WGA

TECHNICAL MEMORANDUM

PROJECT NO.: WGA232254

DATE: 21 FEBRUARY 2025

COMPANY NAME	West Coast Regional Council
ATTENTION	Rachel Clark, Rebecca Inwood
SUBJECT	Mananui Mineral Sands Project – Hydrological Review

1. REVIEW STATUS

The applicant has generally addressed the requests for information raised in the original review.

Additional questions have been raised with regards the original requests 9 and 12. These requests are for clarification (Questions 9a and 9b) and for a different output from the existing model (Question 12a). These requests do not represent critical or key concerns but are rather to enable the reviewer to close out the review process.

Overall, the review has found no fatal flaws with the hydrological and hydrogeological information presented in support of the application. The assessment of hydrological and hydrogeological effects follows an acceptable process and the outcomes are reasonable and defensible.

Review notes and information added to the original Wallbridge Gilbert Aztec (WGA) request for information, in response to the new material from the applicant, are provided in blue font in the following document for clarity.

Comments and suggestions relating to the following documents are provided separately as track-change mark-ups to the drafts received:

- Water Management, Monitoring and Mitigation Plan
- Draft Conditions of Consent

2. INTRODUCTION

During 2023 the West Coast Regional Council (WCRC) received an application by Westland Minerals Company Limited (WMSC) for resource consents authorising the development of a mineral sands mining operation at Mananui, Hokitika. Technical documents were lodged with the WCRC in support of the application and the Assessment of Environmental Effects.

The WCRC commissioned WGA to review the technical documents lodged in support of the application. The review undertaken by Brett Sinclair, Senior Principal Hydrogeologist on behalf of WGA, covered the hydrological and hydrogeological aspects of the application. The objective of this review was to determine if there were any gaps in information and to provide requests for information under Section 92 of the Resource Management Act. A memorandum (WGA 2023[1]) documenting the outcomes from an initial review of the technical documents was provided to WCRC on 27 November 2023.

[1] WGA 2023. Mananui Mineral Sands Project – Hydrological Review. Memorandum to West Coast Regional Council from Wallbridge Gilbert Aztec. Document No. WGA232245-MM-HG-0001_B. Dated 27 November 2023.

The WCRC received responses from the applicant to the matters raised in the WGA (2023) memorandum during December 2024. The WCRC has requested WGA to review the new information provided by the applicant. The following memorandum is based on the original memorandum provided to the WCRC, to provide continuity with WGA's initial review.

A detailed assessment of mine water chemistry and the potential effects of contaminants on freshwater ecosystems is outside my area of expertise and outside the scope of this review. Further review of the leachate water quality assessment would require a specialist in that field.

3. REPORTS REVIEWED

The following documents were considered during the original review of the hydrological and hydrogeological aspects of the resource consent application for the Mananui mineral sands mine.

- Tai Poutini 2023. Application for resource consent to West Coast Regional Council and Westland District Council. Mananui Mineral Sand Project. Report produced by Tai Poutini Professional Services Ltd for Westland Mineral Sands Limited. Dated October 2023.
- Kōmanawa 2023a. Mananui Mineral Sands Project. Hydrological and Water Quality Impact Assessment. Report produced by Kōmanawa Solutions Ltd for Westland Mineral Sands Company Limited. Report #: Z22025_01. Dated 24 October 2023.
- Kōmanawa 2023b. Mananui Mineral Sands Project. Water management, monitoring and mitigation plan. Report produced by Kōmanawa Solutions Ltd for Westland Mineral Sands Company Limited. Report #: Z22025_02. Dated 24 October 2023.
- WMSC 2023a. Mananui Consent Brief Map. Map produced by Westland Mineral Sands Company Limited. Dated 19 October 2023.
- WMSC 2023b. Erosion and Sediment Control Plan. Document produced by Westland Mineral Sands Company Limited. Dated 12 September 2023.

In addition to the above documents, WGA was provided with copies of the following reports, which contain information relied upon by Kōmanawa in the hydrological and water quality impact assessment. Aspects of the following reports were reviewed as being directly relevant to the application review, even though they have not been lodged with the WCRC in support of the application.

- Sephira 2019a. Baseline hydrologic and hydrogeologic assessment, Ruatapu Garnet Project (Draft for Technical Review). Report prepared for NZ Garnet Ltd by Sephira Environmental Ltd. Technical report BAR-A0391-006-v0. Dated December 2019
- Sephira 2019b. Baseline water quality factual report, Ruatapu Garnet Project (Draft for Technical Review). Report prepared for NZ Garnet Ltd by Sephira Environmental Ltd. Technical report BAR-A0391-007R-v0. Dated December 2019.

The following documents, lodged with the WCRC during 2023, have been considered during this updated review of the hydrological and hydrogeological aspects of the resource consent application for the Mananui mineral sands mine.

- Kōmanawa 2023c. Mananui Mineral Sands Project. Hydrological and Water Quality Impact Assessment. Report produced by Kōmanawa Solutions Ltd for Westland Mineral Sands Company Limited. Report #: Z22025_03. Dated 22 December 2023.
- Kōmanawa 2024a. S92 information request response: Hydrological impact assessment. Memorandum to Damien Barr (WMSC) from Zeb Etheridge (Kōmanawa). Dated 31 January 2024.
- Kōmanawa 2024b. Mananui Mineral Sands Project. Water Management, Monitoring and Mitigation Plan. Report produced by Kōmanawa Solutions Ltd for Westland Mineral Sands Company Limited. Report #: Z22025_02 Rev A. Dated 2 July 2024.
- Kōmanawa 2025. Additional question response: Hydrological impact assessment. Memorandum to Brett Sinclair (WGA) from Zeb Etheridge (Kōmanawa). Dated 18 February 2024.
  - This memorandum included links to downloadable model animations showing the extent of mine water distribution within the groundwater system over time. These animations were downloaded for review.
- WMSC 2024a. Westland Mineral Sands Co. Ltd – Proposed Conditions of Consent. Document pdf file dated 6 December 2024.
- WMSC 2023b. Mananui Consent Brief Map. Map produced by Westland Mineral Sands Company Limited. Dated 19 October 2023.

4. PROPOSED MINING OPERATION

The general description of the mining process is consistent between the various reports. The key aspects of the proposed mining operation with respect to mine water management and hydrological impacts are summarised here to avoid repetition later.

- Mining operations will be undertaken over an area of approximately 112 ha, which includes an area of 4.4 ha for the ore processing plant.
- Ore extraction will be undertaken using a sand dredge placed within a dredge pond initially excavated to the groundwater level. The mine void is expected to advance at a rate of approximately 2,000 m/year (170 m/month or 6 m/day) averaged over the life of the mine.
- The proposed dredge path is an average of 50 m wide and will operate in a predominantly North - South direction following the conceptual track presented in Figure 1. As the dredge advances, the trailing void space is progressively backfilled with tailings sand, re-contoured and rehabilitated.

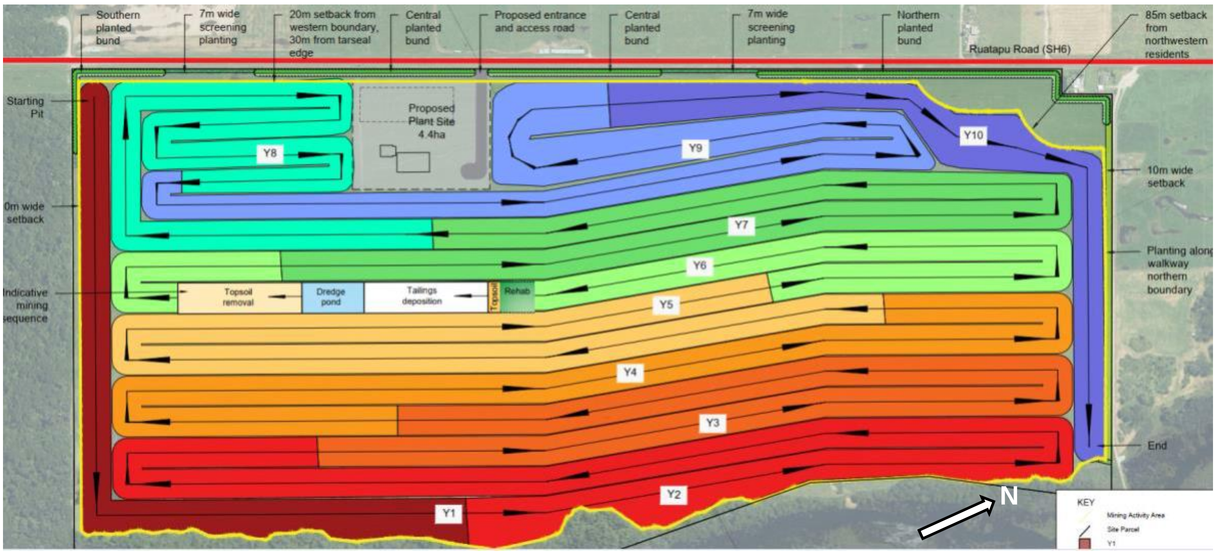

Figure 1. Conceptual Mine Development Sequence Plan (from Tai Poutini 2023)

- The proposed mine operational setbacks (Figure 1) are:
  - 10 m setback from the northern and southern property boundaries.
  - 20 m setback from the western boundary, which is 30 m from the edge of SH6.
  - 85 m setback from the NW corner near adjacent residential dwellings.
  - The edge of the vegetation and to the property boundary along the eastern boundary. For clarity, this setback has been taken as corresponding to the eastern boundary presented in the Mananui Consent Brief Map as attached in Appendix 1 to this memorandum.
- The maximum disturbance area at any one time is 22.5 ha, which equates to 20% of the total mining area or 16% of the property. The average disturbed area is expected to be approximately 16 – 17 ha.
- Mineral sand ore extraction will not extend below an elevation of 0 m AMSL.
- Overburden consisting of sandy topsoil between 0.1 m and 0.6 m thick will be set aside and used for rehabilitation and for boundary bunds.
- The mineral sands are to be processed at the point of mining to remove any oversize (> 2 mm) components. The mineralized component of the ore is pumped to the processing plant as a slurry and the processed wastes (tailings) are returned to the open pit as a slurry.
- No chemicals are to be used to separate the minerals and the sand remains wet for the entire process.
- The water balance for the site is summarised in Figure 2, with the following notes:
  - Any additional water required for the processing plant is to be abstracted from a new bore to be installed.
  - The net flow to the dredge pond is to be about -11 m3/hour in order to maintain positive groundwater flows toward the excavation (Kōmanawa 2023a).

– Excess water is to be discharged to an infiltration basin along the southern edge of the site.
– The water balance for the site can be managed through monitoring and adjusting the above three pumping rates.

- The land is to be progressively rehabilitated to pasture, and an ecological restoration area is to be created along the Māhinapua Wetland and Creek (presumably Tūwharewhare). The ecological area is to consist of approximately 2.37 ha of wetland and 4.75 ha of new vegetation.
- Mining and processing is to occur on a 24 hour, 7 day a week, basis.
- The consent is sought for a total of 16 years, with an anticipated mine life of 10 years at maximum production. The additional time allows for site development, mining, closure decommissioning and final rehabilitation.

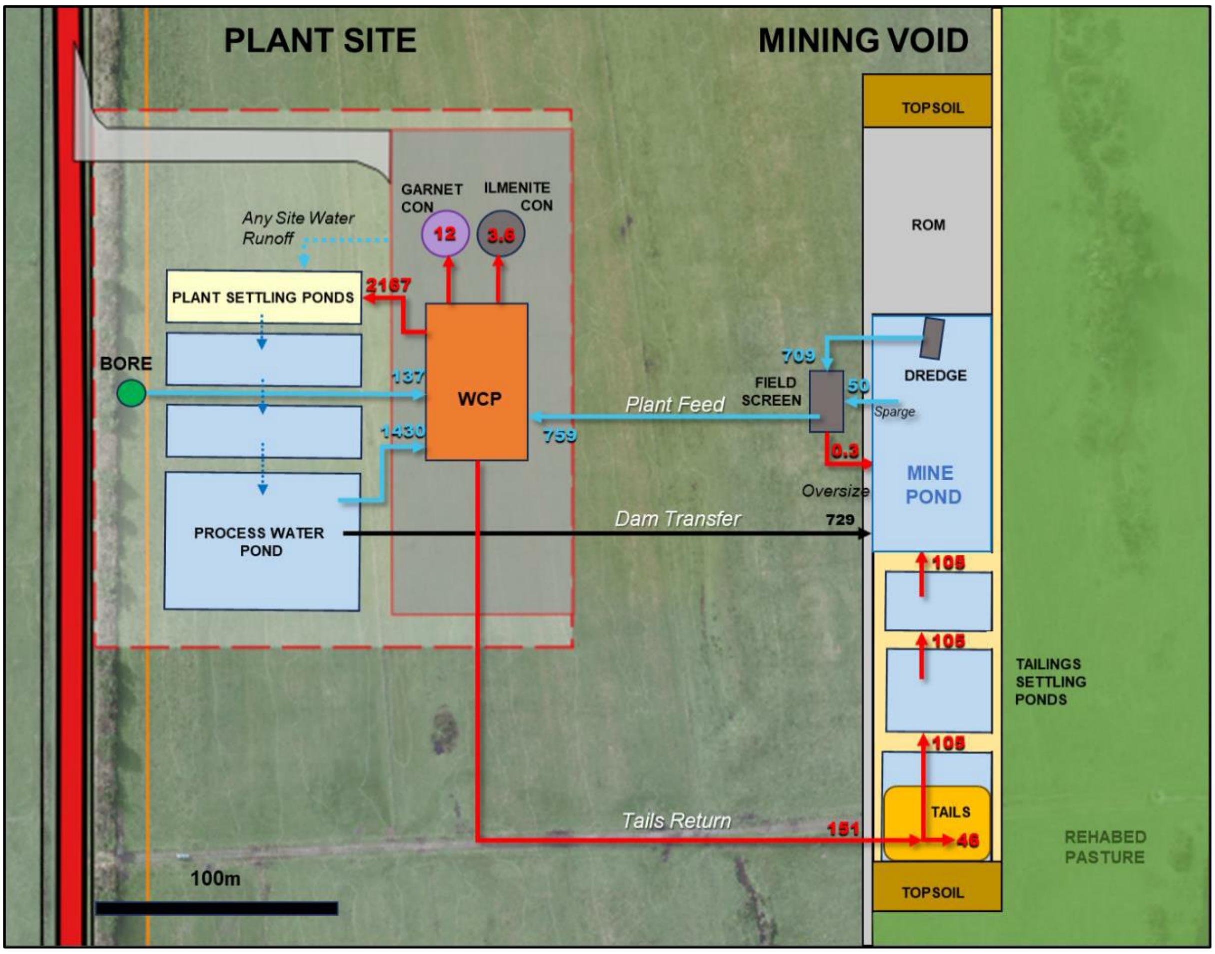

Figure 2. Site Water Balance Diagram with Flows in m^3/hour (from Kōmanawa 2023a)

5. HYDROLOGICAL REPORT (KŌMANAWA 2023A) REVIEW

There is no defined Section 1 to the report.

Sections 3 and 4 provide general background information on the site and the proposed operation. No concerns are raised with respect to the information presented in these sections.

Section 4 documents the existing environment. The location of the site is documented in Section 4.1. the topography of the site is summarised in Section 4.2. The climatic conditions at the site are summarised in Section 4.3. An introduction to the topsoils at the site is presented in Section 4.4. A summary of the geology of the site is presented in Section 4.5. The lithological stratigraphy at the site presented in Table 4-5 of the report is summarised from drillhole geological logs documented in Appendix B of a report by Sephira (2019a). The Sephira report has been reviewed to confirm the general shallow geology at the site and the lithological summary presented in Table 4-5 appears reasonable. **No requests for further information arise with respect to the information presented in Sections 4.1 through to 4.5.**

Section 4.6 describes the hydrology of the existing environment, on and around the site. Although the methods used to evaluate the hydrology of the site and surrounding area are reasonable, it appears that there has only been one formal flow gauging undertaken to support the assessment, with two additional visual estimates of surface flows on-site. The flow gauging was undertaken by Sephira (2019a) during a high flow period. The lack of on-site or near-site flow measurements represents a weakness in the surface water assessment.

The low flow statistics for Tūwharewhare, as presented in Table 1, are based on outputs from an on-line NIWA model calibrated against other catchments. This model is unlikely to take into account the buffering effect of Lake Māhinapua and may therefore underestimate flow rates in Tūwharewhare associated with low flow periods.

Table 1. Hydrological Statistics for Tūwharewhare (from Whitehead & Booker, 2020)[2]

Estimated Hydrological Statistic	Lake Outlet	Hokitika Bar
Upstream Catchment (km^2)	30.7	71.4
Mean Flow (m^3/s)	1.09	3.05
Median Flow (m^3/s)	0.774	1.512
$MALF_{7d}$ (m^3/s)	0.177	0.346
1 in 5 Year Low Flow (m^3/s)	0.106	0.197
FREQ (No. per year)	31.3 events per year	31 events per year

A surface water flow assessment for catchments around the site undertaken by Sephira (2019a) is mentioned in passing in Section 4.6.2. An initial review of the Sephira hydrological assessment has been undertaken, as it appears that the only flow gauging undertaken at the site was documented in the Sephira (2019a) report. The gauging methodology is not documented in the Sephira report and the calculated flow rate in Tūwharewhare of 17.9 m^3/s is at about the 95^{th} or 99^{th} percentile of flows derived from the NIWA model. Therefore, it seems that the measurement may have been made under very high flow conditions. The Sephira (2019a) report noted that two rainfall events exceeding 80 mm/day were recorded at the Hokitika Aero climate station within the previous 8 days. However, it is not clear that the hydrological assessment by Sephira or the associated outcomes are utilised at any point in the Kōmanawa (2023a) assessment.

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[2] Whitehead A L, Booker D J 2020. NZ River Maps: An interactive online tool for mapping predicted freshwater variables across New Zealand. NIWA, Christchurch. https://shiny.niwa.co.nz/nzrivermaps/

Based on a range of site observations, and the topographic and geological information presented, the general conclusion that surface run-off constitutes a small fraction of the incipient rainfall to the site is reasonable. Taking into account the general observations documented in the report, the estimated surface runoff rates from the site presented in Table 2 appear reasonable.

Table 2. Modelled and Estimated Runoff from the Eastern Half of the Site (Kōmanawa 2023a)

Statistic	Northeast corner		Southeast corner	
	Modelled	Best estimate	Modelled	Best estimate
Mean L/s	12	<1	8	<1
Median L/s	2.5	<1	1.6	<1

No requests for further information arise with respect to the information presented in Section 4.6.

Section 4.7 describes the groundwater resources of the existing environment on and around the site.

Three domestic wells are identified in Figure 4-7. All of these wells are shallow and are located hydraulically down-gradient from the northern end of the proposed mine. Two domestic wells are located within 300 metres of the dredge pond at its nearest approach. There is no mention of any domestic well at the building located approximately 300 m southwest of the site.

"*A total of 21 piezometers were installed across the wider landform centred on the site, plus four larger diameter (100 mm ID) pumping test bores were temporarily installed in the period 2016 to 2019 (Sephira Environmental, 2019a). Manual measurements of groundwater level, aquifer testing, and groundwater sampling were undertaken in 2019. Automated, digital logging of groundwater level was undertaken in selected piezometers along the Tūwharewhare littoral from 2022 to present.*" (Kōmanawa 2023a). This effort represents a significant investment in groundwater investigations by the previous lease holder.

"*The ground is fully saturated from elevations below 2.2 – 3.0 m AMSL*" (Kōmanawa 2023a). This conclusion was reached based on the piezometric maps provided in the Sephira (2019a) report. However, Figure 11 in the Sephira (2019a) report provides groundwater level records for several monitoring bores through the period June 2016 to July 2017. This record suggests that groundwater levels at the site may drop below 1.8 m AMSL during dry periods. The actual minimum groundwater level at the site may be controlled by water levels in Lake Māhinapua and Tūwharewhare. The water level in Lake Māhinapua was recorded at 1.83 m AMSL in August 2016, at a date that does not correspond with the lowest groundwater level recorded. In summary, the pre-mining groundwater table on-site may drop below the levels indicated by Kōmanawa (2023a).

As the mining operation is not to extend below 0 m AMSL, the information provided above suggests the dredge pond may at times be less than 1.8 m deep. Furthermore, a "*small volume of water (3 L/s net) will be pumped from the mine pond to maintain positive groundwater flow towards the excavation*" (Kōmanawa 2023a). It is not clear if the proposed positive groundwater flow toward the dredge pond can be achieved while maintaining a sufficient operating water depth for the dredge.

1. **Is there a shallow domestic well installed at the building or residence located approximately 300 m southwest of the proposed mine site?**

   Well exists but has been decommissioned and is not in use.

   Thank you. **No further questions.**

2. **Please provide the minimum operational water depth for the dredge and confirm the dredge can operate within the proposed pond floor limit of 0 m AMSL.**

   Minimum operational water depth of 0.9 m. GPS control on depth of mining, which will be used to keep base of mining in line with the base of the resource.

   Thank you. **No further questions.**

Section 4.8 of the report presents the baseline water quality for the area, with surface water quality documented in Section 4.8.1 and groundwater quality documented in Section 4.8.2. I, Brett Sinclair, am not an environmental water quality expert. The comments and requests for information provided below should therefore be taken as being related to detection limit issues or sampling schedules, rather than the environmental effects of the observed water quality.

Surface water samples have been taken from Tūwharewhare on the 29th of June 2016 and on the 17th of November 2019. Based on information provided in the Sephira (2019a) report, flows in Tūwharewhare on the 29th of June 2016 were probably above average for the 2016 – 2017 hydraulic year. Flows in Tūwharewhare on the 17th of November 2019 to have been close to the 99th percentile high flow for the creek. Therefore, the water quality analytical results presented in Table 4-9 of the Kōmanawa (2023a) report may not be representative of surface water quality under low flow conditions. Furthermore, the sample analyses were for total concentrations rather than dissolved concentrations, with suspended sediment concentrations not provided. Therefore, interpretation of this data set is problematic.

Four water samples were taken from Tūwharewhare during 2022 and 2023. Additionally, one water sample was obtained on 25th August 2022 from the cut-through drain taking drainage water off the site. It is not clear what the flow conditions were at the time of sampling in each case. The analytical results have been documented in Table 4-10 of the Kōmanawa (2023a) report. The sample analysis results from Tūwharewhare are consistent although they are all representative of winter conditions. The analysis results for the cut-through drain indicate poorer water quality than in Tūwharewhare, presumably reflecting the shallow groundwater and localised run-off from farmed pasture.

Dissolved chromium was detected at a concentration of 0.001 g/m^3 in the water sample from the cut-through drain on 25 August 2022. Dissolved chromium was detected in groundwater at HSSC-018 at a concentration of 0.0009 g/m^3. These concentrations are approximately two orders of magnitude higher than the ANZG 99th percentile DGV provided of 0.00001 g/m^3. However, the laboratory analytical detection limit of 0.00005 g/m^3 is also five times higher than the DGV. As the two samples described above derive from different areas of the site, it appears that chromium is locally elevated in groundwater across the site.

3. **Please provide guidance on the flow conditions at the time the surface water samples were obtained in 2022 and 2023. Detailed analysis is not required, simply an indication of high, low or moderate flow conditions.**

   Response: Statistical assessment of Tūwharewhare water level range has been provided covering a period of approximately 14 months (Kōmanawa 2024a). Samples were obtained during periods covering a range of flow regimes (low, moderate, high). Therefore, water quality analysis results are not specific to one flow regime.

   Thank you. **No further questions.**

4. **If water quality compliance criteria are applied to dissolved chromium, is there a laboratory available that can provide analyses with detection limits appropriate to the DGV?**

   The applicant indicates the lowest dissolved chromium (CrVI) detection limit found for a laboratory in New Zealand is 0.001 mg/L or g/m^3. This is slightly different from the detection limit of 0.0005 g/m^3 indicated in the original hydrological impact assessment report (Kōmanawa 2023a). However, either way, the available laboratory detection limits are 50 to 100 times higher than the ANZG (2023) DGV for the protection of 99% of aquatic freshwater species. These detection limits are reasonable for the CrVI DGV for the protection of 95% of aquatic freshwater species, which is 0.001 g/m^3.

I note here that an error was made in the original review memorandum. That memorandum incorrectly stated: "*the laboratory analytical detection limit of 0.00005 g/m^3 is also five times higher than the DGV*".

No further questions.

Section 5 of the report documents the conceptual hydrological model for the site. Section 5.1 presents the hydrogeological data inventory on which the model is based.

A total of 21 piezometers and four larger diameter test bores have been installed at the site for monitoring and testing purposes. The coverage provided by these piezometers and the test bores is considered sufficient to support the technical work documented in this report.

Three forms of hydraulic property testing were undertaken, and the results documented in this report; pumping (aquifer) tests, slug tests and trench injection tests. Hydraulic tests were performed on three of the large diameter bores and on three of these smaller diameter piezometers. The locations and dimensions of these installations are documented in Table 5-1 of the report.

No requests for further information arise with respect to the information presented in Section 5.1.

Section 5.2 of the report summarises the hydraulic tests performed at the site and their associated results.

The results of the three pumping tests are provided in Table 5-3 of the report. These results are derived from the Sephira (2019a) report. In the Sephira (2019a) report, the analysis of the pumping test data differentiates between the ore sand horizon and the underlying medium-coarse gravel. This differentiation is problematic and difficult to defend in terms of the pumping test analyses. However, the transmissivity of the combined layers is within the range from 1,110 to 1,570 m^2/day for the three tests. These results are consistent with the general range that would be expected for the lithologies described at the site. It is difficult to see how the specific yield and storativity values presented in Table 5-3 were derived in the Sephira (2019a) analysis, although the values are reasonable. It should also be noted that the Sephira analysis generated results for specific storage rather than storativity, which is what is presented.

The results of three trench infiltration tests are presented in Table 5-5 of the report. None of the infiltration tests documented in the Sephira (2019a) report was long enough to reach a steady state condition during the test. The transmissivity results for the combined sand and gravel layers derived from the trench infiltration tests are substantially lower than the results derived from the pumping tests. As no sensitivity analysis was performed, it is not clear that the analysis results from the infiltration tests can be relied on.

Four slug tests were performed by Sephira (2019a) and the results are presented in Table 5-6 in the Kōmanawa (2023a) report. However, the select test data and the actual analysis have not been documented in either report. Consequently, it is not clear that the slug test results can be relied on, although they do fall within the ranges provided from analysis of the pumping tests.

Overall, the transmissivity range for the combined sand and gravel lithologies derived from the analysis of the pumping tests is considered the most reliable indicator of the hydraulic behaviour of lithologies at the site.

No requests for further information arise with respect to the information presented in Section 5.2.

Section 5.3 of the report documents the groundwater levels and interpreted flow field at the site. Overall, this section describes the groundwater flow system with the hydraulic catchment divide being much closer to Tūwharewhare than to the western boundary of the site. The number of monitoring bores and their locations is sufficient to support the documented interpretation of the piezometric surface. The report assumes that the mineral sand and underlying muddy gravel deposits would be characterised by the same groundwater levels at any particular point across the site. This is a reasonable assumption based on the lithological descriptions from the drill hole data.

Groundwater levels across the site rise and fall seasonally and in response to rainfall events. Observed groundwater level ranges in three bores are approximately two metres (Figure 5-6). The as-built designs for the monitoring wells are provided in the Sephira (2019a) report. The locations for these three bores are shown on Figure 4-7 in the Kōmanawa (2023a) report. These three bores are each located between 80 and 120 metres west from Tūwharewhare.

No requests for further information arise with respect to the information presented in Section 5.3.

Section 5.4 of the report documents the hydrology and hydrogeology of Tūwharewhare and the adjacent wetland. The soil profile of the Tūwharewhare wetland has been investigated through the excavation and logging of 18 hand-auger holes, which is sufficient to provide a good indication of the wetland subsurface.

Snapshot water levels from Tūwharewhare were taken in 2016 and 2019. An automated monitoring system was installed, recording from July 2022 to October 2023. However, the automated record is only continuous from June 2023 onward. This surface water level record is sufficient to give an indication as to how the groundwater levels documented in Section 5.3 vary in response to surface water levels documented in this section. The water level record plus information provided in cross sections indicate the wetland is regularly inundated to within 50 m of the site southeastern boundary. Generally, groundwater flow across the eastern site boundary is toward Tūwharewhare. However, high water levels in the Creek occasionally appear to result in a reversal of the groundwater flow direction.

An estimate of the groundwater contribution to the Tūwharewhare wetland under low creek levels is provided, with the calculated contribution ranging from 2 m^3/day to 20 m^3/day. The report indicates this groundwater contribution equates to between 1% and 9% of the wetland water budget when the creek is low. Note that this groundwater budget has incorporated two significant assumptions:

- It only takes into account seepage flows through the on-site sands above the level of the wetland surface. Flows through the underlying sand and muddy gravels are not considered.
- It does not take into account the silty organic soils underlying the wetland. These low permeability soils would act to limit vertical seepage flows into and out of the wetland.

The above two assumptions tend to offset each other. It is clear that there is substantial uncertainty in the outcomes of the wetland water budget. However, work documented later in the report indicates that the mining operation is unlikely to have a significant impact on water availability to the Tūwharewhare wetland. The uncertainty identified with respect to the calculations presented in this section of the report is unlikely to significantly affect the overall conclusion.

No requests for further information arise with respect to the information presented in Section 5.4.

Section 5.5 of the report documents the hydraulic characteristics of the soils underlying the site. This section presents an interpretation of the information presented in Section 5.2 of the report. An effort was made to differentiate between the characteristics of the ore sands and the underlying muddy gravels. However, the main outcome was to emphasise that it is difficult to differentiate between these two units when interpreting the results of the pumping tests and trench infiltration tests. In effect, this section appears to reach the conclusion that the transmissivity of the combined sands and gravels provides the best indication of the hydraulic behaviour offers soils underlying the site. I agree with this conclusion.

No requests for further information arise with respect to the information presented in Section 5.5.

Section 5.5 of the report presents the conceptual design for the proposed top-up water supply well. The general details of the proposed water supply bore are reasonable and the projected aquifer drawdown around the bore is consistent with the documented aquifer characteristics. The report notes that an additional bore may be installed if the yield of the first bore is not sufficient for the intended purposes.

However, the documentation in this section does not provide any indication of the magnitude of potential interference drawdown impacts on nearby bores. Table 6-1 in the report states "*Groundwater level changes in local third-party water supply wells are expected to be negligible and inconsequential*", although this statement is not supported technically in the report.

5. **Please provide an assessment of interference drawdown arising from the proposed groundwater abstraction from the top up water supply well. This assessment should include a map showing groundwater drawdown isolines and calculated maximum interference drawdown in the nearby bores.**

The request appears to have been misinterpreted in the applicant's responses. The question relates specifically to the drawdown effects of pumping from the top up water supply well, rather than to the ore extraction operations. Unless the effects of pumping from this well have been included in the overall modelled effects of the mine.

The potential drawdown arising from operation of the top-up water supply well has been checked by applying the Theis equation to calculate drawdown from a continuous pumping rate of 38 L/s over a period of one year. The range of transmissivity applied to the source aquifer is 1,100 m^2/day to 1,570 m^2/day, as indicated in the hydrogeological assessment, and a storativity of 0.1 has been applied. The nearest private bore is approximately 880 m from the proposed top-up water supply well. Based on these inputs, the induced interference drawdown in the private bore would range from 0.5 m to 0.6 m.

The combined potential drawdown at the nearest private water bore arising from the dredging operation (Figure 3-1, Kōmanawa 2023c) and operation of the top-up water supply well is approximately 0.75 m. This projected drawdown over a period of one year does not take into account recharge from incipient rainfall. Therefore, the cumulative maximum interference drawdown is expected to be less than 0.75 m over the course of a year.

The Kōmanawa 2023a hydrological assessment notes that an additional well may be installed if the yield of the first bore is not sufficient for the intended purposes. If an additional bore is required to service the site water supply needs, then it should be positioned further from the private water supply bores than the currently proposed well. The installation and operation of a second top-up water supply well should be subject an application for a separate resource consent or a variation to the consent currently being applied for.

The cumulative maximum interference drawdown is expected to be less than 0.75 m over the course of a year, and this value is considered to be a conservative over-estimate. Therefore, the applicant's assertion that "Groundwater level changes in local third-party water supply wells are expected to be negligible and inconsequential" is accepted.

No further questions.

Section 6 of the report documents the assessment of potential effects arising from the proposed mining activities. Section 6.1 provides a summary of these potential effects, as listed in Table 6-1. This section has been reviewed but no requests for further information are allocated against this summary section. Instead, any requests arising are presented against other relevant sections of the report, with references provided to Table 6-1 where appropriate.

Section 6.2 of the report describes the projected operational mine water quality effects. The effects of the proposed mining operation on groundwater turbidity have been assessed in Section 6.2.2 applying two methodologies.

The projected effects arising from turbid mine water in the dredge pond have been considered through direct comparison with the effects of the Ngahere gold dredge operations. The arguments provided in Section 6.2.2.1 are defensible, conservative and convincing, and indicate groundwater turbidity is unlikely to be impacted by the mining operation beyond a distance of 100 m from the edge of the dredge pond.

A supporting theoretical approach to total suspended solids attenuation in groundwater is presented in Section 6.2.2.2. The text and calculations are not consistent within this section. More importantly, the attenuation results are very sensitive to small changes in the filter coefficient. The information provided in this section is not convincing and has been discounted in favour of the information in the previous section.

The conclusion reached in Section 6.2.2.3, that "*it is unlikely that any significant turbidity would extend further than 40 m into the aquifer*" appears reasonable and defensible.

No requests for further information arise with respect to the information presented in Section 6.2.2.

Section 6.2.3 of the report describes the projected process plant and backfill water quality. I, Brett Sinclair, am not a mine water quality expert. The comments and requests for information provided below should therefore be taken as being related to the review of the proposed mine water management processes, rather than the environmental effects of the observed water quality.

Section 6.2.3.1 indicates six samples were prepared and tested through the use of “shake tests” to provide an indication of likely mine backfill water quality. Although this procedure is commonly used in the mining industry to evaluate potential leachate water quality from mine wastes, I am not familiar with any shortcomings or limitations that might be associated with the interpretation of the test results.

Section 6.2.3 of the report provides an initial screening assessment of the process water quality based on the results of the shake tests described above. The results indicated that processing of the ore is likely to lead to return slurry water that is elevated in dissolved aluminium dissolved chromium and dissolved copper. These findings are generally consistent with the analysis results from some of the groundwater samples obtained on site and from a surface water sample obtained from the cut through drain. In summary:

- The pH of water from the shake tests is slightly acidic but these results are consistent with the water quality in Tūwharewhare.
- The dissolved aluminium concentrations in water from the shake tests are substantially above the ANZG 99th percentile DGV value of 0.027 g/m^3. However, the water in Tūwharewhare is similarly elevated in dissolved aluminium.
- The dissolved chromium concentrations are substantially above the ANZG 99th percentile DGV value of 0.00001 g/m^3. Although groundwater and run off water from the site is also elevated in dissolved chromium, concentrations in Tūwharewhare have been below the laboratory detection limit.
- The dissolved copper concentrations in each of the processed samples are above the ANZG 99th percentile DGV value of 0.001 g/m^3. Although run off water from the site and some site groundwater is also elevated in dissolved copper, concentrations in Tūwharewhare have been below the DGV.

In summary, the key contaminants in the mine water and deposited wastes that appear to require management are dissolved copper and dissolved chromium, in addition to suspended solids.

No requests for further information arise with respect to the information presented in Section 6.2.3.1.

Section 6.2.5 of the report provides an assessment of Tūwharewhare receiving water quality based on flow and mass balance calculations.

A copy of Table 6-5 from the report is provided below. This table presents the key flow factors in the mass balance analysis for the mine. For comparison, a copy of Table 4.6 from the report is also presented below. It is not clear why the Tūwharewhare median and MALF flows are different between the two tables. The derivation of the median and MALF flows presented in the mass water balance, which are substantially higher than the corresponding rates presented earlier in the report, is unclear as these numbers do not appear to have been presented elsewhere in the report.

Table 6-5: Flow rates used for mass balance analysis

Flow path	Flow (m^3/hr)
Supply from bore	137
Water extracted with mineral sample (*Garnet con + Ilmenite con*)	16
Net discharge to mine pond (137 – 12 – 3.6)	121
Tūwharewhare MALF	637
Tūwharewhare median flow	2786
Water to tails + Tūwharewhare MALF	786
Water to tails + Tūwharewhare median flow	2908

Table 4-6: Hydrological statistics in Tūwharewhare at the Lake Outlet and Hokitika Bar sites (Whitehead & Booker, 2020)

Estimated Hydrological Statistic	Lake Outlet	Hokitika Bar
Upstream Catchment (km^2)	30.7	71.4
Mean Flow (m^3/s)	1.09	3.05
Median Flow (m^3/s)	0.774	1.512
$MALF_{7d}$ (m^3/s)	0.177	0.346
1 in 5 Year Low Flow (m^3/s)	0.106	0.197
FREQ (No. per year)	31.3 events per year	31 events per year

6. **Please provide documentation to support the Tūwharewhare median and MALF flows presented in Table 6-5. Please clarify why the flows presented in Table 6-5 are substantially higher than the flows presented in Table 4-6.**

A miscalculation was made in the units conversion during initial review. **No further questions**.

7. **Please clarify why a top-up pumping rate from the proposed bore of 137 m^3/hour is required, when the mass balance presented in Table 4-6 indicates a net positive flow into the dredge pond of 121 m^3/hour. The report states that the groundwater model indicates a loss of about 7 L/s or 25 m^3/hour to Tūwharewhare. Another 16 m^3/day is lost from site with the processed ore. These seem to be the only uncontrolled water losses from site. The flows to the infiltration trench at the southern edge of the site are controlled losses and only occur when required. Therefore, why does the top-up water flow exceed 31 m^3/day?**

Table reference is correctly Table 6-5, thank you.

The top-up bore is specifically used to supply very low turbidity water (<5 NTU). Therefore, the operation of this bore is not linked to any water balance shortfall for the site as a whole but rather to a need for water of a specified quality for ore processing purposes. Clarification accepted, thank you.

No further questions.

8. **Please adjust the outflow rates from the dredge pond to Tūwharewhare from 7 L/s to 9 L/s, as this latter value represents the maximum increase in flow to Tūwharewhare indicated by mine water management Scenario 2 (Figure 6-15).**

The apparent discrepancy arises from a difference between outflow calculation methodologies, as described in the RFI response memo (Kōmanawa 2024a). The clarification is reasonable and is accepted. The model has been updated in response to the requested change and the model results updated accordingly.

No further questions.

A check on the water quality exceedances identified in Table 6-6 identified that the dissolved chromium values are being measured against the laboratory detection limit, which is not appropriate as this is 50 times higher than the ANZG value being applied when determining other screening values for the assessment. If the ANZG value for the protection of 99% of species was applied, dissolved chromium would be consistently above this screening value, even at the defined median flow rate in Tūwharewhare.

It appears that the results from Table 6-6 are superseded by the max balance results documented in Table 6-7. The methodology used to generate the results and Table 6-7 is reasonable. However, there appear to be some inconsistencies in the calculations and results for Table 6-7.

9. **Please verify the input parameters including the MALF and median flows, the calculations, the water quality outputs, and the exceedances presented in Table 6-7.**

The median and MALF flows have been supported through the additional information provided. The information presented in Table 6-7 (Kōmanawa 2023c) is accepted.

New leachate water quality data has been presented in the Kōmanawa update report (2023c) and compared to the data presented to support the original application (Kōmanawa 2023a). The new data (Table 2-2 in Kōmanawa 2023c) indicates the water quality characteristics of the process plant slimes leachate are significantly different from those of the Run of Mine (ROM) leachate. Dissolved metals concentrations are elevated and pH is lower, when compared to the ROM leachate.

The description from the (Kōmanawa 2023a) indicates that the slimes consist of "*The fine fraction of the five ROM samples*". We have assumed that the ROM samples analysed include the fine components.

Further questions:

a) Please clarify why the slimes leachate water quality from the most recent analyses is significantly worse than the ROM leachate water quality.
   - "The cause of higher concentrations of leachable metals in the slimes samples would require detailed laboratory investigation, but the most likely cause is changes in cation exchange associated with the concentration of clay minerals within the slimes. Concentration of organic carbon may also influence chemical processes." (Kōmanawa 2025).

Thank you. **No further questions.**

b) Is there any potential for managing and storing the process plant slimes separately from the other wastes? If so, is there a potential clear and significant environmental benefit in terms of contaminant mass loads discharging off-site from managing the waste streams separately?
   - "*A recent 25 tonne bulk sample collected from the eastern area of the site recorded <1% slimes, which may be indicative of very low slimes content across the site. We cannot be sure that the bulk sample is fully representative of the broader mine area, however*." (Kōmanawa 2025).
   - "*If large pockets of fines are encountered, these will not be run through the plant (the heavy mineral concentration would be low in this material), so the fines material running through the plant will be limited to small, isolated pockets. This, together with exploration drilling findings, mean that slimes generation is expected to be low*." (Kōmanawa 2025).

- "*The minerals processing design will automatically result in good mixing of any slimes with the sand tails (there is no separate slimes output, it all comes out together), so there will be no concentration of slimes. This means that the conditions that are likely to give rise to generation of the high metals concentrations measured in the slimes shake test samples (i.e. concentration of clay minerals and organics) will not arise*." (Kōmanawa 2025).
- "*Processing tanks will need to be cleared of fines periodically. This is the key component of site operations in terms of slimes management. A management action is proposed below in the form a consent condition to ensure that these slimes are adequately mixed with tails and not deposited in the sensitive areas of the site. The Mananui Mineral Sand Project Water Management, Monitoring and Mitigation Plan will need to be updated to reflect this*". (Kōmanawa 2025).

The above assessment of the risk of concentrated pockets of slimes being deposited in sensitive areas, leading to plumes of poorer groundwater quality discharging off site is reasonable. Effectively, the process to manage this risk is to ensure the slimes are evenly distributed throughout the coarser sand tails. The objective is to ensure the mine tailings leachate is of a quality similar to the laboratory analysis results for ROM leachate water.

The incorporation of the need to effectively and evenly mix slimes wastes with the coarser tails should reasonably be able to be achieved through standard mine operation processes. Kōmanawa has also proposed consent conditions requiring effective mixing of the wastes for this reason.

No further questions.

A detailed assessment of mine water chemistry and the potential effects of contaminants on freshwater ecosystems is outside my area of expertise and outside the scope of this review. Further review of the leachate water quality assessment would require a specialist in that field.

10. **Please reassess dissolved chromium against the ANZG value for the protection of 99% of species, not against half the laboratory detection value.**

On consideration, the use of the lowest laboratory detection limit available in New Zealand as the trigger threshold for non-compliance for dissolved chromium is considered a reasonable approach.

No further questions.

Overall, it appears that dissolved aluminium, copper, chrome and nickel are at risk of non-compliance with the ANZG values in Tūwharewhare. Of these, dissolved aluminium is already elevated in Tūwharewhare the mining operation appears unlikely to significantly change the situation. The water quality effects relating to each of these parameters should be updated as a result of responding to the requests 8 and 9, above.

Section 6.2.5 of the report provides an assessment of the saline water intrusion risk resulting from development of the mine. The methodology is reasonable and the outcomes defensible. However, there was no consideration in this methodology regarding the effects of the proposed groundwater take from the top-up bore.

11. **Table 6-1 states "*The proposed activity will not result in seawater intrusion to the coastal aquifer.*" However, a supporting assessment has not been provided in Section 5.6 or elsewhere in this report. The saline water intrusion assessment documented in Section 6.2.7 of the report does not address this particular question. Please refer to Request 5 for the necessary supporting information. Please provide an assessment of saline water intrusion risks specific to the top-up bore operations, as opposed to the broader mine site.**

A saline water intrusion assessment has been presented in the RFI response memorandum (Kōmanawa 2024a). This assessment is based on a standard evaluation procedure and the minimum hydraulic conductivity from the site investigations has been applied to the calculation. This procedure and the associated results are acceptable. The results indicate that saline water intrusion is unlikely to be an issue arising from the proposed groundwater pumping.

In addition to the saline water intrusion assessment, I recommended monitoring and trigger consent condition has been provided in the memorandum (Kōmanawa 2024a). This proposed condition is focused on monitoring of water quality in the top-up water supply well. The use of a consent condition to manage the risk of potential saline water intrusion is reasonable.

No further questions.

Section 6.3 of the report documents the 3D groundwater model developed to evaluate some of the issues potentially faced by the proposed mining operation. The modelling code used for this purpose is appropriate. The layer geometry as described in the report also appears to be fit for purpose. The model domain as shown in Figure 6-6 is fit for purpose.

The hydraulic conductivity parameters used to simulate the mineral sands (Layer 0), and the underlying gravels (Layer 1) are associated with significant uncertainty as previously discussed in this review. However, the transmissivity for the combined layers would be between 1,100 m^2/day and 1,600 m^2/day, on the information presented in Table 5-12. From the information presented in Section 6.3.1.1 it appears that only the minimum K scenario from Table 6-8 falls within this range.

In terms of model hydraulic boundaries representing baseline conditions, the groundwater recharge rates applied to the model of between 1 m/year and 1.5 m/year are reasonable given the local climatic conditions and the soil type. The lateral boundaries representing the Tasman Sea and Tūwharewhare are also reasonable.

The top-up bore has been simulated using an abstraction bore boundary condition in the model, which is appropriate. The moving dredge pond has been represented by the use of injection and abstraction bores, which is an unusual application for these boundary conditions. Similarly, the infiltration trench at the southern edge of the site has been simulated using injection bores. Two general scenarios have been considered in terms of the net flows to the dredge pond:

- The first has a net recharge to the dredge pond of 34 L/s as it progresses across the entire mine site.
- The second has a net recharge to the pond of 34 L/s in areas outside the 'dredge pond water level management zone' (figure 6-10 in the report) and a net abstraction of 3 L/s inside this zone. When the mine is operating within the 'dredge pond water level management zone' there is also a recharge of 37 L/s to the infiltration trench.

In terms of the contaminant transport simulation, where mine water is introduced to the groundwater system the concentration is defined as one. The starting water concentration in the groundwater system is defined as 0 and the concentrations in all natural surface water bodies are also defined as 0. In effect, this concept is used to show the proportion of groundwater at any particular point that is derived from mine water. Absolute concentrations can then be calculated by multiplying the simulated concentration by a dredge pond water concentration that represents a particular contaminant. This methodology is defensible and reasonable, although it would potentially face issues if contaminant attenuation within the groundwater system was to be addressed.

It appears that no outcomes from this contaminant transport simulation have been utilised at any point in the water quality assessment in this report. As a minimum, it would be useful to demonstrate that the mining operation would not have a negative impact on water quality at the nearby domestic bores. The report states that water quality effects on local drinking water supplies will be avoided but also indicates that there is a risk of dissolved aluminium exceeding the drinking water aesthetic value. It is not clear from the report that the management measures applied will actually result in the risk being managed.

12. **Please provide outcomes from the contaminant transport modelling indicating the proportion of mine water reaching each of the nearby domestic bores. These outcomes should be represented in maps of the contaminant plumes and as water quality change charts for each of the domestic bores.**

The response memorandum to the RFI (Kōmanawa 2024a) indicates this question prompted further interrogation of the groundwater model, which in turn identified two issues with the original modelling. The first issue related to the simulation of dredge pond water quality. The second issue related to an inappropriate simulation of the groundwater flow divide, which should pass across the eastern side of the site.

The first issue was addressed by assigning the equivalent of 100% pond water quality to groundwater model cells intended to simulate the dredge pond. The process by which this was done is reasonable and the consequent simulation of water quality at the site has been improved.

The second issue has been addressed by adjusting the hydraulic conductivity of the subsurface materials to the west of the site within a range from 0.01 to 150 m/day. The model results indicated that applying a hydraulic conductivity of between 30 and 50 m/day to the subsurface materials west of the site generates a reasonable simulation of the groundwater divide in the appropriate position.

Kōmanawa (2024a) correctly pointed out that the extent of the mine water plume would change over time in response to changes in the exact position of the dredge pond and changes in mine water infiltration process at the southern edge of the site. Therefore, Kōmanawa provided three animations for review, representing groundwater quality outcomes from three different mine scenarios. These animations have been reviewed and the following key points identified:

- The animations represent the extent of the mine water plume in Layer 1 of the groundwater model. However, the private water supply bores are likely to be taking water from a deeper layer, which has a higher permeability. Therefore, the plumes represented in the animations are not necessarily indicative of the risk to water quality at the nearby private bores.

- The above issue is emphasised by the appearance of mine water discharges along the coast and along Tūwharewhare to the southeast of the mine site. However, there is no indication of a plume within the upper layer of the model between the mine and these discharge areas. Therefore, the mine water plume is presumably spreading within the higher permeability lower layer of the model.

Further request for information:

a) Please provide corresponding animations showing the mine water plume within the lower layer of the model.

The requested animations have been provided by Kōmanawa have been provided. The animations, which present the percentage of mine water in groundwater through the operational period of the mine, are consistent with the model outcomes documented in the report.

No further questions.

13. **Please indicate if there is a risk of water quality at any of the nearby bores being negatively impacted and the effects of the impact with respect to the water meeting drinking water quality standards at these bores.**

The projected water quality impacts on local private bores have been addressed in Section 4.1 of the Kōmanawa (2024a) report. The water quality is initially calculated in terms of percentage of mine water presenting at nearby private wells (Figure 4-1). The modelling indicates the groundwater at two private wells is likely to consist of between 12% and 14% of mine-derived water at some stage in the future.

The results of laboratory analysis of leachate water from ROM and slimes samples have been presented in Tables 2-2 and 2-3 in the Kōmanawa (2024a) report. The only analyte with measured concentrations exceeding NZDWS values was dissolved aluminium. The highest detected dissolved aluminium concentration from the leachate samples was 0.97 g/m^3 (Table 2-3). The NZDWS aesthetic standard for dissolved aluminium is 0.1 g/m^3. For comparison, Kōmanawa (2024a, Section 4.1) indicates the average background concentration of dissolved aluminium in the groundwater upgradient of the private wells is 0.025 g/m^3, which appears a reasonable interpretation.

Calculating 14% x 0.97 g/m^3 + 0.025 g/m^3 = 0.16 g/m^3, which exceeds the NZDWS aesthetic standard value. This is a conservative approach to checking the potential outcomes on water quality at the private wells, in that:

1. The next highest laboratory analysis result for dissolved aluminium of 0.46 g/m^3 would correspondingly equate to a groundwater concentration at a private well of 0.1 g/m^3, which is equivalent to the aesthetic NZDWS value.
2. Incipient rainfall as a diluting factor for the pond is not taken into account in the modelling.
3. Contaminant attenuation factors (e.g. adsorption) during transport through the groundwater system are not taken into account in the modelling.

The calculations presented above are similar to those provided by Kōmanawa (2024a, Section 4.1) and the results are higher due to more conservative assumptions built into the equations. This does not mean the Kōmanawa (2024a) calculations are incorrect or invalid.

Given the higher level of conservatism incorporated in the calculations above, the conclusion from Kōmanawa (2024a) that the "*proposed activity is therefore unlikely to cause dissolved aluminium concentrations to exceed the aesthetic drinking water limit*" is a reasonable conclusion.

The risks to water quality at the private water bores arising from the elevated turbidity and suspended solids concentrations have been addressed earlier in this review and the additional information presented in Table 2-2 of the Kōmanawa (2024a) report does not change the review conclusions.

The new leachate water quality data presented in Table 2-2 of the Kōmanawa (2024a) report shows a clear difference in pH results between the ROM samples (approximately 7.3) and the slimes samples (approximately 6.5). This outcome contrasts with the earlier results presented in Table 2-3, which indicated the pH of all samples tested returned pH values in the range from 6.1 to 6.3. No reason for the contrasting results is presented in the report and the influence this difference may have had on the other water quality results is not clear. Further review of the water quality data is outside the scope of this review and beyond the expertise of the reviewer.

Overall, the contaminant transport modelling presented indicates that the proposed mine represents a low to negligible risk to water quality at the existing private bores, with the risk being limited to the aesthetic NZDWS trigger for dissolved aluminium. Further review of the water quality data is outside the scope of this review and beyond the expertise of the reviewer.

No further questions.

The effects of the simulated mining operation on the groundwater system are documented in Section 6.3.2 of the report. The simulated groundwater drawdown and mounting effects at the identified domestic wells are summarised in Table 6-9 and Figure 6-12 of the report. The general magnitude of drawdown and mounding effects on groundwater at these domestic bores is accepted as reasonable, for both of the defined scenarios for dredge pond water management.

No requests for further information arise with respect to the information presented in Section 6.3.2.

The effects of the simulated mining operation on Tūwharewhare are documented in Section 6.3.3 of the report.

Under water management Scenario 1, the rates of stream depletion and stream augmentation are similar irrespective of the hydraulic conductivity values applied to the groundwater model layers (Table 6-10). Under this scenario, the model indicates mine operations consistently result in stream augmentation through the first seven years of operation. This is reasonable given there is a net recharge to the dredge pond of 34 L/s (3,200 m^3/day) throughout the mine life under this scenario. It is however not clear:

- Why stream depletion should occur late in the proposed mine life, given the ongoing positive net recharge to the pond.
- Why stream augmentation should not exceed 1,300 m^3/day when pond operations approach Tūwharewhare, given the net dredge pond recharge is 3,200 m^3/day.

Under water management Scenario 2, the rates of stream depletion and stream augmentation are only presented for the model incorporating the minimum hydraulic conductivity values. As previously noted, these values appear to be the closest match to the overall aquifer transmissivity of the three models tested. Additionally, the scenario one model outcomes did not differ substantially between models with different applied hydraulic conductivity values. Therefore, the results documented for mine water management Scenario 2 are accepted as representative of the likely water management outcomes.

Bearing in mind that Scenario 1 (ongoing net recharge of 34 L/s) outcomes indicated stream depletion late in the mine life, it is not clear why no stream depletion is identified under Scenario 2. As the dredge pond approaches Tūwharewhare the net flows to the pond change from 34 L/s recharge to 3 L/s abstraction under Scenario 2 but not under Scenario 1.

14. **Please clarify why there is no calculated stream depletion under Scenario 2. If there is some stream depletion, please present depletion rates and the estimated effects on stream flows under low flow conditions.**

The response to this request is difficult to understand and does not clearly address why no stream depletion arises under the Scenario 2 simulation. However, the response does indicate the difference between the two scenarios in terms of stream depletion, is a matter of exactly where the mine water, including the make-up water, is physically returned to the aquifer. i.e. How the return water is distributed between the dredge pond and the infiltration trench.

One of the two simulated scenarios has shown that management of the return water can be achieved in a manner that fully offsets potential stream depletion effects on Tūwharewhare. The results from the other simulation indicate that development of a clear and effective groundwater monitoring and management plan is required to enable the applicant to achieve the objective of no stream depletion during periods when flows in Tūwharewhare are low. Similarly, a clear and effective groundwater monitoring and management plan is required to enable the applicant to minimise potential reductions in groundwater discharges to the riparian wetlands.

In accordance with the above conclusions, the proposed Water Management, Monitoring and Mitigation plan has been reviewed later in this memorandum. The proposed conditions of consent put forward by the client have also been reviewed later in this document.

No further questions.

The effects of the simulated mining operation on the Tūwharewhare riparian wetland are documented in Section 6.3.4 of the report. The simulated changes in seepage face pressures for the wetland appear reasonable and would indicate changes that are within the normal water level ranges for Tūwharewhare. Under both mine water management scenarios, periods with increased seepage pressures and therefore flows approximately balanced the periods with decreased seepage pressures. Taking into account the uncertainty in the modelling, it is reasonable to expect that the mining operation would have an indetectable effect on water availability in the riparian wetland under either mine water management scenario.

No requests for further information arise with respect to the information presented in Section 6.3.4.

The effects of the simulated mining operation on the local groundwater gradients are documented in Section 6.3.5 of the report. The report concludes that deep mining operation will have a negligible effect on groundwater hydraulic gradients around the site. This conclusion is reasonable, especially given the mining operation will not extend below an elevation of 0 m AMSL and therefore will not affect the hydraulic conductivity of the gravel deposits beneath the site.

No requests for further information arise with respect to the information presented in Section 6.3.5.

Section 6.3.6 of the report addresses WCRC groundwater allocation policy and its implications for mine operations. Overall, the mining operation is almost net neutral in terms of the groundwater balance. The volume of groundwater lost from the site with the outgoing treated ore is negligible. The groundwater abstracted via the top up bore is returned to ground via the dredge ponds or the infiltration trench. Any discrepancy in the groundwater balance for the site as a whole is predominantly reflected in augmentation or depletion of flows in Tūwharewhare. The question of whether the proposed mining operation will be acceptable in terms of WCRC groundwater allocation policy is outside the scope of this technical review.

No requests for further information arise with respect to the information presented in Section 6.3.6.

Section 6.3.7 of the report addresses potential impacts on a DOC wetland to the south of the site. The report indicates that the wetland effectively consists of a perched water body on top of a low permeability soil layer, with no direct hydraulic connection between the perched water and the underlying groundwater system. The descriptions of the soils documented in Appendix 2 do not indicate the presence of a shallow low permeability soil horizon in this area. However, the groundwater observations recorded in Appendix 2 to the report appear to support the interpretation of the wetland being perched. It would be useful to know who undertook the field programme and recorded the observations.

15. **Please advise who undertook the field programme investigating the DOC wetland and recorded the observations documented in Appendix 2.**

    The field investigation was undertaken by Mitch Keenan, Senior Geologist at Hardie Pacific Ltd.

    Thank you. **No further questions.**

Section 6.4 of the report summarises the proposed stormwater management for the site. In effect, run-off from the operational area of the site is to be guided to the dredge pond, which is calculated to have sufficient freeboard storage capacity to accept inflows from a 1 in 100-year, 24-hour storm, when infiltration to the underlying and surrounding aquifer is taken into account. Even without taking into account stormwater infiltration, the report indicates the dredge pond retention volume is almost adequate to retain runoff from a 1 in 100-year, 24-hour storm (Table 6-12).

There is significant uncertainty with respect to infiltration rates and runoff coefficients applied to these calculations. However, the site historically had no surface water drainage system discharging directly to either the Tasman Sea or Tūwharewhare. This implies that historical rainfall events were buffered on site through groundwater storage and shallow ponding in the areas between the sand dunes. There is no reason why this stormwater management regime should not continue into the future, provided there is no capacity for runoff from the operational mine area to discharge via the artificial drainage channels to Tūwharewhare or overflow to any other area off-site.

16. **Please incorporate management measures in the site water management plan to ensure that any possible run-off from the operational or recently rehabilitated area of the site, or overflow from the dredge pond, cannot discharge directly via the artificial drainage channels to Tūwharewhare or overflow to any other area off-site.**

    This question falls within the scope of the Erosion and Sediment Control Plan for the site.

    No further questions.

Section 6.5 of the report documents the post-closure effects of the mining operation. The soil volume deficit arising from the removal of the ore from the site is to be partially accommodated through the establishment of three new wetlands along the eastern margin of the site. Additionally, the ground surface is expected to be locally lowered below the current topographic levels. The proposed post-closure topography, as presented in Figure 6-22 of the report, shows the reestablishment of a topographically high area across the eastern half of the site. Shallow collection drains are to be established around the edges of the site, delivering water to the wetlands and thence to the existing outflow drains to Tūwharewhare. This site rehabilitation concept is hydraulically reasonable and should leave the overall storm water and groundwater systems at this site relatively unchanged.

The proposed wetlands at the discharge points from the site are appropriate for suspended solids management. The report also notes that these wetlands can provide benefits in terms of total nitrogen and total phosphorus removal. However, it is not clear from the contents of the report whether nitrogen or phosphorus removal would be required to ensure receiving water quality is not negatively impacted.

No evaluation of the effects of long-term post-closure groundwater movement and contaminant transport from the rehabilitated mine site to Tūwharewhare has been presented in this report.

17. **Please provide a mass balance assessment of the effects of contaminants transported from the backfilled mine wastes on the water quality in Tūwharewhare.**

Updated modelled contaminant concentrations in Tūwharewhare are presented in Table 4-1 of the Kōmanawa (2024a) report. The projected in-stream concentrations under median and MALF conditions are accepted. The model outputs indicate the development and operation of the mine would result in undetectable or marginally detectable changes to the receiving water quality.

Modelling indicates receiving water quality may exceed the ANZG protection for 99 percent of aquatic species criteria for two contaminants: dissolved aluminium and dissolved zinc. These simulated exceedances occur because the background concentrations of these contaminants in Tūwharewhare already exceed the criteria. In both cases, the exceedance only applies during periods of low flow represented by the MALF scenario modelled. In both cases the calculated increase in concentration is small and is unlikely to be detectable. Furthermore, the calculated increases in concentration are likely to be within the range of uncertainty associated with the combined sampling procedure and laboratory analysis.

No further questions.

Overall, the hydrological impact assessment report indicates that the proposed mining operation can be implemented and subsequently closed without significant impacts to the surrounding environment. This review has identified gaps in the documentation and issues with the assessment presented in that report. The two key areas of uncertainty are:

- Whether water quality at nearby domestic water supply bores will be impacted by the mining operation; and
- To what extent the water quality in Tūwharewhare is likely to be impacted by the proposed mining operation, taking into account the questions regarding flow rates and receiving water quality raised in this memorandum.

It appears likely that the modelling work has already been done to respond to both of these concerns, or the adjustments to existing calculations can be easily undertaken. The requests for information presented in this memorandum would enable these two concerns to be addressed.

6. WATER MANAGEMENT MONITORING AND MITIGATION PLAN (KŌMANAWA 2023B) REVIEW

The draft Water Management Monitoring and Mitigation Plan (WMMP) has been reviewed, with the expectation that the plan will be completed and updated as the mine planning progresses. In general, the WMMP is appropriate for the intended purposes.

A number of aspects of the WMMP may need to be modified in line with responses to the requests for information related to the Hydrology report (Kōmanawa 2023a). These modifications predominantly relate to the effects assessment and management actions listed in Table 2. Specifically:

- The effects of possible sea water intrusion arising from the operation of the top-up bore are subject to review and monitoring may be required.

  A proposed condition of consent has been incorporated as Section 7.3.1. of the WMMP. This condition details monitoring and mitigation measures to address the detection of sea water intrusion at the top up well. The steps set out in the recommended condition provided in response to Question 11 are reasonable. However, the ultimate Step 8 closes with the need to develop a “Saline Intrusion Investigation and Response” report. There is no step requiring the implementation of the mitigation measures identified in such a report, or the steps to be taken should the mitigation measures prove unsuccessful in addressing the issue.

- Although the hydrological assessment indicates the dredge pond is capable of accepting runoff from a 1 in 100-year 24-hour storm, this does not negate the need to ensure that any possible overflow cannot simply discharge via the existing drainage systems to Tūwharewhare. Some management measures should be put in place to ensure no direct discharges of mine water to the creek can eventuate.

  It does not appear that the most recent version of the WMMP addresses this concern.

- Monitoring wells are proposed for the northwest corner of the mine site, to help manage any risk to the local drinking water supplies and in the southeastern corner of the mine site to help manage any risk to Tūwharewhare water quality. However, no monitoring wells are proposed along the eastern boundary of the mine site. Keeping in mind the long-term potential movement of groundwater from the site to Tūwharewhare along the entire eastern boundary of the site, it is appropriate that additional monitoring wells should be installed in this area.

  Two additional monitoring wells have been recommended for installation at the southeastern corner of the site, between the infiltration trench and Tūwharewhare. This is a reasonable step to monitor the effects of recharge via the trench on Tūwharewhare. However, no monitoring wells have been recommended to provide advance detection of contaminant movement in the groundwater between the dredge pond and Tūwharewhare.

It is recognised that the testing of ore samples has indicated that the leaching of processed ore will not result in mine water quality exceeding New Zealand drinking water thresholds for dissolved parameters. However, it would be appropriate to monitor the wells proposed at the northwestern corner of the site for dissolved metals to confirm that the off-site groundwater concentrations in this direction are indeed acceptable under the New Zealand drinking water standards.

> Dissolved metals have been incorporated to the monitoring suite for the monitoring wells located between the site and the private bores. Consent threshold criteria have been provided for water quality in the northwestern monitoring wells (piezometers). These criteria, presented in Table 7 of the WMMP relate to turbidity and dissolved aluminium, are considered reasonable.

It is important to ensure that the laboratory detection limits for the dissolved metals listed in the monitoring suite are appropriate for monitoring of ANZG criteria for the protection of 99% of aquatic species.

> Laboratory analysis methods available in New Zealand may not be able to achieve this objective. Specifically, this issue applies to the detection of dissolved chromium. The applicant is proposing to take the best practical steps to detect contaminant discharges. This is accepted as a reasonable approach.

Further comments to the version of the WMMP provided for review are provided separately on a marked-up version of the plan.

7. EROSION AND SEDIMENT CONTROL PLAN (WMS 2023B) REVIEW

The erosion and sediment control plan (ESCP) provided by WMS (2023b) provide sufficient information to demonstrate that the applicant has a reasonable methodology for managing erosion risks and risks of suspended settlement losses to surrounding waterways.

One item that does appear in this plan is the concept of a temporary dams and associated ponds to be installed on the artificial drainage channels leading eastward from the mine site to Tūwharewhare. These ponds are presumably to be installed as sediment control measures while the dredge pond progresses along the eastern edge of the proposed mine site and crosses the drainage channel. I could not find mention of these temporary dams and ponds in any of the other technical reports reviewed. It appears that these ponds and dams are to be constructed outside the area defined as being subject to disturbance by the proposed mining operation.

18. **Please clarify the objective and period of use for the temporary dams and associated ponds shown in the conceptual mine plan images on the final page of the ESCP. Are these ponds outside the area of disturbance defined for the proposed mine in the AEE and the WMMP?**

    An updated ECSP concept map has been provided by the applicant. In this updated map the off-site ponds are no longer present and the water management facilities are all on-site.

    No further questions.

8. DRAFT CONDITIONS OF CONSENT (WMSC 2024A) REVIEW

Comments to the draft conditions of consent are provided separately on a marked-up version of the draft.

Yours Sincerely

Brett Sinclair
Senior Principal Hydrogeologist
WALLBRIDGE GILBERT AZTEC

APPENDIX A MANANUI CONSENT BRIEF MAP

APPENDIX A
MANANUI CONSENT MAPS

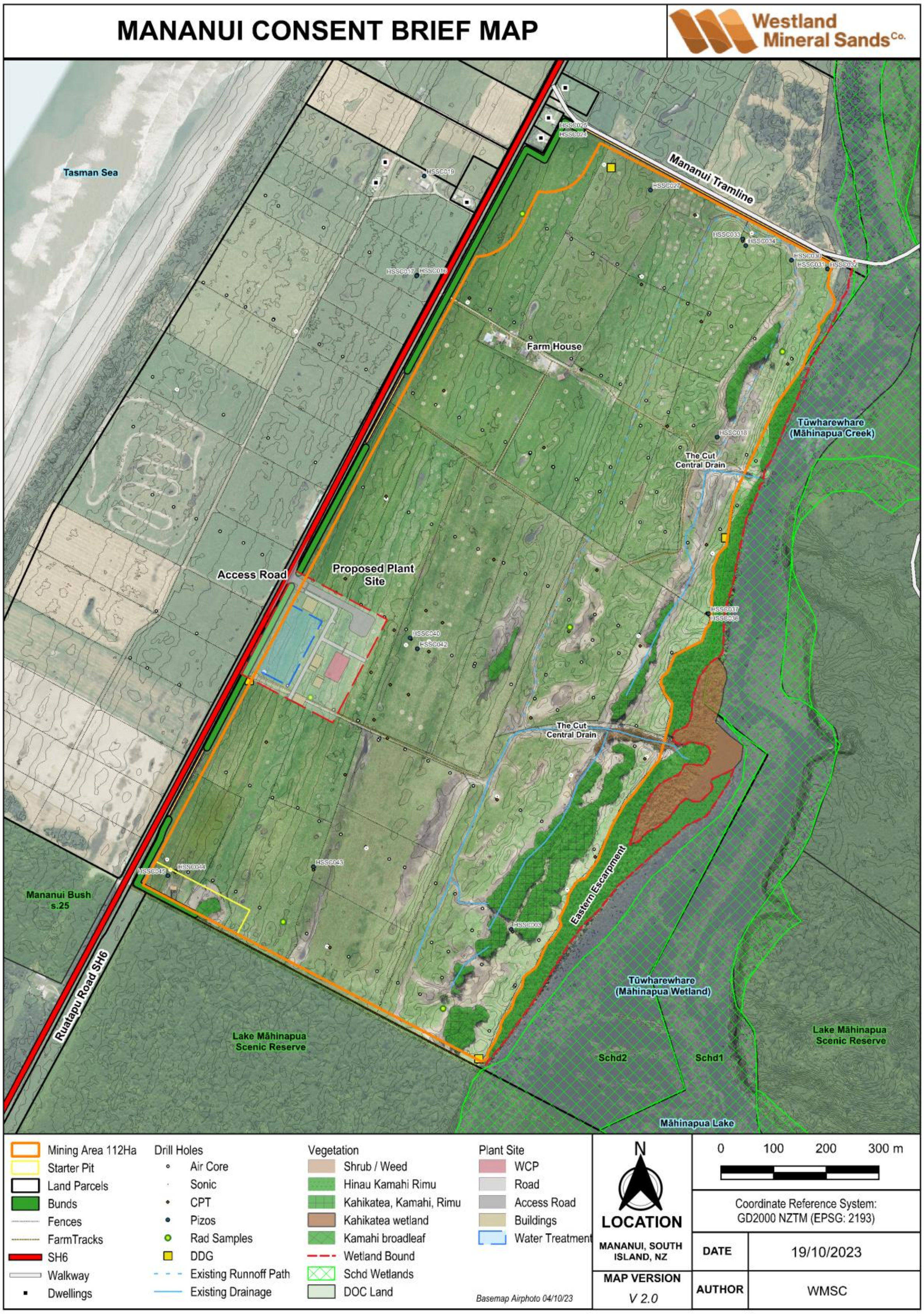

Figure A1: Mananui Consent Brief Map

Figure A2: Mananui Consent Map