KSL
Kōmanawa Solutions Ltd



Mananui Mineral Sand Project

Water Management, Monitoring and Mitigation Plan

Report No: Z22025_02

Version control

Date	Report no	Issue notes
08/10/2023	Z22025_02	First draft
24/10/2023	Z22025_02_RevA	Final for consent lodgement
02/07/2024	Z22025_02_RevA	Revised following additional work responding to S92 request

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Suggested citation

Etheridge, Z. (2023). *Mananui Mineral Sand Project Water Management, Monitoring and Mitigation Plan*

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1. INTRODUCTION

1.1. Background

Westland Mineral Sands Co. Ltd is an established mineral sands development enterprise based on New Zealand's West Coast. The Mananui project located south of Hokitika near the localities of Ruatapu and Mananui. The deposit adjoins State Highway 6 on the landward side, between SH6 and Tūwharewhare and the north-western shore of Lake Māhinapua. WMSC has held mining permit 60508 covering a portion of the Mananui ore deposits since February 2019 to mine the approximately ~112 hectares (ha) permit area.

The deposit underlies low intensity agricultural land, beef grazing and previously deer farming. The overlying land is grassed with stands of native scrub or woodland. The deposit has been extensively mineral drilled for gold and garnet resource delineation.

The proposed mineral sand extraction and rehabilitation project entails excavating the sands in strips to an average of 0 m above mean sea level (ASL) via a dredge mining unit, and delivery of the ore to a processing plant. The processed sand from the plant after heavy mineral concentrates have been removed (referred to as tailings) will be directly re-deposited into the wake of the extraction pit. The land will be rehabilitated to productive farmland with improved drainage and inclusion of new wetlands to intercept runoff from the site on the flow path towards Tūwharewhare.

1.2. Report purpose and scope

This report comprises two main components: a Water Management Plan (WMP) and a Monitoring and Mitigation Plan (MMP).

The purpose of the WMP is to define water management objectives and principles and present a management process which gives effect to these.

The purpose of the MMP is to provide details of the monitoring that will be undertaken to determine whether the WMP objectives are being met and to set out the actions that will be undertaken if monitoring results signal the potential for hydrological impacts to occur.

The scope of work is:

a) Describe the aspects of the proposed activity which could cause hydrological effects.

b) Define water management and monitoring and mitigation objectives.

c) Define water quality action thresholds and the activities that will be undertaken if the action thresholds are exceeded.

A separate Erosion and Sediment Control Plan (ESCP) has been developed and hence stormwater management and sediment control fall outside the scope of this document.

2. DESCRIPTION OF ACTIVITY

A full description of the proposed activity is provided in the Assessment of Environmental Effects (TPRL, 2023). The key activities with respect to hydrological effects are as follows:

The excavation will intercept a series of small local surface drainage features. These will be managed via temporary works as described in the ESCP. An improved drainage system will be constructed as part of the site rehabilitation.

Ore will be pumped from a dredge unit as a slurry to the processing plant. Heavy mineral concentrate will be separated at the plant and the residual sand returned to the excavation as a pumped slurry. The mineral separation process is mechanical and involves no chemical additives, other than flocculants/coagulants if required to assist with removal of fine sediment.

A well will be installed at the site to provide top-up water for the processing plant with a maximum daily pumping rate of 3,283 m^3 (38 L/s) and a maximum instantaneous pumping rate of 60 L/s. Of the 38 L/s maximum daily pumping rate, 4.3 L/s is expected to be retained within the garnet and ilmenite produced on the site and either be transported off site or seep to the ground locally. The reclaiming 33.7 L/s will be discharged either to the dredge pond or to an infiltration trench on the southern site boundary.

A sediment treatment system will be installed at the processing plant to remove fine sediment from the process water so that water can be recycled through the plant. This will minimise the requirement for top-up water from the well.

A small volume of water (3 L/s net) will be pumped from the mine pond to maintain positive groundwater flow towards the excavation while the mine is upstream of Tūwharewhare and the riparian wetland and the domestic water supply wells to the west of the northern part of the site.

The site will be progressively rehabilitated into productive farmland with a new ecological reserve with wetlands along the eastern boundary and a new wetland in the northeast corner.

3. ROLES AND RESPONSIBILITIES

3.1. Project Manager

d) Responsible for the implementation and enforcement of this plan.

e) Authorise any personnel to perform any duties of this plan and ensure that they are competent to complete their duties.

f) Ensure that the consent conditions related to water management of the site are complied with.

g) Inform a Compliance Officer of the Consent Authority immediately if a breach of Consent Condition(s) takes place, or when they believe that a breach may take place.

h) Approve any ‘permits to work’ prior to starting tasks if required (or delegate authority).

3.2. Mine Manager

i) Ensure that all personnel that enter the mining operation areas comply with this plan.

j) Ensure that all pre-start inspections and checklists are being completed.

k) Ensure all personnel operating any vehicles have been deemed competent, hold a current and appropriate permit or are under the escort of a person who holds a current and appropriate permit.

l) Ensure any changes to this plan are communicated to all relevant personnel when they occur.

4. CONSENT CONDITIONS

4.1. Index to relevant conditions

Table 1 summarises the proposed consent conditions and provides cross references to the sections of this document which give effect to the proposed conditions.

Table 1: Consent conditions and plan cross references

Condition	Report section
5.1 At least 20 working days prior to mining activities commencing and thereafter on or before the anniversary date of the commencement of these consents, the Consent Holder must submit a programme of work ("Annual Work Programme") for certification by the Consent Authorities detailing: o The proposed works to be carried out over the next 12 months including: ▪ Equipment to be used; ▪ Areas of topsoil and overburden stripping and stockpile locations; ▪ New areas of land disturbance that will be mined; ▪ Access tracks; ▪ Drill/prospecting sites and other tracks to be constructed; and ▪ Any other site works within the consent area. o The approximate open volume of the working pit at the start of the year including depth of excavations and the area of the working pit. o The progressive rehabilitation works to be carried out over the next 12 months including: ▪ Areas of unrestored land (i.e. all land not finally topsoiled and revegetated) at the beginning of the new year; ▪ The area that will be fully rehabilitated during the forthcoming year; ▪ Maximum slope angles, bench heights and widths of recontoured ground, if applicable; and ▪ Rehabilitation method and technique including replacement of topsoil and vegetation cover. o Description of measures to prevent adverse effects on natural waterbodies, including drainage works within the consent area, and the collection and treatment of site run-off before discharge to land. o Measures that must be adopted to ensure soil conservation and slope stability are controlled; o A description and analysis of any unexpected adverse effects that have arisen as a result of activities within the last 12 months, and the steps taken to address the adverse effect.	

Condition	Report section
5.2 The following plans, reports and results of monitoring must also be submitted as part of the Annual Work Programme: o A detailed plan or aerial photograph showing: ▪ The open working area at the start of the year; ▪ Proposed mine path for the forthcoming year including haul and access roads; ▪ Rehabilitated ground behind the open pit area; ▪ Location of existing and intended topsoil or overburden dumps and their dimensions; ▪ Location of natural waterbodies; ▪ Location of present and intended drainage works and settling ponds; and ▪ Any other site works within the consent area. o An Erosion and Sediment Control Plan in accordance with condition 23.0. o Results of water quality, flow and water level monitoring from the previous 12 months in the form of an annual monitoring report required by condition 26.7. o Any proposed updates to Management Plans submitted in accordance with the respective conditions of consent. o Results of dust monitoring from the previous 12 months required by Condition 28.3 for the previous 12 months.	
5.3 The Consent Holder must provide the Consent Authorities with any further information, which the Consent Authorities may reasonably request after considering any Annual Work Programme. This information must be provided in a timely manner as required by the Consent Authorities.	

Condition	Report section
6.1 At least 20 working days prior to undertaking any activities authorised by these consents, the Consent Holder must submit the following management plans to the Consent Authorities for certification: (a) Noise Management Plan (b) Fauna Management Plan (c) Dust Management Plan (d) Transport Management Plan (e) Water Management Plan~~,~~ (f) Monitoring and Mitigation Plan (g) Erosion & Sediment Control Plan and (h) Indigenous Restoration and Rehabilitation Plan *Advice notes:* (a) *These are collectively referred to as Management Plans.* (b) *Where a plan requires the input of an appropriately qualified professional, the Consent Authorities may engage an appropriately qualified person to peer review the plan as part of the certification process.*	

Condition	Report section
6.2 The purpose of the Management Plans is to implement the relevant conditions of these consents. All Management Plans must include (where relevant): a) The purpose of the plan; b) Reference to the conditions of these consents that the management plan implements;~~;~~ c) How each of the relevant conditions will be given effect to; d) Procedures for implementing the relevant plan; e) Plan auditing check lists; f) Monitoring programmes and/or monitoring protocols; g) Feedback mechanisms for any adaptive management, including circumstances in which a material change to the management plan would be required; h) An organisational chart showing staff and contractor positions and responsibilities for plan implementation; i) Relevant training and induction procedures and training schedules; and j) Reporting procedures and format for providing the results of any monitoring or surveying required by the Management Plans.	
6.3 Site activities must not commence until the management plans required in condition 6.1 have been certified by the relevant Consent Authorities. If the response from the Consent Authorities is that they are not able to certify the management plans, the Consent Holder must consider any reasons and recommendations provided by the Consent Authorities, amend the management plans accordingly, and resubmit the management plans to the Consent Authorities	

Condition	Report section
6.4. The Consent Holder may amend the management plans at any time to take into account: (a) Any positive measure/s to ensure the stated objectives of the management plans are achieved (b) Any required actions identified as a result of monitoring under these consents; and (c) Any changes required to further reduce the potential for adverse effects as a result of actions identified in the Annual Work Programme. Where management plans require the input of an appropriately qualified person, any amendments to those management plans must also be undertaken by an appropriately qualified person. *Advice Note: Some management plans have ongoing annual review requirements which ar required in order to avoid, remedy or mitigate effects. These specific review requirements are stipulated in the relevant conditions on this consent.*	
6.5 Any amended management plans must be provided to the relevant Consent Authorities within 20 working days of the amendment for review and for certification in accordance with Condition 6.1.	
6.6 The Plans must not be amended in a way that contravenes the matters set out in the conditions for the respective Plans .	
6.7 If the response from the Consent Authorities is that they are not able to certify the management plan, the Consent Holder must consider any reasons and recommendations provided by the Consent Authorities, amend the management plan accordingly, and resubmit the management plan to the Consent Authorities.	
6.8 A copy of the latest version of the certified Management Plans must be kept on site at all times and all key personnel must be made aware of the contents of each Plan and their responsibilities under each Plan	
6.9 Subject to any other conditions of these consents, all activities must be undertaken in accordance with the latest version of the certified Management Plans.	

Condition	Report section
24.1 The Consent Holder must prepare a: a) Water Management Plan (WMP); and b) Monitoring and Mitigation Plan -(MMP) The purpose of the WMP is to define water management objectives and principles and present a management process which gives effect to these. The purpose of the MMP is to provide details of the monitoring that will be undertaken to determine whether the WMP objectives are being met and to set out the actions that will be undertaken if monitoring results signal the potential for hydrological impacts to occur	
24.2 The WMP must include details on the: A) water management actions and methods for the site, including details on: i. the baseline monitoring and the receiving environment; ii. the proposed mine disturbance area; iii. site activities with the potential to cause hydrological impacts; iv. operational water level and water quality monitoring requirements for the duration of the activity; v. groundwater level thresholds and actions to be taken should these thresholds be exceeded; vi. surface water level thresholds and actions to be taken should these thresholds be exceeded; vii. final rehabilitation requirements to avoid adverse hydrological impacts on waterbodies postmining; viii. audit checklists; ix. an organisational chart showing staff and contractor positions and responsibilities for plan implementation; and x. relevant training and induction procedures and schedules.	
24.3 The MMP must include details on the: a) proposed operational monitoring methods; b) actions and thresholds; c) implementation activities; and reporting procedures for environmental monitoring and consent compliance.	

<table>
<tr><th>Condition</th><th>Report section</th></tr>
<tr><td>24.4 The WMP and MMP must be reviewed annually by the Consent Holder and any amendments must be submitted to the Consent Authority for certification in accordance with the requirements in conditions 6.1-6.10. The annual review is required to:
a) Reflect the proposed mining operations for the following 12 months; and
b) Provide any additional or amended monitoring and mitigation requirements in order to reduce the potential adverse hydrological and/or water quality effects.

Advice Note: All Management Plans are required to adhere to the requirements in Conditions 6.1-6.10</td><td></td></tr>
<tr><td>25.1 All sediment-laden stormwater from the process plant area and surplus process plant water must be either directed into the mine water facility and recirculated for use in the processing plant, or discharged to the dredge pond or infiltration trench. Not withstanding this, stormwater from the process plant area may be infiltrated to ground in the area of the plant and stormwater from disturbed land within the site boundaries may be infiltrated to ground anywhere on the site.</td><td></td></tr>
<tr><td>25.3 a) The Mine Influenced Water discharges shall not contain any contaminants other than suspended sediments, naturally occurring elements and metals.</td><td></td></tr>
<tr><td>25.4 The Consent Holder shall take all practicable measures to prevent uncontaminated stormwater entering the mine workings and disturbed areas to reduce the volume of water passing through the mining pond/settling pond system, and to improve the efficiency of the water reticulating system.</td><td></td></tr>
<tr><td>26.1 The consent holder must carry out water monitoring at the locations shown in the Water Management Plan shown in Schedule 5, and listed in the table below:
<table>
<tr><th>Location</th><th>Parameter(s)</th><th>Frequency</th></tr>
<tr><td>Processing Plant Well Water Supply</td><td>Pumping volume</td><td>Daily*</td></tr>
<tr><td>Infiltration Trench</td><td>Discharge Rate, water level</td><td>Total flow to be recorded daily and water levels to be</td></tr>
</table>
</td><td></td></tr>
</table>

Condition			Report section
		recorded at a minimum 4-hour frequency when discharging to the trench.	
WQM Piezometers - northwest	Monitoring Suite A**	Monthly for 12 months prior to mining and monthly thereafter until completion of mining. Weekly sampling required when mining in Area A	
WSM Piezometers – southeast	Monitoring Suite A** and B*** Groundwater levels	Monitoring suite A and B – monthly for at least 12 months prior to mining and monthly thereafter until completion of mining. Groundwater levels - daily	

*Water takes are also required to meet the Resource Management (Measurement and Reporting of Water Takes) Amendment Regulations 2020

**Monitoring Suite A includes the following water quality indicators:

Dissolved Aluminium

Electrical Conductivity

pH

Turbidity

<table>
<tr><th>Condition</th><th>Report section</th></tr>
<tr><td>*** Monitoring Suite B includes the following water quality indicators:
Dissolved chromium
Dissolved copper
Dissolved zinc
Dissolved nickel
Advice note: Infiltration Trench water level monitoring should comprise both water levels in the trench and the groundwater level in a piezometer installed adjacent to the eastern end of the trench.</td><td></td></tr>
<tr><td>26.2 If the following water level threshold is exceeded in the southeastern WQM piezometers, the consent holder shall implement the actions outlined in the Water Management Plan, including:

m) Notify West Coast Regional Council (WCRC) within five working days.
n) Develop an action plan to reduce groundwater mounding at the eastern end of the infiltration trench (this is likely to initially comprise expansion of the trench at the western end) and issue the plan to WCRC for review and comment.
o) Increase the frequency of water quality monitoring in the southeastern WQM piezometers to weekly until a westerly hydraulic gradient has been re-established.
The following additional actions shall be undertaken in the event of a water level and water quality threshold exceedance:

p) Develop a plan for water quality monitoring at the edge of the riparian wetland and issue to WCRC for review and comment.
q) Initiate water quality monitoring plan and compare monitoring results to ANZG 99% species protection thresholds monthly. Review and revise action plan in accordance with monitoring result assessment outcomes.

<table><tr><th>Parameter</th><th>Threshold</th></tr><tr><td>Water level</td><td>Where the monthly average groundwater elevations in the southeastern WQM piezometers</td></tr></table></td><td></td></tr>
</table>

Condition		Report section
	are lower than the groundwater elevation in the infiltration trench groundwater level monitoring piezometer.	
Aluminium	a) A statistically significant change of more than 20% from baseline concentrations in the monitoring wells for one or more parameters; and b) A statistically significant upward trend in concentrations of one or more parameters recorded over the preceding 12 samples.	
Turbidity	a) A statistically significant change of more than 20% from baseline concentrations in the monitoring wells; and b) A statistically significant upward trend in concentrations recorded over the preceding 12 samples.	
26.3 If the following water quality thresholds are exceeded in the **northwestern WQM piezometers**, the consent holder shall implement the water quality actions outlined in the Water Management Plan, including: • Notify West Coast Regional Council (WCRC) within five working days of receipt of the laboratory testing results. • Collect confirmatory samples for two consecutive days from each WQM piezometer and collect water samples from the dredge pond to be analysed for the Suite A parameters, as a minimum.		

<table>
<tr><th>Condition</th><th>Report section</th></tr>
<tr><td>

Evaluate water quality trends in relation to the dredge pond distance from the WQM piezometers: a positive correlation between dredge pond distance and increasing aluminium/turbidity in the WQM piezometers would signal that water quality changes relate to mine operations rather than background variability.
Notify the downgradient well owners and enquire whether any water quality changes have been observed. Seek permission to collect water quality samples from their supplies.
If the above investigations find that water quality changes in WQM piezometers relate to mining activity, develop a response plan. The response plan may include:

A temporary increase in the rate of groundwater abstraction from the dredge pond and water level monitoring in the dredge pond and WQM piezometers to confirm that a positive groundwater gradient towards the pond is maintained.
Provision of an alternative water supply to the well owners if water sampling shows that their supply has been affected.

<table>
<tr><th>Parameter</th><th>Threshold</th></tr>
<tr><td>Aluminium</td><td>The greater of 0.1 mg/L and the baseline value</td></tr>
<tr><td>Turbidity</td><td>The greater of 5 NTU and the baseline value</td></tr>
</table>
</td><td></td></tr>
<tr><td>26.4 Notwithstanding Condition 26.2 and 26.3, all discharges associated with the mining operations authorised under these consents must not cause any of the following effects within any receiving waterbody measured at or beyond 100 metres from any discharge:
a) Any conspicuous oil or grease films, scums or foams, or floatable or suspended materials,
b) Any conspicuous change in the colour or visual clarity,
c) Any emission of an objectionable odour,
d) Any significant adverse effects on aquatic life, or
e) The rendering of fresh water unsuitable for consumption by farm animals.</td><td></td></tr>
</table>

Condition	Report section
26.5 Sampling required under this condition must be undertaken and analysed by suitably qualified personnel and the results supplied to the Consent Authority annually as part of the annual works programme.	
26.6 The Consent Holder must inform a Compliance Officer of the Consent Authority immediately if a breach of Consent Condition(s) takes place, or when they believe that a breach may take place.	
26.7 An annual monitoring report shall be submitted to WCRC with the Annual Work Programme in accordance with Condition 5.2 for review and evaluation of compliance. The report should be prepared by a suitably qualified and experienced person and include the following information: 1. A summary of the monitoring undertaken over the preceding 12 months. The summary will: a. Reference the specific consent conditions under which the monitoring has been undertaken to show how the conditions have been complied with. b. Provide tables, graphs and summary data of the water quality, flow and water level monitoring. 2. Discussion and evaluation of the monitoring data in relation to the relevant consent conditions including a summary of compliance with conditions. 3. A summary of the actions that have been undertaken in response to any action thresholds.	
29.1 When mining within the Dredge Pond Water Level Management Zone, the consent holder shall abstract a net daily average of 3 litres per second from the dredge pond, and discharge this water into the infiltration trench located on the southern boundary of the site, in order to maintain a groundwater flow towards the pond.	
30.1 The instantaneous ground water take from the well at the processing plant shall not exceed 60 litres per second and an average rate of 38 litres per second (3,288m^3 per day).	
30.2 The Consent Holder shall undertake monitoring of the water take at 15 minute intervals and supply this information electronically to the Consent Authority every day, or at the interval instructed in writing by the Consent Authority. *Advice note: the Resource Management (Measurement and Reporting of Water Takes) Amendment Regulations 2020 applies to this water take.*	

Condition	Report section
30.3 The Consent Holder shall maintain auditable records and provide data in the format of date, time and rate that is suitable for electronic storage.	
30.4 The Consent Holder shall maintain the measurement device(s) in good working order so as to maintain a measurement accuracy of within ± 5% for a fully pressurised pipe or ± 10% for a partially pressurised pipe. The Consent Holder shall provide the Consent Authority with initial written verification of accuracy from a suitably qualified person that the measurement device measures the volume of water taken to within ± 5% for a fully pressurised pipe or ± 10% for a partially pressurised pipe, and thereafter every five years for the term of the consent.	
30.5 The Consent Holder shall provide the following information to the Consent Authority no later than ten working days prior to the water being taken under this consent: a. The type of measurement device(s) used to undertake the continuous monitoring together with the manufacturer's statement for that device; and b. The location of the measurement device(s) in relation to the water take point(s)	
30.6 Upon notice to the Consent Holder the Consent Authority may require the Consent Holder to cease water abstraction for a period not exceeding 48 hours, in order to undertake monitoring of natural water flows.	

5. POTENTIAL EFFECTS

The Mananui Mineral Sand Project Hydrological and Water Quality Impact Assessment report (KSL, 2023) provides an assessment of hydrological effects for the proposed activity and identifies those activities for which management actions are required as per Table 2 below.

Table 2: Effects assessment and management actions summary

Activity	Potential effects	Assessment summary	Management actions
Groundwater abstraction from top-up supply well	Drawdown in local domestic and stock wells Depletion of Tūwharewhare and the potential for water level changed in the riparian wetlands; and	Groundwater level changes in local third-party water supply wells are expected to be negligible and inconsequential. Any depletion of flows in Tūwharewhare will be temporary, short term, well below widely accepted effects thresholds for ecological stream health and cause no adverse effects. The proposed activity is expected to generally augment flows in the creek for the duration of mining, although the scale of any augmentation will be small. A precautious assessment of changes in groundwater seepage from the eastern edge of the mine site to the Tūwharewhare riparian wetland also shows a very small net increase in seepage during mining. Very small increases and decreases are projected to occur over time and fall within the range of the natural variability. Any reduction in seepage, which would be intermittent and interspersed with increased seepage, would comprise a negligible component of the wetland water budget and be of no consequence to the wetland hydrology. Adverse effects will therefore be avoided.	Not required
	Seawater intrusion due to pumping from well.	The proposed activity is very unlikely to cause seawater intrusion to the coastal aquifer.	Water quality monitoring in the pumping well with associated trigger levels
Net discharge of water from minerals processing plant to mine excavation + stormwater runoff to dredge pond	Mounding in the excavation: potential for overtopping during storm events.	Modelling of mounding in the mine excavation due to the net discharge of water to the dredge pond shows that the water table in the pit could rise by up to 1.5 m at some intervals of the mine life under a worst-case scenario. Runoff calculations indicate that the freeboard volume of the pit and infiltration capacity are adequate to contain a 1:100-year 24-hour rainfall event without any risk of overtopping. Adverse effects will therefore be avoided.	Not required

Activity	Potential effects	Assessment summary	Management actions
Sediment disturbance in mine pond	Turbidity/reduced visual clarity in nearby domestic wells or Tūwharewhare via groundwater transport of turbidity from the dredge pond.	Turbid water in the mine excavation is very unlikely to be transported more than 50 m from the edge of the excavation. Given that the proposed mine pit will be located at least 50 m from the Tūwharewhare and 100 m from the closest domestic supply well, the potential for turbidity changes in the receiving environment is low, even without accounting for dilution in the creek and filtration in the fine substrate of the riverbed. Nonetheless a management approach has been developed to avoid outward seepage of water from the dredge pond when the mine is upgradient of Tūwharewhare, the riparian wetland and the local domestic supply wells. Adverse effects will therefore be avoided.	Install infiltration trench on southern site boundary and abstract 3 L/s (net) from the dredge pond in a designated "dredge pond water level management zone" Undertake precautionary monitoring in piezometers on the northwest site boundary, upstream of the closest domestic supply well.
Discharge of water from process plant to dredge pond	Potential transport of naturally occurring dissolved constituents, including metals or metalloids, from the excavation to Tūwharewhare/wetland via groundwater flow.	A limited suite of dissolved metals may be present in the minerals processing discharge water at concentrations above environmental screening thresholds. Our conservative modelling shows that, after accounting for reasonable mixing, all water quality determinants will be below screening threshold values in Tūwharewhare with the exception of aluminium and chromium which could be slightly elevated. Although the effects of any such discharge are expected to be no more than minor, a management approach has been developed to avoid outward seepage of water from the dredge pond as described above. Adverse effects will therefore be avoided.	
	Potential transport of naturally occurring dissolved constituents, including metals or metalloids, from the excavation to domestic wells via groundwater flow.	Dissolved aluminium concentrations could potentially exceed the aesthetic value for drinking water intermittently in the three local domestic water supply wells. The aesthetic value for aluminium is defined to avoid potential complaints of depositions in or discoloration of drinking water. Although the effects of any such water quality change are expected to be no more than minor, a management approach has been developed to avoid outward seepage of water from the dredge pond as described above. Adverse effects will therefore be avoided.	
Site rehabilitation	Discharge of nutrients and sediments to Tūwharewhare and the riparian wetland via runoff from the rehabilitated site	An improved drainage system and three constructed wetlands will be installed as part of the site rehabilitation plans. Our assessment shows that the wetlands are expected to reduce nutrient and sediment discharges from the site to Tūwharewhare and the riparian wetland significantly.	Design wetland for optimal nutrient and suspended sediment removal.

Activity	Potential effects	Assessment summary	Management actions
	once returned to farming use.		

Management of runoff diversions to avoid adverse effects associated with erosion and sediment discharges is discussed in the ESCP. Rehabilitation will be managed as part of the site rehabilitation plan and is not included in this document.

6. WATER MANAGEMENT PLAN

6.1. Operational water management goals and objectives

The goal of the WMP is to avoid adverse hydrological and water quality effects. This will be achieved via the following objectives:

I. The rate of groundwater abstraction from the process plant top-up supply well will be minimised by the water treatment system installed at the processing plant to remove fine sediment from the process water so that water can be recycled through the plant.
II. The rate of groundwater abstraction from the process plant top-up supply well will not exceed 38 L/s as a daily average (including short periods of pumping at up to 60 L/s) to ensure that the rate of water discharge to the mine excavation does not exceed the rate used for effects assessment.
III. An infiltration trench will be installed on southern site boundary and 3 L/s of water (net) will be abstracted on average from the dredge pond when the mine excavation is operating within the Dredge Pond Water Level Management Zone (the dredge pond will be upgradient of sensitive receptors at these times) to avoid the potential for pond water to seep to these receptors.
IV. A minimum distance of 50 m will be maintained between the mine excavation pond and Mahinapua Creek and local domestic supply wells as an additional precautionary approach to avoid the potential for water quality effects.
V. Monitoring will be undertaken to confirm that adverse water quality effects (including seawater intrusion in the top up pumping well) are avoided.

The proposed water pumping and discharge rates are summarised as follows:

- Maximum instantaneous top up well take = 60 L/s
- Maximum daily average top up well take = 38 L/s
- Up to 4.3 L/s of pumped groundwater could be retained in the Heavy Mineral Concentrate (HMC) and be transported off site or seep to ground in the HMC storage area
- Net maximum daily flow to dredge pond therefore = 38 - 4.3 = 33.7 L/s
- Maximum daily flow to infiltration trench = 33.7 L/s + 3 L/s pumped from dredge pond = 36.7 L/s

6.2. Water management actions

6.2.1. Action summary

The actions below will be undertaken to implement the water management objectives.

The processing plant will be configured such that the top up supply well is only used to supply water to the Wet High Intensity Magnetic Separator (WHIMS), which requires very low turbidity water (<5

NTU). All other water demand will be supplied via recycling of water through the processing plant and treatment ponds. This will minimise the rate of groundwater abstraction from the top up well.

Water will be drawn from the dredge pond when mining in the Dredge Pond Water Level Management Zone (see Figure 4) to avoid the potential for water quality changes in the downgradient domestic wells and in Tūwharewhare. Precautionary monitoring will be undertaken in the northwestern and southeastern site boundary piezometers to confirm that the management system is effective. Water level monitoring will be undertaken in or immediately adjacent to the infiltration trench and the southeastern site boundary piezometers to confirm that the water levels in/immediately adjacent to the trench remain below the groundwater level at the eastern site boundary, adjacent to Tūwharewhare. This management control will ensure that water from the trench cannot seep towards Tūwharewhare.

The rate of groundwater abstraction from the top-up supply well will be measured and an automated control system installed which will discharge water from the processing plant treatment ponds to the southern boundary infiltration trench at a monthly average rate equal to the top-up supply well pumping rate + 3 L/s when the mining within the Dredge Pond Water Level Management Zone. The maximum monthly average rate of discharge to the trench will therefore be 33.7 + 3 ≈ 37 L/s, as per Figure 1 (33.6 L/s = 132 m^3/hour). Although water will flow to and from the dredge pond in slurry lines transporting ore sand and tailings, this configuration will ensure that a net of 3 L/s is abstracted from the pond on average. The rate of discharge to the southern infiltration trench will be measured and reported on to confirm that the rate of discharge is equal to the top-up supply well pumping rate + 3 L/s on a monthly average basis. It is expected that the rate will be fixed at 3 L/s unless additional short-term pumping is undertaken as a water quality action response as per Section **Error! Reference source not found.Error! Reference source not found.** below.

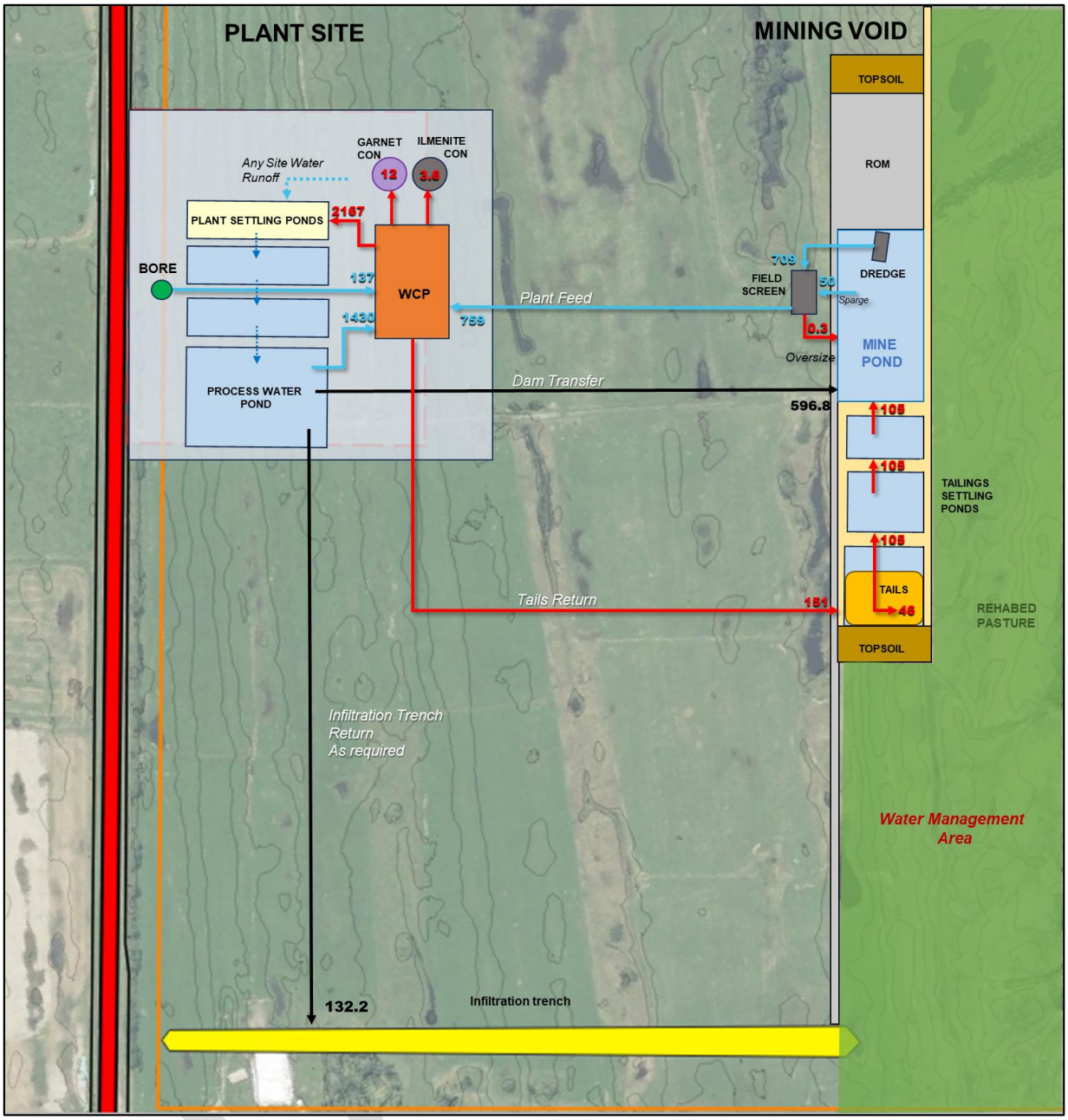

Figure 1: Operational water budget (m^3/hour) for maximum proposed top up well pumping rate

Information on the infiltration trench capacity is provided below. The rate of infiltration trench clogging with fine sediment will be minimised by water treatment in the process water plant settling ponds prior to discharge to the trench. Water levels in the trench will be monitoring via data logger with a high-level alarm system to alert the mine operators when maintenance is required to remove clogging material.

The 50 m buffer maintained between the mine excavation pond and Mahinapua Creek and local domestic supply wells will be implemented as part of the mine planning process.

6.2.2. Infiltration trench capacity

Short duration infiltration trench trials were undertaken in two trenches at the site as part of investigations undertaken by Sephira Environmental Ltd in 2019. The infiltration trial results

summarised in Table 2 show that a stable recharge rate of 2.3 L/s/m² of trench footprint area was achieved for a 0.4 m increase in groundwater level.

Table 3: 2019 trench infiltration trench test results summary

Trench Test No.	Trench area m²	Test duration (mins)	Infiltration rate (L/s)	Max mounding (m)	Water level stabilised?
1	1.5	15	3.5	0.4	Yes, after 10 mins
2	1.5	12	3.5	0.32	No
3	6.2	7	5.6	0.5	No

The groundwater model described in the Hydrological and Water Quality Impact Assessment (Etheridge & Rekker, 2023) simulated a 37 L/s water discharge to a 350 x 20 m infiltration trench under three hydraulic conductivity scenarios comprising the best estimate and upper and lower bounds from all hydraulic testing at the site as per Table 4.

Table 4: Summary of hydraulic conductivity scenarios

Model layer	Layer description	Min K (m/d)	Max K (m/d)	Best Est K (m/d)
0	Coarse mineral sand	14	137	55
1	"Muddy gravel"	101	518	214

Infiltration capacity simulations results for the Best Est and Min K scenarios plotted in Figure 2 and Figure 3 below show a peak mounding of 0.45 and ~0.8 m respectively during the early stages of mining when the excavation traverses the Dredge Pond Water Level Management Zone along the eastern site boundary. The model dimensions of the infiltration trench (7,000 m²) equate to an infiltration rate of 0.05 L/s/m². This is significantly lower than the 2019 infiltration test results (2.3 L/s/m²) which suggests that the modelled rates are conservative. This conservatism accommodates the reduction in infiltration rates that will occur due to clogging of the trench walls and base with fine sediment. The 350-400 m length of the trench will provide for partition into discrete sections via mud dams/baffles to allow removal of clogging material from part of the trench whilst maintaining infiltration upstream of the mud dam/baffle.

The depth to groundwater at the proposed trench location is approximately 5 m based on groundwater level measurements provided in Sephira (2019). The depth of the trench is expected to be approximately 2 m and hence the trench will not intercept the water table.

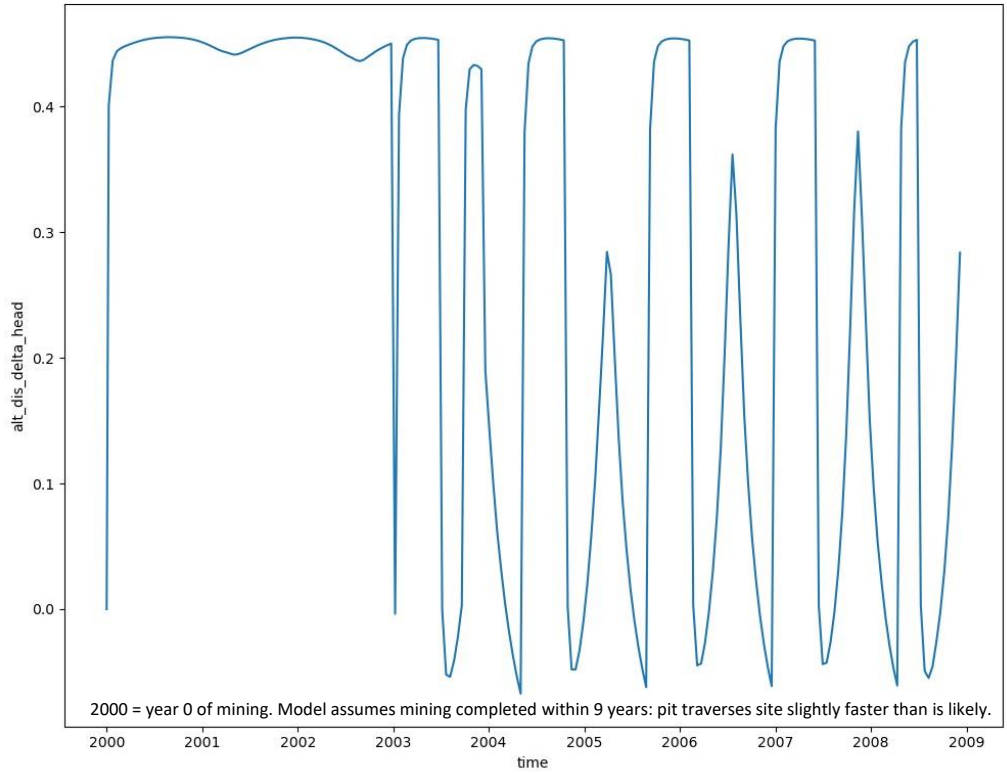

Figure 2: Modelled mounding (m) in southern boundary infiltration trench for Best Est K

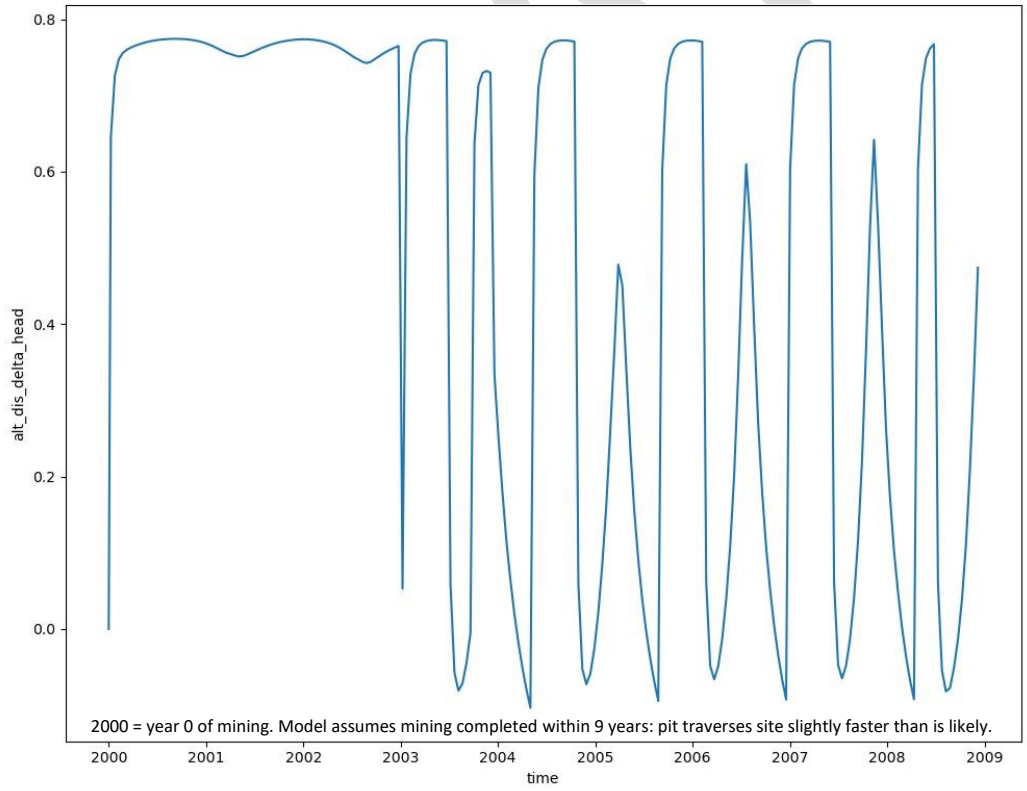

Figure 3: Modelled mounding (m) in southern boundary infiltration trench for Min K

7. MONITORING AND MITIGATION PLAN

7.1. Monitoring and Mitigation Plan Objectives

The objectives of the Monitoring and Mitigation Plan (MMP) are as follows:

- Ensure that potential water quality impacts associated with mining activities are identified as quickly and clearly as possible via monitoring.
- Identify actions that will be undertaken to avoid, remedy or mitigate water quality effects through implementation of appropriate actions in a timely manner where required.

These objectives are achieved by:

- Specification of a monitoring programme which can robustly define baseline conditions and validate the water quality effects assessment findings and identify where water management adjustments are required to avoid adverse effects.
- Definition of action thresholds and an associated set of activities which can be implemented within a suitable timeframe to achieve the objectives of the WMP.
- Setting out reporting procedures for environmental monitoring data and consent compliance.

7.2. Operational monitoring

7.2.1. Background

The Hydrological and Water Quality Impact Assessment (KSL, 2023) shows that dredge pond dissolved aluminium concentrations could potentially exceed the aesthetic guideline value for aluminium. The assessment also shows that dissolved aluminium concentrations naturally exceed the aesthetic guideline values in groundwater at the site in some locations: 0.13 and 0.4 mg/L of dissolved aluminium were recorded in piezometer HSSC018 on 08/06/23 and 21/09/23 respectively, for example. An exceedance of the 0.1 mg/L aesthetic limit in the WQM piezometers could therefore relate to natural variability rather than seepages from the dredge pond. High levels of turbidity, up to 97 NTU, have also been recorded in the groundwater quality monitoring piezometers at the site and hence elevated turbidity in the WQM piezometers may also relate to natural processes (e.g. accumulation of precipitates in the monitoring wells, although this may become less prevalent through implementation of regular sampling using standard good practice methods) rather than mining processes.

The Hydrological and Water Quality Impact Assessment also shows that aluminium, chromium, copper, nickel and zinc could be present in the infiltration trench at concentrations exceeding the ANZG 99% species protection value thresholds. These threshold exceedances in the trench will not translate into exceedances in receiving waters because:

a) any discharge would be diluted significantly, but regardless;

b) discharges will be prevented by managing dredge pond inflows and outflows to maintain positive flow towards the pond as discussed above; and

c) by managing the infiltration trench such that groundwater levels at the western edge of the site (immediately adjacent to the wetland) are higher than those at the infiltration trench location.

7.2.2. Proposed monitoring

Operational monitoring will include:

1. Pumping rates from and electrical conductivity in the top up supply well.
2. Discharge rates to and water levels in the southern boundary infiltration trench (see Figure 4 for approximate location and expected dimensions).
3. Water quality in two piezometers on the northwestern site boundary and two on the southeast boundary.

The monitoring schedule, parameter suite and monitoring site locations are shown in Table 5, Table 6 and Figure 4 respectively.

Table 5: Monitoring schedule

Monitoring site	Parameters	Minimum frequency
Top up well	Pumping rate – daily volume	Daily when mining in Dredge Pond Water Level Management Zone
Top up well	Electrical conductivity	Daily for at least 30 days prior to the start of operational pumping and weekly when pumping thereafter.
Infiltration trench	Discharge rate, water level	Daily when mining in Dredge Pond Water Level Management Zone
WQM piezometers – northwest boundary	Monitoring Suite A	Monthly for at least 12 months prior to mining[1] in Area A in northwest boundary or other suitable piezometers and weekly when mining in Area A
WQM piezometers – southeast boundary	Monitoring Suite A & B + groundwater levels	Monitoring Suite A & B: monthly for at least 12 months prior to mining[1] in Area A and monthly when mining in Area A Groundwater levels: daily from commencement of mining

Notes: 1. Baseline sampling can be taken in northwest and southeast boundary piezometers or other suitable piezometers, e.g., piezometers installed during previous investigation works

Table 6: Monitoring suites

Suite A	***Suite B***
Dissolved aluminium	Dissolved chromium
EC	Dissolved copper
pH	Dissolved zinc
Turbidity	Dissolved nickel

Figure 4: Water management and monitoring

7.3. Thresholds and actions

Noting the information provided in Section 7.2.1, the action thresholds below should be treated as action thresholds to signal the need for more detailed review or a management response rather than consent limits.

7.3.1. Top up water supply well

The following consent conditions have been proposed to avoid seawater intrusion:

1. Prior to the first exercise of this consent the consent holder shall take at least 30 daily electrical conductivity readings in the pumping bore under static conditions to establish the baseline water quality.
2. When the water supply well is being pumped the consent holder shall collect electrical conductivity (EC) readings at a minimum weekly frequency.
3. If the electrical conductivity at 25° C (i.e. adjusted for temperature) exceeds the greater of the mean baseline EC plus three standard deviations and 150% of the mean, the following actions should be undertaken:
4. The consent holder shall notify the Consent Authority as soon as possible and no later than two working days after the initial trigger exceedance.
5. Additional water quality sampling and analysis shall be conducted to determine whether the exceedance relates to seawater intrusion.
6. If seawater intrusion is found to have occurred, response actions shall be implemented no later than five working days after the consent holder becomes aware of the initial trigger exceedance to reverse the potential saline intrusion, by reducing the total daily take from the water supply well by up to 20% of the daily take averaged over the seven days preceding exceedance of the saline intrusion trigger, until such time the monitoring results at the saline intrusion monitoring bore no longer indicate saline intrusion, or as otherwise agreed by the Consenting Authority.
7. Sampling and analysis of the water quality for the parameters Conductivity at 25° C (mS/m), Chloride (Cl) and Sulphate (SO_4), shall be undertaken at weekly intervals until such time the monitoring results no longer indicate saline intrusion or as otherwise agreed by the Consenting Authority. The results shall be reported to the Consenting Authority within five working days of the sample or measurement being taken.
8. If any of the saline trigger levels are still being exceeded in the pumping well 20 working days after the initial breach then, as soon as possible and no later than within 40 working days of the initial breach, a “Saline Intrusion Investigation and Response” report prepared by a suitably qualified and experienced hydrogeological professional shall be submitted to the Consenting Authority for written certification.

7.3.2. Northwestern WQM piezometers

Table 7: Water quality action thresholds – northwestern WQM piezometers

Parameter	*Threshold*	*Reference*
Aluminium	The greater of 0.1 mg/L and the baseline value	0.1 mg/L = aesthetic guideline value for drinking water
Turbidity	The greater of 5 NTU and the baseline value	5 NTU = aesthetic guideline value for drinking water

Note: the baseline value shall be defined as the 90th percentile value calculated from at least 12 months of monthly sampling undertaken prior to mining in Area A.

The following actions shall be undertaken in the event of a water quality threshold exceedance in the northwestern WQM piezometers:

- Notify West Coast Regional Council (WCRC) within five working days of receipt of the laboratory testing results.
- Collect confirmatory samples for two consecutive days from each WQM piezometer and collect water samples from the dredge pond to be analysed for the Suite A parameters, as a minimum.
- Evaluate water quality trends in relation to the dredge pond distance from the WQM piezometers: a positive correlation between dredge pond distance and increasing aluminium/turbidity in the WQM piezometers would signal that water quality changes relate to mine operations rather than background variability.
- Notify the downgradient well owners and enquire whether any water quality changes have been observed. Seek permission to collect water quality samples from their supplies.
- If the above investigations find that water quality changes in WQM piezometers relate to mining activity, develop a response plan. The response plan may include:
    - A temporary increase in the rate of groundwater abstraction from the dredge pond and water level monitoring in the dredge pond and WQM piezometers to confirm that a positive groundwater gradient towards the pit is maintained.
    - Provision of an alternative water supply to the well owners if water sampling shows that their supply has been affected.

7.3.3. Southeastern WQM piezometers

The water level threshold for the southeastern WQM piezometers is triggered when the monthly average groundwater elevation in the southeastern WQM piezometers is lower than the groundwater elevation in the infiltration trench monitoring piezometer.

Water quality thresholds for the southeastern WQM piezometers comprise:

a) A statistically significant change in the 6 month rolling median of more than 20% from the 12 month median baseline concentrations in the monitoring wells; and

b) A statistically significant upward trend in concentrations recorded over the preceding 12 samples.

The following actions shall be undertaken in the event of a water level threshold exceedance:

r) Notify West Coast Regional Council (WCRC) within five working days.

s) Develop an action plan to reduce groundwater mounding at the eastern end of the infiltration trench (this is likely to initially comprise expansion of the trench at the western end) and issue to WCRC for review and comment.

t) Increase the frequency of water quality monitoring in the southeastern WQM piezometers to weekly until a westerly hydraulic gradient has been re-established.

The following additional actions shall be undertaken in the event of a water level and water quality threshold exceedance:

u) Develop a plan for water quality monitoring at the edge of the riparian wetland and issue to WCRC for review and comment.

v) Initiate water quality monitoring plan and compare monitoring results to ANZG 99% species protection thresholds monthly. Review and revise action plan in accordance with monitoring result assessment outcomes.

8. ANALYSIS, REPORTING AND IMPROVEMENT PROCEDURES

8.1. Plan updates

The WMP should be updated on an annual basis. Key components of the WMP to be defined for the year ahead include:

- The proposed mine area for that year.
- A description of all site activities with the potential to cause hydrological impacts.
- The water management actions that will be implemented to avoid hydrological effects.
- Audit checklists.
- An organisational chart showing staff and contractor positions and responsibilities for plan implementation.
- Relevant training and induction procedures and schedules.

The water management plan and associated procedures should be updated to improve water management practices and reduce the potential for adverse hydrological impacts in the following circumstances:

- Ongoing actions or management changes are implemented in response to breaching of an action threshold.
- The monitoring system is not performing as intended (e.g. due to insufficient information being gathered to identify the cause of any water quality issues).

- A pollution incident or one or more near-misses occur which could have resulted in water quality or quantity impacts, and new procedures have been identified to reduce future risk.
- Improvement opportunities identified through the data review and analysis procedures.

8.2. Annual reporting

An annual monitoring report will be prepared by a suitably qualified and experienced person and submitted to WCRC for review. The report will include:

1. A summary of the monitoring undertaken over the preceding 12 months. The summary will:
    a. Reference the specific consent conditions under which the monitoring has been undertaken to show how the conditions have been complied with.
    b. Provide tables, graphs and summary data of the water quality, flow and water level monitoring.
2. Discussion and evaluation of the monitoring data in relation to the relevant consent conditions including a summary of compliance with conditions.
3. A summary of the actions that have been undertaken in response to any action thresholds.

9. REFERENCES

Etheridge, Z. and Rekker, J. (2023). Mananui Mineral Sands Project Hydrological and Water Quality Impact Assessment

Sephira Environmental Ltd. 2019a. Baseline Hydrologic and Hydrogeologic Assessment, Ruatapu Garnet Project (Draft for Techncial Review). Prepared for NZ Garnt Ltd by Sephira Environmental Ltd technical report BAR-A0391-006-v0, December 2019, Christchurch. 87 pages including appendices.

Tai Poutini Resources Ltd, 2023. Assessment of Environmental Effects for Mananui Mineral Sands Project

APPENDIX A. WATER MANAGEMENT AND MONITORING PROCEDURES

To be completed at least 8 weeks prior to start of mining

APPENDIX B. HAZARDOUS SUBSTANCES ENVIRONMENTAL MANAGEMENT PROCEDURES

To be completed at least 8 weeks prior to start of mining