

16 June 2025

**LGOIMA 25-102**

7(2)(a)

Tēnā koe 7(2)(a)

**Request for information: Porirua Wastewater Treatment Plant**

Thank you for your request for information, which was transferred to Wellington Water by Porirua City Council on 10 May 2025 under section 12 of the Local Government Official Information and Meetings Act (LGOIMA – the Act) 1987 related to questions to the recent Joint Venture committee meeting.

We have considered your request in accordance with the Act. Please refer to the appendix on the following page for our responses to each of your questions.

Please note that, in line with our commitment to transparency and in accordance with LGOIMA best practice, we intend to publish this response

<https://www.wellingtonwater.co.nz/about-us/official-requests/official-information-act-responses/> with your personal information removed.

You have the right to seek a review of this response by the Ombudsman under section 27(3) of the Act. Information about how to make a complaint is available at [www.ombudsman.parliament.nz](http://www.ombudsman.parliament.nz) or freephone 0800 802 602.

If you wish to discuss this decision with us, please feel free to email us at [official.information@wellingtonwater.co.nz](mailto:official.information@wellingtonwater.co.nz)

Nāku noa, nā

7(2)(a)

**Chief Operating Officer**

## APPENDIX

1. *Fixing the sludge handling process is vital, the cost of \$8million in just four years - to dump tonnage at the landfill is a gross and irresponsible waste of ratepayers' money. Why the continual deferrals?*

The Porirua WWTP Alternative Solids Handling Upgrade (Stages 1-3) project has not been deferred. Please note that this project is focused on improving the operational reliability of the existing process, and increasing capacity to accommodate expected population growth to 2048. It will not reduce the amount of sludge that needs to be disposed of at landfill.

2. *Why did Council agree to an \$8 million odour project when fixing the sludge handling would resolve the odour?*

For clarity, please note that the Porirua WWTP Solids Handling Upgrade (Stages 1-3) is not an odour project, and will not resolve any of the existing odour issues. The odour project referred to addresses a separate issue, the Air Discharge resource consent condition requirement. For the detailed technical assessment of the Best Practicable Option please refer to:

[https://www.wellingtonwater.co.nz/assets/rep\\_porirua\\_wwtp\\_bpo\\_options\\_fnl\\_v1\\_clean.pdf?file-size=6.6+MB&file-type=pdf](https://www.wellingtonwater.co.nz/assets/rep_porirua_wwtp_bpo_options_fnl_v1_clean.pdf?file-size=6.6+MB&file-type=pdf)

4. *Please provide a copy of Solids Stream Upgrade*

The Porirua WWTP Solids Handling Upgrade project is being delivered in stages, according to priority based on capacity issues that result in environmental impact.

Please refer to the provided document titled Activity Brief: Porirua WWTP Solids Handling Upgrade – final for issue

Information has been withheld under section 7(2)(a) – *protect the privacy of natural persons*.

In accordance with section 7(1) of the Act, we do not consider the withholding of information under the respective section(s) 7 of the Act is outweighed by other considerations which render it desirable, in the public interest, to make that information available.

It may be helpful to note that project updates are included in the Porirua WWTP monthly email Newsletter and all relevant information is on GETS – under Porirua WWTP Alternative Solids Handling Upgrade – Stage 1.

# Porirua WWTP Solids Investigation: Solids Stream Upgrade

PREPARED FOR WELLINGTON WATER | November 2021

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We design with community in mind

Revision Schedule

Rev No	Date	Description	Signature of Typed Name (documentation on file)			
			Prepared by	Checked by	Reviewed by	Approved by
<b>A</b>	22/11/21	Draft for Client Review	7(2)(a)			
<b>B</b>	2/12/21	Following Client Review				

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STATUS Draft for Client Review | Project No 310103619

# Executive summary

The Porirua wastewater treatment plant (WWTP) experiences a variety of challenges with its solids stream process, including poor sludge settleability, poor performance of the gravity thickeners, and limited cake storage capacity. In addition, plant operators have maintained long sludge ages to assist centrifuge performance. The net result of these issues is excessive accumulation of solids in the aeration basin, which in turn has led to sludge carryover from the secondary clarifiers during high wet weather flows.

The main issues with the solids stream process are

## Capacity

- The gravity thickeners are currently overloaded resulting in poor solids capture.
- The gravity thickeners are thought to be limiting cake production due to low thickened WAS solids concentrations particularly towards the end of the week when sludge levels in the thickeners are at their lowest.
- The dewatering/disposal operation is close to capacity at the current 5 day per week operation and existing bin capacity.

## Redundancy

- The gravity thickeners have no redundancy.
- The centrifuges and feed pumps have no redundancy (apart from that provided by weekend dewatering).

## Storage

- Gravity thickener storage capacity is exhausted on the weekends resulting in recirculation of WAS.
- Bin capacity limits cake production and the bins require frequent manual moving and raking to avoid spillage.

## Process Control

- MLSS and sludge age are uncontrolled.
- Around 40% of pumped WAS solids are recirculated back to the aeration basin, making process monitoring difficult.

An upgrade of the solids stream is recommended to debottleneck the system and allow for projected population growth. The proposed upgrade comprises the following elements:

- New WAS pump station (duty / standby)
- New WAS thickeners (duty / duty / standby)
- Conversion of existing gravity thickeners to TWAS storage tanks
- Dewatering / cake storage upgrade; either
  - New self-levelling bins plus additional centrifuge & 14 hour/day duty/duty/standby dewatering; or
  - New live-bottom cake hopper plus move to 24 hour/day duty/standby dewatering

The solids stream upgrade should be implemented within a 3-year timeframe. In the intervening period the existing gravity thickener operation should be optimized to improve solids capture and avoid recirculating WAS.

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## Abbreviations

Abbreviation	Full Name
GBT	Gravity belt thickener
MLSS	Mixed liquor suspended solids
RAS	Return activated sludge
RDT	Rotary drum thickener
SVI	Sludge volume index
SSVI	Stirred sludge volume index
SSVI3.5	Stirred sludge volume index at 3.5 g/L
<b>TWAS</b>	Thickened WAS
WAS	Waste activated sludge
WWTP	Wastewater treatment plant

# 1 Introduction

The Porirua wastewater treatment plant (WWTP) experiences a variety of challenges with its solids stream process, including poor sludge settleability, poor performance of the gravity thickeners, and limited cake storage capacity. In addition, plant operators have maintained long sludge ages for assisting centrifuge performance. The net result of these issues is excessive accumulation of solids in the aeration basin, which in turn causes the following issues with secondary clarifier operation:

- The operators must spend a lot of time and effort in monitoring and manually adjusting the secondary clarifiers to prevent sludge from spilling over the clarifier weirs (termed “sludge carryover events”).
- In an effort to prevent sludge carryover events during wet weather, the plant operators sometimes restrict flow from the aeration basin to the clarifiers, using the aeration basin as wet weather storage. The plant was not designed for this mode and there is a risk of overtopping the aeration basin walls.
- During high wet weather flows, sludge carryover usually occurs anyway. This has occurred eight times so far in 2021. Sludge carryover events breach the plants resource consent and cause a plume of solids at the plant outfall.

The original design flow rate for the secondary clarifiers following Clarifier 3 construction was 1,550 L/s. However due to the capacity of the aeration basin feed pipe (part of the original plant design), the current peak flow rate able to be passed forward to the clarifiers is approximately 900 L/s with excess flows bypassing the aeration basin to the UV channel. The hydraulic upgrade of the WWTP planned for completion in Q1 2022 will allow for the current bypasses to be sent forward to the aeration basin and clarifiers. Due to the existing sludge carryover issues, there is concern that the secondary clarifiers will not have capacity for the higher flows and therefore the frequency of sludge carryover events will increase

It is therefore urgent that the solids handling issues are addressed so that the sludge carryover events are prevented in future. Stantec have been engaged to investigate the solids system and to recommend short- and medium-term improvements to debottleneck the solids stream process.

The solids investigation has been carried out in two stages:

## **Stage 1 – Clarifier Investigation**

The first stage investigated the causes of the sludge carryover events and recommended measures to prevent these occurring. This investigation studied the settling properties of the sludge and modelled clarifier operation using a dynamic process model calibrated with sludge settleability and plant monitoring data.

Based on the measured settleability of the sludge, the investigation recommended a MLSS concentration of 3,500 mg/L to avoid sludge carryover at sustained wet weather flows of 1,300 L/s sustained for up to 14 hours. The MLSS concentration would need to reduce to 3,000 mg/L in future when the peak flow rate increased to 1,550 L/s (sustained for up to 14 hours).

## **Stage 2 – Solids Stream Investigation**

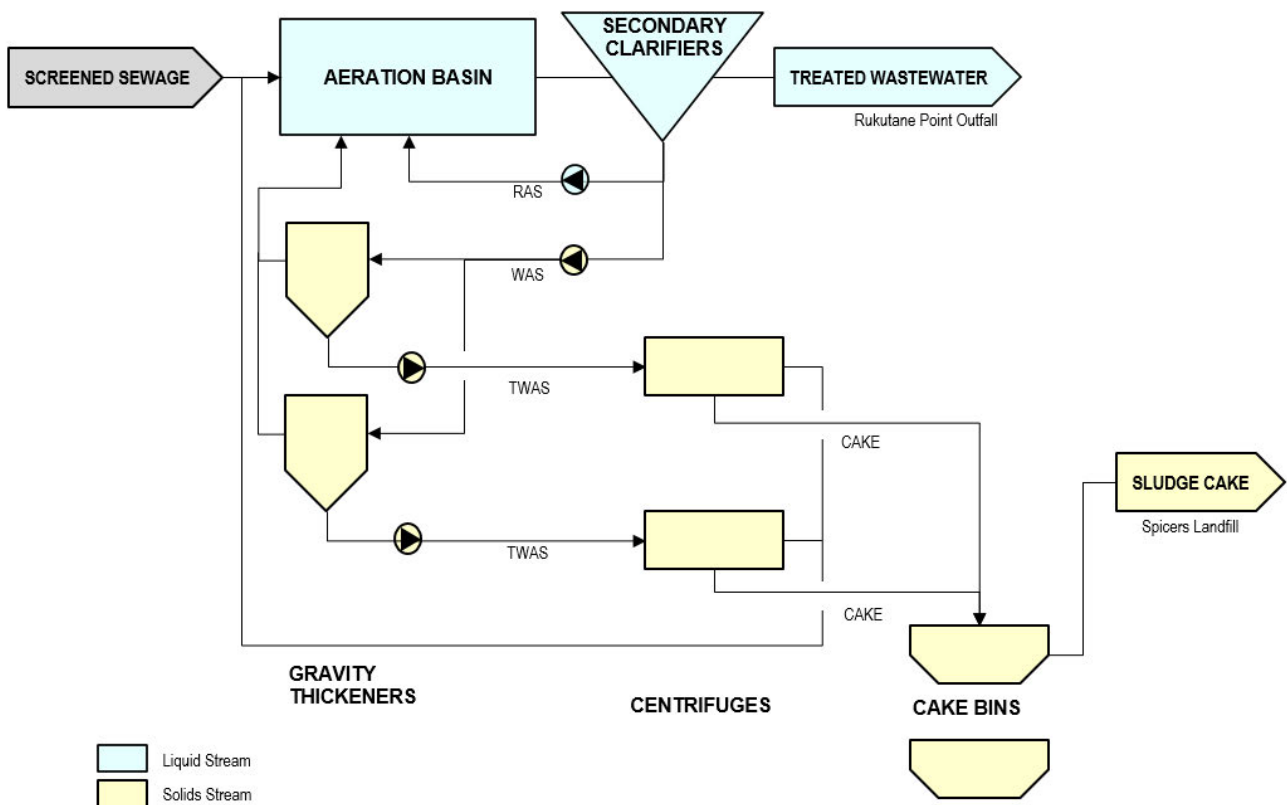
The second stage of the investigation focuses on the Porirua WWTP solids stream process and measures needed to manage the current and projected solids production from the plant based on the most recent population projections and the aeration basin MLSS requirements discussed above.

This report documents the findings of Stage 2 (Solids Stream investigation).

## 2 Solids Stream Description

### 2.1 Overview

A process flow diagram of the Porirua WWTP is shown in Figure 1.



**Figure 1 Porirua WWTP Process Flow Diagram**

The Porirua WWTP solids stream process consists of the following elements:

- WAS pump station
- Gravity thickeners
- Centrifuge feed pump station
- Centrifuges
- Cake storage bins
- Transport and disposal of dewatered sludge to Spicers Landfill

The solids stream process units are described in the following section.

## 2.2 Solids Stream Process Description

### 2.2.1 Dewatering and Disposal

#### Dewatering

There are two centrifuges that operate in duty / duty mode. Each centrifuge has its own feed pump which pumps from its own gravity thickener (the pipework allows for crossover of equipment if necessary).

The centrifuge capacity was reviewed in 2018 (Connect Water, 2018). It was noted that Westfalia, the centrifuge manufacturer, confirmed in 2015 that the centrifuges have dry solids and hydraulic capacities of 500-700 kg/h and 20-30 m<sup>3</sup>/h respectively per machine. Westfalia noted that higher cake solids were achieved at the lower dry solids loading rate.

Practical centrifuge capacity has been reported to be around 500 kg/h (Veolia pers. comm.); pushing the machines above these limits has been reported to cause excessive wear and maintenance on the centrifuge front and rear bearings. As this is at the low end of the manufacturer's capacity range, further discussions with Westfalia are recommended to see if there is any way to increase capacity above 500 kg/h whilst maintaining cake dry solids and not causing maintenance issues.

The centrifuges and feed pumps have no redundancy. If a centrifuge or feed pump is down for maintenance, the system operates on a single dewatering train. Capacity of the single-train operation can be increased by moving to a 7-day dewatering operation however this would only provide 70% of normal 5-day 2-train capacity.

Centrifuge and feed pump details are shown in Table 1.

**Table 1: Porirua WWTP Centrifuge and Feed Pump Details**

Parameter	Units	Value
<b>Centrifuges</b>		
Make and model		Westfalia UCA 501-00-32
Date of installation		2006
Number		2
Operation		Duty / duty
Capacity – dry solids (per unit)	kg/h	500 (rated capacity 500-700 kg/h)
Capacity – flow rate (per unit)	m <sup>3</sup> /h	26 (rated capacity 20-30 m <sup>3</sup> /h)
Average solids capture	%	93% (May to October 2021)
<b>Centrifuge Feed Pumps</b>		
Make and model		Allweiler AEB 2E 1450
Date of installation		2006
Number		2
Operation		Duty / duty
Capacity – flow rate (per unit)	m <sup>3</sup> /h	30

#### Disposal

Dewatered sludge is delivered to Spicers landfill in Porirua in skip bins containing 3.0 to 5.5 wet tonnes of sludge (average delivery weight 4.5 wet tonnes). The landfill accepts WWTP sludge from 7 am to 3 pm Monday to Friday. If needed due to equipment breakdown or emergency, sludge can also be accepted on weekends (7 am to 3 pm Saturday and 9 am to 3 pm on Sundays) by special arrangement with the landfill.

Cake production is limited by landfill operating hours and the current agreement between Spicer's Landfill (via Porirua City Council) and operations (Veolia/WWL) to accept a certain number of bin loads.

Both centrifuges start automatically at around 4:30 am each morning so that one bin is ready for pickup at 7:00 am. Both centrifuges discharge into a single bin, allowing one bin to be transported to the landfill and returned to site while the other is filling. It takes around 45 to 50 minutes for both centrifuges to fill one bin. The final bin is picked up at around 2:30 pm after which dewatering ceases for the day.

Cake production capacity is summarised in Table 2 for both the current 5 day per week operation and 7 day per week operation (for comparison, assuming that weekend disposal is possible).

**Table 2: Porirua WWTP Cake Production Capacity**

Parameter	Units	Value	Comment / Basis
<b>Monday to Friday (normal operation)</b>			
Initial production (prior to 7 am)	kg ds	870	One bin ready by 7 am
Cake production during day	kg ds	7,200	7.5 hours at maximum capacity
Maximum cake production per day	kg ds	8,070	
<b>Weekends (if allowed by landfill for short periods)</b>			
Saturday	kg ds	8,070	Same as weekdays
Sunday	kg ds	6,150	Two hours less dewatering time available
<b>Weekly Production Capacity – Monday to Friday (normal operation)</b>			
Weekly total	t ds	40	
7-day average	t/day	5.7	
<b>Weekly Production Capacity – 7 Day Operation</b>			
Weekly total	t ds	55	
7-day average	t/day	7.8	

Throughout 2021, dewatering occurred from Monday to Friday with no weekend dewatering. Cake production averaged approximately 30 tonnes dry solids per week or 75% of available capacity (excluding weekend capacity).

Whilst the above indicates there is reasonable spare capacity in the system, the following issues are noted:

- Dewatering capacity is thought to be limited by thickener performance as the centrifuges require a constant 2.0% feed concentration to achieve the dry solids capacity. It has been noted by the operators that the centrifuge feed solids concentration reduces throughout the week as the thickener sludge levels are drawn down (Veolia, pers. comm.).
- The aeration basin MLSS was excessively high (above 5,000 mg/L) from March to June 2021 indicating insufficient solids removal from the system.
- As noted previously, the centrifuges and feed pumps have no redundancy. When a centrifuge or feed pump is down for maintenance, the remaining train could switch to 7-day operation however this relies on the landfill agreeing to accept sludge on weekend and would still only provide 70% of normal 5-day capacity.
- The cake bins are not self-leveling and must be moved and manually raked frequently to even out the cake and avoid spillage of cake over the sides.
- The landfill may restrict daily cake production if there is insufficient commercial waste to mix with the sludge cake at the minimum ratio to avoid odour and vector issues. It is understood that this has occurred from time to time, most recently during the Covid Level 4 lockdown when landfill waste volumes dropped (Veolia, pers. comm).

## 2.3 Gravity Thickeners

There are two gravity thickeners which operate in duty / duty mode. The thickeners are fed simultaneously from the WAS pump but the split between the two thickeners is not controlled or measured. The thickeners are fed from the WAS pump station and thicken and store solids in the base, with clarified supernatant returned to the aeration basin.

There is no polymer addition to the feed sludge. The gravity thickeners have rotating “picket fence” agitators to assist thickening and compaction in the base. Feed to the thickeners is 7 days per week however sludge withdrawal is limited to dewatering hours (see previous section) so the gravity thickeners need to store sludge overnight and on the weekends.

Thickener details are presented in Table 3.

**Table 3: Porirua WWTP Gravity Thickener Details**

Parameter	Units	Value	Comment
Internal diameter	m	12	
Side wall depth	m	3.5	
Surface area (both thickeners)	m <sup>2</sup>	226	
Textbook solids loading rate range	kg/m <sup>2</sup> /d	20 - 50	Metcalf & Eddy (2014)
Adopted average loading rate capacity	kg/m <sup>2</sup> /d	20	For purposes of evaluation
Adopted average solids load capacity	kg/d	4,500	For purposes of evaluation
<b>Current average applied load</b>	kg/d	7,000	See Figure 3.
TWAS solids concentration	%	2.0	Average value 2020 - 2021

The following issues are noted with the gravity thickeners:

- The thickeners are operating at or close to their capacity based on the adopted solids loading rate although still within the textbook range (Metcalf and Eddy 2014).
- There is no redundancy.
- Thickeners limit dewatering capacity when the TWAS concentration is less than 2.0% solids. Due to the need to store solids over the weekend, the sludge levels in the thickeners reduce during the week, which is thought to reduce the thickened WAS concentration.
- Thickener storage is often exhausted over the weekend, resulting in WAS being recirculated to the aeration basin.

## 2.4 WAS Pump Station

There are two WAS pumps which operate in duty / standby mode to pump sludge from the clarifier underflow to the gravity thickeners. The pump details are provided in Table 4.

**Table 4: Porirua WWTP WAS Pump Details**

Parameter	Units	Value
Make and model		Flygt NT3153
Motor size	kW	13.5
Date of installation		2015
Capacity per pump	L/s	35

The duty WAS pump operates at 18 L/s which is the minimum flow rate achievable by the pump VSD (and to achieve self-cleansing velocity in the DN150 transfer pipe). As this flow rate is greater than needed for continuous operation the WAS pump operates intermittently (typically on a half hour on, half hour off basis).

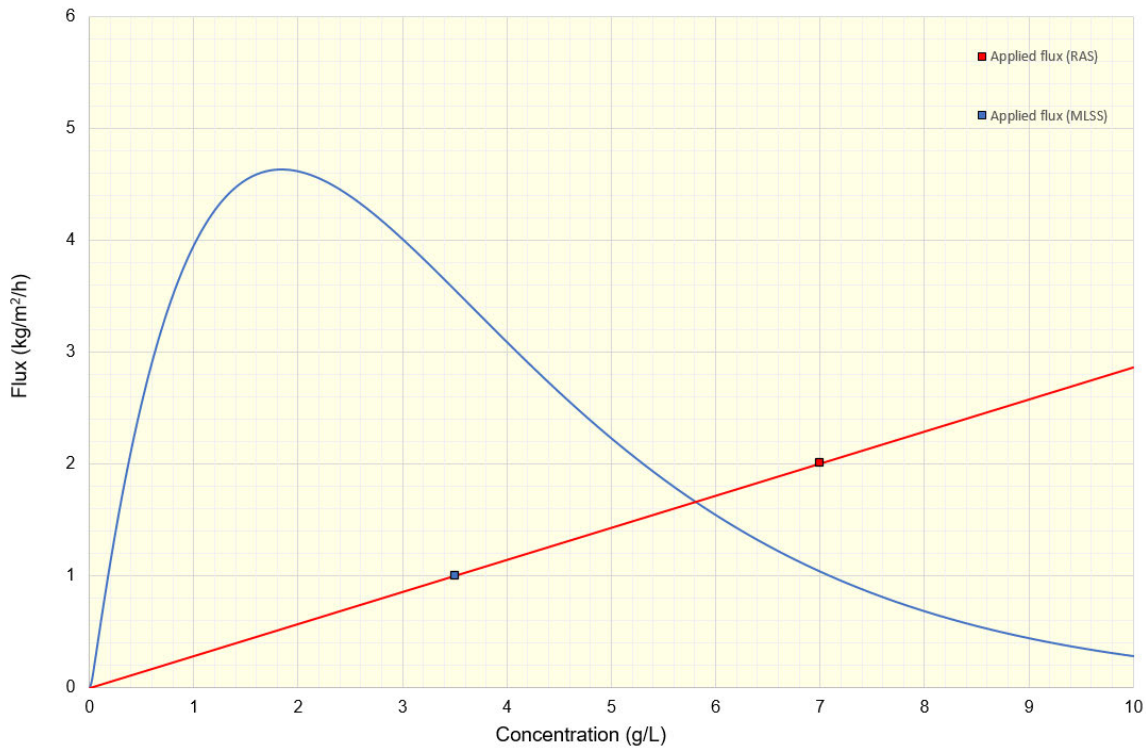
The following issues are noted with the WAS pump operation:

- Intermittent (stop/start) feed is not ideal for gravity thickener performance. Continuous feed would improve performance.
- Based on recent sludge settleability tests which show poorly settling sludge, the gravity thickeners are hydraulically overloaded when the centrifuges are not operating (see Figure 2 overleaf).

Figure 2 shows the gravity flux curve based on recent settleability testing, as well as overflow flux points at the WAS flow rate of 18 L/s assuming the centrifuges are not operating (ie all feed flow is overflow):

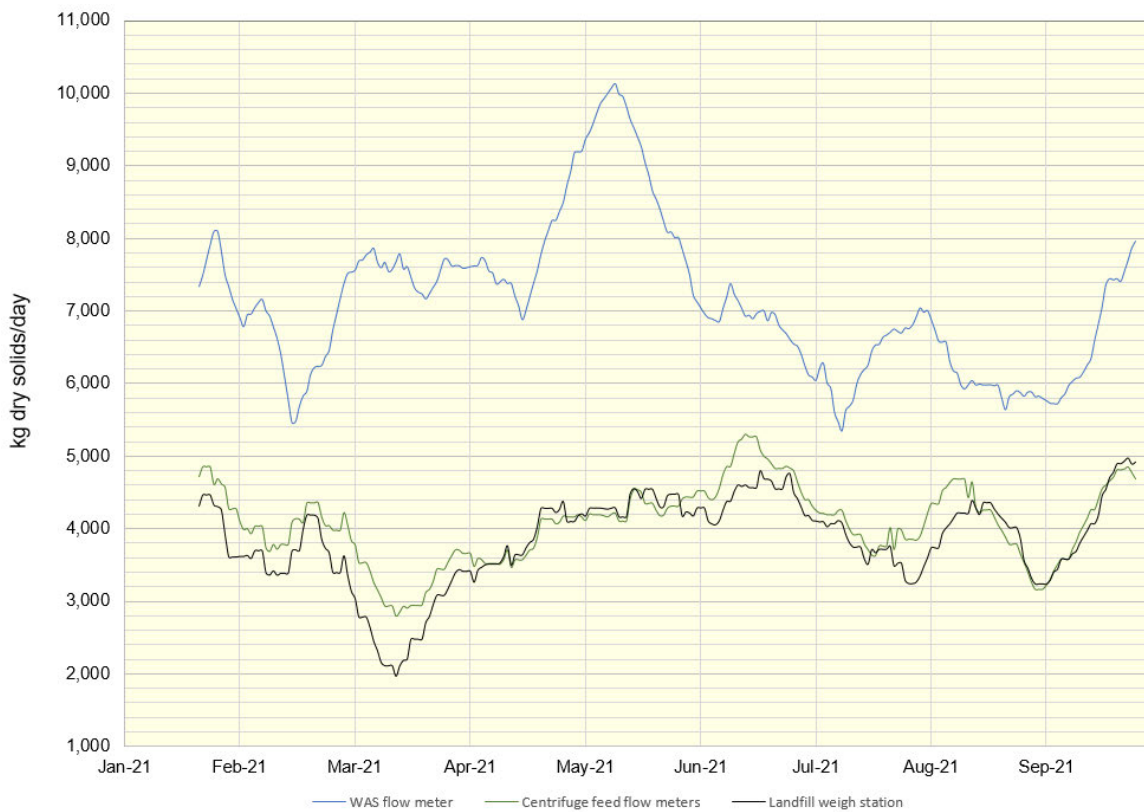
- RAS (assuming 7 g/L TSS)
- MLSS (assuming 3.5 g/L TSS)

As shown in Figure 2, the overflow RAS solids flux using RAS is outside the gravity flux curve, indicating hydraulic overload.



**Figure 2 Porirua WWTP Gravity Thickeners Solids Overflow Flux (Centrifuges not Operating)**

Figure 3 shows the average daily WAS solids load at the WAS pump station (MLSS concentration x WAS volume), the centrifuge feed (centrifuge feed % solids x centrifuge feed volumes) and landfill weigh station records (cake % solids concentration x landfill weigh station weights).



**Figure 3 Porirua WWTP Estimated Average WAS Solids Loads (21 Day Averages)**

As shown in Figure 3, solids capture is poor, resulting in sludge being recirculated. In 2021, WAS pumping averaged around 7,000 kg/day dry solids compared with 4,000 kg/day dry solids leaving the site. This is an overall capture rate of around 60% with the remaining 40% recirculating. The low capture rate in the gravity thickeners is due to overloading of the thickeners. This needs to be addressed so that the mass of WAS solids pumped to the thickeners is matched to thickener capacity and cake production.

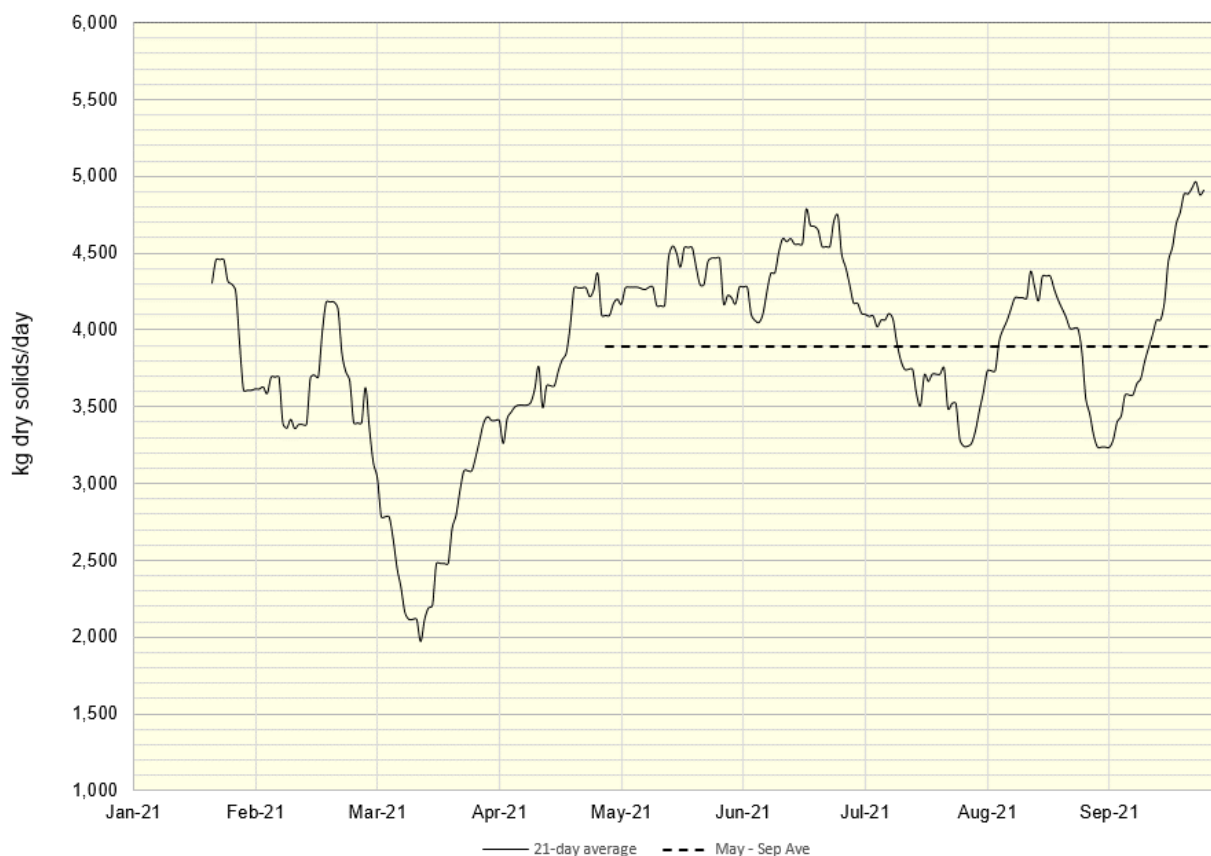
A trial involving wasting from the aeration basin to the thickeners is proposed (see Section 6.1) which would provide continuous thickener feed and greater control of thickener feed loads. Wasting from the aeration basin would improve solids capture by reducing the applied solids flux on the thickeners and assist sludge age and MLSS control by taking out the effect of variable RAS/WAS concentration.

## 2.5 Current Solids Production

Solids production, is presented in Figure 4. Solids production is calculated by multiplying the landfill weigh station weights by the average cake solids content measured at the WWTP for that day.

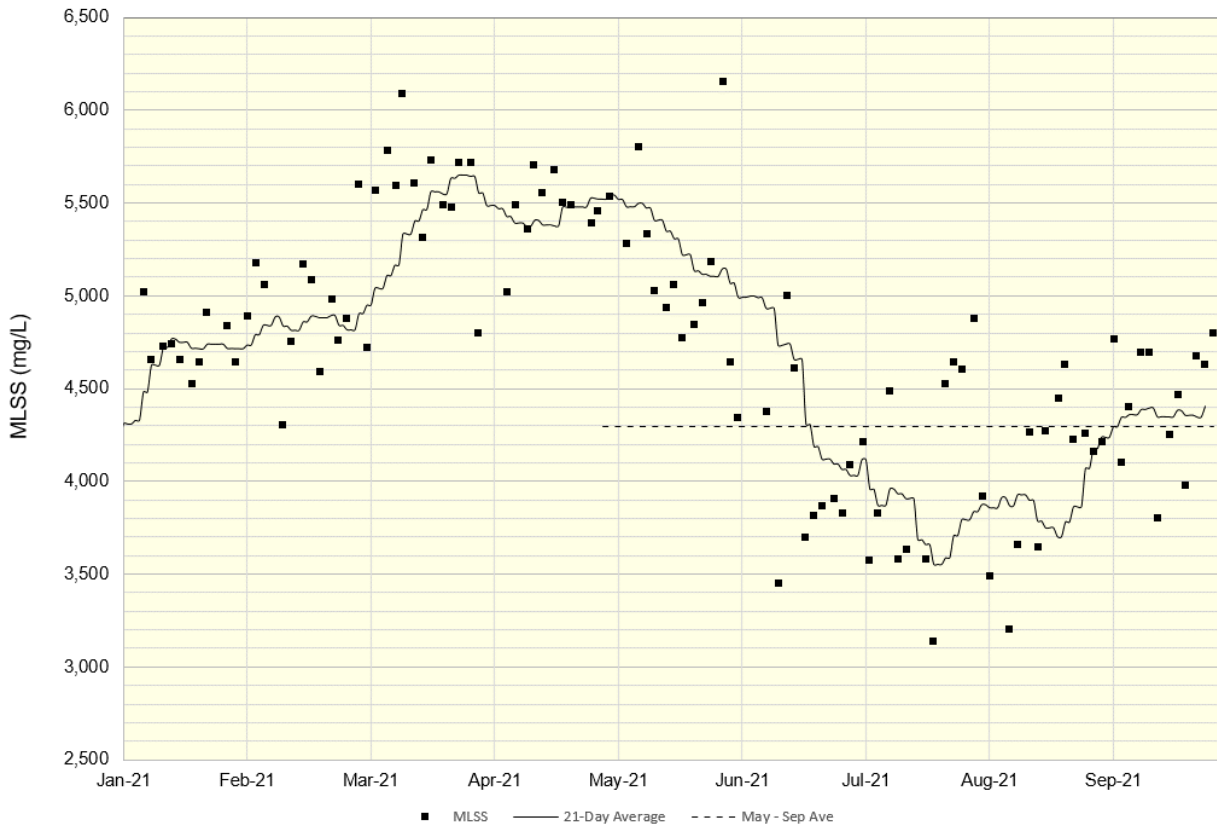
Rolling 21-day averages are used to smooth out the intermittent sludge removal from site (and to align with estimated average sludge age).

The average value from May to September 2021 is shown on the graph, as excessive sludge accumulation in the aeration basin occurred during March and April 2021 which is not considered typical plant operation.



**Figure 4 Porirua WWTP Solids Production 2021 (Weigh Station Records)**

MLSS concentrations for 2021 are presented in Figure 5 overleaf.



**Figure 5 Porirua WWTP MLSS 2021**

Sludge age is presented in Figure 6. Sludge age is estimated by dividing the average solids mass in the aeration basin by the average solids production from weigh station records.



**Figure 6 Porirua WWTP Sludge Age 2021**

As shown in the above figures, MLSS and sludge age are essentially uncontrolled.

## 2.6 Solids Stream Issues Summary

In summary, the main issues with the Porirua WWTP existing solids stream process are:

### Capacity

- The gravity thickeners are currently overloaded resulting in poor solids capture.
- Thickeners are thought to be limiting cake production due to low thickened WAS solids concentrations particularly towards the end of the week when sludge levels in the thickeners are at their lowest.
- The dewatering/disposal operation is close to capacity at the current 5 day per week operation and bin capacity.

### Redundancy

- The gravity thickeners have no redundancy.
- The centrifuges and feed pumps have no redundancy

### Storage

- TWAS storage – Gravity thickener storage capacity is exhausted on the weekends.
- Sludge cake storage – Cake bin capacity limits cake production and the bins require frequent manual moving and raking to avoid spillage.

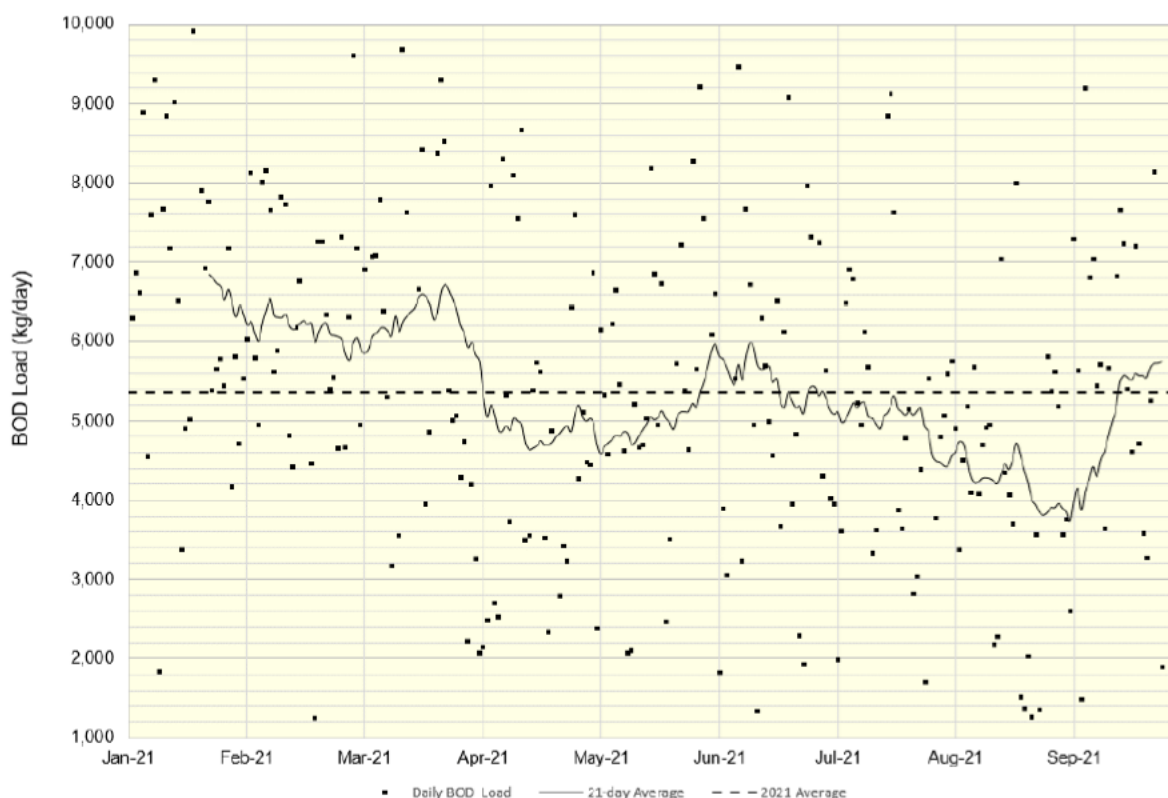
### Process Control

- MLSS and sludge age are uncontrolled.
- Around 40% of pumped WAS solids are recirculated back to the aeration basin, making process monitoring difficult and compromising process performance.

# 3 Solids Stream Design Basis

## 3.1 Influent BOD Load

Composite samples of screened influent are taken daily and analysed for BOD and TSS. Influent BOD loads calculated from the composite sample BOD concentrations and daily influent volumes are presented in Figure 7.



**Figure 7 Porirua WWTP Influent BOD Loads January – September 2021**

There is a problem with the influent composite sampling as shown by the high degree of scatter in the BOD load data. Reasonably accurate influent load data is a critical tool in the management of a treatment plant; the variability of the Porirua influent sampling data as indicated by Figure 7 is higher than expected for municipal wastewater. The sampling system should be investigated and rectified to establish a useful influent load database going forward. A change to measuring COD loads is also recommended, in line with best practice for modelling.

An estimate of the current average BOD load based on the influent data along with the current population estimate is provided in Table 5. Per capita BOD load is also shown, along with the per-capita BOD load estimates from the previous two influent studies.

**Table 5: Porirua WWTP Estimated Per Capita Average BOD Load**

Parameter	Unit	Value
2021 Average daily BOD Load	kg/d	5,350
Connected population	people	92,680
Per capita BOD load	g/p/d	58
Per capita BOD load (Connect Water 2019)	g/p/d	57
Per capita BOD load (Cardno 2017)	g/p/d	51

A more accurate measurement of influent loads will be undertaken as part of the planned influent sampling campaign in early 2022 and the figures in this report will be updated.

## 3.2 Influent Characteristics

Two investigations have been carried out into the Porirua WWTP influent characteristics within the last four years: Cardno (July 2017) and Connect Water (June 2019). The resulting influent COD fractions from these reports are presented in Table 6.

**Table 6: Porirua WWTP Model Influent COD Fractions**

	Connect Water 2019	Cardno 2017	WWL 2022
<b>Fractions:</b>			
Soluble inert fraction of total COD	0.092	0.050	TBC
Readily biodegradable fraction of total COD	0.14	0.089	TBC
Particulate inert fraction of total COD	0.20	0.23	TBC
Particulate fraction of slowly biodegradable COD	1.00	0.93	TBC
COD:VSS ratio of particulate COD (inert & biodegradable)	1.70	1.65	TBC
COD:VSS ratio of biomass and decay products	1.42	1.42	TBC

A steady state process simulation was undertaken at the estimated average BOD load and 21-day sludge age (based on cake removal), using the average Cardno and Connect Water influent characterisation values. The resulting MLSS concentrations are shown in Table 7.

**Table 7: Comparison of Porirua WWTP Influent Characteristics Solids Production Values**

	Units	Value
Average Influent BOD load	kg/day	5,350
Average sludge age	days	21
Average MLSS temperature	°C	15
Average MLSS	mg/L	4,300
<b>Model steady state MLSS (Connect Water fractions)</b>	mg/L	4,290
Model steady state MLSS (Cardno fractions)	mg/L	4,810

Due to the closer agreement with the average measured MLSS value, the Connect Water influent characteristics have been adopted for the process modelling in this report.

An influent characterisation sampling campaign is planned for the Porirua WWTP early 2022 and the influent fractions and process modelling will be updated once the results of this campaign are available.

### 3.3 Projected Population Growth

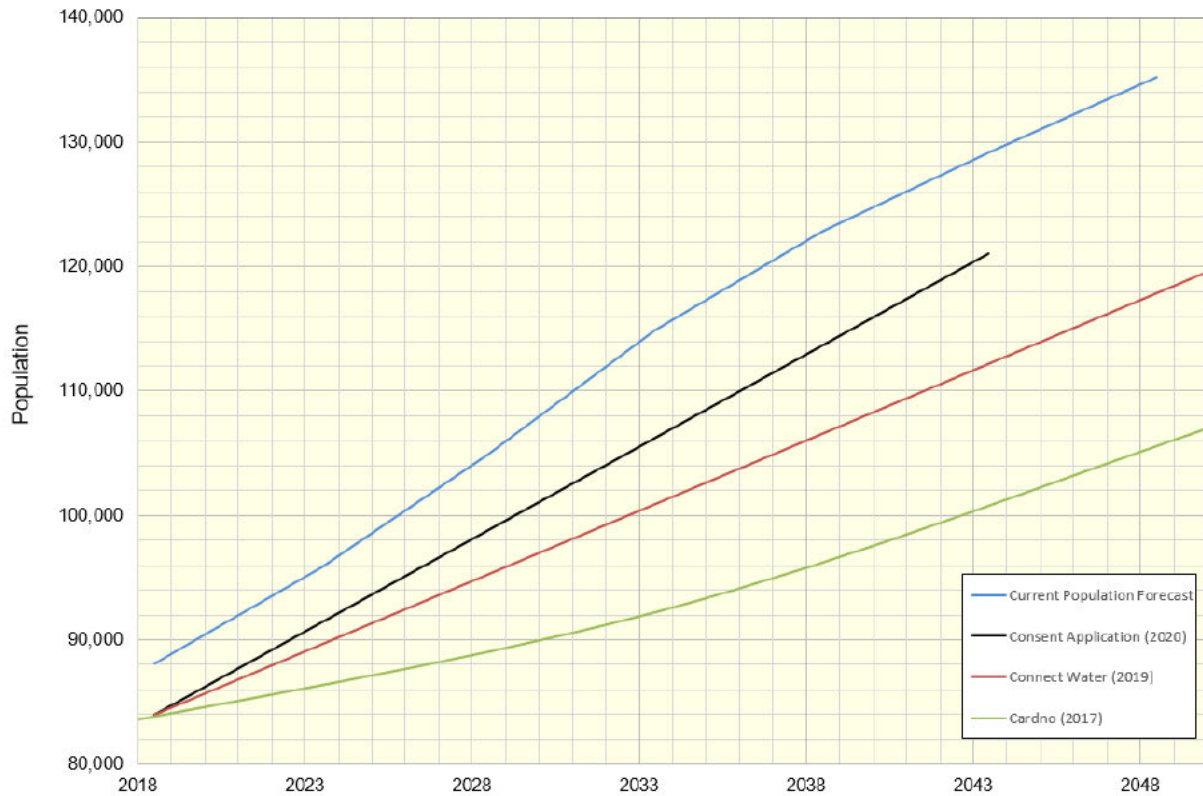
The most recent provisional 50<sup>th</sup> percentile Porirua WWTP catchment population projections are shown in Table 8 (Sense Partners Ltd, 2021). These projections are currently under review but provide the scale of predicted growth for comparison with previous predictions. The numbers will be updated if necessary following review and issue of the final projection figures.

**Table 8: Porirua WWTP 50<sup>th</sup> Percentile Catchment Projected Populations**

		2018	2021	2023	2028	2033	2038	2043	2048
Population	people	88,054	92,685*	95,772	104,917	114,889	122,800	129,155	135,256

\* Current population estimated from 2018 population and projected 2018-2023 growth rate

The most recent projected growth rates are significantly higher than previous estimates as shown in Figure 8 which shows the predicted current forecast and the growth forecasts used in the 2020 consent application, the 2019 Connect Water report and the 2017 Cardno report.



**Figure 8 Porirua WWTP Catchment Projected Populations (Provisional Values)**

The current forecast annual growth rate is the same as in the 2020 consent application, however the 2018 population estimate has increased by 4,000 people. The current forecast growth rate is 30% and 80% higher than those referenced in the Connect Water and Cardno reports respectively.

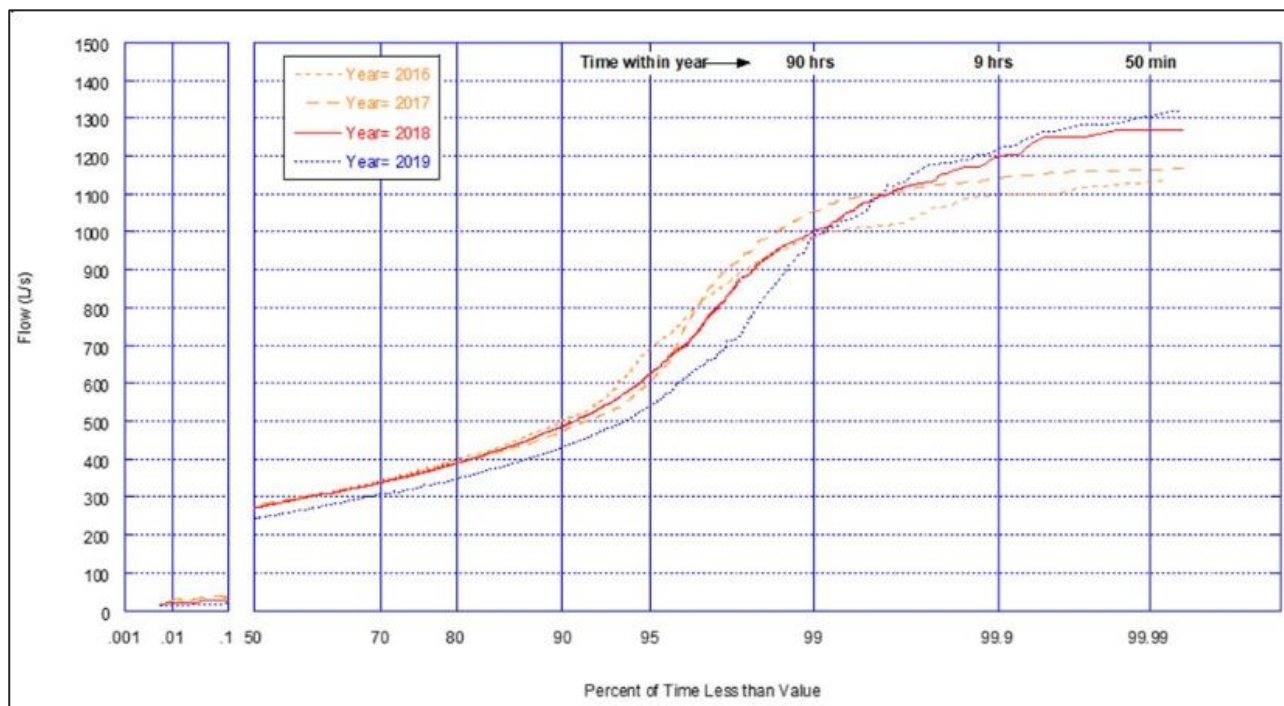
Such a large increase in projected growth rates over a short time period appear somewhat unusual. The provisional growth forecast figures should be confirmed by Wellington Water.

# 4 Projected Solids Production

## 4.1 MLSS Concentration Limits

Based on sludge settleability measurements, the recent clarifier investigation recommended MLSS concentrations of 3,500 mg/L and 3,000 L/s to prevent sludge overflows at peak wet weather flow rates of 1,300 L/s and 1,550 L/s respectively (Stantec, 2021). These flow rates correspond to the current and future (2037) terminal pump station capacities feeding the WWTP. The 1300 L/s peak flow will occur in 2022 once the hydraulic upgrade is completed.

Figure 9 shows the frequency distribution of influent flows from 2016 to 2019 (taken from the 2020 Porirua WWTP consent application)



**Figure 9 Porirua WWTP Frequency distribution of wastewater flows for years 2016 to 2019 (Wellington Water June 2020)**

As shown in Figure 9, the influent flow rate exceeded 1,300 L/s approximately 0.01% of the time (50 minutes per year) based on 2016-19 data.

Controlling the aeration basin MLSS concentration to a set point is difficult due to the large sludge inventory in the aeration basin and clarifiers and the transfer of sludge to and from the clarifiers. In addition, biological processes operate more consistently at a constant sludge age. Therefore it is recommended that the basin be operated at a constant sludge age rather than MLSS concentration from a practical and process perspective. This means that the MLSS will vary naturally with influent load while the sludge age remains relatively constant.

A sludge carryover event requires a high MLSS concentration coinciding with a wet weather event. As these two events are independent of each other, the probability of this occurring is the product of the individual probabilities of either event.

Based on this, for design purposes it is considered reasonable to set the clarifier MLSS limits mentioned above as average values and not maximums. Setting the clarifier MLSS limits as maximums would be overly conservative and lead to low average MLSS concentrations, low sludge ages and high sludge production.

Sufficient flexibility should be provided in the solids stream process to enable the sludge age to be adjusted based on observed plant performance (MLSS, influent load variation, sludge settleability) to keeping the plant within a safe operating envelope and avoiding the risk of sludge carryover.

When the plant is operating in a stable fashion at a consistent sludge age (which has not occurred in the recent period studied) a better picture of the natural influent load variability should become apparent. For the purposes of this report some assumptions have been made on influent load variability (see Section 4.3).

## 4.2 Process Model

To model the sludge age and solids production from Porirua WWTP over time, a process model of the Porirua WWTP was constructed using GPS-X software. A copy of the GPS-X model drawing board is presented in Figure 10.

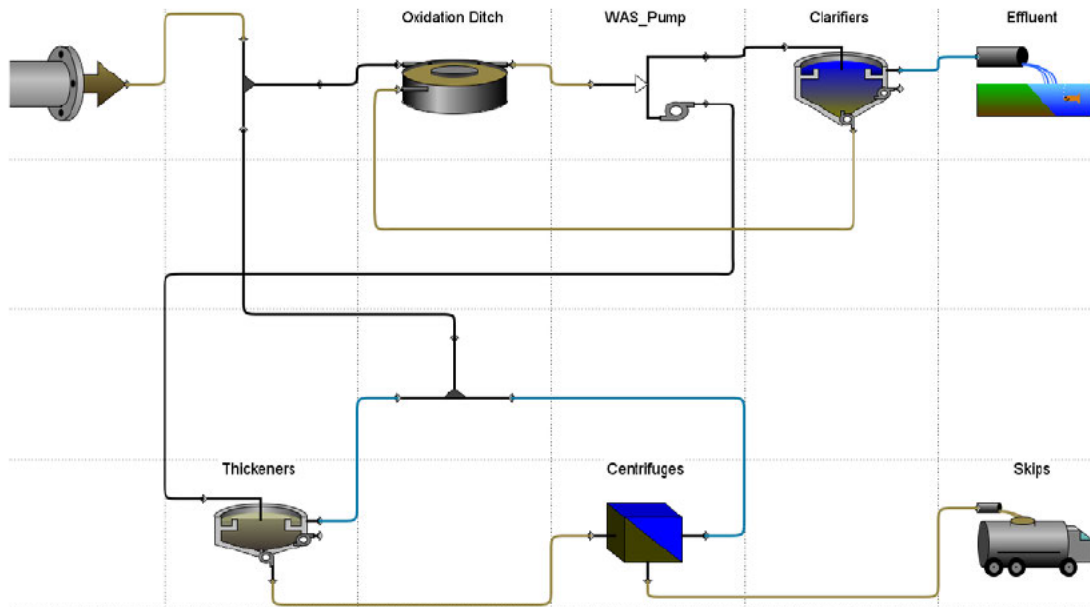


Figure 10 Porirua WWTP GPS-X Model Drawing Board

The model used the estimated per capita BOD load (Section 3.1), the 2019 Connect Water influent fractionation (Section 3.2) and the provisional population growth forecast figures (Section 3.3). These figures will be updated in early 2022 following the planned influent characterisation sampling campaign.

For each modelled year and population scenario, the following modelling procedure was followed:

1. Enter population and corresponding average daily loads.
2. Enter an initial wasting rate and run a steady state model.
3. Compare MLSS with clarifier MLSS limit.
4. Adjust wasting rate if needed and re-run steady state model.
5. Repeat steps 3 and 4 until the MLSS equals clarifier limit. Note sludge age and solids production.
6. Apply maximum steady state load peaking factor and run steady state model for maximum load case.
7. Run a dynamic model over 14 days to assess maximum day and week solids production.

## 4.3 Load Peaking Factors

In the absence of reliable influent load data the following design influent load peaking factors were assumed for calculating peak solids production:

Table 9: Porirua WWTP Model Influent Load Peaking Factors

Period	Load Peaking Factor	Comment
16 days	1.20	Steady state load peaking factor intermediate sludge age
11 days	1.23	Steady state load peaking factor lower sludge age
7 days	1.30	Maximum weekly sludge production
1 day	1.80	Maximum daily sludge production

## 4.4 Sludge Age and Solids Production

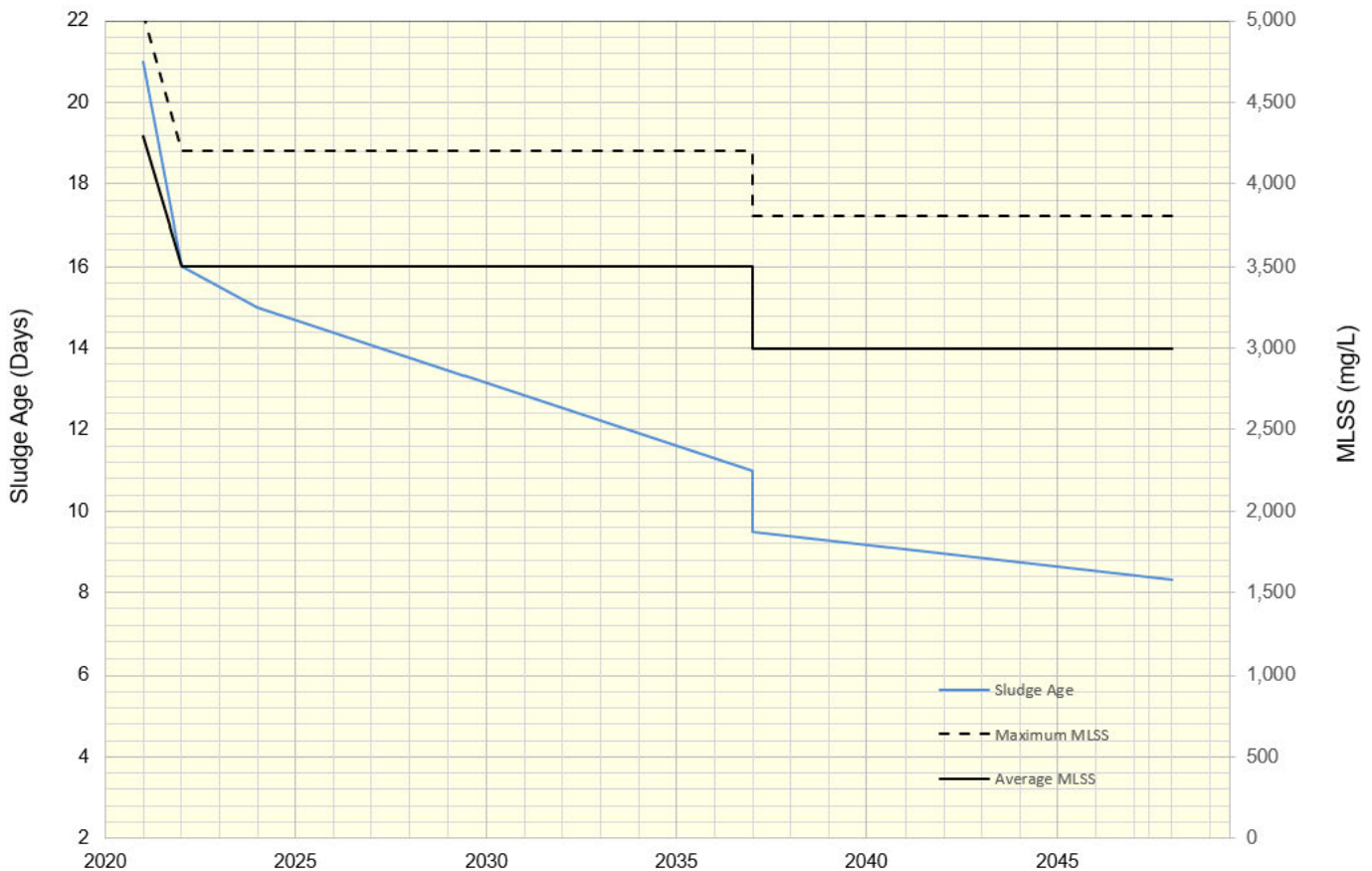
Sludge age and Solids production at 15 degrees C predicted by the process model is shown in Table 10.

**Table 10: Porirua WWTP Projected Solids Production (15 degrees Celsius MLSS Temperature)**

		Current	2022	2024	2037	2037	2048
Population		92,700	92,700	97,600	121,200	121,200	135,300
Average influent BOD Load	kg/day	5,350	5,350	5,630	7,000	7,000	7,810
Sludge age	days	21	16	15	11	9.5	8.3
Solids yield	kg/kgBODin	0.73	0.77	0.78	0.84	0.87	0.90
<b>Solids production:</b>							
Average	t/day	3.89	4.12	4.40	5.91	6.08	7.01
Maximum week	t/day	4.72	5.15	5.50	7.48	7.83	9.10
Maximum day	t/day	4.80	5.22	5.57	7.62	8.00	9.28

As shown in Table 10 with reducing sludge age, the solids produced per kg of BOD (or person) increases. This is because there is less endogenous decay of biological solids at lower sludge ages. So there is a compounding effect of increased population plus more solids production per head of population.

The modelled MLSS concentrations and corresponding sludge ages over time are shown in Figure 11. The step change in MLSS and sludge age at year 2037 is due to the increase in peak wet weather flow rate at this year and corresponding requirement to reduce the MLSS to protect the clarifiers from sludge blanket overflow.

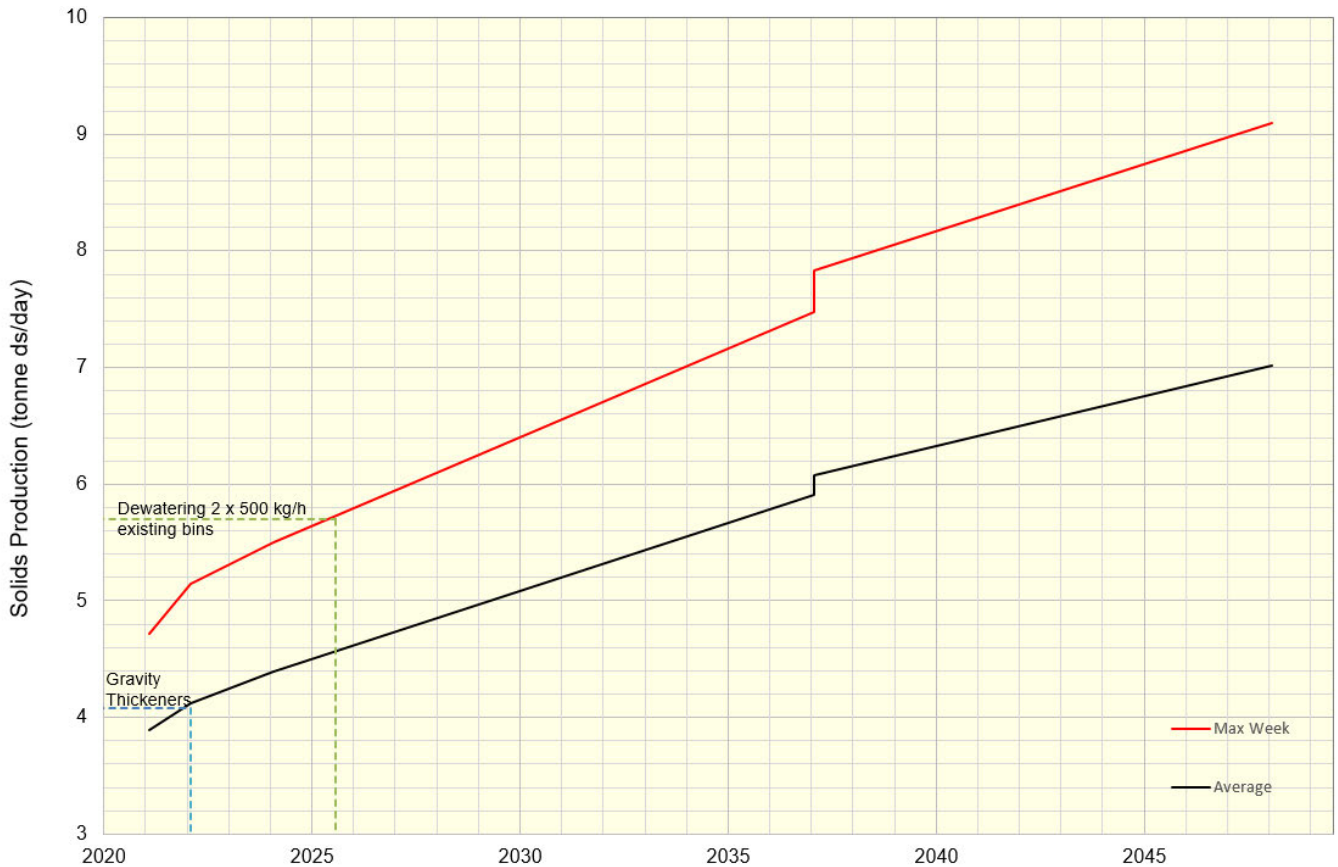


**Figure 11 Porirua WWTP MLSS and Sludge Age**

The projected future solids production loads from Table 10 (maximum week and average day) are presented in Figure 12 along with the existing thickener and dewatering capacities.

The existing thickening and dewatering capacities shown on Figure 12 are based on the following assumptions:

- Thickener solids capture 95%
- Centrifuge solids capture 95%
- Thickener capacity as per Table 3 (based on the average daily solids load)
- Dewatering capacity as per Table 2 for 5,6 and 7 day per week operation
- No landfill limitations on either the amount of sludge received or on weekend reception of sludge



**Figure 12 Porirua WWTP Projected Solids Production and Existing Capacities (5 Day per Week Operation)**

Based on the existing capacities and projected solids production the following key points are noted:

- The gravity thickeners are near or at capacity (this was also noted in the 2017 Cardno assessment).
- The 5 day per week dewatering/disposal operation at current landfill operating hours is close to capacity and is projected to reach its capacity in 2025.

It should be noted that Figure 12 assumes the current 10 hours per day, 5 days per week dewatering hours are maintained and there is no restriction on the amount of sludge able to be accepted at the landfill.

# 5 Solids Stream Upgrade Concept

## 5.1 New WAS Thickeners

As noted in the previous section the existing gravity thickeners are at their capacity and require replacement with new thickeners (ideally within the next 2-3 years) and conversion of the existing thickeners to thickened sludge storage.

Commonly used WAS thickening technologies include rotary drum thickeners, gravity belt thickeners and dissolved air flotation (DAF). Polymer dosing may be needed however the polymer dose is likely to be low. Thickened WAS (TWAS) pumps will be required to transfer TWAS to the storage tanks.

Ideally the new WAS thickeners should thicken to 3 – 4% to maximise TWAS storage capacity, however advice should be sought from Westfalia on the ability of the centrifuges to process at a higher solids content and lower flow rate.

Preliminary process sizing for the WAS thickener and transfer pumps is presented in Table 11.

**Table 11: Porirua WWTP New WAS Thickener and TWAS Transfer Pump Process Sizing**

Parameter	Units	Value	Comment
<b>WAS Thickeners</b>			
Number		3	To provide turndown and redundancy
Type		TBC	Possibly either rotary drum or gravity belt
Redundancy (average load)		Duty / Standby	
Redundancy (max day load)		Duty / Duty	
Capacity – dry solids	kg/h	200	
Capacity – hydraulic	L/s	14	
Target TWAS concentration	% solids	3.0 – 4.0	Subject to confirmation by Westfalia
Polymer dosing requirement		TBC	
<b>TWAS Transfer Pumps</b>			
Number		2	
Redundancy		Duty / Standby	
Capacity – hydraulic	m <sup>3</sup> /h	15	

## 5.2 TWAS Storage Tanks (ex-Gravity Thickeners)

The new WAS thickeners will allow the existing gravity thickeners to be converted into TWAS storage tanks. This will allow the new thickeners to operate continuously whilst maintaining existing Monday to Friday dewatering and disposal. The tanks would be fitted with diffused aeration to keep the contents fully mixed and to prevent odours. This will provide a more consistent feed quality to the centrifuges, which would improve centrifuge performance. The capacity of the tanks is shown in Table 12.

**Table 12: Porirua WWTP TWAS Storage Tanks (Ex-Gravity Thickeners) Capacity**

Parameter	Units	Value	Comment
Minimum operating level	m	0.50	
Maximum operating level	m	3.50	
Storage capacity	m <sup>3</sup>	680	Both tanks
Storage capacity	tonnes ds	20.4	Both tanks
Days' storage (2024 average)	days	4.4	Assuming 3.0% TWAS solids content
Days' storage (2048 average)	days	2.8	Assuming 3.0% TWAS solids content

## 5.3 New WAS Pump Station

The existing WAS pumps are too large for continuous wasting; smaller pumps would allow continuous wasting and thickening. Ideally the new WAS pump station would pump from the aeration basin rather than the clarifier underflow to allow simple and precise monitoring and control of sludge age. WAS pump location would be designed in conjunction with the new WAS thickeners to ensure compatibility (as some thickeners may require a pre-thickened feed ie from the clarifier underflow). The WAS pump sizing is shown in Table 13.

**Table 13: Porirua WWTP WAS Pump Process Sizing**

	Units	Value	Comment
Number		2	
Redundancy		Duty / Standby	
<b>WAS volume (2024)</b>	m <sup>3</sup> /day	1,250	Assume wasting from aeration basin
WAS volume (2048)	m <sup>3</sup> /day	2,300	Assume wasting from aeration basin
WAS pump capacity	L/s	27	Assume wasting from aeration basin

## 5.4 Cake Storage Upgrade

Upgrading the on-site cake storage would provide the following benefits:

- Increase solids production capacity by allowing longer dewatering hours per day and larger truck deliveries.
- Reduce the number truck movements per day.
- Remove the current operator requirement to monitor sludge levels, move sludge around the bins, and manually move the bins themselves.
- Allow for future odour containment and treatment if necessary.

Larger trucks will need more space and larger turning circles and the existing access roadway to the cake loadout area may need to be modified to accommodate the trucks.

The two options considered most suitable for cake storage at the Porirua WWTP are:

- Self-levelling bins (which are loaded onto hooklift trucks and transported to and from the landfill)
- Permanent live-bottom cake hopper (with associated truck loadout facility)

The cake storage upgrade options should be considered along with future dewatering operating hours and dewatering redundancy provision. As mentioned previously there is currently no redundancy with the current dewatering operation. This means that if a centrifuge is down for maintenance, mixed liquor solids build up inside the aeration basin due to decreased solids removal capacity.

If maintaining the current operating hours is preferred going forward, the self-levelling bins would provide sufficient storage, however an additional centrifuge would be needed to provide the necessary standby redundancy (duty/duty/standby).

If dewatering operation was changed to 24 hours per day then the existing centrifuges could operate in duty/standby mode thereby providing redundancy without the need for an additional centrifuge. This would require a live-bottom cake hopper to provide afternoon / overnight cake storage capacity.

The two cake storage options are described below.

### 5.4.1 Self-Levelling Bins

The existing bins should be replaced with new larger self levelling bins inside the existing loading bay. Self levelling bins contain a horizontal spiral conveyor to distribute sludge evenly along the length of the bin. The bins would be loaded onto the back of a hooklift truck for transport to landfill.

Photographs of self-levelling bins are provided in Figure 13 and Figure 14.



Figure 13 Self Levelling Bins (Spirac Spirotainers®)



Figure 14 Self Levelling Bin Loading onto Hooklift Truck (Spirac Spirotainers®)

## 5.4.2 Live-Bottom Hopper

A permanent live-bottom cake hopper would provide more storage than the self-levelling bins. This would allow 24-hour per day dewatering. The hopper would fill up during the afternoon and night and then discharge into the truck during landfill operating hours.

The live-bottom hopper capacity would need to be approximately 60 m<sup>3</sup>. Either a cake pump or a screw conveyor system would be needed to transfer cake from the centrifuges to the hopper.

A photograph of a live-bottom hopper is provided in Figure 15.

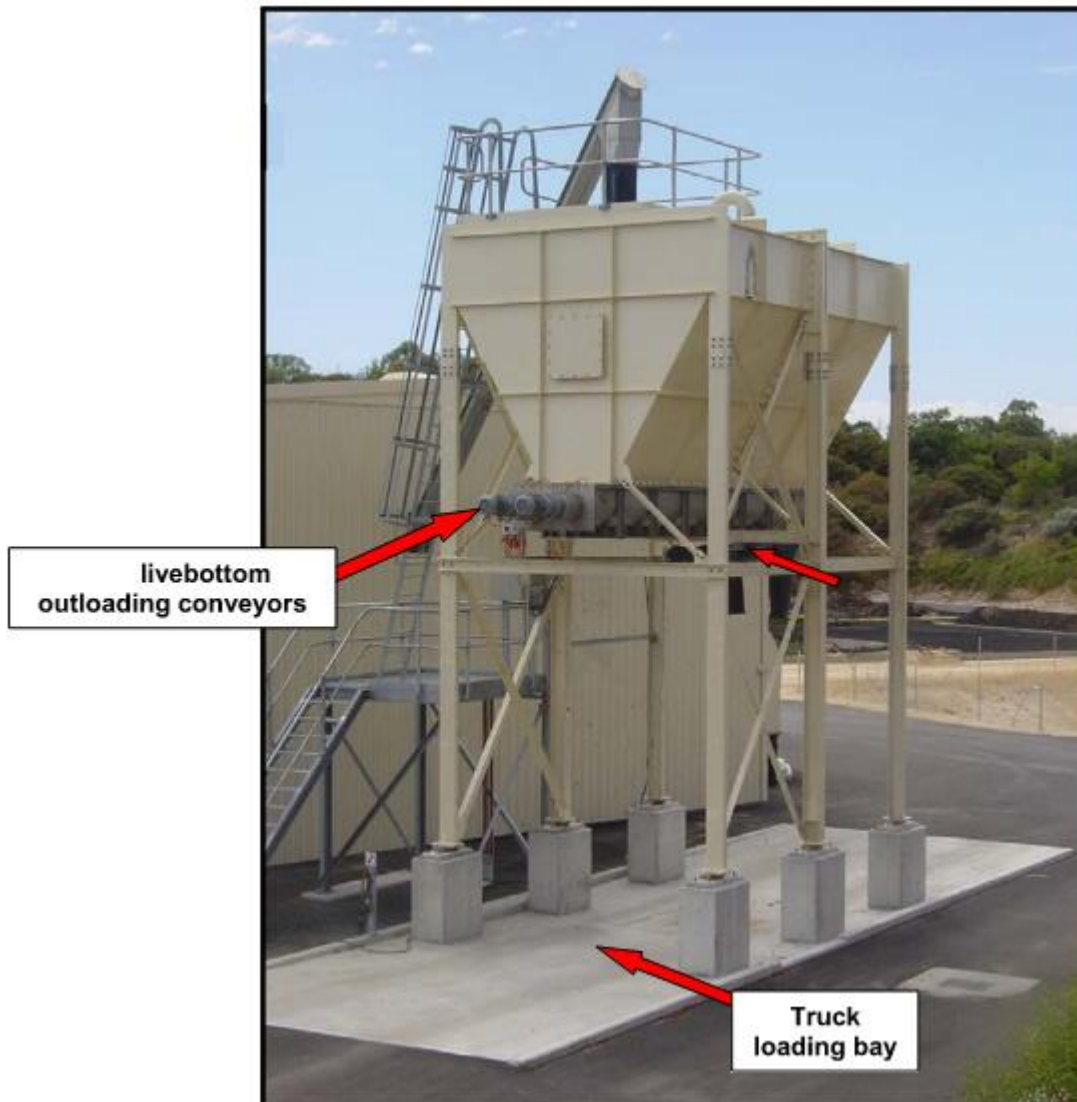


Figure 15 Live-Bottom Cake Hopper (Spirac)

## 5.5 Dewatering Capacity

The dewatering capacity is presented graphically overleaf for the two cake storage options:

- Duty / duty / standby centrifuges plus self-levelling bins, 12 hours/day, 5 days/week dewatering (Figure 16)
- Duty / standby centrifuges plus cake hopper, 24 hours/day, 5 days/week dewatering (Figure 17)

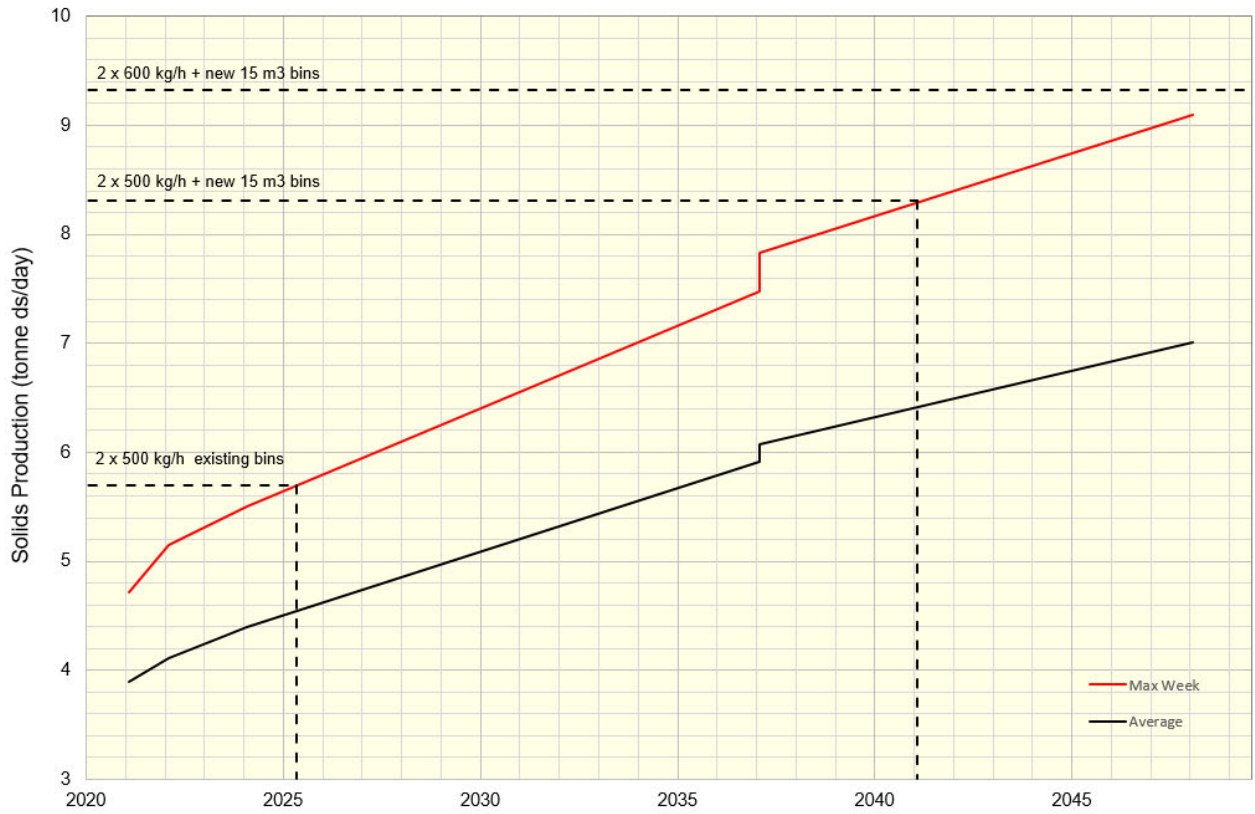


Figure 16 Dewatering Capacity with Self Levelling Bins (12 h/day 5 day/week dewatering)

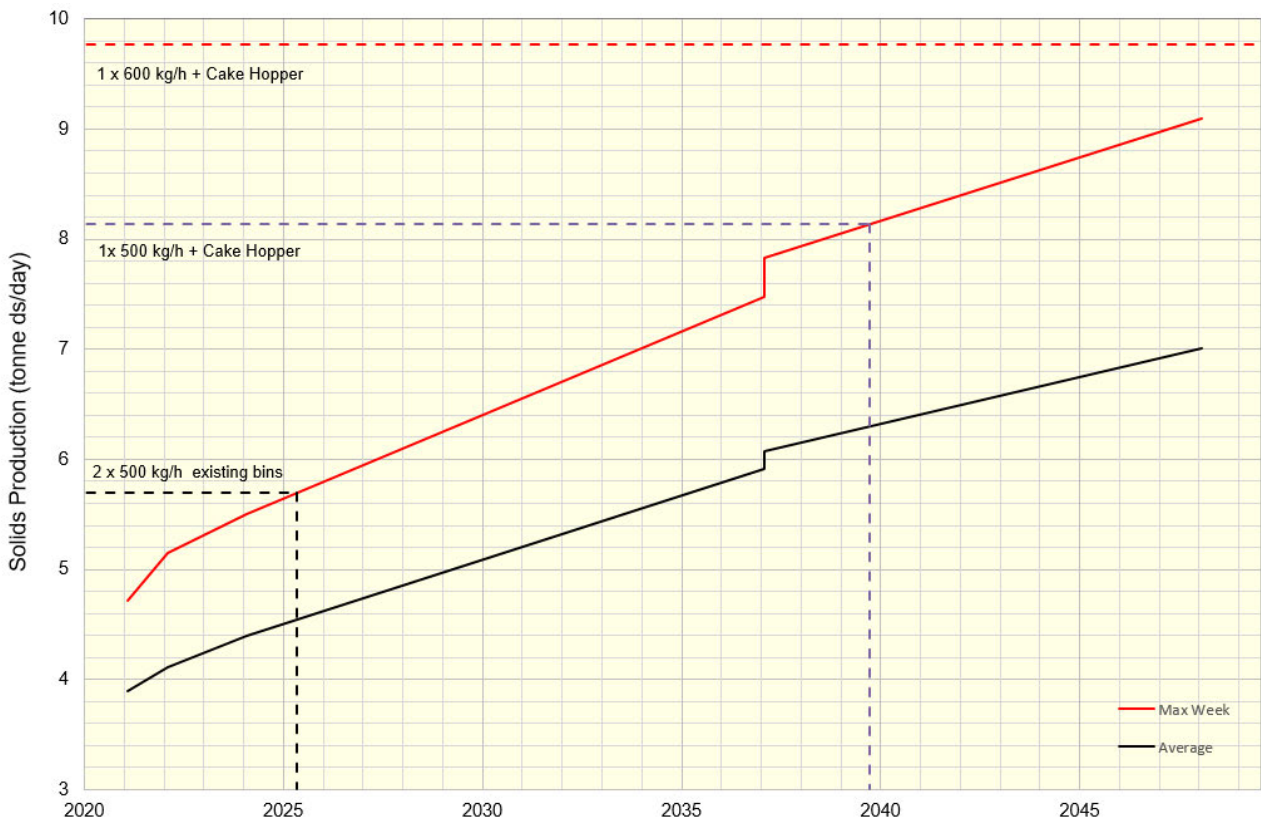


Figure 17 Dewatering Capacity with Cake Hopper (24 h/day 5 day/week dewatering)

The dewatering capacity following cake storage upgrade is shown in Table 14.

**Table 14: Porirua WWTP Dewatering Capacity following Cake Storage Upgrade**

	Units	Current	Self Levelling Bins		Cake Hopper	
Cake storage capacity	m <sup>3</sup>	9 (2.x 4.5)	30 (2 x 15)		50	
Dewatering redundancy		d/d	d/d/s		d/s	
Dewatering hours per day		10	14		24	
Dewatering days per week		5	5		5	
<b>Dewatering capacity</b>			Current	New*	Current	New*
Dewatering capacity	kg/h ds	1,000	1,000	1,200	500	600
Cake production	t ds/week	40	58	65	57	68
Cake production (7-day average)	t ds/day	5.7	8.3	9.3	8.1	9.8

\* Capacity of new centrifuges; the existing centrifuges are due for replacement in 2031t

The future dewatering capacities are based on the following assumptions:

- Maintain current 5 day per week dewatering operation and existing landfill hours
- No landfill restrictions on volume of sludge able to be accepted
- Current centrifuge capacity of 500 kg/h dry solids (due for replacement in 2031)
- New centrifuge capacity 600 kg/h dry solids
- Centrifuge solids capture 95% (current average)

The pro's and con's of the cake storage options are listed in Table 15.

**Table 15: Porirua WWTP Cake Storage Option Pro's and Cons**

	Self Levelling Bins	Cake Hopper
Pro's	Less site works (located below centrifuges)	Allows duty / standby dewatering Continuous dewatering (fewer stop/starts) More storage capacity More basic sludge truck (no hooklift needed)
Con's	Require additional centrifuge for redundancy Need specialist hooklift truck	Cake conveyance from centrifuges to hopper

The cake storage options should be considered separately to this report. As both options provide the same capacity and redundancy, factors to consider are:

- Physical site constraints (space for a third centrifuge versus space for cake hopper)
- Preference for 14 hour per day versus 24 hour per day dewatering
- Appetite for 24-hour dewatering operation (perceived risk of overnight callouts or incidents)
- Flexibility of system to integrate with any future biosolids treatment options

## 5.6 Proposed Solids Stream Upgrade Scope and Layout

The proposed solids stream upgrade comprises:

- WAS pump station
- WAS thickening facility: Thickeners, TWAS hoppers, TWAS transfer pumps, polymer system, building.
- TWAS storage tank (ex gravity thickeners) including blowers and diffused aeration system
- Cake storage upgrade : *either* self levelling bin and third centrifuge *or* live bottom cake hopper

As site layout plan of the proposed solids stream upgrade is presented in Figure 18. Both cake storage options are shown.

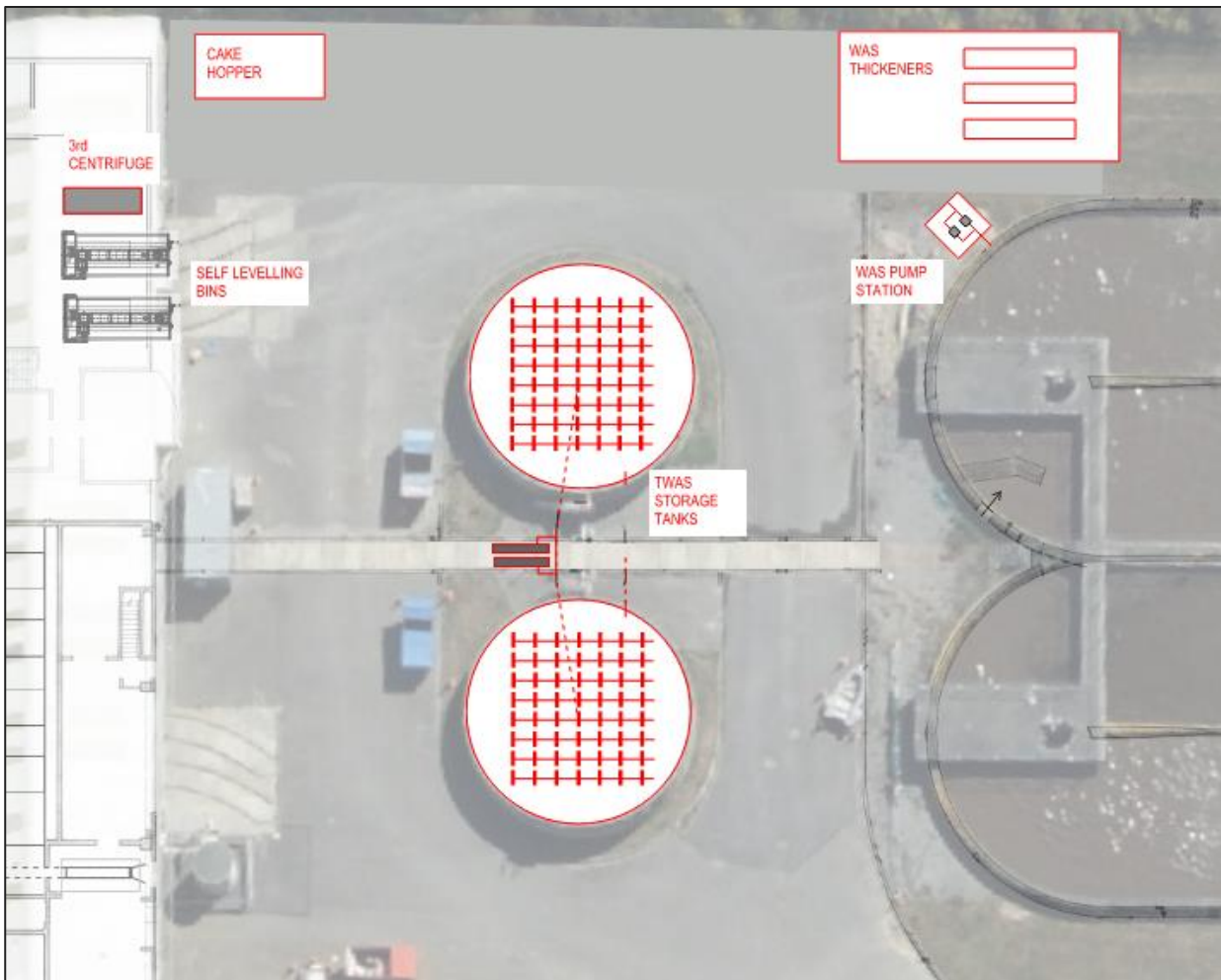


Figure 18 Porirua WWTP Solids Stream Upgrade Site Layout Plan

## 6 Immediate Measures

The proposed solids stream upgrade should be progressed as soon as practicable however it is expected to take 3 years to implement all of the items listed above allowing for budget approval, design and procurement. In the intervening period the following measures should be implemented to assist with solids stream operation.

### 6.1 Aeration Basin Wasting Trial

An aeration basin wasting trial is recommended to assess gravity thickener performance with continuous feed from the aeration basin as opposed to the current intermittent feed from the clarifier underflow. The objectives of the trial would be:

- Maximise solids capture in the thickeners
- Align WAS loads to cake production (avoid recirculating WAS )

This trial would involve connecting a submersible pump with a hose connection to the existing WAS pump station discharge pipework, utilising the existing WAS flow meter. The temporary WAS pipework would include a control valve to allow WAS flow adjustment by manually adjusting the valve position.

If the trial proved successful and provided improved performance, it could be made semi-permanent and maintained until the new permanent WAS pump station and thickeners were installed. Alternatively, the system could revert back to wasting from clarifier underflow but with improved pumping times and volumes to avoid recirculating WAS.

### 6.2 Centrifuge Optimisation

Operating at a reduced sludge age may change the dewatering characteristics of the WAS. If necessary, advice should be sought from centrifuge representatives and/or polymer suppliers to achieve the necessary centrifuge performance. (It is noted that the Western WWTP produces 20% cake solids at a low sludge age so operational experience from this plant should be sought).

Advice should also be sought from Westfalia on operating the centrifuges at a higher feed solids content and lower feed flow rate (in advance of specifying the new WAS thickeners).

## 7 Other Considerations

### 7.1 Long Term Biosolids / Carbon Strategy

The proposed upgrade in this report is designed to debottleneck the solids stream process, avoid conditions causing solids carryover, and allow for projected population growth. Once this has been achieved the longer term biosolids strategy can be addressed. As population and solids production increases over time, further treatment of the sludge may be desirable due to economic and/or quality drivers. In addition, carbon redirection may provide benefits in terms of plant carbon footprint and operating costs. Options include:

- Carbon redirection (eg primary clarifiers, fine sieves, DAF) plus anaerobic digestion
- Aerobic WAS digestion (to reduce solids production and improve sludge stability)
- Thermal drying (to produce class A biosolids and minimise biosolids volumes)

Future sludge treatment options should then follow on from the long term biosolids / carbon strategy to ensure alignment with the strategy.

### 7.2 Impact of Lower Sludge Age on Effluent Quality

As the catchment population increases and the plant sludge age reduces over time, treated wastewater ammonia and nitrate concentrations will increase. This issue was known and addressed in the resource consent application (Wellington Water, June 2020). However the predicted sludge age values in this report may differ from those previously predicted; the relevant sections of the consent application should be reviewed and updated if necessary,

If treated wastewater quality becomes an issue in future, enhancements to the existing aeration basin can be investigated (eg increasing the aerated fraction, adding fixed or floating attached growth media).

## 8 References

Cardno (July 2017)	Capacity Assessment and Capital Works Master Plan Porirua WWTP
Connect Water (April 2018)	Centrifuge Capacity Investigation Letter Report
Connect Water (June 2019)	Porirua WWTP - Process Model
Metcalf and Eddy (2014)	Wastewater Engineering: Treatment and Resource Recovery. 5th Edition, McGraw-Hill, New York.
Sense Partners Ltd (2021)	Estimated Population Forecasts for the Porirua WWTP Catchment.
Stantec (October 2021)	Porirua WWTP Solids Investigation: Clarifier Investigation
Wellington Water (June 2020)	Porirua WWTP – Discharge of Wastewater Resource Consent Application & Assessment of Environmental Effects



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