Shotover WWTP

Project Inception, Basis of Design and Gap Analysis Report

Queenstown Lakes District Council

09 December 2024

→ **The Power of Commitment**

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The Power of Commitment

Executive summary

The Shotover Wastewater Treatment Plant (WWTP) serves the wider Queenstown area, featuring inlet screens, a MLE reactor, clarifier, sludge treatment system, oxidation pond system, UV treatment, and a disposal field. Stage 3 upgrades are underway to support regional growth and include a third inlet screen, second bioreactor, second clarifier, decommissioning of the oxidation ponds, and a raw wastewater calamity pond.

The existing disposal field is operated as a rapid infiltration bed (RIB) system and is not accommodating current flows or meeting resource consent conditions, leading to an abatement notice in May 2021. Queenstown Lakes District Council (QLDC) has been working with Otago Regional Council (ORC) to address non-compliance.

QLDC engaged GHD to develop an alternative discharge solution for treated effluent. This report is the first deliverable and summarises the project objectives, key findings from reviewing information, and data gaps identified for progressing development of a long-list of disposal options. Additionally, this report outlines the design basis for the disposal options. This report is subject to, and must be read in conjunction with, the limitations set out in Section 1 and the assumptions and qualifications contained throughout the Report.

The disposal solution will be designed for 2060 projected flows and loads, targeting a 35-year consent. The current Stage 3 WWTP expansion is designed for 2048 projected flows, with a design average flow of 19 ML/d. Future growth beyond 2048 may increase the design average flow of 24 ML/d. The Stage 3 WWTP expansion will achieve a significant improvement in discharge quality as well as providing additional capacity. The completion of the WWTP upgrade will also cease the blending of secondary clarifier effluent and Pond 3 effluent prior to discharging to the disposal field.

The modifications made to the disposal field by QLDC and Veolia have improved the ability to discharge treated wastewater. However, we concur with the findings of the previous assessments that the existing infiltration area is insufficient to handle the current and future treated wastewater flows without significant modifications or an alternate solution.

Our desktop assessment concluded that whilst there are notable information and data gaps, as outlined in Sections 7.1 and 7.2, there is sufficient information to compile a long list of potential treated effluent disposal options. It has been identified that the viability of land parcels including QLDC owned land and others outside the Shotover Delta for the purpose of treated effluent disposal will be a key criterion for the long list options development and evaluation.

GHD recommends baseline investigations and monitoring take place concurrently with the options assessment. Information gathered from these investigations would be used in assessing the suitability of potential short term remedial options, inform long terms solutions and provide a basis for comparing proposed and current discharge effects. The baseline monitoring and investigations will comprise:

a. Understanding groundwater flow to the river(s) and identification of preferential flow paths, constraints on wastewater infiltration and treated wastewater mixing prior to discharge.
b. Water quality of groundwater discharge, inground treatment achieved and mass discharge to the river(s).
c. Water quality in rivers and identification of mixing zones.
d. Water quality of daylighting (ponded) wastewater on the delta, and potential for public exposure to treated wastewater.

We also have undertaken an initial risk identification and assessment, refer to Appendix B for the Risk Register. This will be updated throughout the project. Project programme and engagement with iwi and communities have been identified as the highest risk issues. Proposed risk mitigations have been included in the Risk Register.

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Glossary

Table 1 Glossary.

Abbreviation	Term
%DS	Percentage of dry solids (a measure of sludge dryness)
ADF	Average daily flow
ADWF	Average dry weather flow
AS	Activated sludge – a common form of biological treatment process, different to ponds and trickling filters.
AWS	Automatic weather station
BOD	Biochemical oxygen demand
Calamity pond	Refers to a temporary holding of wastewater or treated effluent in the event of outages or high flows.
COD	Chemical oxygen demand
DAD	Dose and Drain Land
DRP	Dissolved reactive phosphorus
E.coli	Escherichia coli
g/m3	Concenctration unit, grams per day
Kg/d	Mass unit, kilo grams per day
kW	Energy/power unit, kilowatts
L/s	Flow unit, litres per second
LAWA	Land, Air, Water Aotearoa
LINZ	Land Information New Zealand
m bgl	Metres below ground level
m^3/day	Flow unit, Cubic Meters per day
MLE	Modified Ludzack-Ettinger, a treatment system which removes biological nitrogen, ammonia, and BOD.
MRF	Materials recovery facility
mRL	Metres Relative Level - meters above sea level
NIWA	National Institute of Water and Atmospheric Research
NZGD	New Zealand Geotechnical Database
ORC	Otago Regional Council
PDWF	Peak dry weather flow
PFAS	Per- and polyfluoroalkyl substances
PIF	Peak instantaneous flow
PS	Pump station
PWWF	Peak wet weather flow
QLDC	Queenstown Lakes District Council
RIB	Rapid infiltration beds
SCADA	Supervisory Control and Data Acquisition – the computer-based system that allows monitoring, control, and management of the WWTPP system.

Abbreviation	Term
Sludge	By-products solid from wastewater treatment processes.
t/year	Mass unit, tonne per year
TAN	Total ammoniacal nitrogen
TKN	Total Kjeldahl Nitrogen
TN	Total nitrogen
TP	Total phosphorus
TSS	Total suspended solids
UV	Ultra-violet
UVT	UV transmittance
WAS	Waste activated sludge
WW	Wastewater
WWTP	Wastewater treatment plant

1. Introduction

The Shotover Wastewater Treatment Plant (WWTP) treats wastewater from the wider Queenstown urban area. and includes a MLE reactor, a secondary clarifier, a sludge dewatering system, an oxidation pond system, UV treatment, and a disposal field. Stage 3 upgrades are currently underway to accommodate growth in the Queenstown area.

The existing disposal field (now operated as a RIB system) is no longer operating as designed, is struggling to meet current flows, and is not compliant with the conditions of the resource consent. In particular, the consent has specific conditions regarding no ponding, surface run-off of treated wastewater or no mounding of groundwater to above the ground surface. Surface ponding was observed during the site visit on 6th November 2024.

Given that the disposal field is not complaint with the resource consent, an abatement notice was issued in May 2021. Since then, QLDC has been actively working to rectify the issues of non-compliance and has been in regular communication with ORC. A number of extensions to the abatement notice have been provided over the last three years. The following figures demonstrate how the disposal field has changed over the last 5 years, since construction.

Figure 1 **Disposal field post construction in 2019, photo provided by QLDC.**

Figure 2 **Disposal field ponding occurring in 2021 (although mounding/ponding was first observed in 2019), photo provided by QLDC.**

Figure 3 **Ponding and surface runoff near the disposal field, 2022, photo provided by QLDC.**

Figure 4 **Disposal field now acting partially as a RIB system, photo taken by GHD in Nov 2024.**

1.1 Purpose of this report

QLDC has engaged GHD to identify and develop an alternative discharge solution for the treated effluent of the Shotover WWTP. The investigation will be undertaken in stages, and the first stage (this report) covers the information review, gap analysis as well as developing the initial design basis. This report will inform the subsequent long list options development, option shortlisting and evaluation, preferred option selection, as well as the Business Case.

The purpose of this report is to provide a summary of GHD's understanding of the project, a summary of information reviewed, and a description of information gaps that may warrant additional data collection before development of a long list of disposal options. Additionally, this report will outline the design basis for the disposal options.

1.2 Scope and limitations

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

GHD otherwise disclaims responsibility to any person other than Queenstown Lakes 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 Queenstown Lakes 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

The following assumptions were made during this project inception and gap analysis stage:

- Wastewater flow estimation and design treated effluent standards in Stage 3 upgrades (Year 2048) have been used to estimate the future demand.
- The WWTP Stage 3 upgrade will achieve its performance targets as per the design intent.
- The design horizon of the effluent disposal upgrade is 35 years (i.e. Year 2060). QLDC is currently updating the population growth forecast and the wastewater network model, which will be available in early 2025. Linear extrapolation of the wastewater flow estimates in Year 2048 has been applied for an initial estimate of wastewater flows in Year 2060.
- The previously proposed Materials Recovery Facility (MRF) and eco park was proposed to be constructed in Pond 2, between the calamity ponds. GHD understands this is not planned to be progressed further.
- QLDC preference is for mana whenua support of the disposal best practicable option before lodgement of consent applications, in order to improve the potential for consent to be granted.
- The publicly available environmental data is accurate, unless otherwise stated.
- Refer to Section 6 for specific assumptions made as part of the background environmental information review.

2. Project background

The Shotover Wastewater Treatment Plant (WWTP) was originally constructed in 1974, to treat wastewater in the wider Queenstown area with a basic inlet works channel and three oxidation ponds. The plant has evolved significantly over time to both improve plant infrastructure, treatment and allow for the plant to cater for population growth at Queenstown. Previous upgrades include:

- In 1987, an aeration septage lagoon and new inlet works were built.
- New inlet works were built in 2014 to replace the previous inlet works.
- Stage 1 upgrades were commissioned in 2017, including a grit removal system, a septage receiving facility, a MLE reactor with secondary clarifier, and UV disinfection. The oxidation ponds were retained to treat a portion of the incoming wastewater, and the effluent streams is combined upstream of the UV for disinfection.
- Stage 2 upgrades were performed in 2019, which involved the implementation of a "disposal to land" scheme via rapid infiltration into the Shotover Delta gravels.
- Stage 3 upgrades are currently underway to accommodate growth in the Queenstown area. The upgrades will increase the treatment capacity significantly and the decommissioning of the oxidation ponds. The expected commissioning date of the Stage 3 upgrade works is late 2025.

2.1 Site description and initial scope understanding

The Shotover WWTP is located on the true right bank of the Shotover River, downstream from the State Highway 6 Road Bridge.

Figure 5 Site layout of Shotover WWTP. Google imagery taken July 2022.

As of November 2024, the wastewater treatment plant comprises preliminary treatment consisting of inlet screens and grit removal, secondary treatment consisting of MLE/secondary clarifier operating in parallel with the oxidation ponds, before the combined effluent passes through the UV channel for disinfection. It is noted that the MLE/secondary clarifier is treating a higher percentage of the incoming flows than originally designed for. The treated effluent is then pumped to the DAD disposal field (now acting as a RIB system) where it flows through the ground and ultimately into the Shotover River.

A number of short-term remedial actions were undertaken following the failure of the disposal field but despite these actions, infiltration appears to be limited with surface ponding occurring at the down gradient (southeast) end of the disposal field.

After the Stage 3 upgrade, the treated effluent quality from the Shotover WWTP will be improved considerably as the blending of clarifier effluent and the pond effluent will cease.

The project scope for the Shotover Alternative Effluent Disposal Investigation aims to identify, develop, and consent an alternative discharge solution for the treated effluent produced by the Shotover WWTP. Depending on the chosen solution, this may also involve designing an upgrade to polish the wastewater before it enters the upgraded disposal system or alternative disposal solution.

3. Site visit and operator interview

The GHD team visited the Shotover WWTP Site on the 6th and 7th November 2024 and viewed the wastewater treatment plant and the disposal field areas. A summary of the site visit at both locations is as follows:

3.1 WWTP visit and operator interview

On 6th November, GHD process engineers were shown around the Shotover WWTP, to review the existing plant and recent operational issues/challenges and noted the following key observations:

– Approximately 15 to 20% of plant influent is diverted to the ponds for secondary treatment.
– Pond 1 has been taken offline and is partially reclaimed for the construction of the second bioreactor tank and the additional secondary clarifier. The construction of the new tanks is ongoing.
– The third inlet screen is installed at the Inlet Works.
– Part of Pond 1 will be re-purposed as a raw wastewater calamity pond and a stormwater pond.
– The plant has previously experienced intermittent issues due to (1) high wastewater inflows, (2) mechanical failure and (3) toxic dumping.
– The operators did not indicate that there are any major ongoing problems with the treatment plant.
– Pond 3 effluent is combined with the secondary clarifier effluent upstream of the UV channel. Pond 3 effluent flow is controlled by the pond pump station located at the back end of the pond 3.
– Pond 3 effluent has significantly higher concentrations of BOD and TSS than the clarifier effluent especially in summer months, due to presence of algal growth.
– The operators suggest that polishing of the treated effluent prior to entering the disposal field could be beneficial. The consideration of this will be part of the assessment for improvement or replacement options to the disposal field upgrade.

Figure 6 *Pond 2, November 2024.*

Figure 7 *Pond 3, taken from the transfer pumps, view of the natural baffles which are located halfway across the pond, November 2024.*

Figure 8 *UV system, located at the back end of Pond 3, photo taken at the transfer pumps, November 2024.*

Figure 9 *Stage 3 upgrades underway, November 2024.*

3.2 Disposal field visit

The GHD team were also shown around the current disposal area which has been modified from the original design and note:

- The disposal field is oriented northwest to southeast, parallel to the river (and groundwater) flow direction.
- Due to failure of the previous infiltration beds, the disposal is currently converted to a series of open infiltration ponds. These ponds are approximately 2.5 m deep.
- The ponds were excavated in several stages to increase capacity. In addition, some remediation of the ponds has been undertaken and this has involved removal of gravel that has silted up in order to increase the infiltration rate. Excavated silt and gravel is currently stockpiled at the northern end of the pond area
- In May 2024, a perimeter bund was constructed to increase storage capacity in the infiltration ponds and prevent seepage through the perimeter.

- Following an overflow in September 2024, a pipe was installed to to allow the final cell to overflow to an adjacent pit which then flows out through the fence to reduce the risk of collapse of the perimeter bund.
- Water levels in the ponds are relatively constant (near top of each basin). The infiltration rate to ground appears to be slow. During high flows, water levels increase and internal paths between ponds are submerged.
- The disposal ponds are elevated above the river flood plain. However, there is no evidence of seepage from the long sides of the disposal field. Instead, daylighting (seepage) of water was observed in a former channel bed downgradient (southeast end) of the disposal area and extending towards the Kawarau River, this is interpreted as likely to be surface discharge of treated wastewater.

We also carried out a limited walk-over across the southern extent of the delta to gain an understanding of the general topography, surface water and rivers. Notable areas of groundwater exposure were identified, within former channels of the Shotover River.

Figure 10 ***A portion of the existing disposal field, November 2024.***

Figure 11 ***Existing disposal field, November 2024.***

Figure 12 ***Existing disposal field, taken from above, November 2024.***

Figure 13 ***Surface runoff and ponding near the location of the disposal field, in a public area, November 2024.***

4. WWTP current state understanding

This section describes our understanding of the current state of the Shotover WWTP.

4.1 Stage 3 expansion summary

Stage 3 expansion of the Shotover WWTP is currently underway to accommodate growth in the wastewater catchment. The expansion will involve the construction of the second MLE reactor and the second clarifier, to increase the plant capacity to 19,100 m^3/day (as an average daily flow). The Stage 3 expansion also includes the addition of the third inlet screen, the WAS Tank #2 and the conversion of part of Pond 1 into a raw wastewater calamity pond. Pond 2 and Pond 3 will be decommissioned.

Stage 3 upgrades were split two portions, these include:

2. WWTP upgrades:
   - Addition of a third screen to the inlet works.
   - Construction of a second MLE reactor and a second clarifier.
   - Installation of other plant items including additional blowers, WAS Tank #2, RAS pumps and others.
   - Electrical and mechanical installations.
3. Decommissioning of oxidation ponds and construction of a raw wastewater calamity pond in Pond 1
   - The WWTP upgrades (Portion 1) are currently in the construction phase. Pond 1 is decommissioned and partially reclaimed for the construction of the second reactor tank and clarifier. Pond 1 was also desludged.
   - As a temporary set-up, additional aerators have been put in Pond 2 to handle the additional loads. The construction of the raw wastewater calamity pond will commence following the commissioning of the second bioreactor train.

The following figure outlines an overview of the process upgrade.

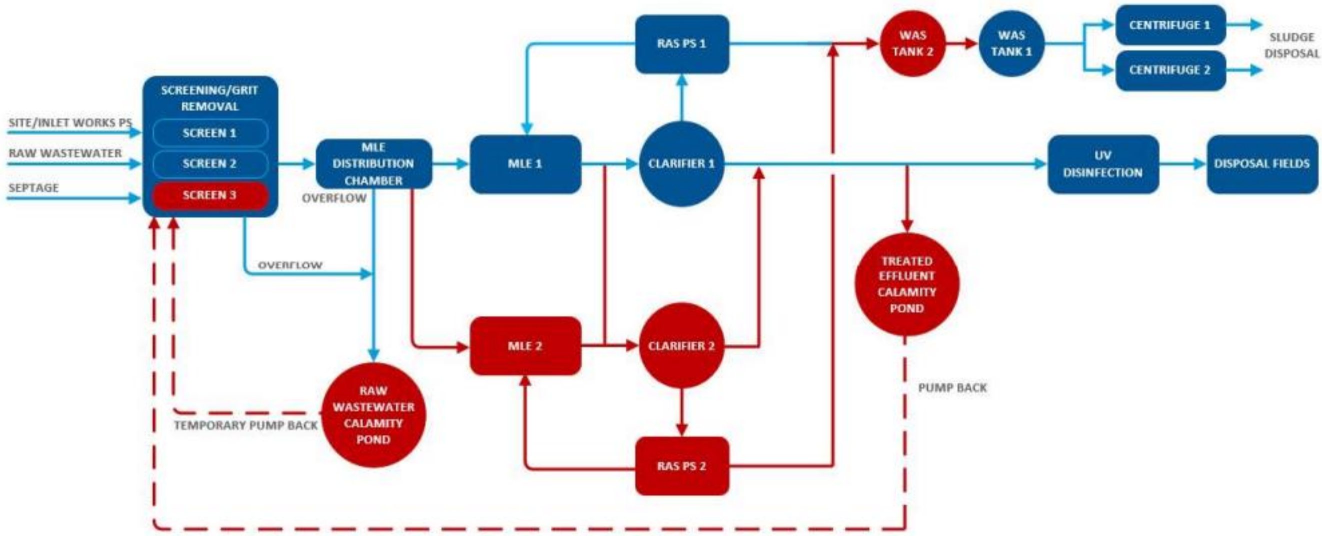

Figure 14 Shotover WWTP Stage 3 Expansion Process Schematic, Blue existing Red new (Beca, April 2022).

Inlet screens

The Stage 3 upgrades will add a third screen to the existing two. The upgrade will spread the raw influent to all three screens. The screen controls will be modified to cycle the duty screens automatically based on an inflow totalizer, ensuring screenings are distributed across the three discharges. Since the plant's inflow rate varies throughout the day, each screen will handle the same wastewater and screenings load before switching duty.

MLE

The Stage 3 upgrades duplicate MLE1 with a second MLE bioreactor with identical reactor zones and mechanical arrangement (e.g. mixers and recycle pumps).

Once MLE2 is online, the total active reactor volume will be 18.6 ML, matching the volume of MLE1.

Clarifier

The second clarifier will share the identical set-up as Clarifier 1 in terms of clarifier mechanism, scum removal , and RAS pump return. The two clarifiers will provide a total clarifier area of 1,816 m^2.

From the Stage 3 design report, we understand that the secondary treatment (MLE reactors and clarifiers) will usually run independently, with cross-over lines provided for flexibility and resilience when needed.

The design report stated the clarifier hydraulic and solids loading as follows:

– 2048 ADF: The predicted total inflow for 2048, including centrate recycle flows, is 19,100 m^3/day (~200 L/s)
– 2048 Peak Hourly Sustained Flow: The peak diurnal flow factor for 2048 PDWF is 34,788 m^3/day (~400 L/s)

WAS tank

WAS Tank 2 of 300 m^3 storage volume has been designed to match WAS Tank 1. Additionally, a load-in facility has been incorporated into the design of WAS Tank 2, allowing the Shotover WWTP to receive tankered WAS (i.e. from Kingston, Cardrona, and Glenorchy).

Raw water calamity pond

The calamity pond will have a capacity of 21,200 m^3, enough to store one day's average flow in 2048 (Beca, April 2022). A temporary mobile pump will be positioned on the pond bank to pump out the stored wastewater when required. The spillway will discharge into a stormwater soakage basin and not into the wider environment.

The ponds will have a grassed surface with access provided.

Other

Stage 3 upgrades will be incorporated into the existing main SCADA terminal. There will be some upgrades to the power of the existing PC so that it can host the added upgrades to the system.

There are also other upgrades as part of the Stage 3 upgrades, including additions to Blower/Electrical Building 2, walkways, accessways and link bridges, pipe work, biofilter upgrades, and more.

Treated effluent calamity pond is not part of the Stage 3 upgrade scope. The Stage 3 detailed design report mentioned that the condition and stability of Pond 3 embankment could be in a poor condition, and may require remediation as part of the treated effluent calamity pond conversion.

Existing services

– Potable water: potable water is supplied to the site office.
– Service Water / Recycled Effluent: there is a recycled effluent system within the existing wastewater treatment system.
– Compressed air: compressed air is used in various plant process areas.
– Power Supply and Backup Generator: An additional generator will be installed to the existing diesel generators.
– Plant SCADA and telemetry: There is a main SCADA terminal which is in the operation building.
– Chemical dosing: Polymer dosing is used at the centrifuges for sludge dewatering.
– Building services: The operations/control building is located near the MLE reactors, comprising an office, a toilet/shower/storage area, a meeting room and a kitchen/lunch area. There is a large shed building adjacent to the UV channel for housing spares and the switchboards. There is no office/building at the disposal field.

4.2 Resource consent summary

The current resource consent (RM13.215.03.V2) permits the discharge of treated wastewater to land from now to 31st December 2031. Summary of the consent conditions is as follows:

- Condition 3 permits the annual average discharge volume of 11,238 m^3/day and the maximum discharge loading rate averaged over the entire disposal area is within 1000 mm per day.
- Condition 4 permits a nitrogen load in the discharge not exceeding 75.5 tonnes per year.
- Condition 7 requires the collection of treated water samples during the first week of each calendar month. Each sample must be analysed for biochemical oxygen demand, total suspended solids, total nitrogen, ammoniacal nitrogen, total phosphorus, and *E. coli*.
- Condition 8 requires the collection of groundwater samples from both upgradient and downgradient of the disposal field during the first week of January and July each year. Each sample must be analysed for total nitrogen, ammoniacal nitrogen, nitrate nitrogen, total phosphorus, and *E. coli*.
- Condition 9 outlines the groundwater level monitoring requirements for the disposal field area, specifying the installation of at least seven piezometers equipped with dataloggers.
- Condition 10 requires the monitoring and record-keeping of any groundwater mounding that rises above the ground surface and persists for more than 48 hours.
- Condition 12 sets wastewater quality limits for biochemical oxygen demand, total suspended solids, total nitrogen, and *E. coli*.
- Condition 19b requires the treated effluent quality to comply with mean limits of 10:10:10:10 (BOD, TSS, TN, *E. Coli*).
- Condition 20 forbids ponding or surface run-off of treated wastewater.
- Condition 21 forbids mounding of groundwater to above the ground surface.

4.3 Wastewater characteristics and loads

This section compares the Stage 3 upgrade design basis and the recent wastewater flows and influent characteristics.

4.3.1 Stage 3 upgrade design basis

For the purpose of this effluent disposal assessment, we have assumed that the treatment performance targets will be met following the completion of the Stage 3 Shotover WWTP. These influent treatment targets are outlined in the following Table 2.

Table 2 Stage 3 Upgrades design basis influent flows and loads taken from (Beca, April 2022).

	Current			Stage 3 Design Basis		
Flows	Feb 2018 – Feb 2020			2048		
ADWF	9,850			-		
ADF	10,500			19,100		
PDWF	12,650			22,300		
PWWF	21,700			39,800		
PIF	456			892		
Loads	Avg. Day*	Peak Month	Peak Day	Avg. Day	Peak Month	Peak Day
BOD	3,200	3,963	4,908	5,800	7,200	9,000
COD	7,300	9,848	16,708	13,300	17,900	30,350**
TKN	680	830	929	1,250	1,500	1,700
TP	94	121	125	170	220	228

	Current			Stage 3 Design Basis		
TSS	3,400	4,804	4,804	6,200	8,700	8,750

** Based on total inflow ADF – includes plant recycles*
*** Indicates high amount of inert COD coming through on the peak day which will not affect the aeration demand, which is largely based on BOD.*

4.3.2 Influent flows

The incoming flow enters the plant via the inlet works and then the flow is split between the ponds and the MLE and Clarifier. Wastewater flows to the ponds are understood to be between 20 to 25% as shown in Table 3.

Following the completion of the Stage 3 upgrade, all wastewater will be treated by the MLEs and clarifiers, and there will be no wastewater bypass to the ponds. Table 3 provides the average influent total flows and split between the clarifier and ponds over the last year (2023 to 2024).

Table 3 ***Influent flows stats from 6/12/2023 to 3/11/2024, data provided by Veolia.***

	Calculated Total Plant Flow, m3/d	MLE and Clarifier Effluent Flow (FIT310)	Calculated Total Pond Flow	Pond Discharge Flow (FIT343), m3/d	Flow % into pond
Average	**11,814**	**8,708**	**3,140**	**3,269**	**26%**

Figure 15 provides a visual representation of the total plant flows into the facility and then the split of flows between the clarifier and the ponds. GHD understands that a higher percentage of flow bypass to the ponds between late 2023 and early 2024 was attributed to operation efforts to address process upsets in the MLE1 at the time.

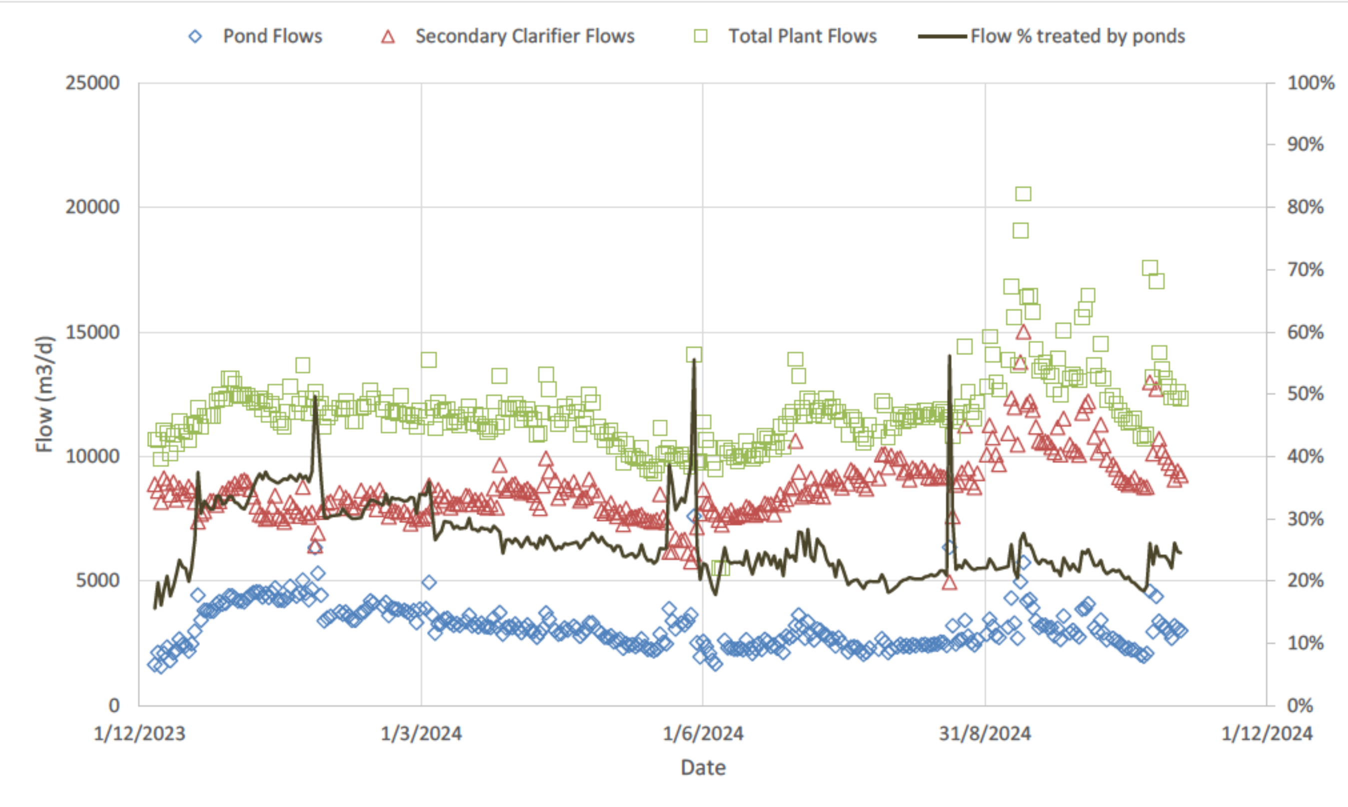

Figure 15 ***Flow data supplied by Veolia, 2023 to 2024.***

4.4 WWTP discharge quality

Sampling data was provided by Veolia from 2001 to 2019. In addition to this, past investigation report by (Beca, 2023(b)) provides some further insight on UVT and solids in the discharge.

4.4.1 WWTP discharge

Veolia has supplied the plant sampling results including the discharge, the discharge results were compared against the consent conditions in Table 4 below.

Table 4 Consent limits and historical data of discharge quality. Orange cells indicate consent limit, red cells indicate consent exceedance.

Parameter	BOD Annual Mean	BOD 95%ile	TSS Annual Mean	TSS 95%ile	TN Annual Mean	TN 95%ile	E.coli 90%ile	TP Average	TAN Average
Consent limits	30	50	30	50	23	35	260		
2018 to 2024	9	24	11	30	14	26	47	3	8
2021	4	9	5	10	8	13	9	2	3
2022	7	14	7	18	8	13	131	2	4
2023	13	49	17	48	17	41	10	4	10
Jan to Sep 2024	20	41	22	39	25	48	166	3	17

The following figures (to Figure 25) present the plant discharge results along with rolling annual means and 95%iles from 2018 to current (September 2024). The 95%tile trend lines are impacted by the process upset in late 2023 and again in 2024, nonetheless the plant performance returned to its normal range for most of 2024.

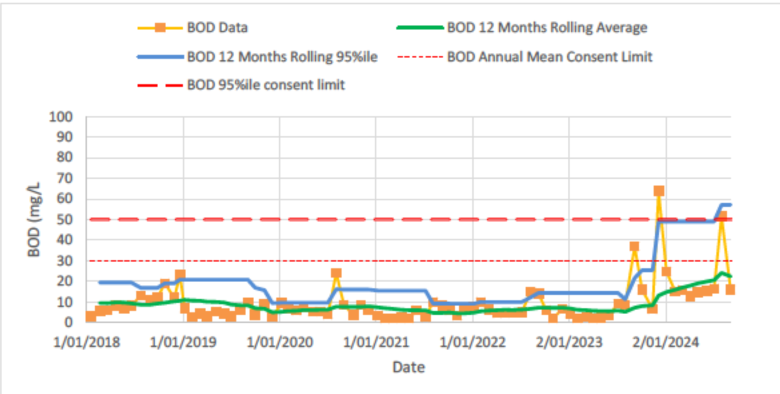

Figure 16 Discharge BOD concentration and consent conditions.

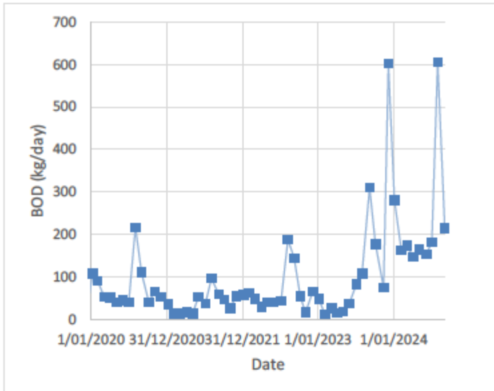

Figure 17 Discharge BOD daily loads based off sampling data and flow data.

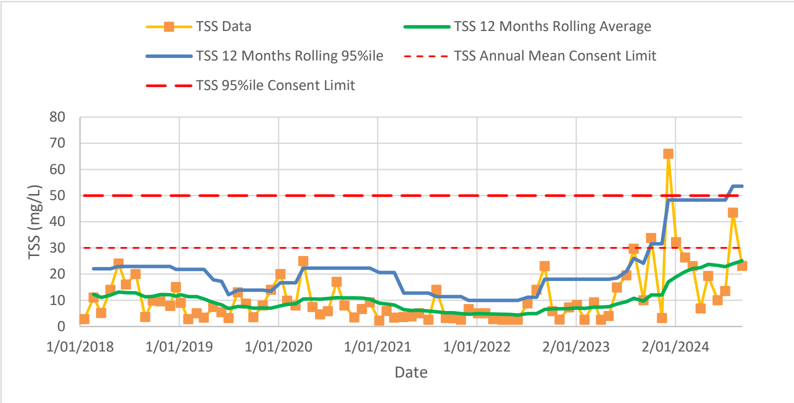

Figure 18 Discharge TSS concentration, trends and consent conditions.

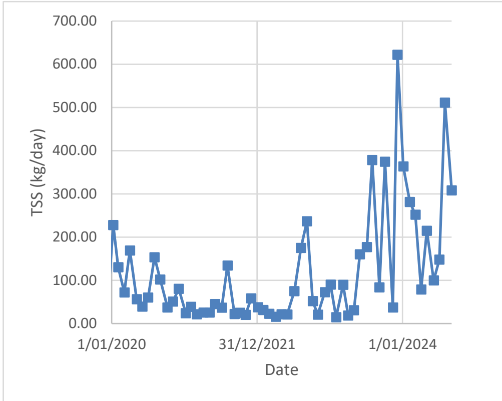

Figure 19 Discharge TSS daily loads based off sampling data and flow data.

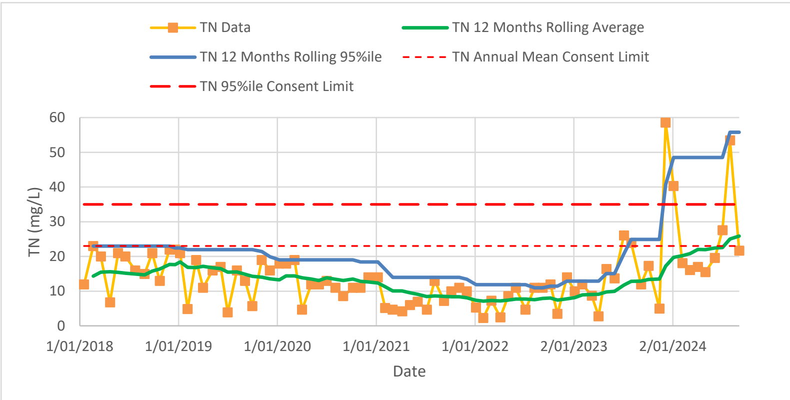

Figure 20 Discharge TN concentration, trends and consent conditions.

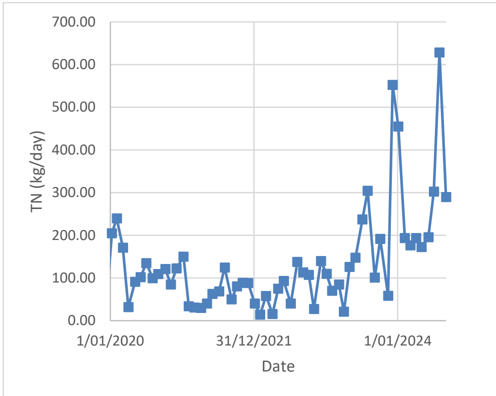

Figure 21 Discharge TN daily loads based off sampling data and flow data.

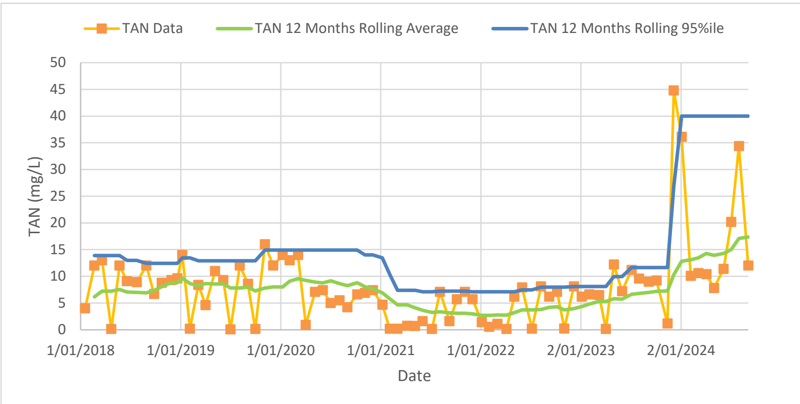

Figure 22 Discharge TAN concentration and trends.

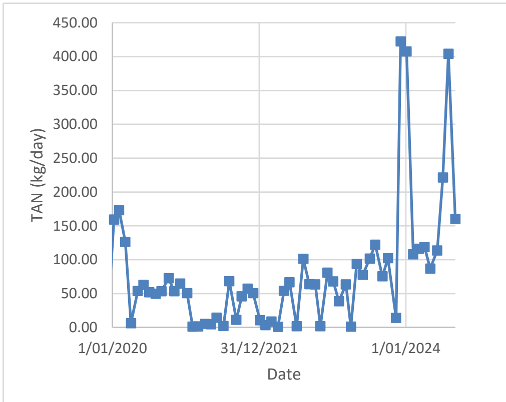

Figure 23 Discharge TAN daily loads based off sampling data and flow data.

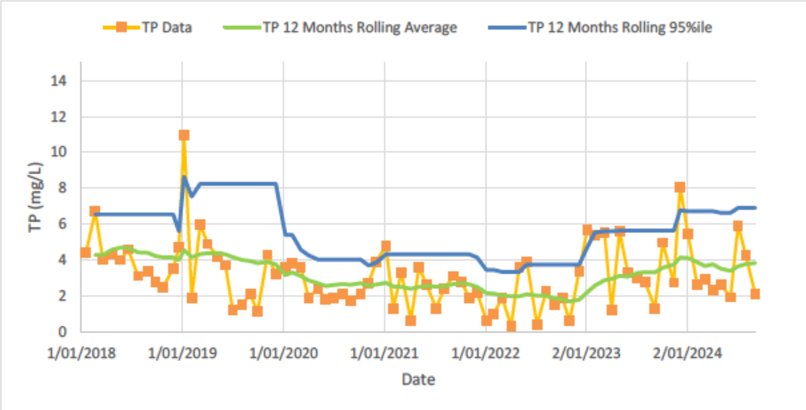

Figure 24 Discharge TP concentration and trends.

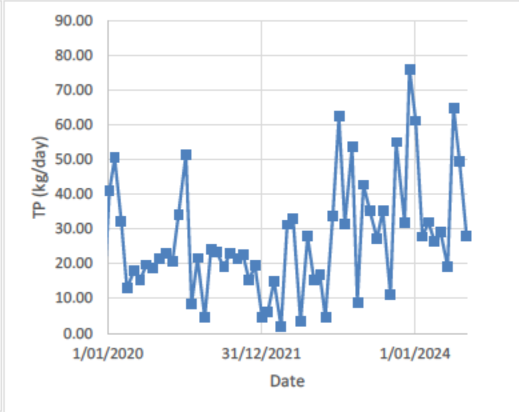

Figure 25 Discharge TP daily loads based off sampling data and flow data.

4.4.2 UV transmittance readings

In 2023 Beca undertook a review of the disposal field performance and the UVT data from 2022. The review concluded the following (note these values were taken from graphs provided by Beca):

- June 2022 UVT transmittance ranged between 0 to 60% (normal values around 60%).
- November 2022 UVT transmittance ranged between 0 to 75% (high UVT of +70% measured during low flow from pond pump station period).
- October 2022 UVT transmittance ranged between 0 to 60% (dropped to 0% when clarifier discharge flow peaks).

Beca also conducted an analysis of the historical solids data from 2017 to 2022, which concluded that the primary source of solids is from the ponds (see table below).

Table 5 Historical (2017 to 2022) annual solids load from pond and clarifier (Beca, 2023(b)).

Source of solids	Average Flow, m^3/d	Mass of DS (dry solids), t/year	Volume of (3% assumed) sludge, m^3/year
Pond	7,440	29.9	1000
Clarifier	2,210	11.5	390
Combined	9,650	41.4	1390

4.5 WWTP effluent flow management

The current flow management practice increases the percentage of incoming flows bypassing the MLE/Clarifier via the oxidation ponds when the incoming flows are high. This practice is necessary to avoid overloading of the secondary clarifier. The practice will cease following the Stage 3 upgrade completion.

The Stage 3 update will provide an equal split of flow to the two MLE reactors. The process lines will be fitted with individual flow meters to allow for adjusting the gates if required. During high flows, a bypass weir will be in place to divert the high flows to the new raw wastewater calamity pond (21,200 m^3), and the stored wastewater will then be pumped back into the MLE reactors when there is capacity available.

Treated effluent from the MLE/secondary clarifier will have the ability to be diverted to a future treated effluent calamity pond when required. The details of the treated calamity pond will be developed as part of this disposal alternative assessment project. We understand from the Stage 3 design report that the treated effluent calamity pond is intended to provide temporary storage of treated effluent when UV disinfection or the disposal field is available.

4.6 Basis of design

This section outlines parameters and criteria that will form the basis of the design for the disposal solution. It includes information on plant capacity, design flows, and the effluent requirements.

4.6.1 Design horizon

The design horizon for the alternative effluent disposal solution is 35 years (i.e. 2060), based on obtaining a long-term resource consent. To optimise capital expenditure, the disposal option evaluation will include consideration of staged expansion.

4.6.2 Design future flows

We understand that QLDC is in the process of updating the future population forecast and wastewater flow estimates, which will be available in early 2025.

In the absence of the latest forecast, this report has adopted the Stage 3 expansion flow estimates as the basis for this Shotover Alternative Effluent Disposal Investigation with a linear extrapolation to 2060, as summarised in Table 6 below. It should be noted that the below design flow estimates will be updated when the revised forecast figures are available from QLDC in early 2025.

Table 6 Stage 3 WWTP Expansion Design Wastewater Flows, reproduced from Table 3-2 of (Beca, April 2022).

	Current flows (2018-2020)	2028 flows	2038 flows	2048 flows (Stage 3 Design)	2060 flows [1]
Usual population	QLDC data to come				
ADWF (m^3/day)	9,850	*Not provided*	*Not provided*	*Not provided*	-
ADF (m^3/day)	10,500	14,300	16,900	19,100	25,800
PDWF (m^3/day)	12,650	16,600	19,700	22,300	29,600
PWWF (m^3/day)	21,700	24,600	29,100	39,800	54,000
PIF (L/s)	456	>710	*Not provided*	892 [2]	1,260 [2]

Notes:
1/ Forecasted flows prepared by GHD based on linear extrapolation, rounded to the nearest hundred.
2/ Peak instantaneous flow (PIF) to be confirmed with QLDC wastewater hydraulic model update.

As part of the Stage 3 peak flow estimates, contribution of flows from Jacks Point Village, Hansleys Farms, Ladies Mile and the Kingston Housing Infrastructure Fund were included. In addition, new lines to the plant from areas such a as Coneburn were considered. (Beca, April 2022)

The following flow observations need to be considered for future long term treated effluent disposal:

– The increase of wastewater flows between current and 2048 is in the order of 81%.
– The peak day dry weather flow (PDWF) would reach 22,300 m^3/day by 2048.
– The peak wet weather flow (PWWF) would increase from 21,700 to 39,800 m^3/day.
– Growth provision between 2048 and 2060 is estimated to be 35% *(a placeholder value for the purpose of options comparison)*.

4.6.3 Shotover WWTP design capacity

The Shotover WWTP Stage 3 expansion has been designed to accommodate the growth up to 2048. Hence, the treatment plant is assumed to have adequate capacity to treat and handle:

– Design ADF and PDWF of 19,100 and 22,300 m^3/day respectively.
– The secondary clarifiers will treat up to 34,560 m^3/day (~400 L/s).

The WWTP will require another capacity upgrade when the wastewater flows reach the WWTP Stage 3 design capacity. This could be in the form of additional trains (e.g. MLE3) or process intensification.

4.6.4

4.6.4 Stage 3 upgrades effluent discharge requirements

We understand that the WWTP Stage 3 expansion will meet the effluent requirements as required by Discharge Permit 2008.238.V1 as outlined in the following Table 7.

Table 7 Shotover WWTP Effluent Discharge Limits (Post Stage 3 upgrades), reproduced from Table 3-1 of (Beca, April 2022).

Parameter	Unit	90%ile	Annual Mean
BOD	g/m3	20	10
TSS	g/m3	20	10
NH4-N	g/m3	-	-
TN	g/m3	15	10
TP	g/m3	10	8
DRP	g/m3	-	-
E.Coli	Cfu/100mL	100 (95%ile)	10 (geomean)

We have identified that the above table does not contain specific targets of ammoniacal nitrogen and dissolved reactive phosphorus which are important considerations for assessing the impact on the receiving environment in different disposal options.

Additionally, it is important to note that under the current consent requirements, Condition 4 allows for a maximum nitrogen discharge load of 75.5 tonnes per year. However, with an estimated average design flow of 25,800 m^3/day by 2060, the effluent TN concentration will need to be reduced to 8 g/m^3 or less as the annual mean.

More stringent discharge limits may be appropriate for some disposal alternatives, which might require additional treatment improvements.

5. Review of recent disposal system investigation reports

A review of recent investigations was undertaken and is summarised the following sections. Our review of these investigations summarises the author's findings and interpretations, which may differ to GHD's interpretations. The findings of these investigations have indicated an issue with the disposal field, primarily as a result of 'blinding' of the aquifer materials beneath and immediately surrounding the disposal field due to solids in treated wastewater effluent clogging the field and progressive biofouling.

The river gravels naturally contain silt and silt rich lenses or channels due to the nature of the river deposition. Groundwater is relatively shallow in this area, this in conjunction with decreased permeability (from silt and biofouling) is likely to influence infiltration rates with subsequent mounding, ponding and surface runoff of the disposal field.

The investigations also suggested short term improvements and monitoring to assist in managing the problem.

Long term options to address the inadequacies were also identified (Beca, 2023(a)), and included:

- Rapid infiltration disposal of treated wastewater.
- Deep well injections.
- Rock channels.
- Boulder holes (shallow bore injection).
- Beneficial irrigation.
- Infiltration at Airport site and Frankton.

5.1 Summary of: QLDC Report on apparent failures in Shotover Disposal Field 2021

An investigation and report on the apparent failures at the disposal field was written by QLDC on 28th January 2021, roughly six months after the first instance of mounding was observed. The report recorded observations that:

– Mounding occurs more frequently with increased rainfall / river level.
– Water level reaches the top of storage baskets.
– There was minimal sewage sludge deposits in the baskets. Sample testing and lab results performed which confirm this.
– Fine silt in baskets, assumed to be from rising river levels.
– Infiltration of silt into the brick layers.

The initial conclusion from the report was that flooding events (dates not provided) of the Shotover River had pushed silt into the drainage layers, blocking sideways and vertical drainage over time, causing water to start mounding. Recommended prevention of this in the report included lining the side trenches with Geofabric.

Figure 26 Observed water level at disposal field, 2021.

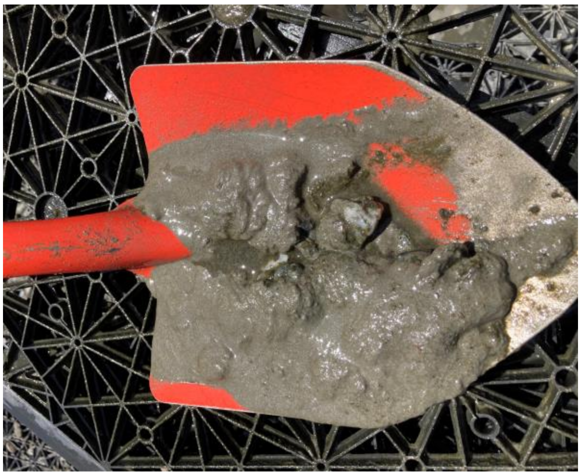

Figure 27 Material recovered from the scrapings of the baskets.

5.2 Summary of: Shotover WWTP Disposal "Full" sizing and Long List for Medium Term Options 2023

In July 2023, Beca investigated the option of an “all-in” RIB solution including costing for this option (Beca, 2023(a)). The investigation also supplied a list of alternative long list options. A summary of the investigation is listed below:

– Long list option: “Full size” RIB disposal, requiring a total area of 27 hectares, exceeding current RIB areas. Refer to Figure 28 below for the sketch outline of the RIB system.
  - Key design assumptions for RIB included:
    – 24,000 m^3/d flow.
    – 416 mm/hr infiltration rate.
    – 30 mm/hr design rate.
    – 1 day of applications per week to each RIB bed.
    – 20% additional area for bunds, access and maintenance.
  - Long term RIB solution can be staged, therefore full cost of solution can be paid over stages.
  - Estimated cost for total reconstruction is $57M with a +/- 50% cost accuracy.

– Alternative long list option: Deep well injection.
– Alternative long list option: Rock channels.
– Alternative long list option: Boulder holes (shallow bore injection).
– Alternative long list option: Beneficial irrigation.
– Alternative long list option: Infiltration at Airport site and Frankton.

While providing details of a “all in “ RIB solution for information purposes, Beca did not recommend it as a solution and considered it unfeasible in the current form.

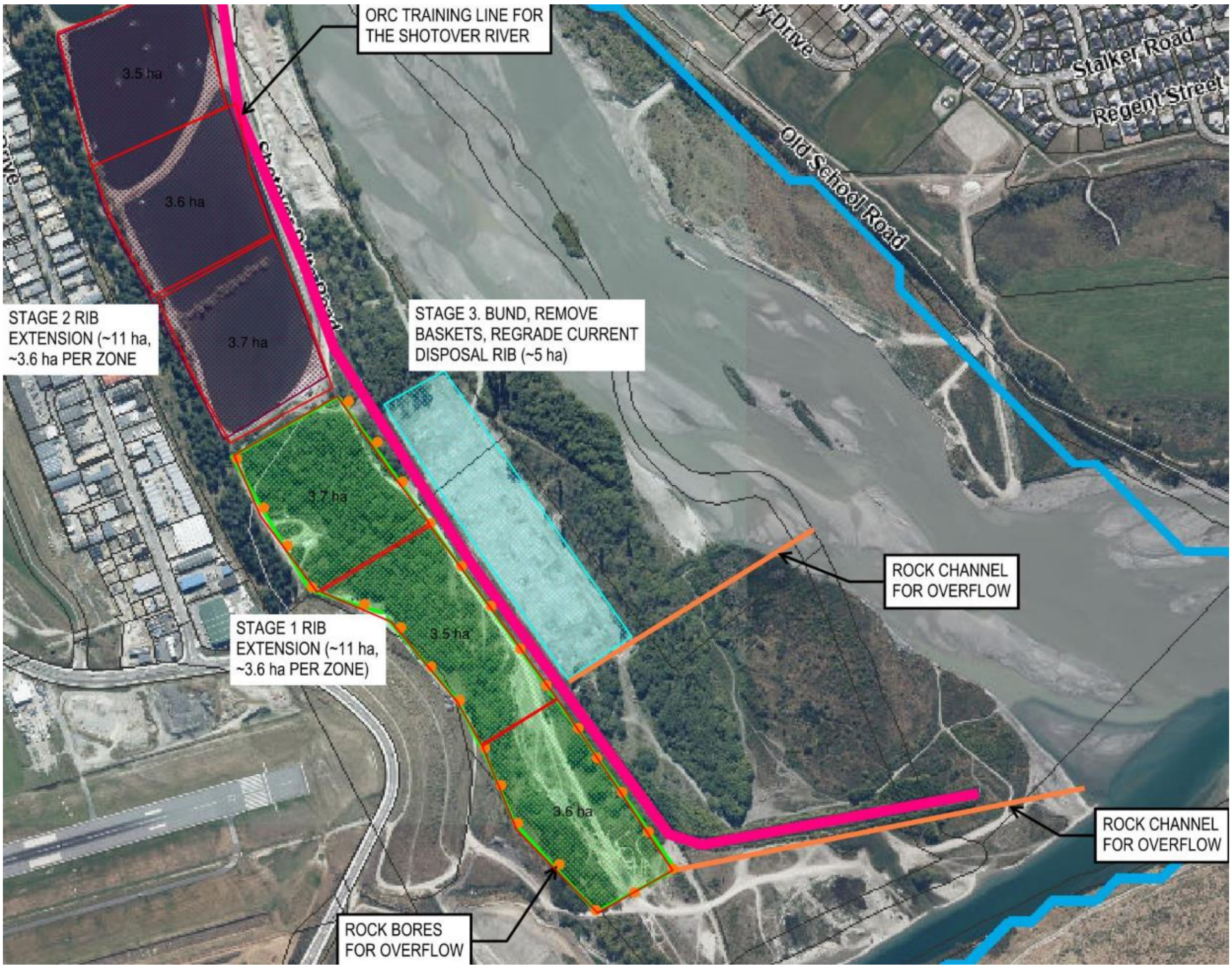

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Figure 28 ***Sketch outline of an all-in Rapid Infiltration Basin (RIB) option, using only land on the delta near the existing Shotover Wastewater Treatment Plant (Beca, 2023(a)).***

5.3 Summary of: Shotover WWTP Disposal Field Report - Assistance with Remedial Works 2023

In September 2023, Beca investigated the issues occurring at the Shotover disposal field including some short-term mitigations and long-term solutions (Beca, 2023(b)). A summary of this investigation is summarised below:

– Key findings from the investigation included:
  - The hydrogeological review indicated that the current disposal field is too small, prone to clogging, has a shallow groundwater table, and faces hydraulic performance limitations.
  - Book-end/buried design makes access and maintenance very difficult.
  - The site is prone to flooding, erosion, and sedimentation.
  - The disposal system was interpreted to be at high risk of blinding when the clarifier reaches high flows, combined with pond effluent discharges.

    - Clogging of infiltration trenches due to solids in wastewater (primarily from ponds) was interpreted to be the primary cause of reduced infiltration performance.
    - Investigation of UVT data from 2022 suggests that the pond is the likely source of the solids.
    - The investigation considered that the disposal field might be remediated to minimise overtopping, albeit at a potentially high cost. However, it is unlikely to meet future demand or provide adequate cycling and scarification.
- A range of short-term improvements/mitigations were recommended. These included::
    - To perform continuous turbidity monitoring on both pond and clarifier effluent streams, to provide more data on the solids issue.
    - Install an effluent return pipeline from the Pond PS to the closest Queenstown Main (either QT1 or QT2 main) so that any algal biomass can be captured into the activated sludge process.
    - To consider reshaping the disposal field, installing a perimeter bund to prevent breakouts flowing offsite.
    - To consider reshaping the site to maximise infiltration over the total available area within the disposal field, by creating a series of surface basins in the space.
    - To install surveillance cameras and monitor the extent and frequency of over topping/flooding at the site and prepare a monitoring and response plan.
- Long-term recommendation included the following.
    - To investigate area requirements and alternative sites for rapid infiltration disposal of treated wastewater.

From the recent discussion with QLDC and the site visit, Veolia has opted to convert the disposal fields as open rapid infiltration beds (RIB).

5.4 Summary of: Shotover WWTP 2023 Annual Report

At the end of 2023, Veolia and QLDC prepared a report for ORC in accordance with condition 17 of the Resource Consent RM13.215.03.V2. The report covers the period from 1st January 2023 to 31st December 2023.

The report provides an overview on the following for the 2023 period:

- Monitoring requirements.
- The flows and quality of wastewater.
- Groundwater mounding and quality assessment.
- Consent condition requirements and if they were met.
- Complaints.

Key findings / concerns relevant to this study included:

- Total wastewater discharge of 3,648,102 m^3 (11.6% higher than 2022) and an annual daily average discharge of 9,995 m^3/d which was below the consent limit annual average volume of 11,238 m^3/d.
- Throughout 2023, the 12-month 95th percentile and annual mean for BOD, TSS and TP in treated wastewater were within the consent limits. However, spike was noted in December 2023, resulting an exceedance of the 95th percentile TN limit. E.coli results were within the consent limits.
- Ponding at the disposal field led to further extension of the already existing abatement notice.
- Following the commissioning of Stage 2 upgrade, the field has had blockages, causing treated wastewater to break out and pond on the surface. Sludge accumulation and overflows had been noted.
- The report states that the hydraulic conductivity of engineered fill in the Dose and Drain Land (DAD) trenches decreased due to the sandy silts from adjacent gravel filled the voids during major flooding. The report author concluded that the silts prevented infiltration of the treated wastewater to the permeable sandy gravel below, causing water to pool and reducing performance.

- A visual assessment of the wastewater flows and piezometer readings showed that changes in wastewater flows generally matched changes in groundwater levels, as indicated by piezometer readings. It was also noted that peaks in wastewater flows are likely influenced by the environmental conditions, such as rainfall.
- Investigation and remediation work to reduce surface water at the disposal fields was ongoing.

6. Summary of environmental data

6.1.1 Topography

LiDAR topographic data was obtained from Land Information New Zealand (LINZ), with a 1 m resolution (pixel size) and a vertical accuracy of approximately 0.1m in flat areas, with greater errors in uneven terrain (e.g. river banks). The data was captured by Landpro between 13 and 14 March 2021 and indicates that Frankton Flats, where the site is located, consists of two distinct terraces:

– Upper Terrace (western side): elevations range from approximately 345 to 355 meters above sea level (mRL).

– Lower Terrace (eastern side): situated near the Shotover River, where the WWTP is located, with elevations ranging from 310 to 315 mRL.

The approximate locations of these terraces are shown in Figure 29, while the LiDAR data is represented in Figure 30.

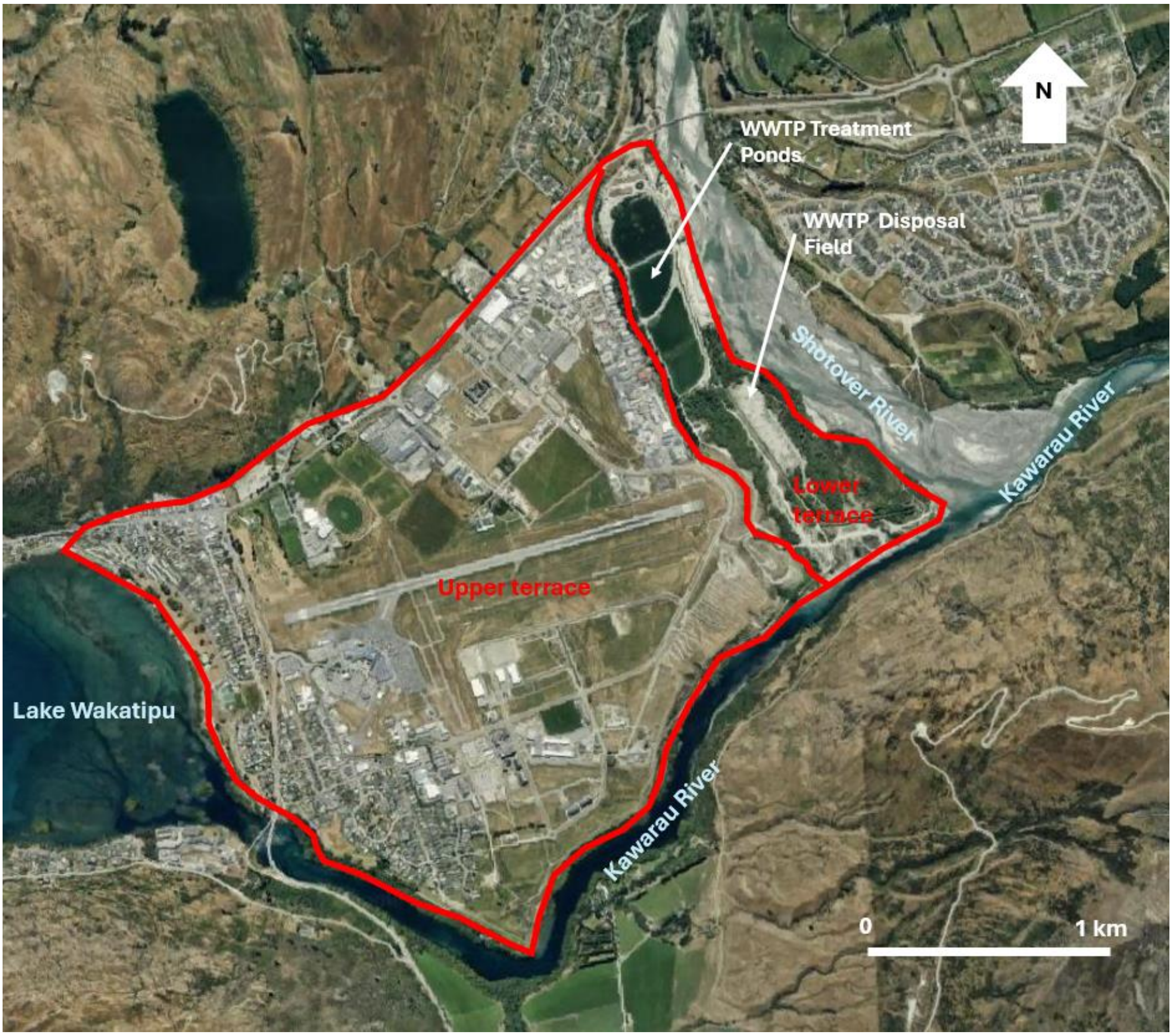

Figure 29 *Frankton Flats and the approximate locations of the upper and lower terraces.*

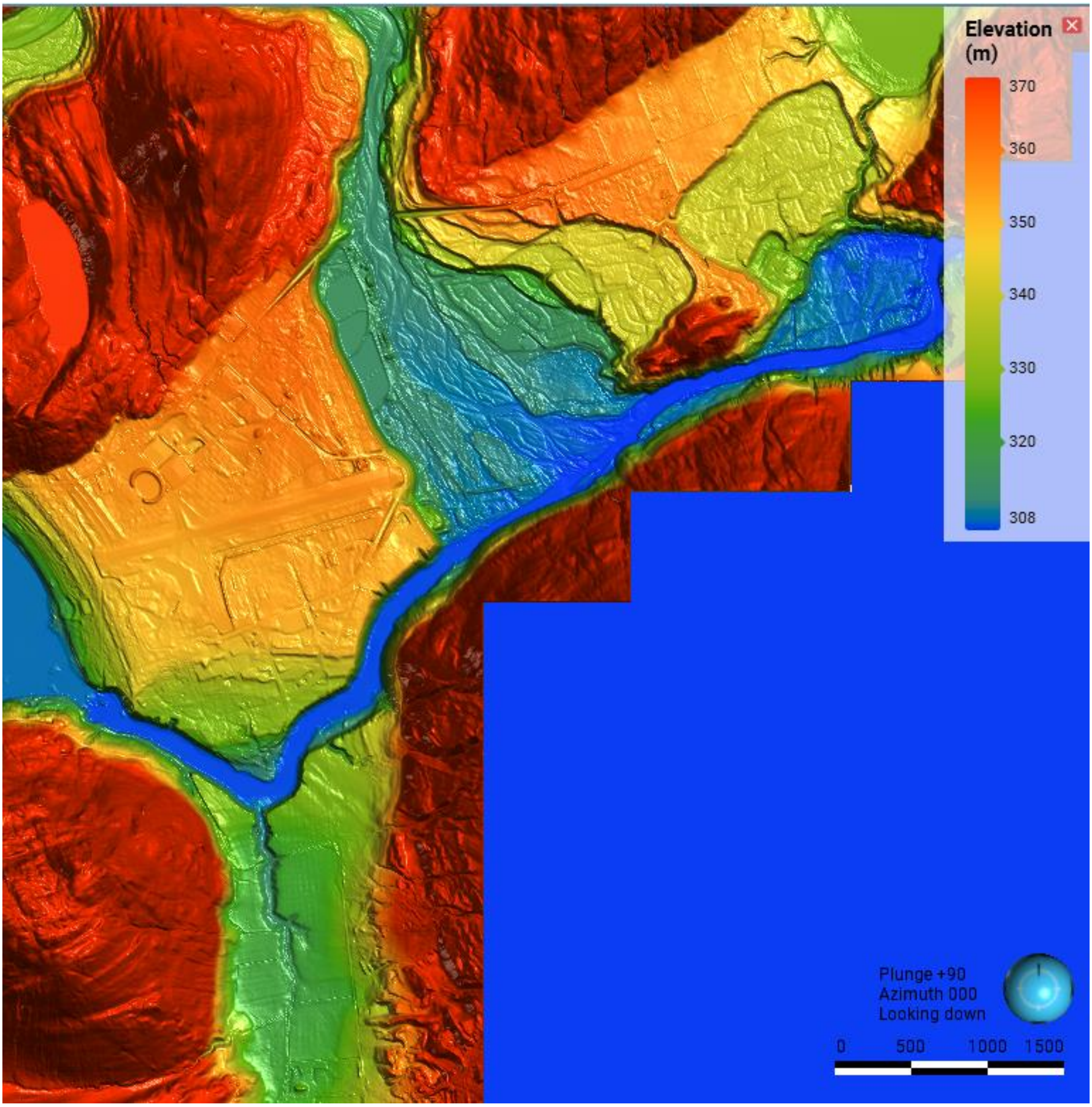

Figure 30 ***Topography of the area surrounding the WWTP, based on LiDAR data from 2021 with 1m resolution.***

Survey data was also collected along cross sections of the Shotover and Kawarau Rivers near the WWTP, by Landpro in 2024. The location of the survey and the profile of key cross-sections are shown in Figure 31. The survey provided results similar to the LiDAR data captured in 2021.

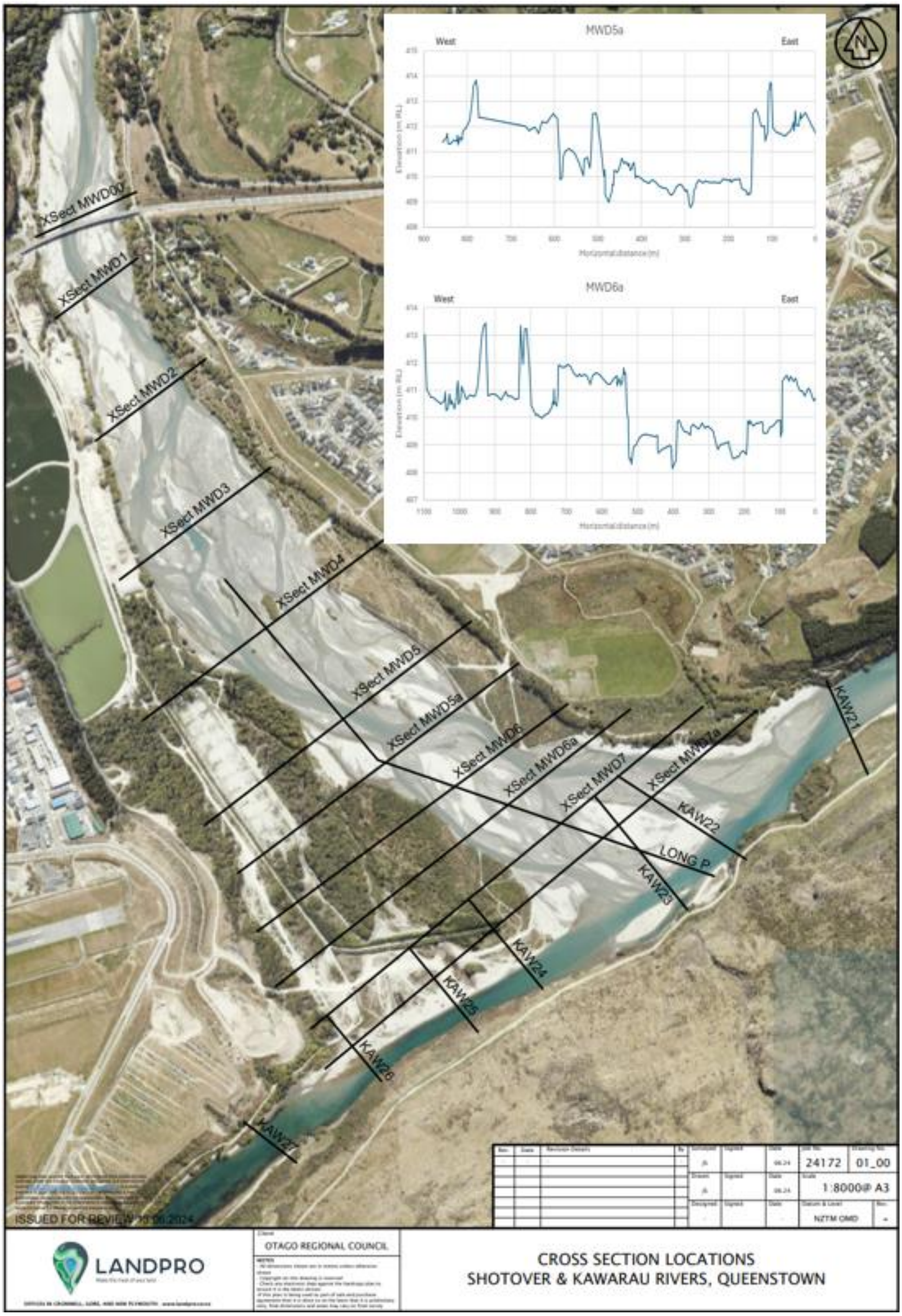

Figure 31 ***Location of the survey undertaken by Landpro.***

6.1.2 River flow and level

River flow and level data from the past 20 years was obtained from four nearby NIWA and ORC river gauging stations, as shown in Figure 32. A summary of the available data types, monitoring period and average values is presented in Table 8.

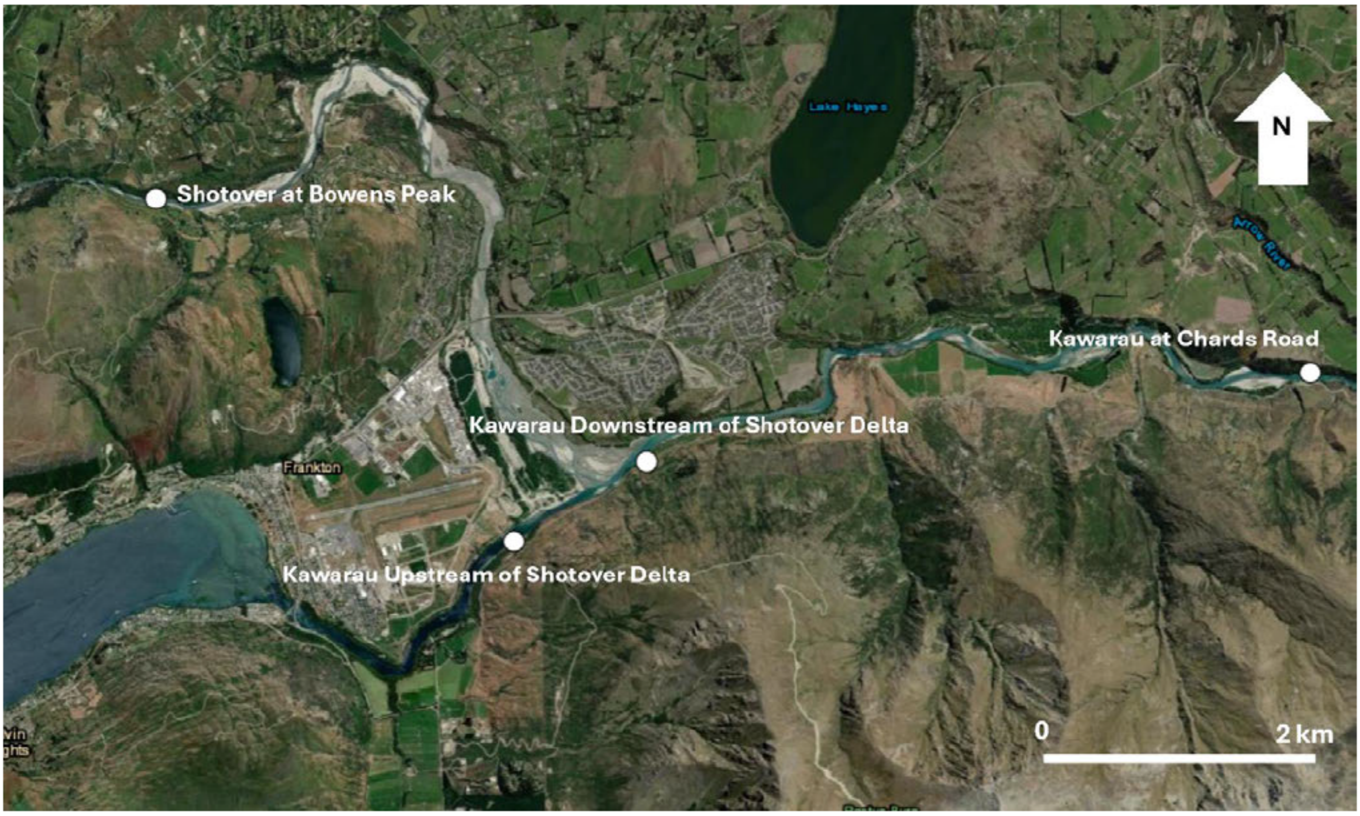

Figure 32 *River gauging station locations.*

Table 8 *Summary of river flow and level data.*

Location	Parameter	Frequency	Initial Measurement	Last Measurement	Average values
Shotover at Bowens Peak	Flow (L/s)	Daily	1 Jan 2004	3 Jul 2024	35,100
	Level (mRL)				330.7
Kawarau at Chards Road	Flow (L/s)		1 Jan 2004	16 Jul 2024	201,700
	Level (mRL)				300.8
Kawarau Downstream of Shotover Delta	Level (mRL)		1 Sep 2004	23 Oct 2024	308.6
Kawarau Upstream of Shotover Delta	Level (mRL)		1 Sep 2004	23 Oct 2024	309.3

6.1.3 Geology and soils

The following geological and soil information was obtained and reviewed:

– The geology of the area (From GNS (2024)), shown in Figure 33, comprises:
  - Frankton Flats and Shotover Delta: Holocene (recent) alluvial, river, and fan deposits consisting of unconsolidated gravel, sand, and silt.
  - Hill areas to the north and south: Rakaia and Caples terrane schist and Pleistocene glacier deposits. The schist is inferred to underlie the basin alluvium (including Frankton area) at variable depths. The Pleistocene glacier deposits consist of poorly sorted boulders, gravel, sand and silt.

– NZGD and ORC Wells database: borelogs from nearby investigations indicate that the subsurface consists mostly of boulders, gravel, and sand, with minor silt lenses/ layers. Figure 34 shows the location of these investigations.
  - The data also indicate the basement rock is deep: a 90 m deep bore in the upper terrace did not reach the basement, while a 40 m deep bore in the lower terrace also did not encounter the basement rock.

- Lowe (2016): provides particle size distribution results from 15 shallow test pits (0.7 to 2.2 m deep) excavated in 2016 in the WWTP disposal field location before its construction (Figure 34).
- WSP (2019): contains logs for eight test pits (of up to 3 m deep) located north of Pond 1, including trace element concentrations measured in soil samples collected in 2019 (Figure 34).
- Geosolve (2021): includes borelogs for 11 bores located in or near to WWTP disposal field, with locations shown in Figure 35 (Section 6.1.4), and with depths ranging from 3.0 to 40.0 m below ground level (bgl).
- McMillan (2021): reported cone penetration tests through the disposal field, for depths ranging from 4.6 to 12.0 m bgl.
- S-Map Database: soils present in the Frankton Flats are indicated as being predominantly sandy and loamy, with good drainage properties.

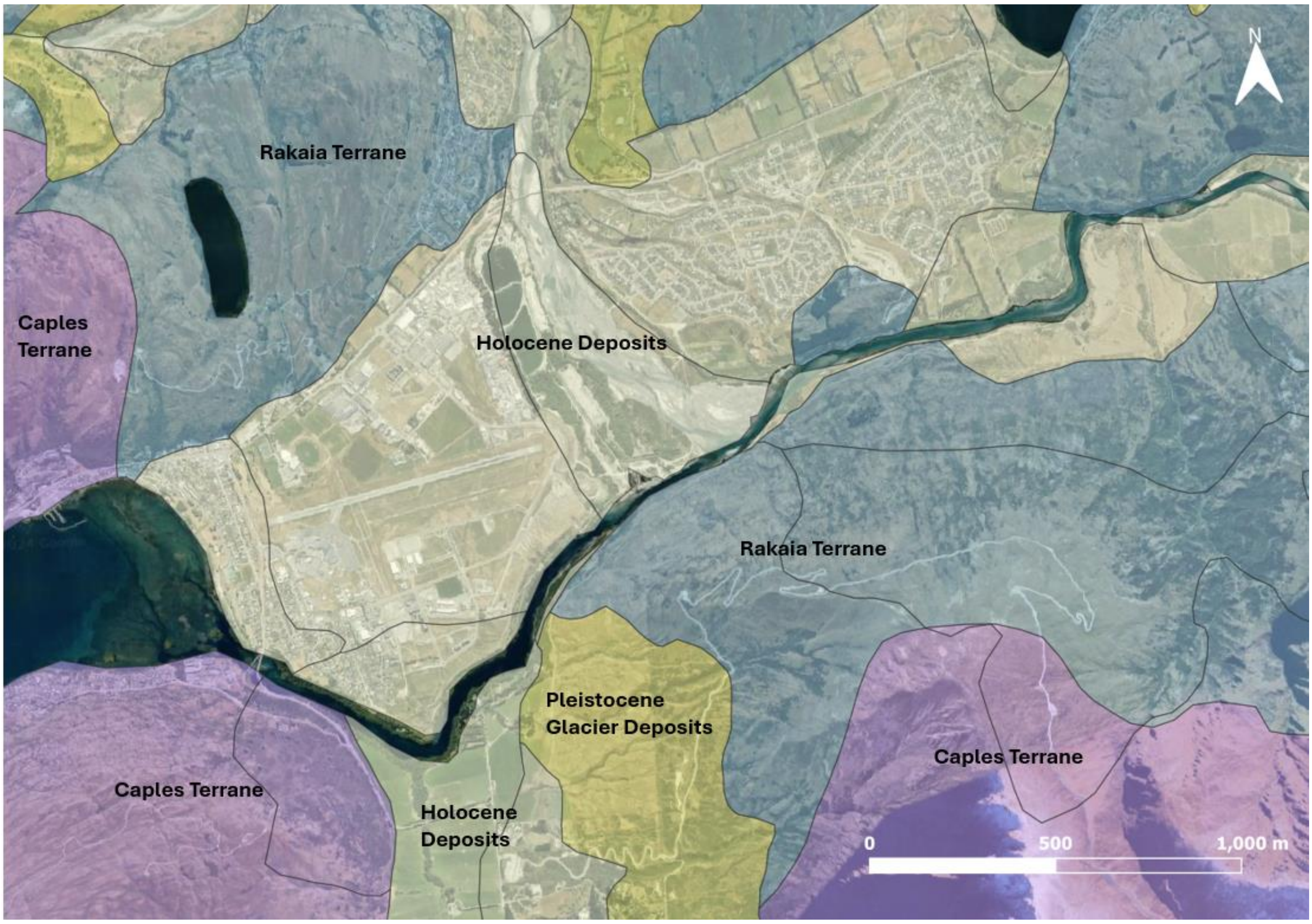

Figure 33 Geology of the area. Data source: GNS (2024).

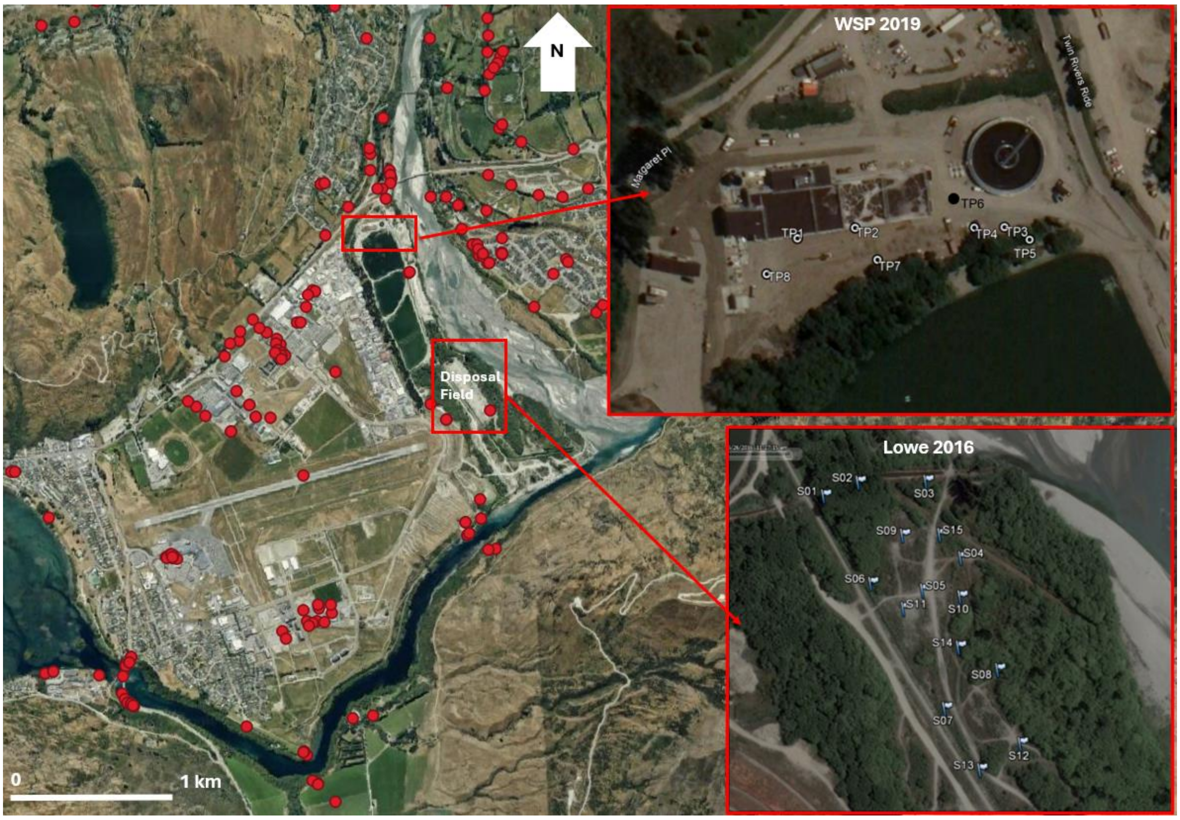

Figure 34 Nearby geological and soil investigations.

6.1.4 Groundwater

Several groundwater data sources were reviewed:

– An ORC (2014) report on the Wakatipu Basin aquifers highlights three major aquifer units:
  - Shotover Alluvial Ribbon Aquifer: located where the WWTP is situated (Figure 35), this unconfined aquifer consists of sandy gravel with high transmissivity, directly connected to the Shotover River.
  - Frankton Flats Aquifer: located adjacent to the WWTP (Figure 35), this is a large, deep sandy gravel aquifer with high permeability, extending to depths over 90 m bgl. A 2007 pumping test estimated transmissivities between 1,000 to 3,000 m²/day and a specific yield of 0.10 to 0.15. The test location is shown in Figure 35.
  - Windemeer Aquifer: located on the true left bank of the Shotover River, across from the WWTP (Figure 35), this is a high permeability unconfined aquifer composed mostly of sandy gravels. The aquifer is deep, with bores reaching 70 m bgl and not finding the basement.
  - No aquifer information was found for the terrace south of the Frankton Flats, where the Jack's Point community is situated (Figure 35).

– Groundwater levels were monitored in eight ORC piezometers (ORC 1 to 8) situated at the edge of the disposal field from 2018 to 2024 (locations shown in Figure 35): this data was sourced from the client's telemetry system (WaterOutlook). However, from September 2022 onward, the data appears inaccurate, as most piezometers show identical water levels (Figure 37).

– New Zealand Geotechnical Database (NZGD) and ORC Wells database: available groundwater level data shows that groundwater in the upper terrace is generally deep (over 40 m bgl, as measured in four boreholes), while the lower terrace has shallow groundwater levels (2.3 to 4.0 m bgl, as measured in two boreholes, shown in Figure 35). The location of these measurements is shown in Figure 35.

– Pumping test data provided by QLDC: pumping tests were conducted in 2007 and 2008 in shallow bores (less than 20 m deep) in the Shotover Delta, before the WWTP disposal field was constructed. The tests estimated transmissivity values ranging from 4,800 to 5,500 m²/day for shallow bores (less than 20m deep).

– Reports by Lowe (2016, 2019, 2021) suggest that:

- Shotover River flow, measured at the Bowens Peak NIWA station (whose location is shown in Figure 32, section 6.1.2), significantly affects groundwater levels in the disposal field, increasing the levels by 0.5 m, which dissipates in 5 to 10 days.
- The WWTP discharge also influences groundwater levels, causing fluctuations of 0.3 to 0.4 m (Figure 36).
- Groundwater elevations in the Frankton Flats are approximately 311 mRL, with flow directions generally northwest-southeast influenced by the Shotover catchment recharge.
- Hydraulic conductivity values range between 4.5 and 65 m/day, based on particle size analysis from samples collected in the WWTP disposal field location, before its construction.
- Infiltration rates in the disposal field before construction were estimated at 10 m/day based on particle size distribution and infiltration test pit results obtained between 2007 and 2009, as well as in 2016.

– A report by Beca (2023(b)) estimated a theoretical mound rise above ground level for infiltration rates exceeding 0.5 m/day, which is lower than the 10 m/day rise estimated by Lowe (2016).

– A report from Landpro (2024b): this report provided groundwater measurements for a piezometer located on the eastern side of the Shotover River, opposite the WWTP (Figure 35).

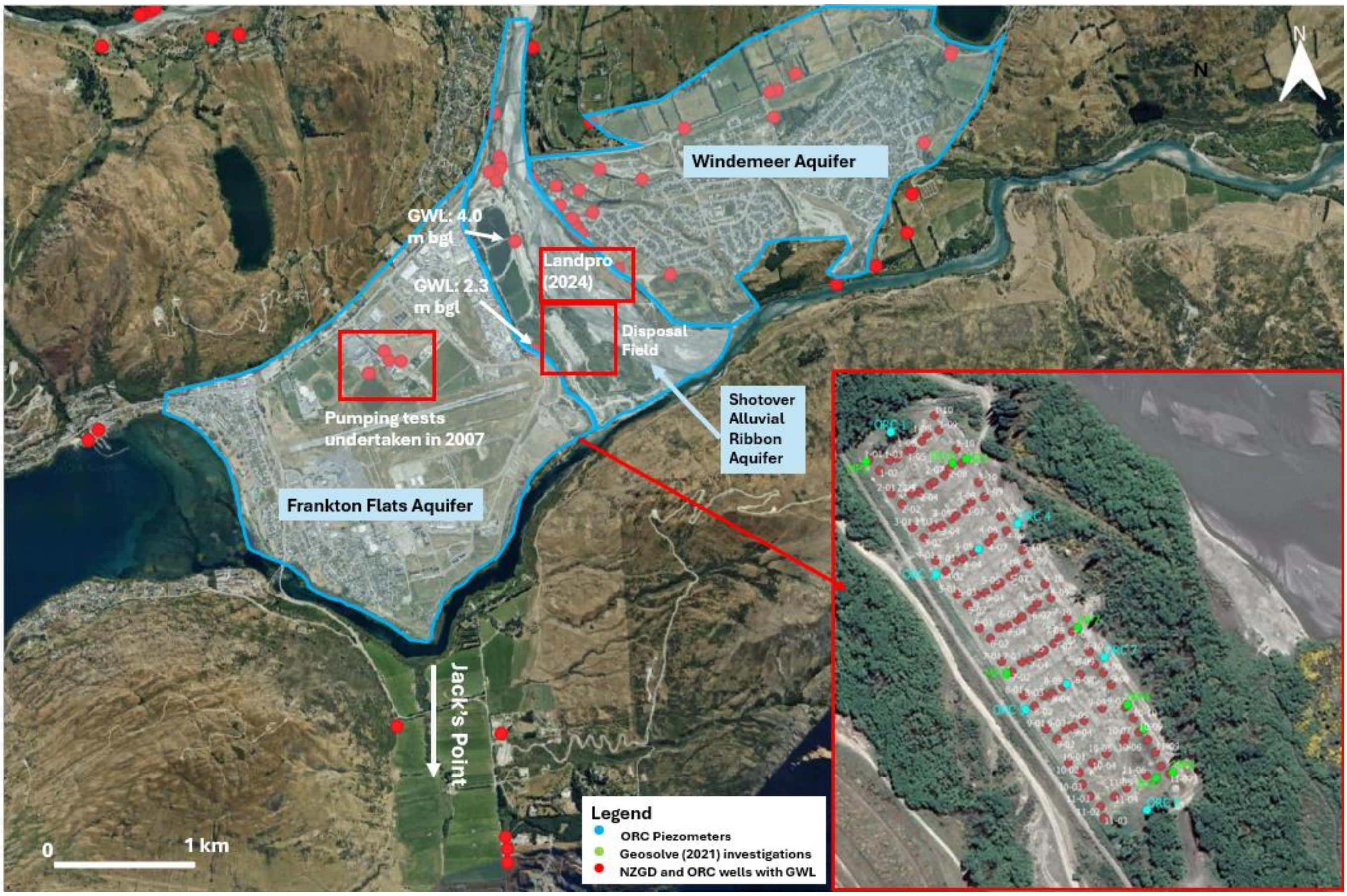

Figure 35 *Location of the main aquifer units in the area and nearby investigations with groundwater levels. Disposal field image source: WSP (2022).*

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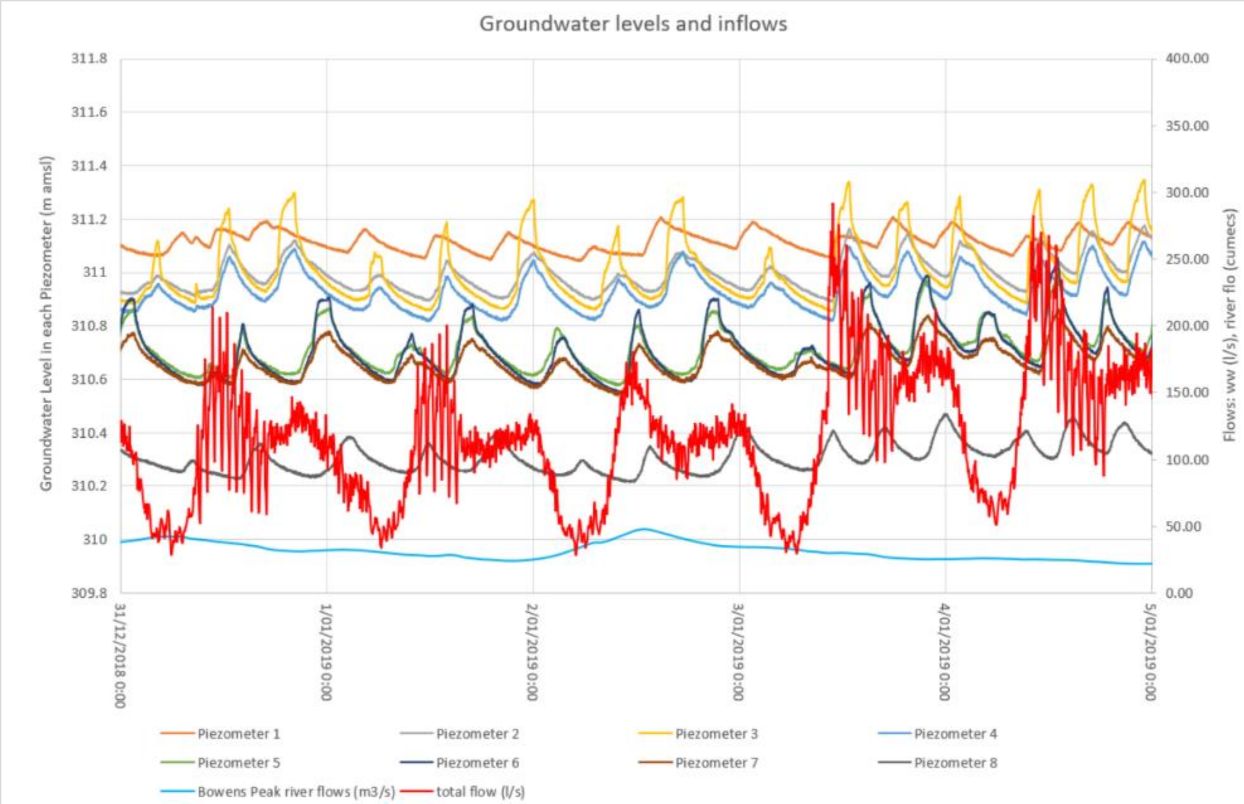

Figure 36 *Piezometers water levels and Shotover and WWTP flows (2019).*

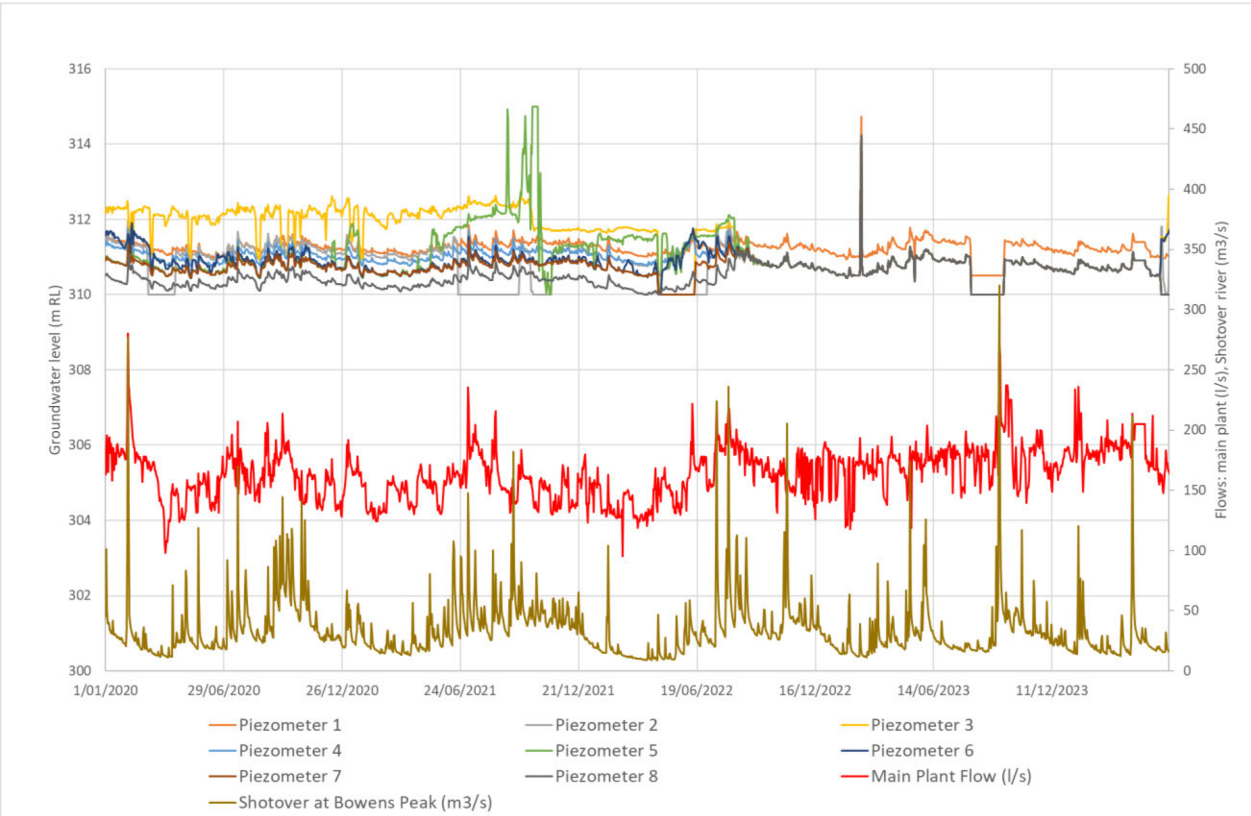

Figure 37 *Piezometers water levels and Shotover and WWTP flows (full record). From September 2022 water levels for Piezometer 2 to 8 are the same (obscured beneath grey line of Piezometer 8 record).*

6.1.5 Water quality

QLDC provided water quality data for WWTP effluent and for eight piezometers in the disposal field (ORC 1 to 8, shown in Figure 35, Section 6.1.4). The data was typically collected at monthly intervals. Table 9 summarises the water quality data provided by QLDC.

Table 9 Water quality results provided by QLDC.

Location	Parameter	Initial Measurement	Last Measurement
Shotover WWTP effluent	pH	Jan 2001	Sep 2024
	Biochemical Oxygen Demand (BOD)	Jan 2001	Sep 2024
	Total Suspended Solids	Jan 2001	Sep 2024
	Total Phosphorous	Jan 2001	Sep 2024
	Total Ammoniacal Nitrogen	Jan 2001	Sep 2024
	Total Nitrogen	Jan 2001	Sep 2024
	Nitrate	Jan 2001	Sep 2024
	*E. Coli**	Mar 2003	Sep 2024
	Faecal coliforms	Jan 2001	Jul 2015
	Dissolved Oxygen	Jul 2008	Feb 2017
ORC Piezometers 1 to 8	*Ammoniacal Nitrogen*	Jan 2019**	Sep 2024***
	Nitrate Nitrogen		
	Total Nitrogen		
	Total Phosphorus		
	E. Coli		

**Intermittently collected until March 2018, after which it was collected on a monthly basis*
***Piezometers 1 and 8 had their initial measurements in Nov 2018*
****Piezometer 2 had its last measurement in Mar 2024*

Additional water quality data was obtained from the ORC Environmental Data Portal, LAWA, and the NIWA Hydro Web Portal for sites shown in Figure 38. The parameters measured differ across sites, but typically include at least one of the following: Ammoniacal Nitrogen, Chloride, Electrical Conductivity, Nitrate Nitrogen, pH, Total Phosphorus, and Turbidity. The data records generally extend over a period of more than 10 years, with sampling normally occurring on a monthly basis.

Figure 38 Water quality sites from NIWA, LAWA and ORC.

Table 10 presents the State of Environment information obtained from LAWA for two of these NIWA water quality sites: Shotover at Bowens Peak and Kawarau at Chards Road. The State of the Environment is defined by the Ministry for the Environment in the National Policy Statement for Fresh Water Management (2020) and includes 4 bands:

– A: no expected adverse effects on ecological communities, the parameter analysed is similar to the natural conditions.
– B: minor adverse effects on ecological communities, the parameter analysed is slightly above natural conditions.
– C: adverse effects on ecological communities, the parameter analysed is above natural conditions.
– D: substantial adverse effects on ecological communities, the parameter analysed is significantly above natural conditions.

Table 10 State of Environment for Shotover and Kawarau Rivers.

Station	Parameter	State
Shotover at Bowens Peak	*E. coli*	Not assessed
	Clarity	D
	Ammoniacal Nitrogen	A
	Nitrate Nitrogen	A
	Dissolved Reactive Phosphorus	A
Kawarau at Chards Road	*E. coli*	A

Station	Parameter	State
	Clarity	D
	Ammoniacal Nitrogen	A
	Nitrate Nitrogen	A
	Dissolved Reactive Phosphorus	A

Additionally, a report by Landpro (2024c) was also reviewed, which provides water quality results for the Shotover and Kawarau Rivers at three locations each, near the WWTP (Figure 39).

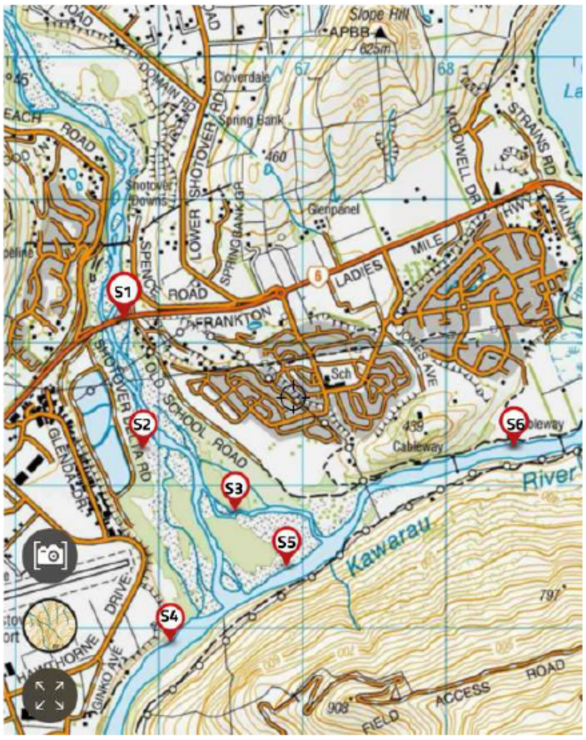

Figure 39 Map of the six sample locations from Landpro (2024c).

6.1.6 Consents and land ownership

A review of the ORC consents database was undertaken, with this following identified:

- No currently active consents for water take or bore construction in the terraces or Frankton Flats area were identified. However, the following were identified:
  - Two community drinking water supply bores were identified as being in the upper terrace, owned by Property Ventures Limited, whose consents for bore construction expired in 2008 and 2009.
  - Several community drinking water supply bores owned by QLDC were identified as being located to the north of the WWTP and on the true left of the Shotover River, near the Shotover Country subdivision.
- A water take consent for groundwater exists on the left of the Shotover River (across the WWTP), granted to QLDC for community supply.
- Four consents for bore construction on the left of the Shotover River and close to the above-mentioned water take consent.
- Several consents for discharges to land and water on Frankton Flats and the airport area.

The location of these consents is shown in Figure 40.

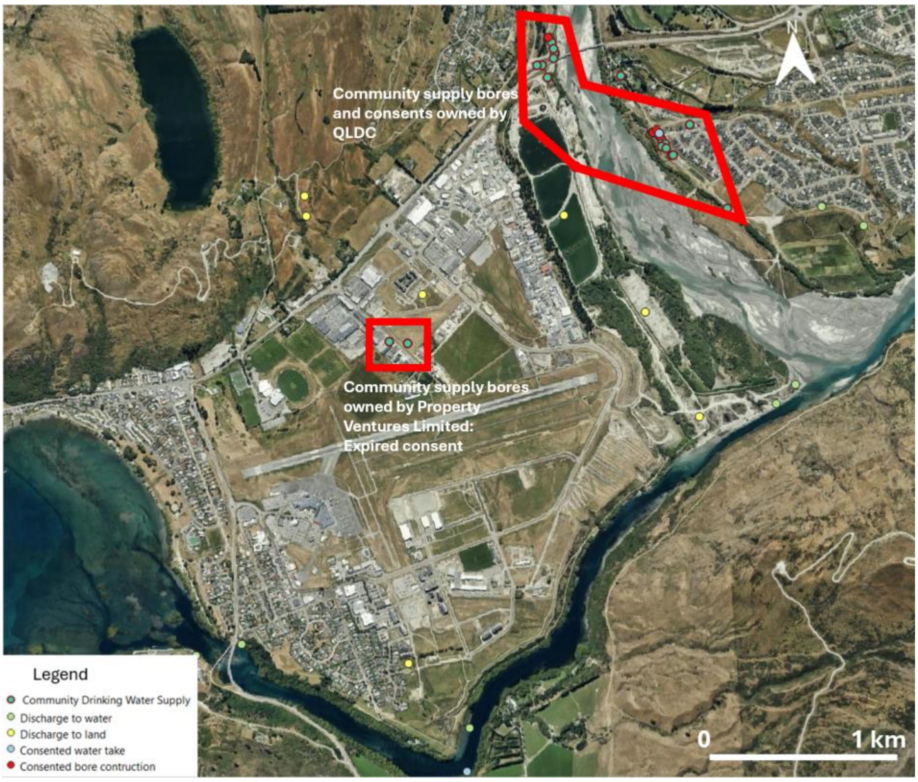

Figure 40 *Nearby consents and community drinking water supply bores.*

The LINZ database was also reviewed for land ownership in the area. Figure 41 shows the parcels owned by QLDC, while Figure 42 shows the parcels owned by the Crown and Figure 43 shows the parcels owned by Crown but administered by LINZ.

Figure 41 *Land parcels owned by QLDC (property boundaries outlined in white).*

Figure 42 *Land parcels owned by the Crown (property boundaries outlined in white).*

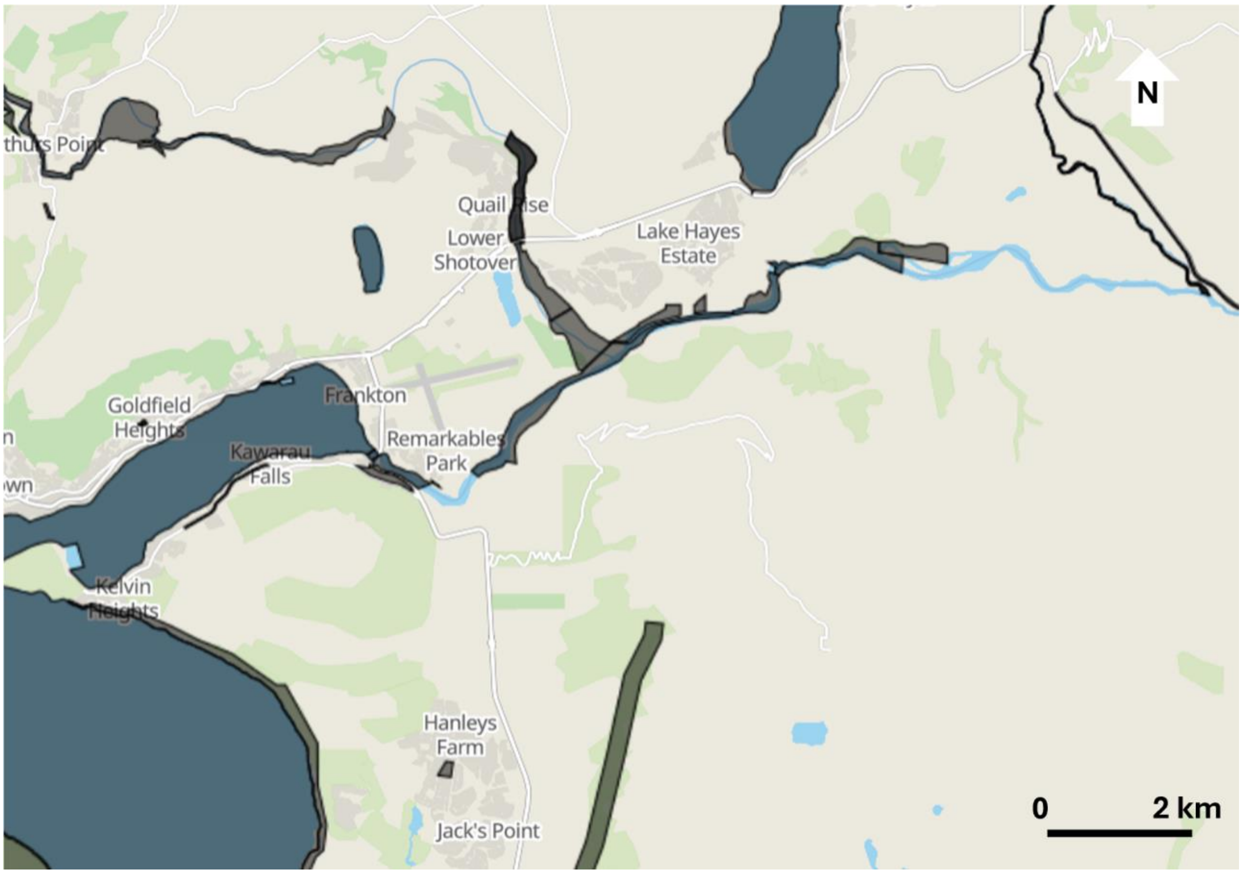

Figure 43 *Land parcels owned by the Crown but administered by LINZ (properties shown by dark polygons).*

6.1.7 Climate

Daily rainfall, temperature and evaporation data were obtained for the NIWA Queenstown Aero Aws station, for the period from January 2002 to October 2024. The station location is shown in Figure 44.

Figure 44 Location of Queenstown AWS station.

7. Information gaps identified

Following a review of the existing information on the current treatment system and disposal field system, data gaps were identified as outlined in the following sections (7.1 and 7.2). In general, we consider that there is sufficient information to compile a long list of potential disposal options. However, we have also identified baseline monitoring and/or investigations that we recommend undertaking concurrently with the optioneering and MCA phase of the project (refer to Section 7.2.1). This information may be useful in assessing the suitability of potential short term remedial options and inform long term solutions.

In addition, the viability of land parcels including QLDC owned lands outside the Shotover Delta for the purpose of treated wastewater disposal will be a key criterion when considering the long list options.

The information gaps will be examined again during optioneering stages, to inform short list development.

Appendix A contains a summary table of the information supplied, and a Gap Analysis Register is collated as part of this report.

7.1 WWTP related issues

Several data gaps were identified, specifically:

– Available data on effluent quality following Stage 3 upgrades:
    - Historical data for wastewater effluent are available from 10/01/2001 to 04/09/2024. More recent data can be requested as needed. As described in Section 4.6.4, the Stage 3 WWTP expansion is expected to achieve the discharge quality described in Table 7. Any further treatment requirements will be identified in the subsequent effluent disposal alternative option assessment.

- Future projected flows and population growth:
    - Population and flow forecasts are based on Beca's Stage 3 design report and the linear extrapolation for the 2060 flows as shown in Table 6. With the growth forecast and wastewater network model currently being updated, the population forecast and future wastewater flow estimates will be updated when the new information is available in early 2025.
- Impact of alternative disposal decision on the treatment plant:
    - In addition to possible treated effluent quality improvement, the final effluent disposal solution and location could have an impact on the treatment plant in terms of flow storage management, transfer pumping and others. This will be covered in the alternative disposal option assessment.
- Disposal field monitoring:
    - The integrity of water level data collected from monitoring wells within and around the disposal field appear to have been impacted through 2022 and onwards. The reliability of this data should be confirmed and improvements made to ensure ongoing collection of reliable data.

7.2 Environment information

A number of data gaps were identified from the environmental data review as outlined in Section 6. In general, there is a lack of detailed data outside of the immediate WWTP disposal field. Nonetheless, we consider that there is sufficient information to compile a long list of potential disposal alternatives.

Following the completion of long list options evaluation, the information gaps should be re-assessed, to identify and scope additional investigations if required to inform short list options development. The data gaps identified so far are as follows:

- **Geology**
    - Geological variability in the river gravels, thickness of alluvial gravels overlying schist.
    - Geology beneath the Kawarau River and groundwater connectivity to the rivers.
    - Refined geology of alternate disposal areas, including Frankton Flats, the area south of the Kawarau River, and the terrace on the left bank of the Shotover River.
- **Hydrogeology**
    - The effect of the discharge on groundwater levels in the Shotover delta immediately outside the disposal field.
    - Groundwater data and aquifer information for Southern Corridor area (Hanley’s Farm, Jacks Point)
    - The influence of historical river channels on groundwater flow rates and potential for preferential flow paths.
    - Interaction of groundwater with surface water, there is no continuous, real-time data correlating groundwater levels to river flow and levels for the Shotover and Kawarau rivers.
    - Uncertain integrity of the disposal field groundwater monitoring data from September 2022 onwards (see section 6.1.4).
- **Hydrology**
    - Changes in channel locations on the delta in response to flooding.
    - Previous flood events’ height and duration in the Shotover and Kawarau Rivers.
    - Effect of climate change on river flow and rainfall patterns.
- **Water Quality and Public Health**
    - Water quality of standing water areas around the delta.
    - Groundwater quality across the Shotover delta (outside of the current disposal field) and current influence of treated wastewater discharge to ground and whether inground treatment is being realised.
    - Groundwater quality in alternate disposal areas, including Frankton Flats, the area south of the Kawarau River, and the terrace on the left bank of the Shotover River.

- Trace contaminants (e.g. metals) and emergent contaminants (eg. PFAS, microplastics etc) – no data is available for these parameters.
- Public health risk – limited or no data available for microbial contaminants (e.g. bacterial, protozoa and viruses) and only anecdotal information regarding the recreational use of the delta area, and collection of mahinga kai from the Shotover and Kawarau rivers.

– **General**
  - Details of the engineered structure built on the banks of the Shotover, immediately upgradient of the current disposal field.
  - Details on the flood embankment (river training line) construction downstream of the current disposal field.
  - While the current topographical data may be sufficient for the initial stages of this project, a higher resolution survey is expected to be needed in the future to gain a more accurate understanding of the terrain, particularly in uneven areas like riverbanks.

7.2.1 Baseline monitoring

We recommend the following investigations are undertaken concurrently with the options development:

a. Water quality of groundwater discharge to the river(s)
b. Water quality in rivers
c. Water quality of daylighting (ponded) wastewater
d. Groundwater flow direction and preferential flow paths (former channel features)

7.3 Initial risk assessment

A preliminary risk assessment has been undertaken as part of this report, and refer to Appendix B for Risk Register.

The risk register will be maintained and updated throughout the project.

8. References

– Beca. 2023(a). Shotover WWTP Disposal 'Full' Sizing, and Long List for Medium-Term Options. Prepared for Queenstown Lakes District Council.
– Beca. 2023(b). Shotover WWTP disposal field report - assistance with remedial works. Prepared for Queenstown Lakes District Council.
– Beca. 2022. Project Shotover Stage 3 – Detailed Design Report. Prepared for Queenstown Lakes District Council.
– Geosolve. 2021. Frankton WWTP Logging. Prepared for Queenstown Lakes District Council.
– GNS. 2024. Interactive geological map of New Zealand. **https://data.gns.cri.nz/geology/** [Accessed November 2024].
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– Landpro. 2024c. Water quality baseline snapshot for Queenstown wastewater treatment plan and surrounds. Prepared for Queenstown Lakes District Council.
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- LAWA - Land Air Water Aotearoa. 2024. **https://www.lawa.org.nz/** [Accessed November 2024].
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- Lowe. 2021. Memorandum to Lane Vermaas and Andrew Strahan - Shotover DADS Groundwater Mounding Assessment.
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- S-map online. The digital soil map for New Zealand. **https://smap.landcareresearch.co.nz/** [Accessed November 2024]
- WSP. 2019. Project Shotover stage 3 - detailed site investigation.
- WSP. 2024. Memorandum to Rob Potts and Louis Ferreira - Post Trench Mitigation Water Level Assessment.

Appendices

Appendix A

Information received summary

8.1 Information received

A substantial amount of information was received. All documents and data sources were briefly reviewed, and those relevant to this project were examined in more depth. The following Table 11 outlines the documents and data sources that have been reviewed and selected for inclusion in the project inception and gap analysis report. These documents and data sources are pertinent to the project and may provide details that will assist with various aspects of the project.

Table 11 Summary of key information received and included in the gap analysis review.

Documents and data sources	Scope of report/info	Key contents or findings	Relevance to this upgrade
Shotover WWTP Disposal "Full" sizing and Long List for Medium Term Options. July 2023.	Summarises findings for an "all-in" RIB option and provides rough order of cost, in addition to a list of longlist options.	"Full size" RIB disposal - require 27ha area in total, in excess of current RIB areas Not possible/feasible solution, estimated to be $57M for total reconstruction, +/-50% cost accuracy Section 3 contains a list of long list options Recent WWTP effluent has better E coli and TN than consent requirements.	Long List options outlined in section 3 may have relevance for when we do our long-term options Provides report and findings on an "all-in" RIB option, if this option is considered these findings can be used.
Shotover WWTP Disposal Field Report - Assistance with Remedial Works. September 2023.	The report highlights issues with the current disposal field, including its size, clogging, and flood risks, and recommends both short-term improvements and long-term alternatives.	Hydrogeological review confirming that the current disposal field is too small, prone to clogging, shallow GW table and hydraulic performance limitation Book-end/buried design made it very difficult to access and maintain Site is prone to flood hazards, erosion and sedimentation Process review indicated when clarifier reaches high flows and with combination of pond effluent discharges creates high risks of blinding Clogging of infiltration trenches due to solids in WW (primary source being ponds) appears to be main issue A range of short term improvement/mitigations were recommended Long term recommendation of investigating area requirements and alternative sites for RIBs (such as WWTP ponds and the airport)	Provides understanding behind the issue and what is causing it. Provides some recommendations (short and long term which could still have relevance) Outlines works which were part of Stage 3 upgrades but not included in tender.
2021.01.28_QLDC_Report on apparent failures in Shotover Disposal Field	A report on the failures in Shotover Disposal Field. -Mounding occurring more frequent with increased rainfall -Water level at top of storage baskets -Minimal sewage sludge deposits in the baskets -Fine silt in baskets (assumed to be from the rising river levels) -Infiltration of silt into the brick layers	The initial conclusion is that the flooding events of the Shotover River have pushed silt into the drainage layers and over a period of time have blocked sideways and vertical drainage causing the water to start mounding. The disposal report shows minimal WW sludge (only silt) in the disposal field baskets and trenches (note this conflicts with the Shotover WWTP Disposal Field Report 2023 where it is assumed sludge is the main issue for clogging).	Background information on investigation and potential conclusions on the mounding and why it may be occurring. Findings indicate that the river water table is interfering with the disposal field during flood events (causing silt to clog baskets).
Summary of Shotover WWTP 2023 Annual Report	Shotover WWTP Annual Report 2023, goes over monitoring requirements, flows and quality, ground water mounding and quality assessment, consent requirements, complaints.	Summary of investigative works Ponding at disposal field leading to further extension of abatement notices Discharge flows keeping within consented flow limits TN exceeding its 95th percentile consent limit in December 2023 Blockages on disposal field	Provides insight to current status of site and compliance.
Disposal Field Construction Presentation	Presentation on the construction of the disposal field. Provides drawings and photos of the construcition of the field.	Provides context to the construction of the disposal field.	Context of the existing disposal field and how it was constructed.
WWTP Proposed pond decommissioning location	Provides a screenshot for a plan over the existing ponds (this would result in the decommissioning of the ponds).	Planned items for the pond 1,2 and 3 areas once they are decommissioned - Raw water calamity pond - Treated water calamity pond - MRF system (building, access and storage) - ECO park	Important to understand in case we decide to consider the decommissioned pond area in any of the options. Currently decommissioned pond area is planned

Documents and data sources	Scope of report/info	Key contents or findings	Relevance to this upgrade
			to be used for raw water calamity pond and treated water calamity pond
Site photos	Photos of the site (many of the disposal	Photos which show the site and mounding of the disposal field	Background context of the problem.
Shotover WWTP Stage 3 Upgrade CIVIL DRAWING SET (FOR CONSTRUCTION)	Stage 3 upgrades civil drawing set for construction	Provides civil detail on upgrades. Including location of the raw water calamity pond.	Provides understanding of Stage 3 upgrades.
Shotover WWTP Stage 3 Upgrade MECHANICAL DRAWING SET (FOR CONSTRUCTION)	Stage 3 upgrades mechanical drawing set for construction	Provides for construction drawings of both the MLE and clarifier. Also has detail on inlet works, RAS pumps and WAS tanks.	
Shotover WWTP Stage 3 Upgrade PROCESS DRAWING SET (FOR CONSTRUCTION)	Stage 3 upgrades process drawing set for construction	Including PFD and P&ID Gives good indication to what the treatment site consists of	
Project Shotover Stage 3 Detailed Design Report	Provides good context to site background and stage 3 upgrades.	Stage 3 is split into two portions, which include: 1) WWTP upgrades, 2) decommissioning of ox ponds & construction of new SW basin and calamity ponds.	
Hydraulic profile Stage 3	Hydraulic profile following stage 3 upgrades	Hydraulic profile	To be used when designing upgrades, it is important to use the hydraulic profile as much as possible. This reduces the need for pumping, which saves energy, lowers costs, and provides a more sustainable solution.
ORC Letter - Consenting History (ref A774778)	Consenting application letter decision and discharge permit application – Applications RM13.215 and RM13.537 variation for the Queenstown Sewage Treatment System	Consent applications RM13.215 and RM13.537 variation application for the Queenstown Sewage Treatment System	Provides background on the 2015 consent application.
RM13.215.03.V2 Project Shotover discharge to land	Discharge permit for RM13.215.03.V2. Allows discharge of treated water to land to 31 December 2031. Issued June 2015.	Discharge permit for treated water to land – issued 2015	Provides background on the 2015 discharge permit.
RM13.215.03.V2 Shotover WWTP discharge to Land 2023 Audit Report - 25th May 2023	Consent audit report (discharge premit to land).	Provides a summary of non-compliance occurring in 2023 Significant non-compliance	Provides understanding of non-compliance in 2023.
Shotover Discharge Flow Totals	Daily discharge flows to the disposal field	Shotover discharge daily flows 2017 to September 2024	Provides understanding of flows into the plant.
SHOTOVER WASTEWATER LAB RESULTS	Shotover effluent sampling results, groundwater (bores) sampling results, piezo levels,	Discharge volume and quality data 2001 to September 2024 Groundwater sampling results 2018 to September 2024 Groundwater levels May 2024 to June 2024	Provides understanding of ground water, ground water levels, wastewater flows, incoming loads and treatment .
Shotover WWTP lab results	Influent, clarifier effluent, pond discharge, discharge sampling data October 2023 to November 2024	Sampling data (SCADA, in house lab and Eurofins) for influent, clarifier effluent, pond discharge, discharge effluent, sludge dewatering from October 2023 to November 2024	Provides understanding of wastewater flows, incoming loads and treatment.
Shotover Flow + WQ Results	Plant flows and clarifier, pond discharge and discharge effluent sampling data December 2023 to November 2024	Plant total flows, clarifier effluent flows, pond flows and discharge flows from December 2023 to November 2024 Clarifier, pond discharge and discharge effluent sampling data from Eurofins and inhouse lab	Provides understanding of wastewater flows, incoming loads and treatment.
ORC Environmental Data Portal	Environmental data across the Otago Region	Flow data for nearby rivers Stage data for nearby rivers and lakes	Provides background information and

Documents and data sources	Scope of report/info	Key contents or findings	Relevance to this upgrade
		Water and groundwater quality data Groundwater levels	understanding to inform the environmental data review. Some information could be used to establish constraints and criteria for options development and evaluation.
NIWA hydro web portal	Environmental data across New Zealand	Flow data for nearby rivers Stage data for nearby rivers and lakes Water and groundwater quality data Groundwater levels	
ORC maps	ORC map service contains different types of maps and spatial data	Consents Groundwater levels Geology of the area	
New Zealand Geotechnical Database - NZGD	A database containing logs of geotechnical and geological investigations across New Zealand	Groundwater levels Geology of the area	
LAWA - Land Air Water Aotearoa database	Environmental data across New Zealand	Flow data for nearby rivers Stage data for nearby rivers and lakes Water and groundwater quality data Groundwater levels	
S-map online	Online map displaying different soil parameters across New Zealand	Types of soil in the area around the WWTP	
CliFlo database	Climate data across the Otago region	Rainfall, evaporation, temperature and soil moisture data for the nearby Queenstown Aero Aws station	
LINZ data service	National database for geospatial data	- LiDAR data for the Queenstown region - Land ownership around the WWTP	
Review of Existing Information and Consent Scoping	A review of the test pit investigations, aquifer testing, soil infiltration testing, particle size information and the depth to groundwater.	- Groundwater levels ranged from 0.75 to 2.8 m bgl in tests undertaken in test pits between 2007-2009 - Particle size distribution (PSD) results in test pits done in 2016, before the construction of the disposal field. - Estimates of permeability (K) values based on PSD results	
Sewage to Land and Land Use Consent Conditions and Assessment of Environmental Effects	Variation to discharge of Treated Sewage to Land and Land use Consent Conditions and Assessment of Environmental Effects	- 2m deep Geological cross-sections close to the ponds - Groundwater mounding assessment - Particle size distribution tests - Groundwater levels ranged from 1.2 to 2.0 m bgl - Soil information - Permeability ranged from 4.5 – 64 m/day in tests undertaken in 2009	
2014.02.21_GWJ155_LEI_QLDC_Memo 21 Feb 2014.pdf	Memorandum on groundwater level behavior at the Queenstown wastewater treatment plant. Data from Oct 2013 to Feb 2014	Groundwater level ranged from 314.3 to 313.2 m RL	
2022.03.22 WSP_Memorandum-Post_Trench_Mitigation_Water_Level_Assessment.pdf	Water level monitoring in the disposal field from Nov 2020 to Feb 2022	- Groundwater level monitoring in the disposal field from Nov 2020 to Feb 2022. Values ranged from 1.53 to -0.26 m bgl - Shotover flow approx. 25 cumecs - WWTP flow approx. 80k m3/day	
ME-10432-QLDC-GroundwaterBenchmarking-190430 JSR comments	QLDC Shotover dose and drain (DAD) flow monitoring. Groundwater level monitoring in the WWTP	- Groundwater levels in the WWTP rose approx. 0.3 to 0.4 due to the DAD system inflows. - Groundwater levels in the WWTP largely influenced by the Shotover River	
Investigation into the Wakatipu Basin Aquifers	General information on Groundwater quality, quantity, recharge and allocation in the Wakatipu Basin Aquifers	Nearby aquifers in the WWTP include Frankton Flats Aquifer, Shotover Alluvial Ribbon Aquifer and Windemeer Aquifer	
Environmental Monitoring Report - Shotover River Confluence Swamp	Environmental monitoring on the left side of the Shotover River bank	Groundwater levels for piezometers on the left side of the Shotover River bank	
24131 Water quality baseline snapshot for Queenstown WWTP surrounds FINAL	Water Quality Baseline Snapshot for Queenstown Wastewater Treatment Plan and Surrounds	- Water quality results for the Kawarau and Shotover Rivers - Samples obtained near the WWTP, on August 2024 - Information about the hydrology and hydrogeology of the area	
Bore Logs - of WWTP monitoring wells	Geological logs for wells constructed in the WWTP disposal field	- Bore logs of investigations In the disposal field - Bores up to 40 m deep. - Basement not found.	

Documents and data sources	Scope of report/info	Key contents or findings	Relevance to this upgrade
		- Dominated by gravel and sand	
Cone Penetration Test (CPT) Report in the WWTP	CPT logs for investigations in the WWTP field	Geotechnical parameters in the disposal field	
Project Shotover Stage 3 - Detailed Site Investigation Report	Detailed Site Investigation (DSI) for the proposed new extension to Shotover Wastewater Treatment Plant (Project Shotover Stage 3)	Soil samples in test pits - inorganic lab results. Collected north of the ponds	

Appendix B

Risk register

QLDC Shotover WW Disposal Risk Register

Project: C-25-002 Shotover
Project Number : 12645246 Shotover WW Disposal

						CONTROLS		CURRENT RISK RATING				RISK TREATMENT / ACTIONS		RESIDUAL RISK RATING		
Risk No.	Category	Risk Issue	Risk Description	Impact / Consequence	Project Stage	Current controls and status	Effectiveness Rating (1-5)	Consequence Category	Consequence	Likelihood	Rating	Proposed treatment Strategies and Actions	Responsible	Consequence	Likelihood	Rating
1	Stakeholders/Public	Stakeholders capability and capacity to effectively engage	Stakeholders not available to provide effective input and engagement resulting in delays and added cost to the project	Delays and added cost to the project	Optioneering / Consent Stage	Engagement plan currently being drafted to aid in the engagement process	3	Time	3-Moderate	B-Likely	Significant	Regular meetings with the stakeholders	QLDC	3-Moderate	C-Possible	Medium
2	Stakeholders/Public	Objection on proposed solution by stakeholders or public	- Public engagement low - Neighbours and other stakeholders could negatively impact the consenting outcome - ORC buy-in could be difficult - Engagement of experts by other interested parties - Stakeholder acceptance of trade-offs, time and non-negotiables Resulting in delays or prevention of consent acceptance	Delays or prevention of consent acceptance	Optioneering / Consent Stage	Engagement plan currently being drafted to aid in the engagement process	3	Time	4-Major	B-Likely	High	Regular meetings with the stakeholders	QLDC	4-Major	C-Possible	Significant
3	Stakeholders/Public	Concerns amongst community about financial impacts	Community concerns about capital cost may further impact future rates.	Public dissatisfaction, negative media attention	Optioneering / Consent Stage	Budget set aside for the project	3	Financial	4-Major	C-Possible	Significant	Cost is a MCA criteria	QLDC / GHD	4-Major	C-Possible	Significant
4	Stakeholders/Public	Local councillor influences	Local councillor influences external to the project plan, may cause change or delays during delivery.	Change or delays during delivery.	Optioneering / Consent Stage	-		Time	3-Moderate	C-Possible	Medium	Follow QLDC established protocol, including report/update to relvant council committees	QLDC	3-Moderate	C-Possible	Medium
5	Programme	Programme delays due to tight programme timeline	QLDC indicative programme is very ambitious, i.e. consent application by late 2025. Balancing project programme and the defensibility of decision making. A robust optioneering process, to provide a high level of defensibility, may not be achievable within the timeframes proposed by QLDC.	Delays to program	Optioneering / Consent Stage	Monthly reporting which allows GHD and QLDC a chance to note and account for any delays or changes to program	3	Time	4-Major	B-Likely	High	Monthly programme update / communication to track progress	QLDC / GHD	3-Moderate	C-Possible	Medium
6	Programme	Staff changes/turnover during project.	Staff changes/turnover resulting in project delays	Delays to program	All Stages	-		Time	3-Moderate	C-Possible	Medium	Clear documentation of optioneering and decision making	QLDC / GHD / LandPro	2-Minor	C-Possible	Low
7	Programme	Limited local construction resources	Not enough resources available locally, having to outsource resources which would result in a delay on programme	Having to outsource resources, delay on programme & cost escalation	Construction and commissioning	-		Time	3-Moderate	D-Unlikely	Medium	Procurement strategy to be developed once the selected option is known	QLDC	2-Minor	D-Unlikely	Low
9	Operation	Risk that operations and maintenance is not straightforward and easy to understand for operators.	Complex operation and maintenance associated with the new disposal alternative option	Significant increase in O&M cost, prone to operation errors and non compliance	Design Phase	-		Business / Operation	3-Moderate	C-Possible	Medium	Operability as a MCA criteria	QLDC / GHD	3-Moderate	C-Possible	Medium
10	Iwi	Iwi capability and capacity to effectively engage	Iwi not available to provide effective input and engagement resulting in delays to program	Delays to program	Optioneering / Consent Stage	Iwi engagement is ongoing and will continue to participate in the optioneering workshops	3	Time	4-Major	B-Likely	High	Continued progress update / communication, as well as provide pre-reading materials ahead of key hui(s)	QLDC	4-Major	C-Possible	Significant
11	Iwi	Objection on the proposed solution by Iwi	The final design decision not aligning with iwi's values which will impact consent acceptance	Not obtaining iwi acceptance which will impact consent approval process	Optioneering / Consent Stage	Iwi engagement is ongoing and will continue to participate in the optioneering workshops	3	Legal / Compliance	4-Major	B-Likely	High	Iwi representatives will be kept informed and receive updates, in addition to key options evaluation & decision workshops. Early input sought into appropriate solutions	QLDC	4-Major	C-Possible	Significant
12	Design	Archaeological and heritage requirements not identified until late in the project	Insufficient gap analysis or additional information coming out during the consenting phase resulting in delay or added cost to the project	Delay and/or cost escalation to the project	Optioneering / Consent Stage	Gap analysis is kept and updated throughout the project	3	Time	3-Moderate	C-Possible	Medium	Identify required investigations prior to options selection and consent lodgement	QLDC / GHD	3-Moderate	D-Unlikely	Medium
13	Design	Delays due to specialist resource availability	Potential project delays due to specialist resource availability	Delays	Optioneering / Consent Stage	-		Time	3-Moderate	C-Possible	Medium					
14	Design	Insufficient supplied information	Poor quality / suitability of third party supplied information might delay the programme and technical assessment	Delays	Optioneering / Consent Stage	Gap analysis is kept and updated throughout the project	2	Time	3-Moderate	C-Possible	Medium	Identify required investigations prior to options selection and consent lodgement	QLDC / GHD	3-Moderate	D-Unlikely	Medium
15	Design	Additional investigations	Additional investigations might delay the programme	Delay and/or cost escalation to the project	Optioneering / Consent Stage	Similar to #14		Time	3-Moderate	B-Likely	Significant	Identify required investigations prior to options selection and consent lodgement	QLDC / GHD	3-Moderate	D-Unlikely	Medium
16	Design	Access for land parcels	Possible cost and time delay associated with accessing lands (not owned by QLDC) for investigations and future solutions	Delay and/or cost escalation to the project	Optioneering / Consent Stage	-		Financial	3-Moderate	B-Likely	Significant	Land accessibility is a MCA criteria	QLDC / GHD	3-Moderate	C-Possible	Medium
17	Design	Technical robustness of selected option - Design	Uncertainties and lack of technical information to demonstrate robustness of selected solution will work.	Delay and/or cost escalation to the project to verify the solution	Optioneering & Design Phases	-		Time	3-Moderate	C-Possible	Medium	Technical feasibility is a MCA criteria	QLDC / GHD	3-Moderate	C-Possible	Medium
18	Design	Technical robustness of selected option - Operation	Difficulties in operation associated with the solution (e.g. the DAD field set-up)	Increase in OPEX and potential non-compliance	Operation	-		Financial	4-Major	C-Possible	Significant	Operability as a MCA criteria	QLDC / GHD	3-Moderate	C-Possible	Medium
19	Design	Technical robustness of selected option - Operation	Design modelling or assumptions incorrect. Resulting in new design not working as intended.	Design not working as intended resulting higher OPEX	Optioneering & Design Phases	-		Business / Operation	4-Major	C-Possible	Significant	Inclusion of Operation staff in workshops and throughout design phase	QLDC / GHD	3-Moderate	D-Unlikely	Medium
20	Design	Limit on future expansion	The selected disposal solution having a capacity limit and hence restricts future expansions	Require separate disposal solution in future, resulting more future cost	Optioneering / Consent Stage	-		Business / Operation	4-Major	C-Possible	Significant	Stageability as a MCA criteria	QLDC / GHD	3-Moderate	C-Possible	Medium
21	Design	Bird strike due to WWTP location being next to the Queenstown airport	Design may include components that bring more birds to the area i.e. open water and surface water wetlands	Bird strike on planes, increase of likelihood	Operation	-		Health and Safety	5-Catastrophic	D-Unlikely	High	Part of option consideration / MCA criteria	QLDC / GHD	5-Catastrophic	E-Rare	Significant
22	Design	Flooding risk	Flooding risks around the location of the disposal solution (e.g. Shotover Delta)	Damage of assets	Operation	-		Environment	4-Major	C-Possible	Significant	Flooding risk is part of options evaluation criteria	QLDC / GHD	4-Major	C-Possible	Significant
23	Operation	Septage receival / toxic substance causing WWTP process upsets	Septage discharges or toxic substances in wastewater resulting treatment process upsets and deterioated effluent quality. This could result in disposed effluent not meeting the consent discharge criteria.	Increase in OPEX and potential non-compliance	Operation	-		Legal / Compliance	4-Major	C-Possible	Significant	Trade waste monitoring	QLDC / Operation	4-Major	D-Unlikely	Significant
24	Operation	Impact of inflow and infiltration (I&I)	Potential I&I increase in future as existing network deteriorates, requiring more higher hydraulic capacity in the disposal solution	Expansion required, increase in future CAPEX	Operation	-		Business / Operation	3-Moderate	C-Possible	Medium	I&I monitoring	QLDC / Operation	3-Moderate	D-Unlikely	Medium
25	Design	Discharge quality enhancement for disposal solution	Whilst Stage 3 upgrades improve the effluent quality, the disposal solution may require further enhancement.	Additional treatment as part of disposal solution	Optioneering / Consent Stage	Part of disposal solution evaluation	2	Business / Operation	2-Minor	C-Possible	Low					
26	Design	Population forecast and Wastewater flow estimation	Current Stage 3 WWTP expansion is based on 2022 forecast, which will soon be updated by early 2025. Risk of under-sizing future infrastructure needs	Additional CAPEX	Optioneering / Consent Stage	Update population forecast and wastewater flow estimation from QLDC in early 2025	1	Business / Operation	4-Major	C-Possible	Significant	Review Design Basis prior to select the Disposal Solution	GHD	3-Moderate	D-Unlikely	Medium

						CONTROLS		CURRENT RISK RATING				RISK TREATMENT / ACTIONS		RESIDUAL RISK RATING		
Risk No.	Category	Risk Issue	Risk Description	Impact / Consequence	Project Stage	Current controls and status	Effectiveness Rating (1-5)	Consequence Category	Consequence	Likelihood	Rating	Proposed treatment Strategies and Actions	Responsible	Consequence	Likelihood	Rating
27	Design	MCA process not robust and defensible	Inadequate MCA process resulting revisiting of long list options later in the project	Delays and added cost to the project	Optioneering / Consent Stage	Transparent and robust MCA process	2	Business / Operation	3-Moderate	D-Unlikely	Medium					
29	Design	Condition of existing pond 3 embankment	Stage 3 design report stated that the condition/stability of existing pond embankment 3 is unknown and likely in poor condition. This may require remedial cost	Delays and added cost to the project	Detailed design	-		Financial	3-Moderate	C-Possible	Medium	To be considered during the project options and design phase. Investigations to be understaken as required.	GHD	3-Moderate	D-Unlikely	Medium
30	Design	Not addressing the current issues with ground conditions	Ground condition of existing disposal field is not best suited for infiltration. If this is not addressed or considered in the design, the same mistakes as what occurred for the disposal field could occur.	Cost and consent non-compliance	Optioneering / Consent Stage	-		Business / Operation	4-Major	C-Possible	Significant	To be considered during the project options and design phase. Investigations to be understaken as required.	GHD	3-Moderate	D-Unlikely	Medium
31	Design	Power supply to site	Loss of treatment performance due to power cut from site	Performance affected - temporary impact	Operation	Onsite generator for existing and stage 3 upgrades	2	Legal / Compliance	3-Moderate	C-Possible	Medium	To incorporate a review of the power requirements for the proposed solution and ensure there are adequate measures in place for power to be supplied (i.e. additional generator onsite if required)	GHD	3-Moderate	E-Rare	Low
32	Design	Wastewater pipes crossing water bodies	Wastewater crossing water bodies would be culturally offensive to iwi, risk that if pipe breaks contamination to water body, public health risk	Culturally offensive, public health risk	Optioneering / Consent Stage	-		Legal / Compliance	4-Major	C-Possible	Significant	Cultural and social acceptance and technical robustness are part of MCA criteria	GHD	3-Moderate	D-Unlikely	Medium
33	Design	Odour issues	Odour issues as a result of proposed solution	Odour issues, public dissatisfaction	Optioneering / Consent Stage	-		Environment	3-Moderate	C-Possible	Medium	Odour and air quality - part of MCA criteria	GHD	2-Minor	D-Unlikely	Low
34	Regulation	Changes and Increasingly complex regulatory planning environment	Changes and additional complexity in consenting process resulting in delay and cost escalation	Delay and cost escalation with the consenting of alternative discharge, including hearing cost.	Optioneering / Consent Stage	-	-	Financial	4-Major	C-Possible	Significant	QLDC to discuss with LandPro on consenting approach	QLDC			
35	Regulation	WW Discharge standards	ORC Policies and Plan Changes Taumata Arowai WW Discharge Standard Both may change the required discharge standards and/or additional treatment to address other contaminants	Increase in CAPEX and OPEX, and project delays	Optioneering / Consent Stage	-	-	Legal / Compliance	4-Major	C-Possible	Significant	Keep an eye on the Regulatory Changes	QLDC / GHD / LandPro			
36	Budget	Budget limitations / Affordability	The selected discharge solution exceeds QLDC affordability and budget	Similar to #3	Optioneering / Consent Stage		-	Financial	4-Major	C-Possible	Significant	Similar to #3	QLDC / GHD	3-Moderate	C-Possible	Medium
37	Budget	Cost escalations	Cost escalations caused by construction market, consenting delays and other factors	Added costs to project	All phases	-		Financial	4-Major	C-Possible	Significant	Explore staging opportunities provide flexibility and possible CAPEX deferrals to later funding cycles.	QLDC / GHD	3-Moderate	D-Unlikely	Medium
38	Construction	Commissioning risks	Risk of environmental damage and reputational damage from commissioning incidents	Delays, Cost and Reputational damage	Construction and commissioning	-		Health and Safety	3-Moderate	B-Likely	Significant	To be reviewed once the selected solution is confirmed				
39	Construction	Confined spaces	Risk of injury / death from works in confined spaces during construction in trenches, if required.	Injury	Construction and commissioning	-		Health and Safety	4-Major	D-Unlikely	Significant	To be reviewed once the selected solution is confirmed / Contractor's construction methodology				
40	Construction	Excavation	Risk of injury / death during excavation works, , if required.	Injury	Construction and commissioning	-		Health and Safety	4-Major	D-Unlikely	Significant	To be reviewed once the selected solution is confirmed / Contractor's construction methodology				
41	Construction	Services – Working near HV power	Risk of injury from works around HV power mains running across site	Injury	Construction and commissioning	-		Health and Safety	4-Major	D-Unlikely	Significant	To be reviewed once the selected solution is confirmed / Contractor's construction methodology				
42	Construction	Vehicles and mobile equipment	Risk of injury / death from vehicles and mobile equipment (construction and operation)	Injury	Construction and commissioning	-		Health and Safety	4-Major	D-Unlikely	Significant	To be reviewed once the selected solution is confirmed / Contractor's construction methodology				
43	Construction	Wind	Risk of injury to contractors and operators due to high wind loading	Injury	Construction and commissioning	-		Health and Safety	3-Moderate	C-Possible	Medium	To be reviewed once the selected solution is confirmed / Contractor's construction methodology				
44	Construction	Services	Risk of injury from working around live sewer mains / underground services	Injury	Construction and commissioning	-		Health and Safety	3-Moderate	D-Unlikely	Medium	To be reviewed once the selected solution is confirmed / Contractor's construction methodology				
45	Construction	Water – being in, near or on	Risk of drowning / injury from working near oxidation ponds or Shotover River	Injury	Construction and commissioning	-		Health and Safety	4-Major	C-Possible	Significant	To be reviewed once the selected solution is confirmed / Contractor's construction methodology				
46	Construction	Working at heights / raised and falling objects	Risk of injury / death from fall from height	Injury	Construction and commissioning	-		Health and Safety	4-Major	D-Unlikely	Significant	To be reviewed once the selected solution is confirmed / Contractor's construction methodology				
47	Construction	Biological	Risk of injury to contractors from exposure to wasteater biological hazards	Injury	Construction and commissioning	-		Health and Safety	4-Major	C-Possible	Significant	To be reviewed once the selected solution is confirmed / Contractor's construction methodology				
48	Construction	Manual handling / body stress	Risk of injury due to manual handling during construction and operation of plant	Injury	Construction and commissioning	-		Health and Safety	3-Moderate	C-Possible	Medium	To be reviewed once the selected solution is confirmed / Contractor's construction methodology				
49	Construction	Tools and equipment (powered or hand)	Risk of injury to contractors through use of tools and equipment	Injury	Construction and commissioning	-		Health and Safety	4-Major	C-Possible	Significant	To be reviewed once the selected solution is confirmed / Contractor's construction methodology				
50	Design	Southern end of disposal field	Southern end of the disposal field was over-topped in the past due to inadequate capacity and monitoring to pass the effluent via infiltraton. In the event where the existing location is used as part of the solution this should be considered to avoid a repeat of this.	Non-compliance and daylighting of treated effluent	Operation / Design	QLDC mitigated the risk by digging more infiltration area in the disposal beds as well as having an engineered overflow as a temporary solution	3	Legal / Compliance	4-Major	C-Possible	Significant	Futher discussion regarding interim improvements (if applicable)	QLDC			
51	Environment	Threat to native specieis (birds)	The current disposal fields and ponds are home to many birds (native birds included), there is a risk that the habitat for these birds is destroyed or damaged during the project. And also risk of birds being injured.	The habitat for these birds is destroyed or damaged during the project, the birds are injured.	Construction and commissioning	Bird monitoring performed by QLDC	2	Environment	3-Moderate	B-Likely	Significant					

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