeners. This modification also allows one of the digesters to be taken offline without significantly negatively impacting the digestion performance.

5.6.2 Pathway 4b: Third Digester Upgrade

Dewatered sludge is currently sent to the Purewa landfill. If the landfill changes its acceptance criteria in future (e.g. all of the sludge to be treated to Grade B stabilisation), the TWAS stream will have to be treated by the anaerobic digestion, requiring a third digester tank to be built. Ancillary equipment such as sludge mixing and biogas collection would be installed at the same time.

The timeframe of this pathway is unknown.

5.6.3 Pathway 4c: Regional Biosolids Strategy

This scenario considers the possibility of treating all biosolids and/or collected food waste in the Northland region or within the Whangārei District. This scenario will incur significant changes to the treatment processes, in both solids and liquid treatment streams.

The sludge quantity and food waste volume under this pathway is not known, potentially requiring a fourth digester and major changes to the liquid stream to manage the nutrient loads associated with the external biosolids and food waste streams.

5.7 Pathway 5 Odour Management

This pathway considers odour management associated with the treatment plant operation.

Pathway 5a considers the scenario to address the intermittent odour issues by installing covers on sludge and screening bins as well as undertaking an investigation to optimise operations of the equalisation basin (EQ basin) to reduce flow storage time.

Once Pathway 5a is completed, the periodic odour survey will review if there is a need to install additional measures, such as odour extraction and treatment of inlet works and sludge equipment. If additional odour treatment is needed, Pathway 5b would be initiated.

6. Implementation of the Adaptive Pathway Plan

Regular review of the adaptive pathway plan for the WWTP should be carried out to assess the urgency of key drivers and reprioritise where necessary. These reviews may be timed to align with the 6 yearly review of the Ruakaka WWTP ocean outfall feasibility reviews to allow for streamlined implementation of an ocean outfall if and when it is feasible. Other reviews will also need to take place to ensure the Whangārei WWTP Adaptive Pathway Plan is truly a “living document”.

6.1 Monitoring and Enabling Studies

Various monitoring schemes and enabling studies are required on an ongoing basis to assess and quantify the immediacy of the different drivers and inform a decision to change pathways or go ahead with building other key infrastructure (inlet works upgrade, etc). These include but are not limited to:

– Population growth monitoring
– Network flow monitoring and modelling
– Septage/trucked waste monitoring
– Receiving environment water quality monitoring
– Stakeholder engagement
– Whangārei WWTP inter-stage sampling program
– Whangārei Drought/Water Resilience study
– Whangārei district / Northland regional biosolids management strategy.

6.2 Next Steps

1. A draft of this options report was presented to WDC and the wastewater working group on 1 June 2021 for comment and endorsement of the approach and preferred pathway(s) to move forward with for this scheme.
2. Following this, a Master Plan of the augmentation and the proposed short to medium-term upgrades (first 10 years) was prepared alongside preparation of the resource consent application. This finalised options report provides supporting information to both the Master Plan and resource consent application.
3. This will then be followed by the commencement of the Plant Augmentation upgrade design.

7. References

GHD, 2019. Department of Internal Affairs - Three Waters Review Cost Estimates for upgrading wastewater treatment plants that discharge to ocean, prepared December 2019.

GHD, 2021a. Whangārei WWTP Plant Data Analysis Technical Memo, 21st January 2021.

GHD, 2021b. Whangārei WWTP Consenting - WWTP Plant Assessment, October 2021.

GHD, 2021c. Whangārei WWTP Consent Application - Water quality and public health risk assessment, Final, October 2021.

GHD, 2021d. Whangārei WWTP Air Quality (Odour) Assessment, (August 2021).

Ministry for Environment (MfE), 2020. Wastewater Sector Report.

NIWA, 2018. Climate Change Prediction for the Northland Region, website link - Climate change projections for the Northland region | Ministry for the Environment (updated 31st May 2018).

Appendices

Appendix A

Long List Options Memorandum

Memorandum

10th November 2020

To	Whangarei District Council (Hai Nguyen, Sarah Irwin and Simon Charles)		
Copy to			
From	Ian Ho & Danielle Maynard	Tel	
Reviewed	Sarah Sunich and Anthony Kirk		
Subject	Long List Options - Summary Report	Job no.	12528591

Issue	Date	Description
1	25/09/2020	*Draft memo – High level summary only, pre-WDC Long List Discussion*
2	19/10/2020	*Draft memo – High level summary only, post-WDC initial Long List Discussion*
3	10/11/2020	*Final Draft Memo – Post Long List Workshop 29th Oct, including draft evaluation summary*

1 Summary

This memo summarises the long list options considered for the Whangarei WWTP best practicable option (BPO) assessment. For details refer to Table 1 overleaf and powerpoint prepared by GHD to inform the Long List Stakeholder Workshop (refer to Appendix 1).

The long list options evaluation considers the following criteria:

- **Investment objectives:**
  - Consentability - WDC desires to obtain a consent term of 25 to 35 years to provide greater certainty of investment
  - Enhanced environmental and public health outcomes – maintain environmental and health values of Limeburners Creek and the upper harbour.
  - Community affordability – willingness to pay via rates, plus the intention to lift investment levels through the water reform programme.
  - Operation robustness, reliability and efficiency – Annual operating costs, minimising failures, potential for remote operation, standardised design etc.
- **Environmental, Social and Cultural Factors:**
  - Impact on Limeburners Creek and upper harbour water quality.
  - Impact on groundwater (applicable to land-based discharge options).
  - Impact on adjacent land use options – e.g. potential spray drift (applicable to land-based discharge options), potential for odour impacts, potential for amenity impacts.
  - Cultural and community acceptability.

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- **Critical Success Factors:**
  - Consenting Pathway – issues or impacts that would make consenting difficult or likely to result in conflicts with iwi or the community.
  - Constructability – ability to implement.
  - Long term flexibility – adaptation to changes in growth assumptions or regional facility, ability to stage.
  - Risk Factors – to be identified, could include things like ownership of land used for land-based discharges, climate change etc.

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Table 1 Whangarei Long List Options High Level Option Technical Attributes

	Option 1 Existing Discharge – Plant Expansion	Option 2 Existing Discharge – Process Intensification	Option 3 Existing Site and a Satellite Plant at Nth Whangarei	Option 4 Existing Site and a Satellite Plant at Whangarei Heads	Option 5 Ocean Discharge and relocate Whangarei WWTP	Option 6 Ocean Discharge and Whangarei WWTP pump to ocean	Option 7 Land-based discharge (dry weather) with Existing WWTP site	Option 8 Supplemented with Reuse	Option 9 Deep Bore Injection / Existing WWTP Site	Option 10 Lower Harbour Discharge from Existing WWTP Site
Wastewater Treatment	Additional capacity of Peak Flow treatment, Primary clarifiers and second AS basin, filter/UV system Possible additional digester	Additional PFT, Primary clarifers, filter/UV system Possible additional digester Convert AS Basin via MBR or MABR retrofit	New NW WWTP (e.g SBR system), built over the next 10 years Upgrade current Whangarei WWTP like Option 1, with smaller flow increase Centralised biosolids management	New WH WWTP (e.g SBR system) Upgrade current Whangarei WWTP like Option 1, with smaller flow increase. Centralised biosolids management	**Relocate WWTP** to Whangarei Head**,** comprising new primary, secondary and tertiary treatment with new biosolids facilities.	Upgrade current Whangarei WWTP like Option 1, except tertiary filtration may not be required.	Upgrade current Whangarei WWTP like Option 1	Upgrade current Whangarei WWTP as Option 1 or 2 Additional treatment step to suit reuse requirements.	Capacity upgrade at Whangarei WWTP, followed by Advanced WTP (e.g. MF/RO)	Upgrade current Whangarei WWTP like Option 1
Effluent Discharge	To Limeburners Creek via existing wetlands	To Limeburners creek via existing wetlands	NW WWTP treated effluent to land-based discharge (~222ha) with a large storage pond. Whangarei WWTP continue to Limeburners Creek via wetlands.	WH treated effluent to low harbour outfall (2.1 ML/d in 2056) Whangarei WWTP continue to Limeburners Creek via wetlands.	New ocean outfall (100% flow)	New rising main 33km for 100% flow to WH New ocean outfall	New land based discharge (100% ADF), 760ha Wet weather flow discharged to Limeburner Creek via existing wetlands	Continue with wetlands and Limeburners Creek Investigate reuse opportunities including landscape/recreation space reuse, forest or land-based discharge and industrial reuse.	Deep bore injection (100% treated effluent)	New rising main 30km for 100% flow to WH New lower harbour outfall
Key features	Extend reticulation network Plant upgrades/additions – centralised treatment at Whangarei WWTP (ADF: 27ML/d)	Extend reticulation network Plant upgrades/additions – centralised treatment at Whangarei Can be designed to achieve higher N&P removal	New North Whangarei satellite plant (ADF: 8ML/d) Plant upgrades/additions to Whangarei WWTP Changes to reticulation around northern suburbs	New Whangarei Heads satellite plant (ADF: 2.1ML/d) Plant upgrades/additions to Whangarei WWTP Changes to reticulation around Whangarei head	Relocation of entire WWTP to Whangarei Heads Major reticulation network changes All effluent discharges to ocean	Extend reticulation network Less stringent N and P removal than wetland/land discharge Long rising main to WH and ocean outfall	Extend reticulation network Plant upgrades/additions, more stringent limits All effluent discharge to land (ADF only), only wet weather flow to Limeburner Creek	Extend reticulation network Plant upgrades/additions The percentage of effluent reuse may increase with time as appropriate opportunities are being identified.	Extend reticulation network Plant upgrades/additions Additional treatment potentially include indirect potable reuse standards from overseas	Extend reticulation network Less stringent N and P removal than wetland/land discharge
Effect on Limeburner Creek	Possible, requires investigation	Possible, requires investigation	Slightly lower than Option 1 due to less future discharge volume	Possible, requires investigation	No risk – no discharge to creek	No risk – no discharge to creek	Lower risk – discharge to creek only in wet weather	Possible, requires investigation	No risk – no discharge to creek	No risk – no discharge to creek
Impact on groundwater	Negligible (wetland discharge)	Negligible (wetland discharge)	Possible, requires investigation	Negligible (lower harbour discharge)	Negligible (ocean discharge)	Negligible (ocean discharge)	Possible, requires investigation, for 700+ha	Possible, requires investigation	Probable, requires significant investigation	Negligible (lower harbour discharge)
NRC Planning Rule/Risks	Discretionary activity (PNRP), existing activity recently went through a rigorous consent variation.	Discretionary activity (PNRP), existing activity recently went through a rigorous consent variation.	Discretionary activity and likely designation process. Meets intent of plan promoting land discharge.	Discretionary activity and likely designation process. Complexities around water discharge	Discretionary activity and likely designation process. Complexities around relocation of water discharge.	Discretionary activity. Complexities around relocation of water discharge.	Discretionary activity and likely designation process. Meets intent of plan promoting land discharge.	Discretionary activity and likely designation process. Meets intent of plan promoting land discharge.	Discretionary activity. Complexities associated with unknowns with this option.	Discretionary activity. Complexities in relation to water discharge and loss of mixing zone classification.
Relative CapEx	High	High to Very High	Very High	Very High	Extremely High	Extremely High	Very High	High	Extremely high	Extremely high
Stageability	Some stage-ability	Better stage-ability	Some stage-ability	Little stage-ability	Poor	Poor	Little stage-ability	Yes stage-ability	Poor	Poor
Risks/ Unknowns	Available space on site Wetland treatment efficacy (continual monitoring)	Available space on site Wetland treatment efficacy (continual monitoring)	Location of satellite WWTP and irrigation site	Location of satellite WWTP Only small flow reduction to Whangarei	Major changes to reticulation network, likely odour and septicity issues.	Construction and high cost of rising main and ocean outfall	Cost, location and availability of land for discharge Adjacent land use	Cost, location and availability of effluent reuse opportunities	No NZ standards for groundwater recharge applications, nor any existing references. Significant risks	Construction of rising main of treated effluent and acceptability of lower harbour discharge

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	Option 1 Existing Discharge – Plant Expansion	Option 2 Existing Discharge – Process Intensification	Option 3 Existing Site and a Satellite Plant at Nth Whangarei	Option 4 Existing Site and a Satellite Plant at Whangarei Heads	Option 5 Ocean Discharge and relocate Whangarei WWTP	Option 6 Ocean Discharge and Whangarei WWTP pump to ocean	Option 7 Land-based discharge (dry weather) with Existing WWTP site	Option 8 Supplemented with Reuse	Option 9 Deep Bore Injection / Existing WWTP Site	Option 10 Lower Harbour Discharge from Existing WWTP Site
	Potential future NES may stipulate further upgrades and pushes into Option 2		Network reticulation changes, odour and septicity issue	WWTP, increase operation complexity	New location for WWTP, and sludge trucks between WH and landfill		Increase operation complexity	Additional operation complexity	Significant increase in operation complexity	

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2 Long List Options

This section presents a high level description of the long list options and common assumptions made during this assessment. Further information for each option is also provided in the supporting Stakeholder Long-List Options workshop powerpoint presentation (refer to Appendix 1).

2.1 Common Assumptions

2.1.1 Population Growth

The current WDC population connected to the Whangarei WWTP is 65,000. The WDC population forecast predicts from 2018 up to 2051, however, to allow for a 35 year consent, we have linearly extrapolated the population forecast to 2056. This provides an estimated population of 95,000 EP in 2056 for the current Whangarei WWTP catchment (~46% growth predicted).

We have considered two satellite plant options in the long list, North Whangarei and Whangeri Heads.

The potential satellite plant for North Whangarei (including the entirety of: Hikurangi-Springs Flat, Kamo East, Three Mile Bush, Tikipunga North) is then predicted to have a population of 27,900 EP in 2056, thus catering for a large percentage of the growth predicted.

The potential satellite plant for Whangarei Heads (including the entirety of: Parua Bay, Patua – Whareroa – Bream Head) is then predicted to have a population of 7,600 EP in 2056, thus catering for a small percentage of the growth predicted.

2.1.2 Inflow and Infiltration (I&I) Reduction

For the purposes of the long list and short list options comparison, future flows are based on linear extrapolation of existing flows with population growth, as network modelling is still underway with a draft report detailing the outcome of the network modelling expected at the end of November 2020.

Flow estimates will be revised to incorporate the latest network modelling results and I&I data, for use in the shortlisted options evaluation or concept design. This is likely to affect the peak flow treatment requirements.

2.1.3 Current and Future Wastewater Flows

From the population growth and I&I reduction assumptions described above, Tables 2, 3, and 4 below present the estimated current and future wastewater flows for Whangarei WWTP and the two possible satellite plants. Whangarei WWTP flows also include trucked waste, carrying across the current percentage of 0.8% increase in plant inflow.

For the satellite plants mentioned below, the following areas were included in the population estimations as advised by WDC (email, 17/09/2020):

- North Whangarei: Hikurangi – Springs Flat, Kamo East, Three Mile Bush, Tikipunga North
- Whangarei Heads: Parua Bay, Patua – Whareroa – Bream Head

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Table 2 Current and Future Wastewater Flows – Whangarei WWTP

	2020/Current	2051	2056
Population	65,000	91,000	95,000
Average Daily Flow (m^3/day)	18,491	25,908	27,025
Maximum Daily Flow (m^3/day)	99,703*	139,584	145,720
% Average Daily Wastewater Flow Increase	N/A	40%	46%

** We have not included the recent 1 in 500 year storm event, resulting in excess of 140ML/d. This was significantly higher than the next higher flow event of 100 ML/d.*

Table 3 Current and Future Wastewater Flows – North Whangarei (Satellite Plant) and Whangarei WWTP Split

	2020/Current	2051	2056
Population connected to **North Whangarei WWTP**	16,327	26,211	27,889
Average Daily Flow (m^3/day)	4,645	7,456	7,934
Maximum Daily Flow (m^3/day)	25,044	40,205	42,779
% WW flow Increase	N/A	61%	71%
Population connected to **Whangarei WWTP**	48,673	64,789	67,111
Average Daily Flow (m^3/day)	13,846	18,452	19,091
Maximum Daily Flow (m^3/day)	74,659	99,379	102,941
% Average Daily WW flow Increase	N/A	33%	38%

Table 4 Current and Future Wastewater Flows – Whangarei Heads (Satellite Plant) and Whangarei WWTP Split

	2020/Current	2051	2056
Population connected to **Whangarei Heads WWTP**	5,531	7,328	7,606
Average Daily Flow (m^3/day)	1,573	2,085	2,164
Maximum Daily Flow (m^3/day)	8,484	11,240	11,667

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	2020/Current	2051	2056
% Average Daily WW flow Increase	N/A	33%	38%
Population connected to **Whangarei WWTP**	59,469	83,672	87,394
Average Daily Flow (m^3/day)	16,918	23,823	24,861
Maximum Daily Flow (m^3/day)	91,219	128,344	134,053
% Average Daily WW flow Increase	N/A	41%	47%

2.1.4 Estimation of Future Discharge Quality for Limeburner Creek

For the purpose of this long list options comparison, the current nitrogen (TN) and phosphorus (TP) mass loads in the plant effluent have been estimated using the limited number of TN and TP samples taken from the wetland influent sampling point, and correlating flows measured through the normal flow UV system. The mass loads were then used to estimate future discharge quality based on the assumption of maintaining the mass loads at the plant outlet.

It is recommended these treated effluent nitrogen and phosphorus concentrations and loading are reviewed following implementation of the updated sampling programme (commenced mid-October) to provide a more comprehensive and up-to-date benchmark of current plant effluent loads. A review of these plant loads will be undertaken as part of the concept design/master plan, around January 2021.

WDC to note that the nitrogen and phosphorus mass loads are critical assumptions for establishing the future discharge quality requirements. Therefore, figures are to be reviewed after more sampling data is collected.

Current Nitrogen Loads at WWTP Outlet

The data ranges from January 2018 (first available UV flow measurements) to October 2019 (last available TN measurements), with 12 data points in total.

- Current treated effluent (pre-wetland) TN concentration – 28.3 mg/L.
- Current TN load (based on ADF of 18,098 m^3/day through normal flow UV during TN sampling periods) – 573.8 kg/day

Current Phosphorus Loads at WWTP Outlet

The data ranges from January 2018 (first available UV flow measurements) to July 2018 (last available TP measurements), with 4 data points in total.

- Current treated effluent (pre-wetland) TP concentration – 3.3 mg/L
- Current TP load (based on ADF of 17,452 m^3/day through normal flow UV during TP sampling periods) – 51.3 kg/day

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Anticipated Treated Effluent Quality for Discharge to Limeburners Creek

For estimating the treated effluent quality required for discharge to Limeburners Creek, it is assumed that the current mass loads for TN and TP are maintained.

Table 5 Anticipated Treated Effluent Quality for Discharge to Limeburners Creek

	2020/Current	2051	2056
Average Daily Flow (m^3/day)	18,491	25,908	27,025
Average TN Concentration (mg/L)	31.0	22.1	21.2
Average TN Mass Load (kg/day)	574	574	574
Average TP Concentration (mg/L)	2.8	2.0	1.9
Average TP Mass Load (kg/day)	51	51	51

The long-listed plant upgrade options are intended to achieve the median TN and TP of 20 and 2 mg/L respectively.

WDC to note that future National Environmental Standards may stipulate a higher quality of plant discharge requirement, for example, the median nitrogen and phosphorus concentration limits could be 5 mgN/L and 1 mgP/L respectively based on indications given in recent reporting by the Department of Internal Affairs. This will be accounted for in the master planning stage for future treatment system expansion, for example Option 2 can be designed to achieve more stringent nitrogen limits than Option 1.

2.1.5 Irrigation Area Required for Land Based Discharge Options

For estimating the land area and the treated effluent nitrogen concentrations required for application to land, a weekly loading of 25 mm/week and a nitrogen loading rate of 150 kgN/ha/year were assumed initially. The estimated ADF for 2056 was also used, for Option 7.

For Option 3, North Whangarei Satellite Plant, there is also the assumption that wet weather flow will be stored on site.

Example land based discharge calculations for the current (2020) ADF, with full discharge to land, all year round:

$$ADF\ (2020) = 18{,}491\ \frac{m^3}{day} = 18{,}491{,}000\ \frac{L}{day}$$

$$Areal\ loading\ rate\ = 25\ \frac{mm}{week}\ = 0.0036\frac{m}{day}$$

$$Land\ required\ = \frac{18491}{0.0036} = 5177480\ m^2\ = 517.7\ ha$$

$$N\ loading\ rate\ = 150\ \frac{kgN}{ha\ \times year}$$

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$$N\ loading\ rate\ =\ 150\ \frac{kgN}{ha\ \times year} \times 517.7\ ha\ = 77662.2\ \frac{kgN}{year} = 212.77\ \frac{kgN}{day}$$

$$Required\ N\ concentration\ in\ effluent\ = \frac{212.77}{18491000} \times 1000000\ \frac{mg}{kg} = 11.51\ \frac{mgN}{L}$$

As seen from this calculation, the plant upgrade for the land-based discharge options will have to achieve a median TN of 11.5 mg/L.

The acceptable phosphorus loading on land will be specific to the type of soil of the irrigation site, hence we recommend a detailed desktop review will be carried out if any of the land-based discharge options are carried forward.

Table 6 Anticipated Treated Effluent Quality for Option 7 Land Based Irrigation – All Year Round

	2020/Current	2051	2056
Average Daily Flow (m^3/day)	18,491	25,908	27,025
Area (ha)	518	725	757
Average TN Concentration (mg/L)	11.5	11.5	11.5
Average TN Mass Load (kg/ha/year)	150	150	150
Average TP Concentration (mg/L)	TBC	TBC	TBC
Average TP Mass Load (kg/ha/year)	*Require soil characteristic data*		

Potentially High Hydraulic Application Rate for Summer-only Irrigation

The hydraulic application rate can potentially be noticeably higher if aiming for a summer-only irrigation scenario. For instance, the example calculation is based on 50 mm/week potentially for future reuse, e.g. Option 8. Nevertheless, this higher hydraulic application rate will need to be verified to avoid exceeding the soil hydraulic and nutrient capacity if carried into the shortlisted option phase.

Example land based summer discharge calculations for a nominal 100 ha irrigation area in 2056:

$$ADF\ (2026) = 27{,}025\ \frac{m^3}{day} = 27{,}025{,}000\ \frac{L}{day}$$

$$Areal\ loading\ rate\ = 50\ \frac{mm}{week}\ = 0.07\frac{m}{day}$$

$$50ha\ of\ land\ Land\ can\ treat\ =\ 1{,}000{,}000\ m^2 \times 0.07\ \frac{m}{day}\ = 7{,}000\ m3/day$$

$$Flow\ \%\ to\ land = \frac{7{,}000}{27{,}025}\ = 26\%$$

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During the winter months, the hydraulic application rate would drop to a similar level as described in the all-year-round irrigation scenario (Option 7).

2.2 Long List Options Description

Refer to Workshop PowerPoint presentation for Long List Options Description, in Appendix 1.

3 Long List Options Workshop (22nd October)

A Long List Stakeholder Workshop was held on 22nd October 2020 at the Whangarei WWTP, with the intention of explaining the background of the existing plant (including population growth, flow increase, receiving environment), leading into a discussion of the long list options and an Multi-Criteria Assessment (MCA) scoring applying weighted criteria discussed in Section 1 above.

Attendees included representatives from the Department of Conservation (DOC), Northland District Health Board (NDHB), local Iwi, Northland Fish and Game (F&G), WDC, and GHD, with apologies from Northland Regional Council (NRC) and Forest and Bird.

During the workshop, Option 8 was modified to include more reuse opportunities, including parks/gardens, industrial, and plantation applications in addition to wetland discharge (as opposed to the original suggestion of 100 ha land-treatment).

The participants agreed to streamline the shortlisting process with a critical flaw analysis based on feedback from the stakeholders. The unsuitable options were then removed, and have been summarised in Table 7.

Key points raised in the workshop by stakeholders include:

- General concerns over water quality standards not being improved enough – less concern over discharge location, more concern around water quality
- Need to see more longer view e.g. 50 years of the treatment plant rather than limited to the consent length of 35 years, and consider aspiration values for wastewater.
- Carter Holt Harvey site adjacent and north of the site may be available for sale.
- Monitoring of the effectiveness of the offload sites
- a Cultural Values Assessment
- Consideration given to what other iwi groups may need consulting within the event one of the satellite schemes and/or alternative discharge locations are pursued.
- Mixed Model options consideration
- .Aspirational goal for enhanced water quality in receiving environment and greater clarity sought on how each option can address this goal. A longer term view to be taken (100 years) with regard to options on the table, although concern raised over 35-year consent term and stakeholder involvement through a more adaptive management approach.
- Strong support for reuse and recycling, especially in light of water scarcity/drought last year.

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- Greater focus given to source control (water use efficiencies) and network I/I reduction to reduce flows to the plant.

Following the workshop, a discussion amongst the project team highlighted the following matters that require further work:

- Clarification on what each option can deliver in terms of discharge quality and thus load reduction to achieve/maintain the Proposed Northland Regional Plan (PNRP) water quality standards in the Hatea River and/or achieve a net improvement (enhancement).
- Clarification of the difference in costs between upgrading the plant (option 1) versus a complete change in process (option 2) to address the potentially more stringent NES limits (yet to be defined).
- Further exploration of solids waste/biosolids management required as the wastewater treatment plants are gradually being viewed as a resource recovery facility (e.g. producing reclaimed water from the treatment process, energy from biosolids and organic food waste and soil conditioner from digested biosolids).
- Confirmation on whether further odour sampling is necessary to support the consent application (it is noted Green Fingers Garden Waste company has raised a recent odour complaint).

Both the Workshop PowerPoint presentation and the minutes are included as Appendix 1.

4 Option Evaluation

The below table shows the long list options, with their scoring and reasoning as to why several options were ultimately excluded from being scored. For more detail, refer to the MCA evaluation sheet in Appendix 2.

Table 7 MCA scoring and option evaluation

No.	Option title	MCA scoring	Carry forward?
1	Existing Discharge - Plant Expansion	2	Yes
2	Existing Discharge - Process Intensification	1	Yes
3	Existing Discharge plus a Satellite Plant (Nth Whangarei)	-	No, considered difficulty to complete the necessary investigations within the pre-consent timeframe. Could be investigated as part of future consent review and may not be limited to North Whangarei.
4	Existing Discharge plus a Satellite Plant (Whangarei Head)	-	No, fatal flaw – caters for small flow only and increased complexity.

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No.	Option title	MCA scoring	Carry forward?
5	Ocean Discharge - Relocate Whangarei WWTP	-	No, significant hurdles associated with consent and construction of pipeline and outfall.
6	Ocean Discharge - Existing WWTP and pump to ocean	-	No, significant hurdles associated with consent and construction of pipeline and outfall although could be investigated as part of future consent review in line with Ruakaka WWTP upgrades.
7	Land-based Discharge (dry weather) - Existing WWTP site	-	No - fatal flaw around land availability and land costs but could be investigated as part of future consent review.
8	Existing Discharge supplemented with reuse and/or partial summer land-based discharge regime.	3	Yes
9	Deep Bore Injection - Existing WWTP site	-	No - fatal flaw around aquifer impact, aquifer recharge necessity, cost, and consent uncertainty.
10	Lower harbour discharge - Existing WWTP	-	No - fatal flaw around no/lack of support from Tangata whenua.

5 Next Steps

As agreed with WDC at a teleconference held on 3rd November 2020, GHD will continue the BPO assessment via an Adaptive Pathways Planning approach ("Adaptive Pathways"). An Adaptive Pathways approach will enable WDC to frequently review upgrade options for the Whangarei WWTP through consideration of a number of key drivers such as:

- Plant asset capacity limitations.
- Plant asset age and condition.
- Legislative changes such as new NES standards.
- Community aspirations and/or climate change necessity fornon-potable reuse opportunities.
- Other climate change factors (sea level rise / flooding).
- Flexibility to continue exploration of satellite scheme/ocean outfall/land application options.
- Regional solids waste and biosolids management strategy

An Adaptive Pathways approach provides greater flexibility and long-term view to optioneering infrastructure solutions in a rapidly changing environment and minimises Councils risk to locking into options that could become redundant in years to come. The first step of this approach would involve

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a follow-up stakeholder workshop in November, to identify and agree the key drivers for the WWTP master plan consideration. This will be followed with an options assessment and determination of trigger points for various plant improvements.

Appendices

Appendix 1 – Long List Options Powerpoint for Workshop

Appendix 2 – Long List Options MCA Evaluation Sheet

6 Limitations

This report: has been prepared by GHD for Whangarei District Council and may only be used and relied on by Whangarei District Council for the purpose agreed between GHD and the Whangarei District Council as set out in section 1 of this report.

GHD otherwise disclaims responsibility to any person other than Whangarei District Council arising in connection with this report. GHD also excludes implied warranties and conditions, to the extent legally permissible.

The services undertaken by GHD in connection with preparing this report were limited to those specifically detailed in the report and are subject to the scope limitations set out in the report.

The opinions, conclusions and any recommendations in this report are based on conditions encountered and information reviewed at the date of preparation of the report. GHD has no responsibility or obligation to update this report to account for events or changes occurring subsequent to the date that the report was prepared.

The opinions, conclusions and any recommendations in this report are based on assumptions made by GHD described in this report. GHD disclaims liability arising from any of the assumptions being incorrect.

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Whāngarei WWTP – Long List Options Workshop

22nd October 2020, 10:00am – 1:00pm
Whāngarei WWTP

Agenda

10.00 am	Welcome and introductions
10.10 am	Programme
10.20 am	Background – existing plant, population growth, flow increase
10.45 am	Long list options
11.15 pm	Break
11.30 pm	Discussion of assessment of long list options
12.45 pm	Next steps
1.00 pm	Close

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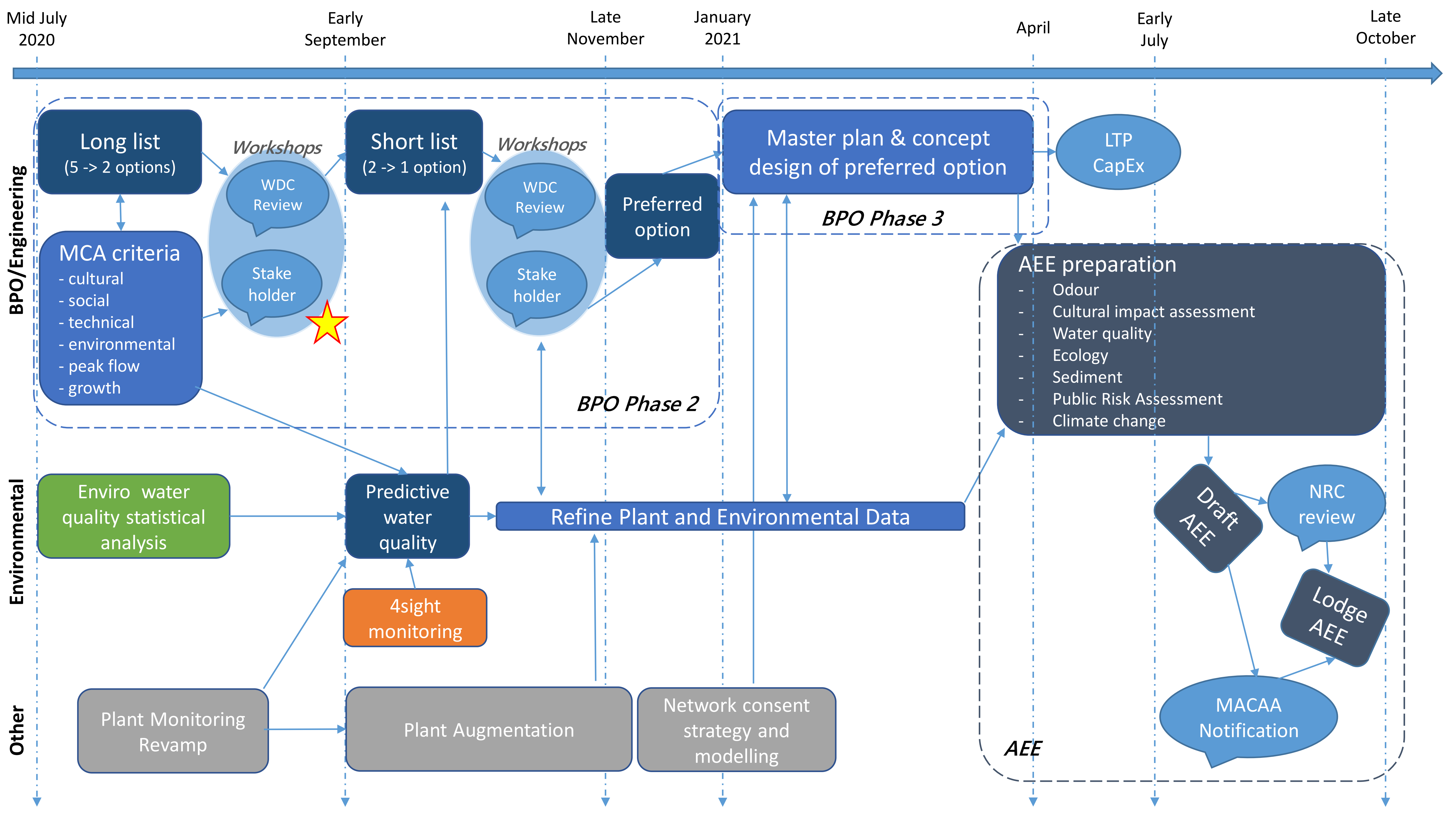
Welcome and Introductions

Purpose and Desired Outcome of workshop

Programme to Consent Lodgement (July 2020)

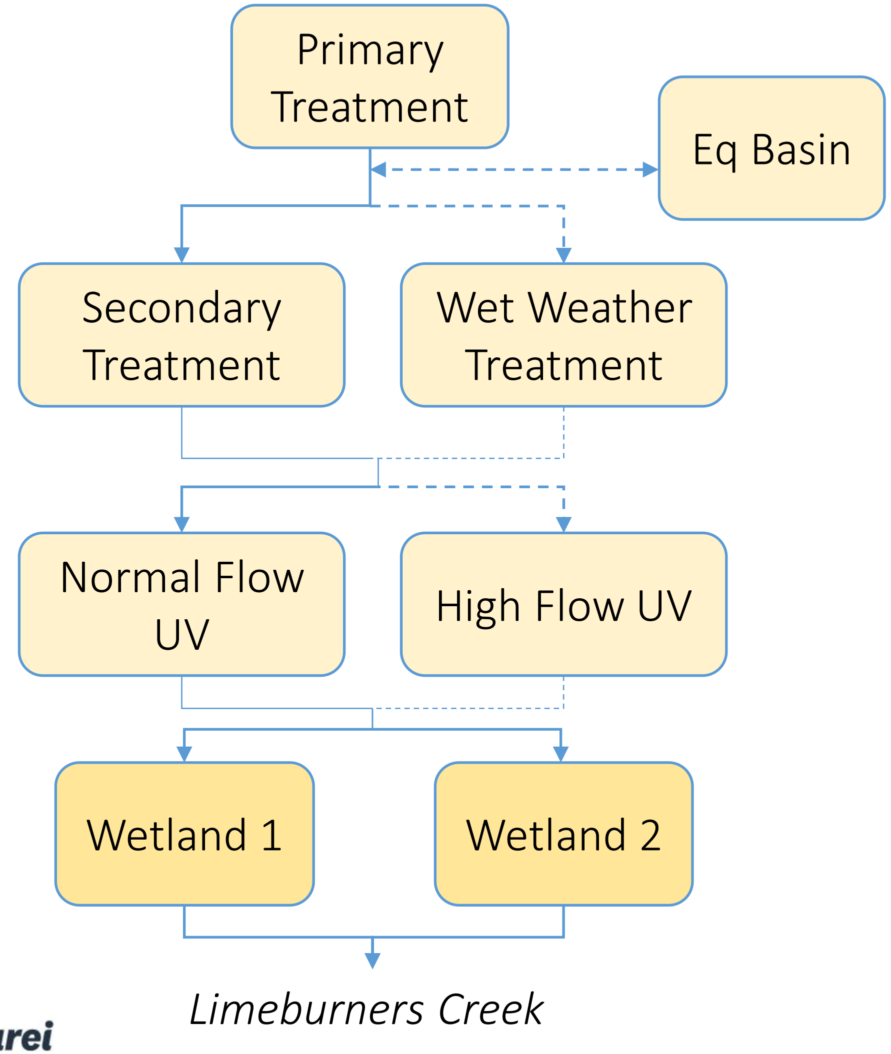


Mid July 2020
Early September
Late November
January 2021
April
Early July
Late October
BPO/Engineering
Long list
(5 -> 2 options)
Workshops
WDC Review
Stake holder
Short list
(2 -> 1 option)
Workshops
WDC Review
Stake holder
Preferred option
Master plan & concept design of preferred option
LTP CapEx
BPO Phase 3
MCA criteria
- cultural
- social
- technical
- environmental
- peak flow
- growth
BPO Phase 2
AEE preparation
- Odour
- Cultural impact assessment
- Water quality
- Ecology
- Sediment
- Public Risk Assessment
- Climate change
Environmental
Enviro water quality statistical analysis
Predictive water quality
Refine Plant and Environmental Data
4sight monitoring
Draft AEE
NRC review
Lodge AEE
Other
Plant Monitoring Revamp
Plant Augmentation
Network consent strategy and modelling
MACAA Notification
AEE

Existing Treatment Plant, Growth Forecast and Receiving Environment


Whangarei i-SITE Visitor Information Centre
Anzac Rd
Morningside Rd
Morningside Rd
Anzac Park
High St
High St
PORT WHANGAREI
PlaceMakers Whangarei
Habitat for Humanity (Northland)
Kioreroa Rd
The PBT Group - Whangarei
Renovation Warehouse
Kioreroa Rd
SPCA Whangarei Centre
Alter-Natives Nursery & Landscaping
Kioreroa Rd
Wrack Auto Electrical
South End Ave
Re:Sort
Gumdigger Pl
Rewa Rewa Rd
Toll New Zealand
Keith Andrews Trucks Whangarei
New Zealand Couriers
Bidfood
Northland Parts Warehouse

Existing plant

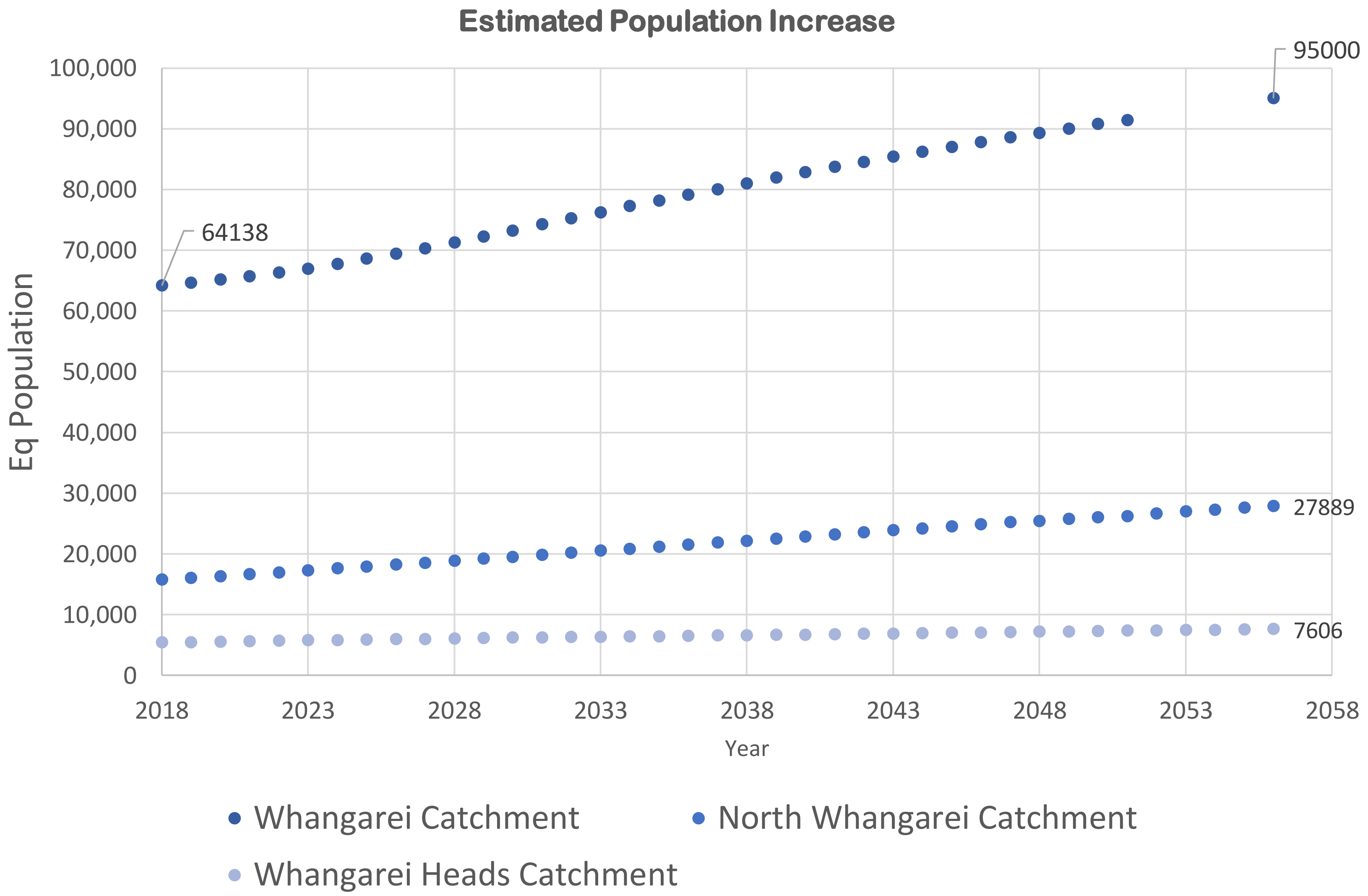


Predicted population growth

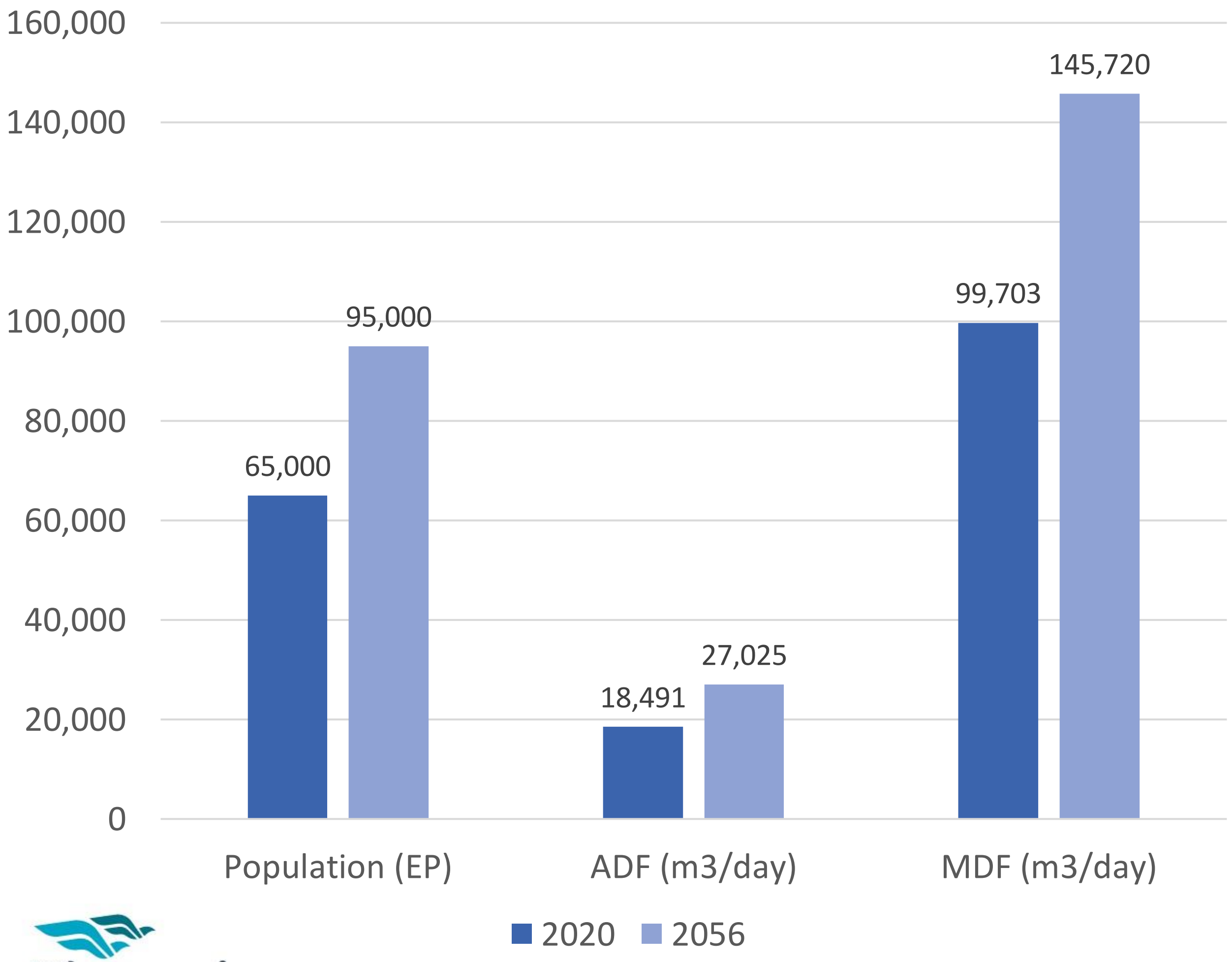
WDC seeks 35 years resource consent, extrapolating population forecast between 2018 and 2051, to 2056

Potential satellite schemes:

- North Whangarei
- Whangarei Heads



Plant flows – Whāngarei WWTP



Whāngarei catchment

46% increase in flow from 2020 to 2056

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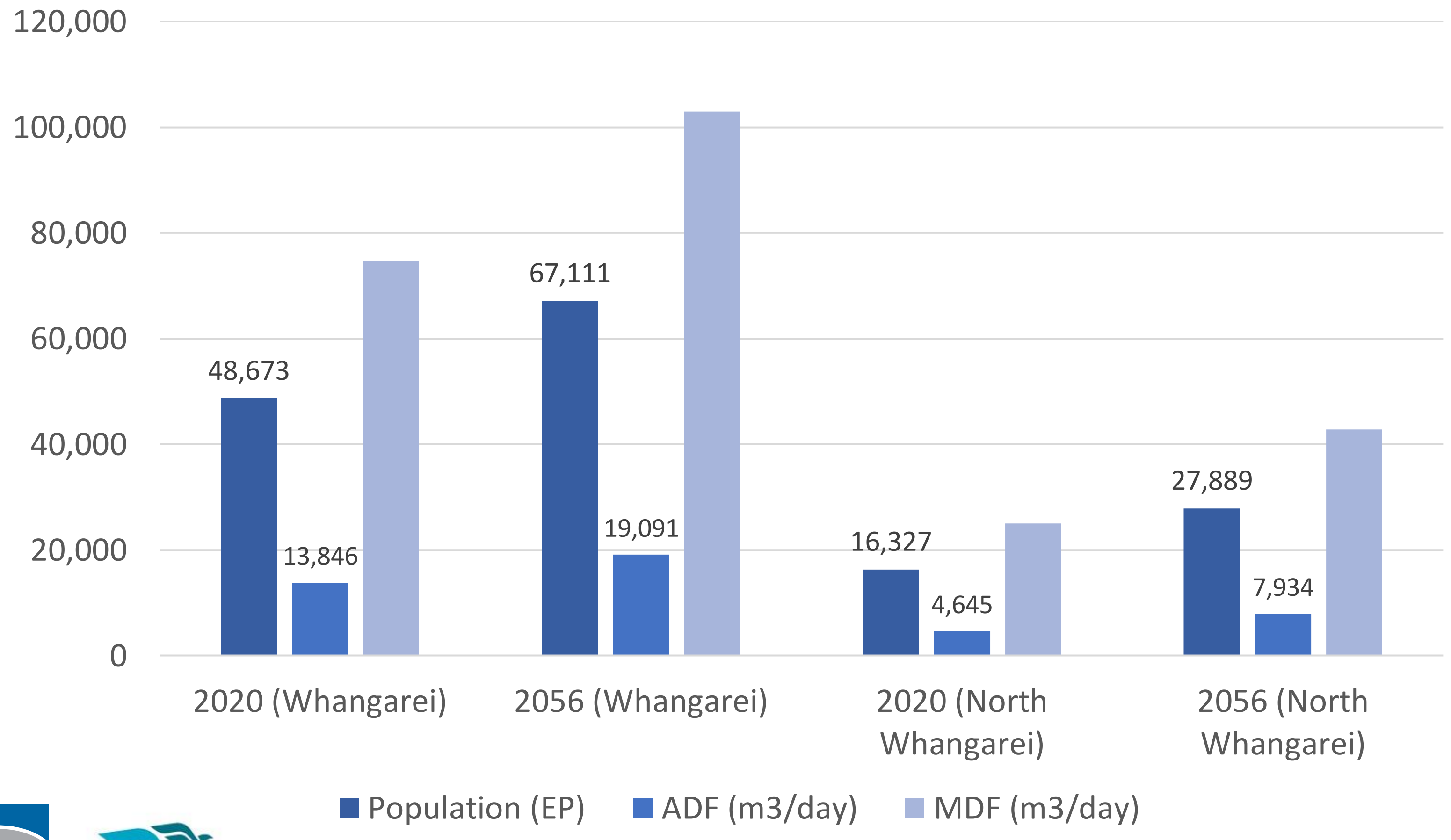
Plant flows – North Whāngarei (Satellite) and Whāngarei WWTPs



Whāngarei WWTP - 38% increase in flow from 2020 to 2056

North Whāngarei Satellite WWTP - 71% increase in flow from 2020 to 2056

Diverted 30% of flow to North Whangarei scheme

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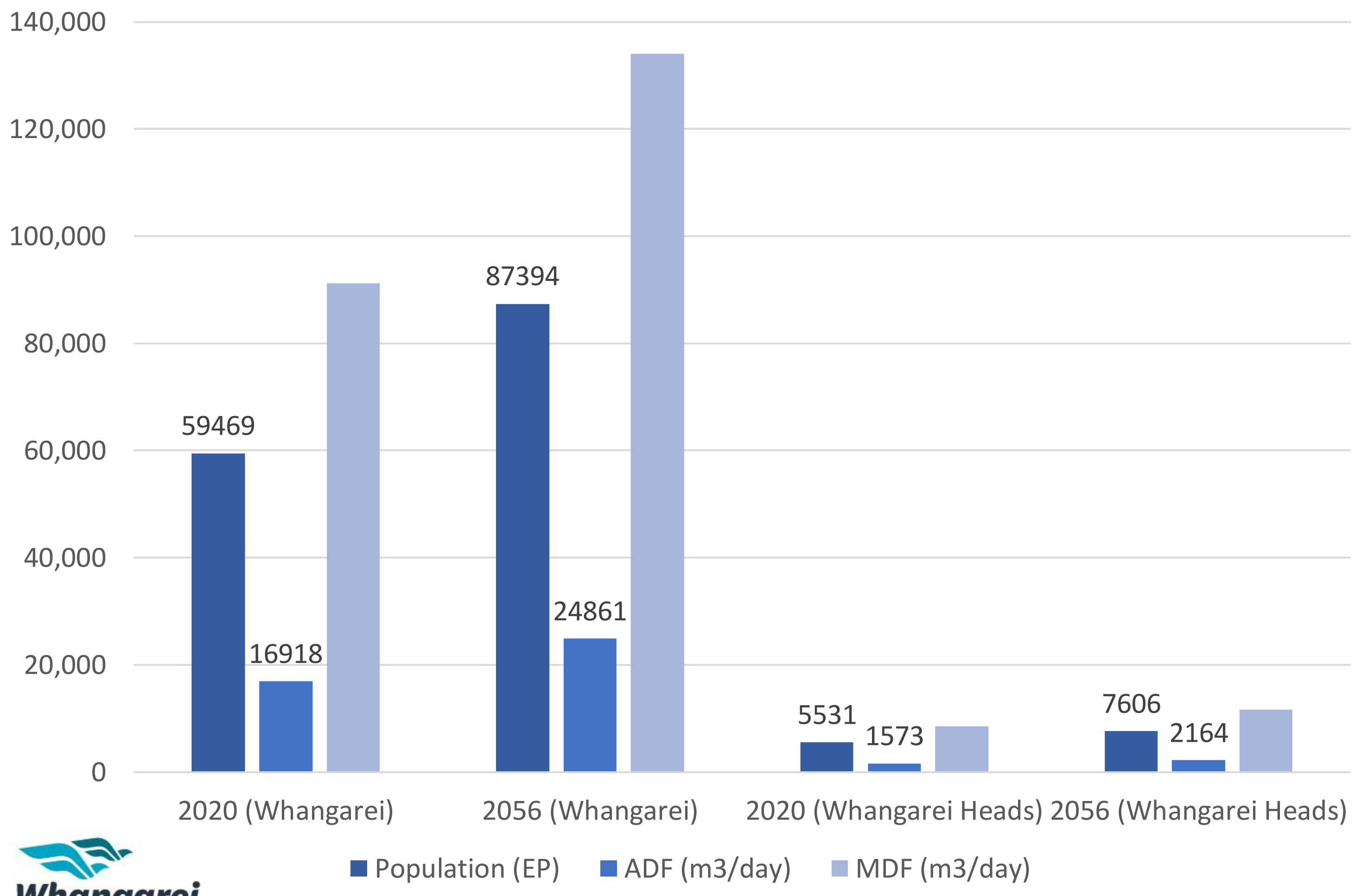
Plant flows – Whāngarei Heads (Satellite) and Whāngarei WWTPs



Whāngarei WWTP, 47% increase in flow from 2020 to 2056

Whāngarei Heads Satellite WWTP, 38% increase in flow from 2020 to 2056

Diverted 8% of flow to Whangarei Heads scheme

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Existing plant – capacity summary

- Light loading
- Possible future capacity issue
- No/little extra capacity

Wastewater Treatment	Current capacity
Inlet works	
Primary clarifiers	
Trickling filters	
Anoxic selector	
Activated sludge basin	
Secondary clarifiers	
Normal flow UV	
Trickling filters	
Storm clarifiers	
High flow UV	

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Receiving environment

- Two wetlands, numerous cascades into the Limeburners Creek, then to Hatea River.
- The creek is influenced by urban activities, hence generally not known for swimming and shellfish gathering.
- Higher contribution of nutrients into the Hatea River during summer.

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Long List Options

Long List Options Summary

1. Upgrade Existing Plant, Same Discharge
2. Process Intensification, Same Discharge

One Treatment Plant, Same Receiving Environment

3. Satellite Scheme for Northwest area

4. Satellite Scheme for Whangarei Head area

Satellite Scheme Alternatives

5. Relocate Whangarei WWTP, discharge to lower harbour

6. Upgrade Existing Plant, pump to ocean outfall

10. Upgrade Existing Plant, pump to lower harbour for discharge

7. Dry Weather land-based discharge

8. Partial dry weather land-based discharge

9. Deep Bore Injection

Alternative receiving environment

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1) Plant expansion, existing discharge

Option Description and Treatment Process:	Additional capacity of Peak Flow treatment, Primary clarifiers and second AS basin, filter/UV system Additional Biosolids capacity
Discharge Method and Location:	Existing wetlands (100%) then to the Limeburners Creek

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2) Process intensification, existing discharge

Option Description and Treatment Process:	Additional Peak Flow Treatment, Primary clarifers, filter/UV system, Secondary Treatment may involve conversion of AS Basin into Membrane Bioreactor (MBR) or Membrane Aerated Biofilm Reactor (MABR) Additional Biosolids capacity
Likely Discharge Method and Location:	Existing wetlands (100%, excluding wet weather flow to Limeburners)

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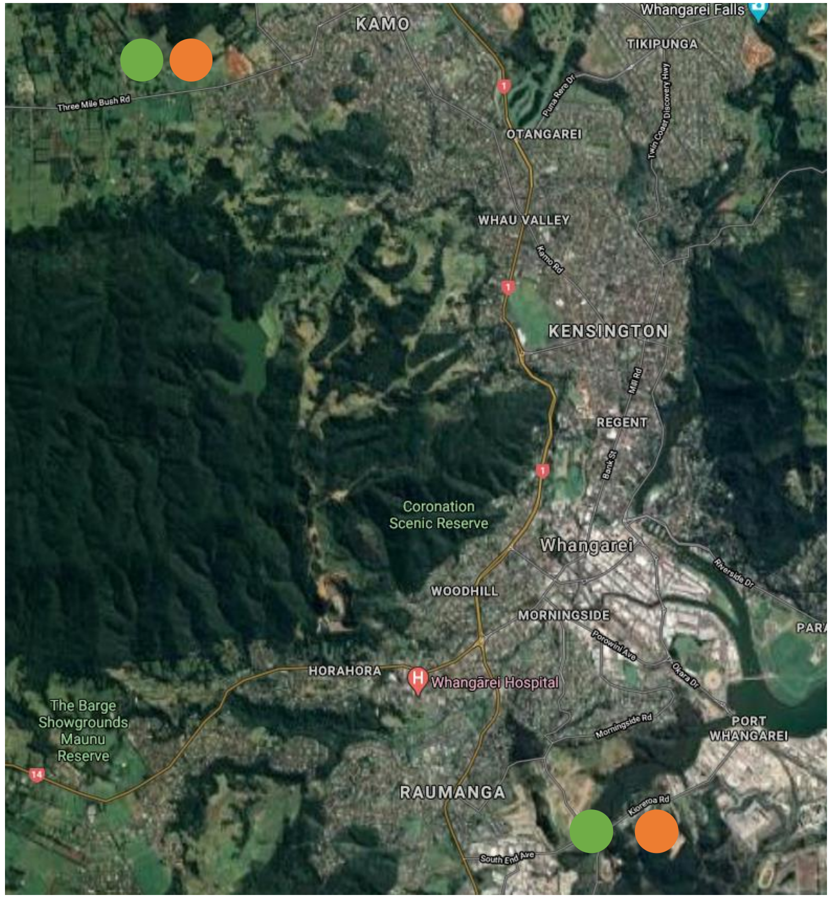
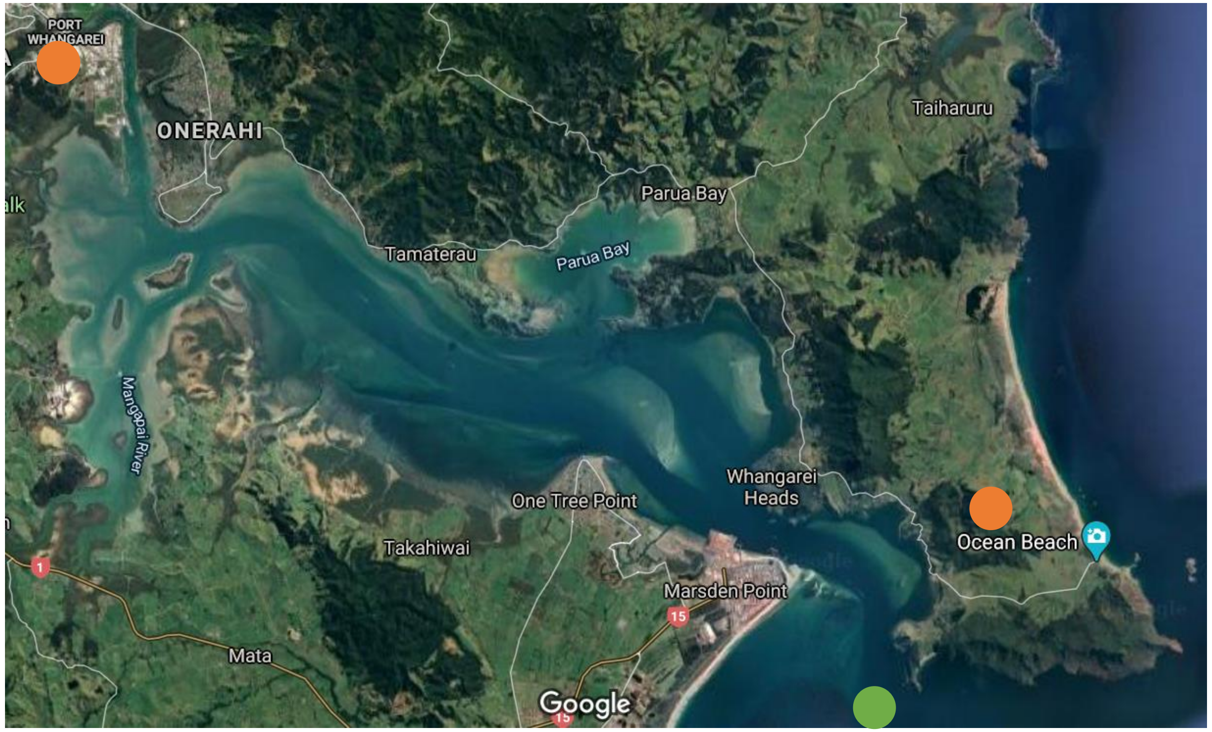
3) Existing site, North Whāngarei satellite plant



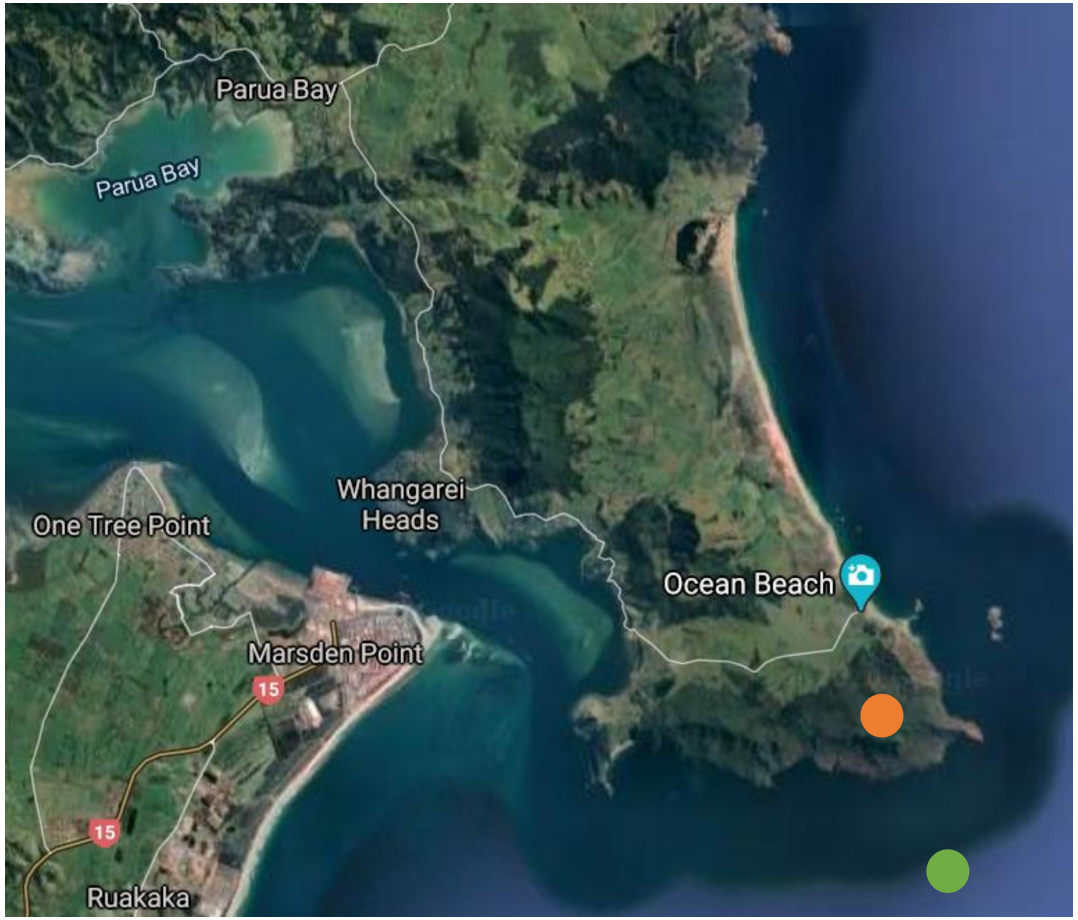
🟠	**Option Description and Treatment Process:**	New satellite scheme for Northwest catchment, built over the next 10 years Upgrade current Whangarei WWTP like Option 1, with smaller flow increase Centralised biosolids management
🟢	**Likely Discharge Method and Location:**	Northwest WWTP treated effluent to land-based discharge (~200ha) with a storage pond Existing Whangarei WWTP – continue with wetlands and into the Limeburners Creek

4) Existing site, Whāngarei Heads satellite plant



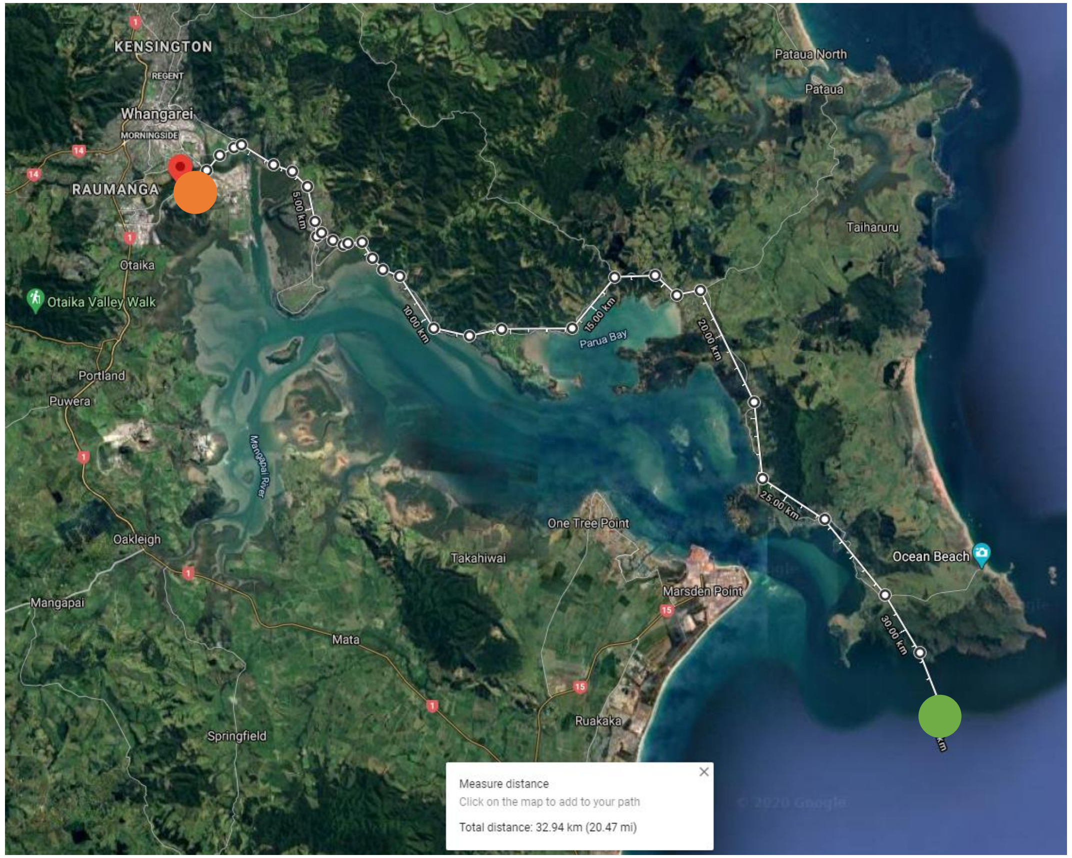
Option Description and Treatment Process:	New scheme for Whangarei Head Upgrade current Whangarei WWTP like Option 1, with smaller flow increase Centralised biosolids management
Likely Discharge Method and Location:	Main WWTP continues to discharge into wetlands then into the Limeburners Creek Whangarei head WWTP treated effluent to lower harbour outfall (2.1 ML/d in 2056)

5) Relocate plant, ocean discharge



Option Description and Treatment Process:	Relocate WWTP to Whangarei Head, comprising new primary, secondary and tertiary treatment with new biosolids facilities.
Likely Discharge Method and Location:	New ocean outfall (100% flow)

6) Plant expansion, ocean discharge



🟠	**Option Description and Treatment Process:**	Upgrade current Whangarei WWTP like Option 1, except tertiary filtration may not be required.
🟢	**Likely Discharge Method and Location:**	New rising main 33km for 100% flow to Whangarei Head New ocean outfall

7) Plant expansion, land based discharge

Land based discharge site TBD

Option Description and Treatment Process:	Upgrade current Whangarei WWTP like Option 1
Likely Discharge Method and Location:	New land based discharge (100% ADF), 760ha Wet weather flow discharged to wetland then to Limeburners Creek

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8) Plant expansion, partial land based discharge

Land based discharge site TBD

Option Description and Treatment Process:	Upgrade current Whangarei WWTP like Option 1
Likely Discharge Method and Location:	New land based discharge (nominal 100ha, ~13% ADF, higher in summer) Remaining to existing wetlands and Limeburner Creek

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9) Plant expansion, deep bore injection

Option Description and Treatment Process:	Capacity upgrade at Whangarei WWTP, followed by Advanced WTP (e.g. MF/RO) as required
Likely Discharge Method and Location:	Deep bore injection (100% treated effluent)

Deep bore injection site TBD

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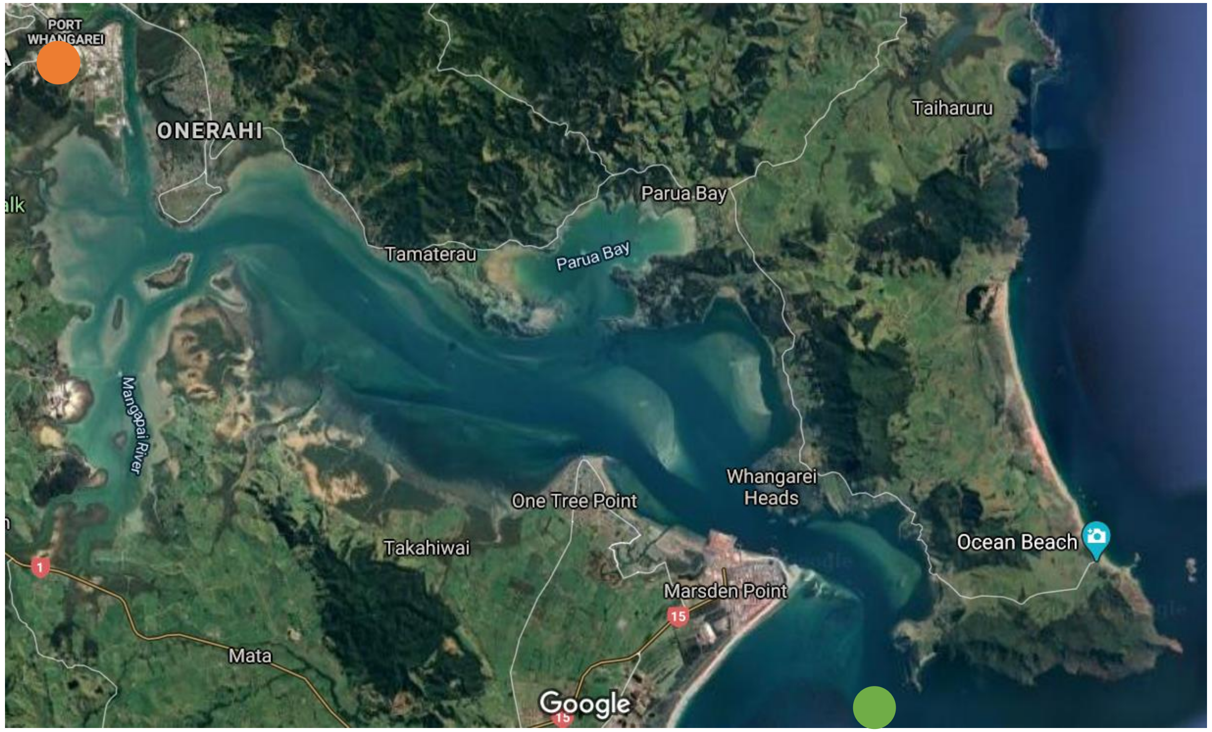
10) Plant expansion, lower harbour discharge



Option Description and Treatment Process:	Upgrade current Whangarei WWTP like Option 1
Likely Discharge Method and Location:	New rising main 30km for 100% flow to Whangarei head area New lower harbour outfall

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Scoring Long List Options

MCA assessment criteria

Investment objectives

- Consentability (long term consent)
- Enhanced health and environmental outcomes
- Community affordability
- Operation robustness, efficiency and reliability

Environmental/ cultural/ social factors

- Impact on Limeburner creek and upper harbour quality
- Impact on groundwater quality
- Impact on adjacent land use options
- Cultural acceptability
- Community acceptability

Critical success factors

- Consenting pathway
- Constructability
- Long term flexibility
- Risk factors

Long list scoring

5	*Strongly meets the criteria in all respects*
4	*Meets the criteria in most respects*
3	*Only partly meets the criteria*
2	*Does not meet the criteria*
1	*Fails to meet and is contrary to the criteria*
0	*Fatal Flaw*

All options will be scored against this same set of criteria, for an objective evaluation of benefits, risks and challenges.

Next steps

1. Refine the Shortlisted Options
2. Determine further investigations for shortlisted options evaluation
3. Shortlisted Options evaluation
   - Further details for constraints identification
   - Planning / consent assessment
   - Layout / Schematics
   - Cost estimates

WHANGAREI LONG LIST MCA

Scoring	
5	Strongly meets the criteria in all respects
4	Meets the criteria in most respects
3	Only partly meets the criteria
2	Does not meet the criteria
1	Fails to meet and is contrary to the criteria
0	Fatal Flaw

Option title	Weight	Score	Option 1 - Existing Discharge - Plant Expansion	Score	Option 2 - Existing Discharge - Process Intensification	Score	Option 3 - Existing Discharge plus a Satellite Plant (Nth Whangarei)
Option description			Keep the existing discharge at Limeburners Creek, with installing additional treatment tanks		Keep the existing discharge at Limeburners Creek, with intensifying existing process through MBR or MABR		Keep the existing discharge at Limeburners Creek, and construct a satellite plant in North Whangarei with land disposal
Number of WWTPs			1		1		2
Receiving environment - main WWTP			Limeburners Creek (100%) via wetlands		Limeburners Creek (100%) via wetlands		Limeburners Creek (100%) via wetlands
Receiving environment - satellite WWTP			N/A		N/A		Land (100%) with storage
CapEx Range/Order			High		High		Very High
Investment objectives	**Weight**	**Score**		**Score**		**Score**	
Consentability - long term consent	20%	5	Baseline	5	Same as Option 1	3	More complex related to two facilities and two discharge permits. Satelite plant location needs detailed investigation, carries more uncertainty.
Enhanced health and environmental outcomes	30%	3	Baseline - Tangata Whenua keen to see higher discharge standards	4	Same discharge environment as 1. More effective removal of E coli and TSS than 1. Likely equivalent phosphorus removal as 1.	4	This satellite plant reduces 30% of ADF and loads to Limburners Creek than Option 1. However, there is some degree of uncertainty about land application around the satellite plant, which will be a state of the art facility.
Community affordability	25%	4	Baseline	3	Likely more expensive for MABR/MBR retrofit, requires reprogramming scada, retrofitting clarifiers, etc. There are some hidden costs like . more time for operator to get used to new configuration. 1 and 2 will be cheaper than all other costs, so to keep score not drop score too low.	1	Likely to be significantly more expensive than Option 1
Operation robustness, efficiency and reliability	25%	3	Possible issues with space, if putting additional treatment options - will be tight. If pop grows too much, may not be able to have the space on site	3	More space for expansion, new state of the art technology	2	Additional management of second plant. Although replacing Hikurangi (so replacing or enhancing a plant). New system requires integration with scada etc.

Option title	Score	Option 4 - Existing Discharge plus a Satellite Plant (Whangarei Head)	Score	Option 5 - Ocean Discharge - Relocate Whangarei WWTP	Score	Option 6 - Ocean Discharge - Existing WWTP and pump to ocean	Score	Option 7 - Land-based Discharge (dry weather) - Existing WWTP site
Option description		Keep the existing discharge at Limeburners Creek, and construct a satellite plant in Whangarei Head with ocean outfall		Move the Whangarei WWTP to a site in Whangarei Head, and discharge to ocean, east of Whangeri Head		Keep the Whangarei WWTP at the existing site, and pump to a ocean outfall, east of Whangarei Head		Stop discharging effluent into the Limeburners Creek in dry weather, and pump to irrigation site suitable for full flow. Wet weather discharged to Limeburner's Creek via wetlands
Number of WWTPs		2		1		1		1
Receiving environment - main WWTP		Limeburners Creek (100%) via wetlands		Ocean (100%), east of Whangarei Head		Ocean (100%), east of Whangarei Head		100% ADF to land Excess to wetlands and Limeburner Creek
Receiving environment - satellite WWTP		Harbour		N/A		N/A		N/A
CapEx Range/Order		Very High		Extremely High		Extremely High		Very High
Investment objectives	**Score**		**Score**		**Score**		**Score**	
Consentability - long term consent	0	Not acceptable to Tangata Whenua, very likely sensitive users of the harbour, for food gathering etc. **Fatal Flaw - no further scoring of this option.**	1	Very difficult consent related to rising main, treatment plant and ocean outfall.	1	Very difficult consent process anticipated, especially there are some pump station overflows out currently, construction of effluent rising main will be difficult for the community to support	0	Need lots of land (>700ha). Expect easier to consent than outfall options (Option 4 to 6)
Enhanced health and environmental outcomes		This satellite plant reduces 8% of ADF and loads to Limburners Creek than Option 1. Ocean outfall around satellite plant will unlikely to cause local environmental impact.	3	This option removes discharge into the Limeburners Creek. New uncertainty about the environmental impact near the new discharge point	3	This option removes discharge into the Limeburners Creek. New uncertainty about the environmental impact near the new discharge point		
Community affordability			1	Likely to be prohibitive expensive in terms of community affordability, as none of the existing plant assets can be reused.	1	Likely to be significantly more expensive than Option 1		
Operation robustness, efficiency and reliability			2	New state of the art treatment plant. however will be offset by septicity and odour issue related to long/difficult rising main	2	Rising main maintenance and operation	0	Land availabilty feasibility for 760ha or more is very difficult **Fatal Flaw - no further scoring of this option**

Option title	Score	Option 8 - Existing Discharge supplemented with reuse	Score	Option 9 - Deep Bore Injection - Existing WWTP site	Score	Option 10 - Lower harbour discharge - Existing WWTP
Option description		Similar to Option 1 or 2, with higher discharge quality enable current and future reuse opportunities (e.g. parks/gardens, or industrial, or plantation)		Significantly improve WWTP quality for deep bore injection, design for Indirect Potable Reuse quality		Keep the Whangarei WWTP at the existing site, and pump to Lower Harbour, close to Whangarei Head
Number of WWTPs		1		1		1
Receiving environment - main WWTP		Reduce ADF to land Excess to wetlands and Limeburners Creek		Recharge to Groundwater Aquifier		Lower Harbour near Whangarei Head
Receiving environment - satellite WWTP		N/A		N/A		N/A
CapEx Range/Order		High		Extremely High		Extremely High
Investment objectives	**Score**		**Score**		**Score**	
Consentability - long term consent	3	Reuse opportunities including land irrigation are yet to be defined. However, identifying future reuse opportunities is in line with NRC and iwi aspiration	0	Extremely difficult to consent (no other case in NZ carries significant uncertainty and risks). **Fatal Flaw - not further scoring of this option**	0	Not acceptable to Tangata Whenua, very likely sensitive users of the harbour, for food gathering etc. **Fatal Flaw - no further scoring of this option.**
Enhanced health and environmental outcomes	5	Land-based discharge or reuse options will result in reduction in nutrient loads to the Limeburners Creek and harbour	0	Extremely difficult to consent (no other case in NZ carries significant uncertainty and risks). **Fatal Flaw - not further scoring of this option**		
Community affordability	2	Additional capital expenditure than Option 1, with additional treatment processes, effluent conveyance and irrigation equipment/land purchase				
Operation robustness, efficiency and reliability	3	More complex than existing. Depends on how far pipeline goes				

WHANGAREI LONG LIST MCA

Scoring	
5	Strongly meets the criteria in all respects
4	Meets the criteria in most respects
3	Only partly meets the criteria
2	Does not meet the criteria
1	Fails to meet and is contrary to the criteria
0	Fatal Flaw

Option title			Option 1 - Existing Discharge - Plant Expansion		Option 2 - Existing Discharge - Process Intensification		Option 3 - Existing Discharge plus a Satellite Plant (Nth Whangarei)		Option 4 - Existing Discharge plus a Satellite Plant (Whangarei Head)		Option 5 - Ocean Discharge - Relocate Whangarei WWTP		Option 6 - Ocean Discharge - Existing WWTP and pump to ocean		Option 7 - Land-based Discharge (dry weather) - Existing WWTP site		Option 8 - Existing Discharge supplemented with reuse		Option 9 - Deep Bore Injection - Existing WWTP site		Option 10 - Lower harbour discharge - Existing WWTP
Investment objectives - score out of 100	100%	73		74		51		0		37		37		0		67		0		0	
Environmental/cultural/social factors	**Weight**	**Score**		**Score**		**Score**		**Score**		**Score**		**Score**		**Score**		**Score**		**Score**		**Score**	
Impact on Limeburner creek and upper harbour quality	25%	4	Baseline	4	Same as baseline	5	Less flow to creek			5	Remove discharge into Limeburners Creek	5	Remove discharge into Limeburners Creek			5	Removing more flows and nutrients into the Limeburners creek, and more during summer (critical)				
Impact on groundwater quality	10%	5	No impact - no discharge to land	5	No impact - no discharge to land	4	Satellite plant land-based discharge			5	No impact - no discharge to land	5	No impact - no discharge to land			3	Potential impact				
Impact on adjacent land use options	10%	4	Expand clarifiers, may struggle for space. Need another digester. But no immediate neighbour. Odour mitigation provided	4	Can be slightly more compact plant	3	Associated with new plant. Issues around buying land, neighbours of new plant			3	Quite rural, may not have neighbours close	4				3					
Cultural acceptability	30%	4		4		4	Irrigation component			1	Tangata Whenua indicated they have significant concerns in discharging into ocean because of volume	1	Tangata Whenua indicated they have significant concerns in discharging into ocean because of volume			4					
Community acceptability	25%	3		4	Can offer higher nutrient removal efficiency hence less in the discharge	3				2		2				4	Desired by stakeholders				
Environmental/cultural/social factors - score out of 100	100%	77		82		78		0		57		59		0		81		0		0	
Critical Success Factors	**Weight**	**Score**		**Score**		**Score**		**Score**		**Score**		**Score**		**Score**		**Score**		**Score**		**Score**	
Consenting pathway	25%	4	Baseline	4	Same as baseline	3	More complex related to satellite plant			1	Very difficult consent process anticipated	1	Very difficult consent process anticipated			3	Similar to Option 7				
Constructability	25%	4	Generally acceptable, there maybe space constraint at the site	2	Additional complexity related to integration into the existing systems etc	2	Land availability and wastewater network reconfiguration			1	Considerable challenges in construction of new infrastructure (conveyance, WWTP and ocean outfall)	1	Construction of effluent rising main and outfall			2	Additional complexity related to integration into the existing systems etc				
Long term flexibility	25%	3	Some upgrade items can be staged	4	Conversion into MBR/MABR can potentially be staged, to suit the timeframe of future NES triggers	3	Little stageability, require at least 60% capacity of satelltite plant. However, potential solution for catering growth beyond 2056			2	Most infrastructure required to be built initially, little staging or future flexibility	2	Most infrastructure required to be built initially, little staging or future flexibility			4	Provide more flexiblity of staging. More flexibility of staging for future reuse and land based discharge opportunities				

WHANGAREI LONG LIST MCA

Scoring	
5	Strongly meets the criteria in all respects
4	Meets the criteria in most respects
3	Only partly meets the criteria
2	Does not meet the criteria
1	Fails to meet and is contrary to the criteria
0	Fatal Flaw

Option title			Option 1 - Existing Discharge - Plant Expansion		Option 2 - Existing Discharge - Process Intensification		Option 3 - Existing Discharge plus a Satellite Plant (Nth Whangarei)		Option 4 - Existing Discharge plus a Satellite Plant (Whangarei Head)		Option 5 - Ocean Discharge - Relocate Whangarei WWTP		Option 6 - Ocean Discharge - Existing WWTP and pump to ocean		Option 7 - Land-based Discharge (dry weather) - Existing WWTP site		Option 8 - Existing Discharge supplemented with reuse		Option 9 - Deep Bore Injection - Existing WWTP site		Option 10 - Lower harbour discharge - Existing WWTP
Risk factors	25%	4	Baseline	4	Same as baseline	3	Higher risk associated with establishing the satellite scheme			2	Construction challenges, community and cultural acceptance potentially difficult	2	Construction challenges, community and cultural acceptance potentially difficult			3	Higher risk associated with establishing the irrigation area				
Critical Success Factors - score out of 100	100%	75		70		55		0		30		30		0		60		0		0	
Overall total out of 100		**75**		**75**		61		0		41		42		0		**69**		0		0	
Rank		**2**		**1**		4		7		6		5		7		**3**		7		7	
Carry forward for further analysis			**YES**		**YES**		No, considered difficulty to complete the necessary investigatons within the pre-consent timeframe. Can be investigated as part of future consent review		No, fatal flaw - small flow (8%) and increase complexity		No, significant hurdles associated with consent and construction of pipeline and outfall		No, significant hurdles associated with consent and construction of pipeline and outfall		No - fatal flaw around land availability		**YES**		No - fatal flaw around aquifier impact, cost and consent uncertainty		No - fatal flaw around no/lack of support from Tangata whenua

Appendix B

October and November 2021 Wastewater Working Group Workshop Minutes

Minutes

29 October 2020

Project	Whangarei WWTP	From	Sarah Sunich
Subject	Long List Stakeholder Workshop	Tel	
Venue/Date/Time	Whangarei WWTP / 22 October 2020 / 10am	Job No	12528591//
Copies to	All		
Attendees	Dave West and Aurelia Robertson (DOC) Nikki Wakefield (Rewarewa Block D representative) Mira Norris (Te Parawhau –Resource Management Advisor) Jo (Johanna) Dones (NDHB) Rudi Hoetjes (F&G Regional Manager) Simon Charles, Andy Keith, Sarah Irwin & Hai Nguyen (WDC) Sarah Sunich & Ian Ho (GHD)	Apologies	Erica Wade (DOC) NRC Forest & Bird

1 General

1.1	Is WDC doing any monitoring on the offload sites at the time of discharge to illustrate the level of treatment being achieved? – suggestion made to implement a programme of monitoring.	WDC regularly tests 3 discharge points from the wetlands as well as the point of discharge to the wetlands. This data will be reviewed as part of the analysis for the Wastewater Network Consent.
1.2	Rewarewa D block – Papakianga development indicated on a map by Nikki to the SW of the WWTP. Adjacent to the forestry block to the west of the WWTP site.	
1.3	Group would like to see Information on the different levels of treatment quality achieved through the plant – supported by quality data.	WDC to provide for next meeting
1.4	Request by the group for better understanding of what areas might contribute to the potential satellite schemes. At this stage of the project this is very high level evaluation and is more about the idea of taking a portion of flow from the current plant to ensure existing contaminant loads at the main plant to be maintained (or enhanced). More detailed engagement with other mana whenua groups would be required if this option were to be taken further.	To be provided if these options are to be taken forward.

Minutes		Action
1.5	Giving effect to cultural values – this is to be addressed through the development of a Cultural Values Assessment – further discussion is needed on who/how this would be prepared. Noted that the Limeburner Creek areas and the wider Whangarei Harbour has historically been a major food basket and tangata whenua have never been compensated for this lost. Civic Center CIA – Sarah Irwin to see how that is working. Have a wider hui to enable wider engagement to then find out who might be keen to be involved in the CIA.	WDC – Date of a Hui to be determined with WDC Maori Relationship advisors. Consultation plan has an initial hui after the next working party meeting.
1.6	WDC to provide a list of the water quality attributes that are being focused on for the effect's assessment – namely the Proposed Regional Plan Water Quality Standards –(see Table 22, Hatea River water quality standards in appealed version of the plan found at: https://www.nrc.govt.nz/media/4i2jloyu/proposed-regional-plan-appeals-version-august-2020.pdf .	
1.7	Emerging contaminants raised as a concern. NRC have carried out some harbour studies (David Lindsey), also consider the national emerging contaminants group (i.e. Grant Northcote) for more information.	WDC to address as part of AEE
1.8	Carter Holt Harvey site for sale - Lot 2 DP 208563 (54 ha) adjacent and north of the site, as well as the fertilizer site Part Lot 1 DP 50814 (10 ha) located adjacent to the Carter Holt Harvey Site.	
1.9	Biowaste composting – other options for disposal.	
1.10	Nikki would like to work with Sarah Irwin to prepare some words around the options work done today to go to the other hapu that may have interest, particularly around those options that could have an effect on those other hapu (e.g. satellite plant scenarios).	SI/NW
2	**Scoring options**	
2.1	35-year consent – Mira indicated she felt this was too long. Consideration of cultural triggers, engagement triggers, and review clauses in the consent – taking a more adaptive management approach could this been a solution?	

Minutes		Action
2.2	Costings for options requested from F&G to assist in making decisions. Ian Ho presented some very high-level ball park figures for each of the options, more detailed costings to be provided for the shorter-list options.	
2.3	Water scarcity – was an issue last year –strong support for further consideration of reuse / recycling.	
2.4	Mixed model options consideration.	
2.5	Source control initiatives needing greater consideration - suggested by Dave.	
2.6	Lower harbour discharges a no go.	
2.7	Deep bore injection a no go due to cost and uncertainties and level of treatment needed perhaps unnecessary.	
2.8	Soils at Whangarei Heads perhaps more conducive to higher rate irrigation (sandy soils).	
2.9	Group considers the plant is not located in a good part of the harbour for mixing in the harbour.	
2.10	WDC have looked at climate change/sea level rise at a high level and effects on plant – the wetlands are unlikely to be compromised at their current bund height within the 100 years of predicted coastal inundation.	

Minutes		Action
2.11	General concerns that the water quality standards aren't being improved enough, although not wanting to speak on behalf of all, Nikki less concerned about where the discharge goes but more about the quality being proposed.	Noted. The standards to be met will be considered in the AEE.
2.12	Aspire that the waterways are swimmable (Rody).	
2.13	Mira, Nikki and Jo on the water harbour catchment group – where aspirational values are being promoted and they would like to see similar here. Take a longer view – 50 years for the plant rather than limiting to 35 years, prepare aspirational values for wastewater.	Noted.
2.14	Need more information on the performance standards for the different options.	
3	**Next steps**	
3.1	Due to time constraints with the workshop – WDC / GHD to prepare some scoring of the options to circulate for consideration by the wider group.	
3.2	Circulate to all parties for their input, may be a need for a further meeting/workshop to go through the results – could be online or another workshop.	

Sarah Sunich

Minutes

18 March 2021

Project	Whangarei WWTP Consenting	From	Sarah Sunich
Subject	Technical Working Group -Workshop #2	Tel	021446925
Venue/Date/Time	Whangarei District Council, 26th November 2020, 1-4pm	Job No	12/528591/
Copies to	All attendees and Name (Company)		
Attendees	Sarah Irwin (WDC) Simon Charles (partial meeting) (WDC) Hai Nguyen (WDC) Ian Ho (GHD) Sarah Sunich (GHD) Anthony Kirk (GHD) Danielle Maynard (GHD) Erica Wade (DoC) Laura Wakelin (DoC) Johanna Dones (NDHB) Rudi Hoetjes (Fish and Game)	Apologies	Mira Norris (Iwi) Nicki Wakefield (Iwi) Shane Henare (Forest and Bird) Stuart Savill (NRC) Dave West (DoC)

Minutes	Action
Welcome and recap of previous workshop • Sarah Irwin – circulated previous workshop minutes/MCA scoring/MCA memo. • Purpose of workshop to introduce and confirm Adaptive Pathways Approach to managing options for the Whangarei WWTP going forward (as an alternative to traditional MCA approach) and discuss and agree on key drivers and triggers to be considered in the adaptive pathway assessment. • Regional council decided a conflict if they were in technical group	
Summary of Long list MCA • Ian Ho revisited long-list options summary and reasons for carry forward/leave of options. • Options are not mutually exclusive and thus lead to the consideration of taking a more Adaptive Pathways Approach to optioneering over the long-term.	

GHD Limited
Level 3 27 Napier Street Freemans Bay Auckland 1011 PO Box 6543 Victoria Street West Auckland 1142 New Zealand
T 64 9 370 8000 **F** 64 9 370 8001 **E** aklmail@ghd.com **W** www.ghd.com

Minutes	Action
• Adaptive pathway approach does not exclude other 'options' and could be supported through flexible consent conditions (regular reviews of options in light of changing drivers) to allow for consideration of these options (or parts of) at different times over the term of the consent and longer.	
Assessment of Water Quality • Anthony Kirk presented initial findings from assessments on Enterococci, Faecal Coliform counts, and nutrients in Limeburners and Upper Harbour. Also presented nutrient projections taking consideration to population growth. • Guidelines for intertidal creeks does not capture Limeburners Creek (classified as a mixing zone). • DoC request update on ecological health and sediment quality status of receiving environment – 4sight have completed a baseline assessment focusing on Limeburners Creek and the confluence with the Hatea River. • Anthony Kirk gave a broad summary of 4sight report with key issue being Sediment. - Lots of mud accumulation and conditions adapted to this environment (particularly Hatea River acting as sediment trap). - Not many larger fish species. - Nutrients not a particular issue.	Sarah Irwin - to circulate 4sight baseline monitoring report
Project Programme and Adaptive Pathway Approach • Project programme – Ian Ho presented – WWTP options assessment to commence following Workshop 2. Workshop #3 to comment and finalise Adaptive Pathway for Whangarei WWTP early Feb 2021 followed by Council Approval Feb 2021. • Intent for high level costing to be included to inform Adaptive Pathway, but may be issues with costings from suppliers over the Christmas period.	
Drivers (see white board notes) • Cultural Aspirations. – Need to consider cultural factors, importance to treaty partners. – Harbour wanted to recreation (swimmability) and food gathering. – Discharge via wetlands important and accepted. – Cultural impact assessment to be produced. Necessary to have guidance from hapu iwi to ensure inclusion of those who need to be. • Regulatory – New standards implemented through Regional Plan (longer term)	

Minutes	Action

- NES for wastewater discharges expected to be a disruptor (shorter term).

- Climate Change
  - Periods of intense rainfall expected to have increased volume. Generally, Whangarei expected to have a lower level of rainfall in general. Plant needs to be able to cope with these intense flows.
- Reuse - What does ‘reuse’ look like to the group?
  - Industrial reuse (e.g. potentially nursery watering) may have different requirements (not just pathogens). Need flexibility around consent – if majority of consent is around reuse in industry, rapid issues caused around how to address disposal if industry no longer needs it. Need to consider transport of water to industry use
  - No NZ standard for reuse water – consider Aus standards.
  - Improvement of pathogen treatment opens up different options (i.e. park/land application, toilet flushing).
  - Cultural sensitivities around reuse of water need to be checked.
  - Water reuse to power? Maybe not economic for this scale. Already some biogas co-generators on site. Power generation only 2.6MJ last year.
- Sustainability.
  - Reuse, climate change (carbon), water scarcity/water resource, carbon energy.
- Freshwater source management
  - Initiatives to incentivise population to decrease water use, reducing overall flow to plant (i.e. shorter showers, greywater reuse), education around what people are ‘tipping down the sink’ affecting the loads to the plant
- Residential development and changing community.
- Wider environmental drivers.
  - Improvement of quality of overall harbour catchment environment (Harbour Catchment Group and strategy already incorporated into proposed regional plan. Could release new guidelines).
  - Aspirational Whangarei Harbour Catchment Strategy (WDC/NRC’s websites, guideline for NRC planning).
  - Catchment restoration or farm management practice improvement -> overall water quality improvements -> negative perception of WWTP as major contributor.
  - Changing use within the catchment.
  - Changing use of upper and lower Hatea.
  - Marina discharge into Limeburners Creek
- Other matters raised
  - New contaminants identified.

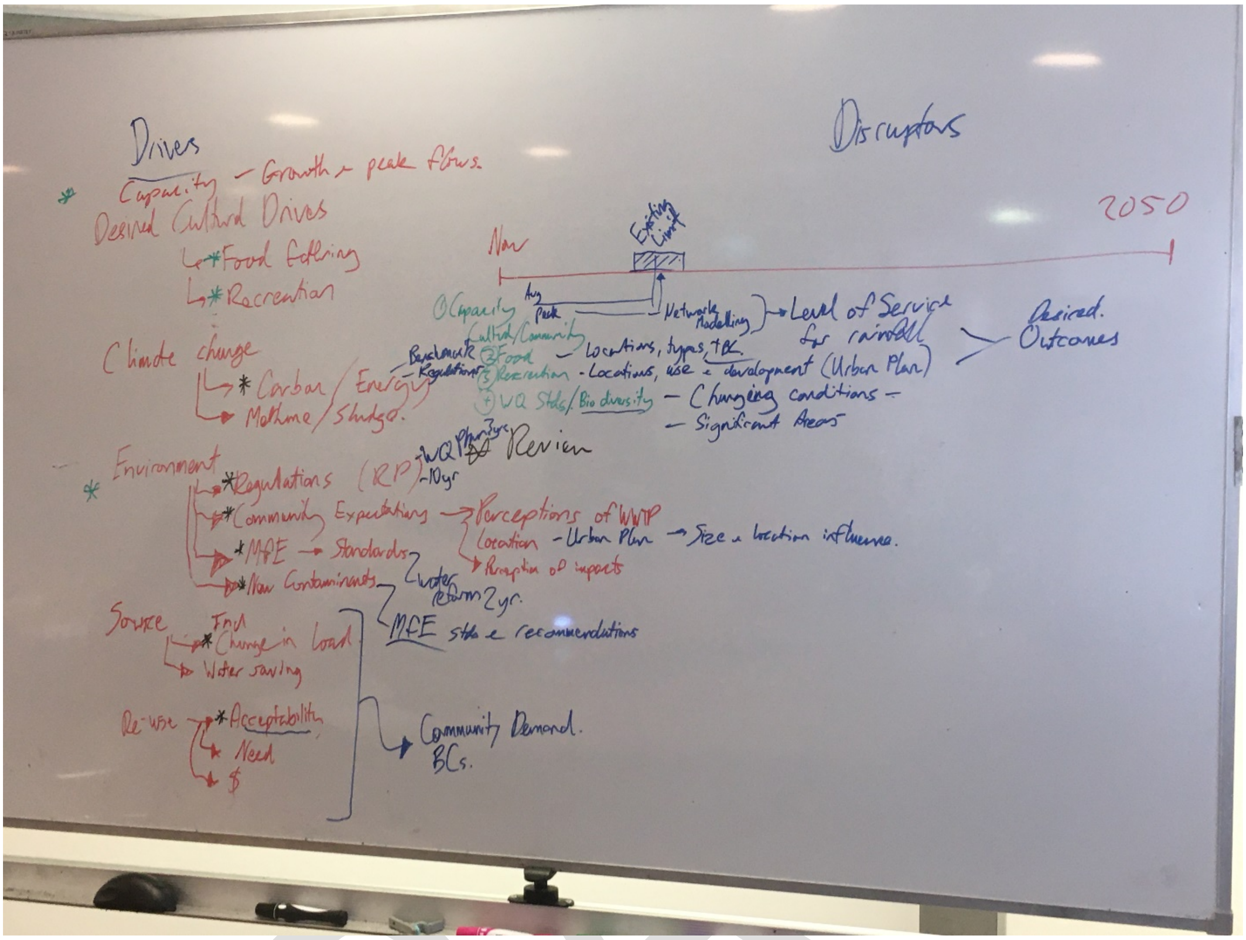
Minutes	Action
– Cost difference between addressing drivers/disruptors sooner rather than later. – Aspirational goals for next 10-20 years, how do we rank them?	
Primary drivers needing immediate consideration • Capacity limitations at plant. • Environment – PNRP. • Climate change – heavy rainfall/drought conditions. • Cultural factors (shellfish gathering/swimmability/etc.) – there is a desire to improve the catchment area even if the WWTP is not the main contributor to the issues being experienced in the upper harbour.	
Aims for treatment plant • Improve swimmability – how do we define this? • Hold nutrient mass load and/or improve. • Make best use of biosolids (energy source and good soil conditioner). • Improvement to UV disinfection will reduce risks to downstream activities (marina, etc.) and open up opportunities with reuse initiatives. • Understand climate change effects on plant performance. • Continued use of wetlands and possible expansion. Possible increase of wetland harvest (explore impact of nitrogen polishing on the environment and how it is measured). • Support no net loss of biodiversity.	
Triggers • Capacity – Stagger upgrades or plan now for 50-year population? Currently focused on next 35 years. – Levels of service for dealing with rainfall (output of network modelling and network master planning). – Size of plant and community expectations around this – how large to allow plant to expand before needing to move operations? – What is capacity limit of plant? • Food gathering – Identify what this means from a cultural point of view, in terms of types of food and important locations. • Recreation: – Development of town basin (urban plan), changes to marina and waterfront may increase desire for swimmability.	

Minutes	Action
– Improved water quality may lead to increased biodiversity (fish species, shellfish) which may in turn increase fishing/recreation. – Waka Ama complaints about burning sensations on skin. • Water quality: – Degradation of biodiversity in the area. – Impact on protected species. – NRC are mapping significant ecological areas, inner harbour likely to have some protected species. • Regulations: – PNRP and MfE water quality standards changing. – Regulations (RP) WQ Plan change for freshwater limits in the next 3 years (10-year cycle following that). – MfE standards water reforms likely to be in the next 2-3 years. – Emerging contaminants could come through in the NES (hormones, pharmaceuticals, microplastics, toxoplasmosis, etc). • Climate change: – Cloudy info and legislation around GHG emissions from treatment plant – Zero carbon act. – Blue carbon and use of marine ecosystems to store and sequester carbon. • Source control and reuse: – Loss or change in industrial use. – Water saving initiatives resulting in lower flows. – Composition of waste changing.	

<u>Attachments Enclosed</u>

Attachment 1 - Power point presentation:

Attachment 2 - Whiteboard notes:



Attachment 3 – 4Sight Baseline Ecological and Sediment Quality Report

Appendix C

Site Layout Drawings

- Infrastructure shown is indicative only. Further work is required to fully assess suitability of proposed locations.
- Proposed infrastructure not shown includes additional blower rooms, switchrooms or roadworks.

Augmentation works

Pathway 1b

- Maintain mass loads at the discharge point
- Gradual additions of activated sludge tanks and secondary clarifiers

Pathway 1d

- Maintain mass loads at the discharge point
- Gradual capacity increase by constructing a side-stream Membrane bioreactor train

Pathway 2

- Reduce nutrient mass loads at discharge point
- Decommissioning existing trickling filters and convert into MBR tanks

Appendix D

Process Description for Pathways

This appendix outlines the process descriptions and infrastructure requirements for the pathways described in the above sections.

PROCESS DESCRIPTIONS FOR PATHWAYS

This appendix outlines the process descriptions and infrastructure requirements for the pathways described in above sections.

1. Key assumptions

– The process calculations are based on typical treatment design guideline values.
– We recommend calibrated plant-wide BioWin models to be built in future to confirm the assumptions such as sludge age, sludge yield, clarifier loading rates. Thus, the estimated timeframe of upgrade triggers will be updated.
– Conceptual design and Safety in Design (SiD) will be necessary to develop further details of new plant layout and address any issues of construction, operation and maintenance access.

2. Existing plant augmentation

2.1 Inlet works and septage receival

The existing band screens and vortex grit removal in the inlet works are limited to approximately 100 ML/d. Additional screening and grit removal capacity will be required as peak flows increase, estimated to be approximately 2030-2035.

The current septage receival facility is located at the inlet works. It has been observed by Whangārei District Council (WDC) sampling technicians that the discharge from septic tank truck often results in blinding of the inlet screens. Hence, it is proposed to establish a separate facility near the digesters where septic tank sludge will be processed by covered gravity thickener and the digesters. This also reduces the solids loads on the primary clarifiers and trickling filters. This is expected to occur around 2025. Odour control will be required as part of these works.

The other trucked waste streams such as Puhoi cheese wastewater, landfill leachate and other wastewater will continue to be discharged into the existing septage station for treatment.

2.2 Activated sludge basin

To address the ammonia spikes observed in the final effluent, additional aeration and bioreactor capacity is required. To meet this need, the existing basin at the south of the site will be repurposed to operate as an activated sludge basin (operating in parallel with the existing adjacent basin). This will increase the total activated sludge basin volume to 3,000 m^3. To operate with a minimum sludge age of 10 days, the Mixed Liquor Suspended Solids (MLSS) is expected to be in the range 2,500 to 3,500 mg/L. The influent to the activated sludge basins is expected to remain at 10% primary effluent that has bypassed the trickling filters, and 90% trickling filter effluent. Aeration will be provided via surface aerators. This is expected to occur by 2025.

2.3 UV disinfection upgrade

Both the normal flow and high flow Ultra-violet (UV) disinfection systems are not able to consistently meet the current consent conditions; minimum UV dose of 30 mWs/cm^2 for flows < 30.4 ML/d, and a minimum UV dose of 40 mWs/cm^2 for flows > 30.4 ML/d.

The normal flow UV channel is hydraulically limited and needs to be expanded to consistently service future wastewater flows, say 2x Average Daily Flow (ADF).

2.4 Tertiary filters

To address the elevated suspended solids in the effluent, tertiary filters would be installed between the secondary clarifiers and UV disinfection. It is noted that there has been solids carry-over from the secondary clarifiers, and the WDC operations team is conducting field investigations to reduce pin floc and improve clarifier performance. This may eliminate or defer the need for tertiary filtration.

Table 1 Existing plant augmentation summary

Item	Description	Trigger
Second activated sludge basin	Repurpose existing basin, including: • Return Activated Sludge (RAS) and Waste Activated Sludge (WAS) pumps • Pipework modifications • New aeration system	Ammonia in effluent > current consent
UV disinfection upgrade	New UV channel for normal flow and high flow	Existing UV unable to consistently meet current consent
Tertiary filters	Adding filter	Elevated Total Suspended Solids (TSS) in effluent
Inlet works	Additional screens and vortex grit removal	Peak Wet Weather Flow (PWWF) > 100 ML/d (should be sufficient for the interim, given peak flow screens can also handle excess flows).
Septage receival	New septage receival facility, including screening and odour control	Operation improvement

3. Pathway 1 – Improved quality

3.1 Pathway 1a: Improved quality with activated sludge tanks

3.1.1 Primary clarifier

Under current operating conditions, the surface overflow rates for the existing 3 no. primary clarifiers (PST’s) are:

– Approximately 11 $m^3/m^2/d$ during dry weather flow. This is less than the typical design range of 30 to 50 $m^3/m^2/d$.
– Up to 63 $m^3/m^2/d$ peak flows. This is less than the typical design range of 80 to 120 $m^3/m^2/d$.

As flow increases, it is possible that a fourth primary clarifier will be required to manage peak flows. It is estimated that this would be required at approximately 72,000 Equivalent Population (EP). However, there is a risk that this would result in low loading during dry weather conditions.

As an alternative, it may be possible to operate two PSTs during dry weather, and during peak events operate all three clarifiers as chemically enhanced primary treatment (CEPT). This would also defer capital expenditure, however further work would be required to determine the effect the CEPTs would have on the solids handling system and in particular the effect on the solids retention time in the anaerobic digesters. For the purpose of this assessment, we have assumed CEPT is preferred over constructing the fourth primary clarifier.

3.1.2 Activated sludge tank

After conversion of the existing basin to a second activated sludge basin, it is expected that the plant would be able to achieve sufficient nutrient removal to meet the premise of maintaining water quality and avoiding further degradation in water quality in the Hātea River as a result of the plants operation in line with the Proposed Northland Regional Plan (PNRP – Appeals version) water quality standards until approximately 72,000 EP. Construction of BioWin models is strongly recommended to confirm the plant capacity.

At this point in time, it is expected that an additional 4 ML of reactor volume would be required to achieve sufficient nitrification, considering a minimum MLSS concentration of 2,500 mg/L and a minimum sludge age of 10 to 12 days. The new activated sludge tank would be constructed where trickling filter 4 is currently located.

The existing anoxic selector would not have sufficient capacity for the expanded plant, and the new activated sludge tank would have its own dedicated anoxic selector channel. The two activated sludge basins may continue to rely on the existing selector channel, or have their own dedicated anoxic zones retrofitted.

After construction of a third activated sludge tank, it is expected that the plant would be able to achieve sufficient nutrient removal to achieve the maintenance of mass loads being discharged from the plant until approximately 82,000 EP. At this point in time, it is expected that a fourth 4 ML of reactor volume would be required.

For the proposed aeration tanks, additional influent is expected to be diverted to the activated sludge plant, resulting in less trickling filter effluent to the aeration tanks (refer table below for approximate expected split). This will increase the COD:TKN ratio and promote denitrification.

Table 2 Approximated Activated Sludge Plant (ASP) influent split

ASP Influent source	Approximate influent breakdown%		
	Two aeration basins	Two aeration basins & one aeration tank	Two aeration basins & two aeration tanks
Screened raw influent	0%	15%	30%
Primary effluent (TF bypass)	10%	30%	30%
Trickling filter effluent	90%	55%	40%

3.1.3 Secondary clarifier

Based on a maximum solids loading rate of 5 to 6 kg/m^2/h (on average loading) and average hydraulic rise rate of 20m/d at capped maximum flow, the existing 2 no. secondary clarifiers are expected to reach capacity at a dry weather flow of approximately 22 ML/d. This is projected to occur around 75,000 EP. It would therefore be appropriate to construct a third secondary clarifier at the same time as the construction of the new activated sludge tank.

Table 3 Pathway 1a infrastructure summary

Item	Infrastructure	Trigger
Primary clarifier	1 no. 24.6 m dia. primary clarifier (to match existing) OR Changed operation of existing PSTs: • Two PSTs for Average Dry Weather Flow (ADWF) • Three PSTs for PWWF, operated at CEPT	PWWF > 1,320 L/s

Activated sludge tank	2 no. 4 ML activated sludge tank with anoxic selector integrated into new bioreactor	Plant unable to meet ammonia limit of < 2 mg/L and sludge age >10-12 days
Secondary clarifier	1 no. 26 m dia. secondary clarifier (to match existing)	Clarifier solids load rate > 5 to 6 kg/m2.h Clarifier overflow rate >20m/d
	1 no. 26 m dia. secondary clarifier (to match existing)	

3.2 Pathway 1b: Improved quality with larger activated sludge tanks

Pathway 1b considers the same infrastructure as pathway 1, however the construction of a larger activated sludge tank will defer the construction of additional tanks beyond that for pathway 1a.

Table 4 Pathway 1b infrastructure summary

Item	Infrastructure	Trigger
Primary clarifier	As per pathway 1a	PWWF > 1,320 L/s
Activated sludge tank	1 no. 7 ML activated sludge tank with anoxic selector integrated into new bioreactor	Plant unable to meet ammonia limit of < 2 mg/L and sludge age >10-12 days
Secondary clarifier	As per pathway 1a	Clarifier solids load rate > 5 to 6 kg/m2.h Clarifier overflow rate >20m/d

3.3 Pathway 1c: Improved quality with MBR upgrade

Pathway 1c considers the retrofitting of the new activated sludge tanks constructed along pathway 1a or 1b with Membrane Bioreactor treatment (MBRs) (or other technology) to increase capacity.

3.3.1 MBR upgrade

The MBR upgrade would see the conversion of the activated sludge tank to a dedicated MBR tank. Adoption of this option would require additional planning works to be completed during the design of the activated sludge tank to allow sufficient space for membrane cassettes for future conversion. The MBR tank would receive mixed liquor from the activated sludge tank(s), and potentially also the activated sludge basins. Permeate from the MBR tank would be pumped to the UV disinfection system, while the WAS and RAS stream would be wasted or recycled from the MBR tank.

The MBR tank would have an adjacent building housing blowers, permeate pumps, chemical storage for membrane cleaning, and other instrumentation.

Table 5 Pathway 1c infrastructure summary

Item	Infrastructure	Trigger
Primary clarifier	As per pathway 1a	PWWF > 1,320 L/s
MBR tank	Conversion of activated sludge tank to MBR tank, including: • Installation of membrane cassettes into a dedicated channel to treat up to 46 ML/d (hydraulic) • MBR building with blowers and permeate pumps • Chemical storage	Plant unable to meet ammonia limit of <2 mg/L and sludge age >10-12 days
Activated sludge tank	Additional activated sludge tank	MBR plant is unable to meet ammonia limit of <2 mg/L and sludge age >10-12 days

3.4 Pathway 1d: Improved quality with MBR side-stream

Pathway 1d considers implementation of a side-stream MBR or similar technology, initially 3500 m^3 with a second reactor of the same size added later to accommodate population growth. The existing trickling filter and activated sludge process which will be capped at 15-18 ML/d. The remaining flow treated by the side-stream MBR will have a target effluent TN of 10 mg/L for blending.

This option negates the need to put more flow through the existing trickling filter/activated sludge process, and doesn't require the addition of more secondary clarifiers.

Table 6 Pathway 1d infrastructure summary

Item	Infrastructure	Trigger
Primary clarifier	As per pathway 1a	PWWF > 1,320 L/s
MBR tank	Conversion of activated sludge tank to MBR tank, including: • Installation of membrane cassettes into dedicated channel to treat up to 25 ML/d (hydraulic), staged expansion with cassettes added progressively through 72,000 to 92,000 EP • MBR building with blowers and permeate pumps • Chemical storage	Plant unable to meet ammonia limit of <2 mg/L and sludge age >10-12 days
Activated sludge tank	2x 3.5 ML AS reactors providing side-stream treatment. Side-Stream AS Reactors are designed to 15-20 days Solids Retention Time (SRT), more resilient than Pathway 1a and 1b	72,000 EP: 1st reactor 82-85,000 EP: 2nd reactor

3.5 Pathway 1 assumptions

- No hydraulic calculations for the flow split to the activated sludge plant have been considered.
- Construction of the fourth Primary clarifier is deferred by converting the existing clarifiers with chemical dosing during wet weather events.
- If pathway 1a diverges to pathway 1c after the construction of a single activated sludge tank, the total activated sludge reactor volume of 7,000 m^3 is expected to provide sufficient biological treatment capacity to 2056, based on a minimum sludge age of 15 days and operating MLSS up to 7,000 mg/L.
- If either pathway 1a or 1b diverge to pathway 1c once the activated sludge plant reaches capacity in approximately 2056, a new activated sludge tank would be required. This may coincide with the decommissioning of trickling filters 1 & 2 due to the end of their asset life.
- Timing of the upgrades is subject to further work, including a BioWin capacity estimation for concept design. Spreadsheet calculations have been used to maintain minimum SRT of 10 to 12 days and maximum MLSS of 3,500 mg/L for AS basin. MBR AS reactors were based on 15 to 20 days sludge age and maximum MLSS of 7,000-9000 mg/L. Secondary clarifier overflow rate is limited to 6 kg/m^2/h on average flow.

4. Pathway 2: Enhanced quality

4.1 MBR

The MBR upgrade would see the construction of a dedicated MBR tank, to treat hydraulically up to 46 ML/d. The MBR tank would receive mixed liquor that is pumped from the two activated sludge basins. Permeate from the MBR tank would be pumped to UV disinfection (bypassing the tertiary filters if installed), while the WAS and RAS stream would be wasted or recycled from the MBR tank.

The MBR tank would have an adjacent building housing blowers, permeate pumps, chemical storage for membrane cleaning, and motor control centres.

As part of this upgrade the trickling filters would be decommissioned.

MBR has been nominated as the benchmark technology due to space constraints on site and the ability to increase capacity within the existing footprint. However, a number of other technology options may be considered, e.g. aerobic granular sludge, fixed film, etc. A detailed technology evaluation will need to be undertaken prior to implementation.

4.2 Activated sludge tank

Like pathway 1c, an additional activated sludge tank would be required to increase capacity. The timing of this is subject to the construction of new activated sludge tanks as part of pathway 1 upgrades that may have occurred prior to the divergence to pathway 2.

4.3 Chemical dosing

To achieve lower phosphorous concentrations in the effluent, chemical dosing for phosphorous removal will be required. The dosing point would be inside the activated sludge tanks, to form phosphorus precipitates, to be removed with the WAS.

Table 7 Pathway 2 infrastructure summary

Item	Infrastructure	Trigger	Estimated timing
Primary clarifier	As per pathway 1a	PWWF > 1,320 L/s	2030
MBR upgrade	MBR tank with 6 no. trains to treat up to 46 ML/d (hydraulic) MBR building containing: Blowers Permeate pumps Chemical storage	National Environmental Standard (NES) introduced and plant is unable to meet ammonia and nitrogen limits	Unknown
Chemical dosing	Chemical storage and dosing equipment	NES introduced and plant is unable to meet new TP limit	When MBR is installed
Activated sludge tank	Additional activated sludge tank	MBR plant is unable to meet ammonia limit of <2 mg/L and sludge age >10-12 days	Unknown

5. Pathway 3: Treated effluent reuse and alternative disposal

5.1 Short Term Recycled Effluent Infrastructure Requirements

To build resilience into the reuse of treated effluent onto Council owned gardens, trees and sportsfields during times of water restrictions a new supply tank located at the Whangārei WWTP, where UV treated effluent is fed into this tank with a new hypochlorite storage and dosing system is proposed. The recycled effluent is required to have less than 1000 cfu/100mL as faecal coliform. Water tankers will be used to transport the recycled effluent to the sites to receive treated effluent.

5.2 Assumptions

– As no additional recycled effluent users (in addition to Council Parks Department)have been confirmed, sizing of this option has been based on a demand of 500 m^3/d and the specified hypochlorite dose rate in current resource consent (NRC file no: 41633).

Table 8 Pathway 3 infrastructure summary

Item	Infrastructure	Trigger	Estimated timing
Short term recycled water infrastructure	2 no. 100 kL recycled water tanks 1 no. sodium hypochlorite storage tank and dosing skid	Sufficient demand for recycled water	Unknown
Additional recycled water infrastructure	TBC	Increased demand for recycled water	Unknown
Land-based disposal infrastructure	TBC	Increased demand for land-based disposal and availability of land	Unknown
Ocean outfall	Combined ocean outfall with Ruakaka WWTP (TBC)	Ruakaka WWTP ocean outfall feasibility	Unknown. To be reviewed every 6 years

6. Pathway 4 - Biosolids Management

It is assumed that a third anaerobic digester is required to manage the additional solids load from the WAS. This will include infrastructure for sludge mixing, sludge heating, gas collection and gas storage.

6.1 Recuperative thickening

The existing sludge digesters are estimated to be operating with a solids retention time (SRT) of approximately 17 days with an assumed 15% of non-reactive volume (i.e. dead volume due to grit accumulation or mixing limitations). Further to this, if one digester is taken offline for cleaning (say every 10 years), the remaining digester will be operating with an SRT of <9 days. Robust anaerobic digestion design allows for a minimum of 15 days solids retention time when one tank is taken offline. This considers the effective volume, which is a function of the build up of inert solids and mixing effectiveness. This can be confirmed with a tracer test.

The installation of a recuperative thickening process for the digested sludge would increase the SRT of the two digesters and could defer the construction of a third digester. By increasing the concentration of the digested solids to 3.5%, the SRT would be approximately 30 days in 2056, or 15 days if one digester was taken offline. These works should be completed over the next 10 years, based on the need to increase the SRT. If one or both of the digesters require cleaning, recuperative thickening should be installed beforehand to ensure that a single digester can manage the entire solids load from the plant.

6.2 Gravity belt thickener

The gravity belt thickener currently used to thicken WAS prior to blending with digested sludge is duty only and a single point of failure. An additional thickener should be installed to operate in duty/standby configuration to provide redundancy for the WAS handling system.

6.3 Dewatering upgrade

The existing centrifuges have been in operation since the 1980s and are expected to have surpassed their expected asset life. There is risk in continuing to operate the centrifuges if a breakdown results in the loss of a centrifuge for an extended period of time.

6.4 WAS Stabilisation Requirements

Currently the digesters treat only thickened primary sludge and WAS is only thickened prior to blending with the digested sludge for final dewatering.

The existing two digesters cannot handle the additional Thickened Waste Activated Sludge (TWAS) volume within the minimum sludge age requirements, hence a third digester would be constructed in the vicinity of the existing digesters.

6.5 Assumptions

– The existing 2 no. gravity thickeners are currently operating at approximately 29 $m^3/m^2/d$, which is close to the maximum recommended limit of 31 $m^3/m^2/d$. However, the existing primary clarifier wasting regime yields a low solids concentration in the primary sludge (typically < 0.3%). By reducing the wasting from the primary clarifiers to increase the solids concentration to > 0.5%, the construction of an additional gravity thickener due to hydraulic loading rate could be avoided.
– In the absence of any data, the effective volume of the 2 no. digesters has been assumed to be 85%.
– Concentration of thickened sludge returned to the digester = 5%.

Table 9 Biosolids management infrastructure requirements

Item	Infrastructure	Trigger	Estimated timing
Recuperative thickening	Recuperative thickening building containing: • 2 no. drum thickeners with 20 m3/h throughput (duty/standby) • Polymer dosing system	Digester SRT < 15 days	Now to 2030, depending on funding availability
Dewatering upgrade	2 no. centrifuges or belt filter press (duty/standby)	End of asset life	In the next Long Term Plan (2024 circa)
Gravity Belt Thickener	Extend the existing Gravity Belt Thickener building to accommodate the second thickener	Single point of failure mitigation	Part of plant upgrade at 70,000 to 72,000 EP
Anaerobic digester	1 no. 12.8 m dia. anaerobic digester, including: • Gas mixing • Sludge heat exchanger • Gas collection and storage	Landfill requirement changes	TBA/Unknown

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Appendix C
Wastewater Working Group Minutes

Minutes

03 June 2021

Project name	Whangarei WWTP Consenting	**From**	Sarah Sunich
Subject	Technical Working Group – Workshop #3	**Tel**	=6421446925
Date / Time	1st June 2021, 10 – 1:30pm	**Project no.**	12528591
Attendees	Mira Norris (Te Parawhau – Resource Management Advisor) Georgina Olsen (CIA consultant) Johanna Dones (NDHB) Simon Charles (WDC) Sarah Irwin (WDC) Hai Nguyen (WDC) Ian Ho (GHD) Anthony Kirk (GHD) Sarah Sunich (GHD)	**Apologies**	Andy Keith (WDC) Shane Henare (Forest and Bird) Laura Wakelin (DOC) Rudi Hoetjes (Fish & Game Regional Manager)
Objective	Update group on environmental investigations and baseline monitoring results Seek endorsement for pursuing Dynamic Adaptive Pathway #1.		

Minutes	**Notes**	**Action**
Welcome	– Sarah Irwin gave a recap of the project, introduced the workshop purpose and agenda.	–
Adaptive Pathway	– Ian Ho revisited the DAPP approach and why WDC is pursuing with this approach. – Ian presented the DAPP diagram including a description of the different pathways (pathway 1a – 1d, 2 (which relate to liquid stream treatment) and 3 (which relates to alternative disposal) + comment on additional pathways for odour control ('4') and solids management ('5'). – MN noted iwi's abhorrence to the ocean outfall proposed for Ruakaka, and the offensive discharge there. – Ian discussed the next steps in terms of master planning – costing out augmentation works and endorsed pathway.	– Clarification/update on DAPP diagram: • Population – within Whangarei "city" • Add arrow of Trigger 1 to link to Pathway 2
Receiving Waters investigation	– Anthony Kirk provided a summary of Baseline Water & Sediment Quality Monitoring Data, 4Sight baseline ecological surveys, Baseline pathogen data and public health risk conditions in the Harbour – key issues for the harbour are sediment (not related to the WWTP) and pathogens (augmentation work to	–

Minutes	Notes	Action
	address improvements to pathogens from WWTP). – Anthony further presented next steps based on DAPP approach which is to confirm the appropriate triggers for implementing upgrades/reviews, how these triggers are to be monitored and reported. – SI noted that the water quality section of the PNRP is potentially going to be reviewed again in 2022. – Community in the upper catchment of the Awaroa Creek is on septic tanks, also a number of septic tanks still in use in Onerahi. – Oysters were prevalent in the Upper harbour. – Onerahi was a white sandy beach now prevalent in mangroves. – 3 permanent signs at the outlet of the Upper Harbour, one at the boat ramp at Onerahi Beach (north of the picture given on pg 17 of the presentation).	
Air Quality Monitoring Update	– Sarah S presented the FIDOL methodology being used to assess odour and the results of the two odour surveys completed. – Mira noted that in the evening, particularly in times of mist, the odour from the WWTP is notable (held low perhaps), particularly at the port rd bridge, across the bridge to Onerahi and as far as Kissing Point (following the valley and river). Mira considers the odours were particularly bad in the 90's and have worsened. – JD also noted historical odours from the old CHH site but this site has been closed now for a year. – The next steps are to finalise the assessment and identify triggers for upgrades/monitoring requirements in line with development of a specific odour control pathway in the DAPP.	–
Consent Application Preparation	– Sarah Sunich presented the timeline for the consent application process. – Technical investigations completed end of July. – Workshop #4 to be arranged for first week of August. – AEE preparation to occur over August/September. – Working group feedback on AEE will be requested in late September/early October. – Lodgement end of October.	–
Revisit to Pathways	– Those present generally endorsed the DAPP approach being taken. – In order for the group to make a more informed endorsement over the 'liquid stream' pathways, Ian has prepared the	–

Minutes	Notes	Action
	advantages and disadvantages to each of the pathways (refer to Attachment 1). – Agreement made to cost pathways 1b and 1d as part of master planning because: • 1b will require 1 major expansion within the consent period (unless NES trigger occurs). • Larger bioreactor in 1b is less sensitive to uncertainty of population growth. • Costing for 1b can be easily adapted for 1a. • 1d provides an alternative pathway to 1a/1b.	
Next Steps	– Endorsement for above approach sought through feedback from the Technical working group. – Workshop #4 to discuss finalised technical documentation. – Sarah Irwin/Georgina to discuss programme for CIA development.	–

ATTACHMENT 1: ADVANTAGES AND DISADVANTAGES TO EACH PATHWAY

Pathway	Advantage	Disadvantage
Pathway 1a – Improved Quality through staged expansion	Staged improvement of treated effluent quality to manage population growth Familiar treatment process to the operation team Staged expansion of new bioreactors thus no need to work around existing process.	Relying on old trickling filters and secondary clarifier tanks (>30 years old) to perform for the next 30 years New secondary clarifiers #3 and 4 could become redundant if future technology changes.
Pathway 1b – Improved Quality through a large bioreactor instead of two tanks	Familiar treatment process Larger bioreactor than Pathway 1a thus manage greater growth up-front	Same as 1a Higher initial Capex than 1a Complexity associated with significantly larger structure.
Pathway 1c – Converting into MBR during the consent period	Similar technology to Pathway 2, thus more efficient in nutrient removal. Staged approach to change in technology – more manageable lead in time for replacement of existing infrastructure than Pathway 2. Introduction to more compact technology thus of benefit on this compact site and capable of	Significantly higher Capex Higher operating cost associated with process aeration and membrane cleaning.

	catering for a larger population than pathways 1a, 1b and 1d.	
Pathway 1d – Side-stream MBR	Better final effluent quality than Pathway 1a and 1b in terms of TSS, BOD_5 and pathogens Staged expansion of MBR (by removing trickling filters) Able to cater for a larger population within the existing site footprint	Additional operational complexity associated with MBR (two types of technology being operated) Higher operating cost associated with process aeration and membrane cleaning
Pathway 2 – Converting into MBR at the start of the consent period ("Enhanced Quality"	Compared to Pathway 1, significant improvement in discharge quality immediately by a new treatment process (e.g. MBR) Able to cater for a larger population within the existing site footprint	Very high capital cost as existing plant assets will be replaced by a new treatment process High operating costs associated with process aeration and membrane cleaning. May require another extensive upgrade if the future NES is significantly more stringent than the assumptions being made.

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