

Technical Review

To:	Alexandra Smith	Date:	21/05/2025
Authority:	Environment Southland	Ref:	24116_2D
Consent:	Waikaka Gold Mines LTD		
From	Role in Audit	Internal Reviewer	
Alexandra Badenhop	S92 Groundwater and AMD Review	Simon Bloomberg	

This memo follows from our original technical review of the groundwater and acid mine drainage application information dated 29/11/2024. Additional information was provided 27th January, 2025 in response to an s92 request for information, and further responses to my draft response on 7 May 2025.

My overall impressions have not altered from my original assessment, and I have included some of these key points below:

For an application of this scale, with this level of effects, it is reasonable to expect further work to have been completed to conceptualise the site, including continuous water level monitoring in groundwater monitoring bores around the site and in close proximity to Waikaka Stream.

Connectivity between groundwater and surface water has not been investigated. The assessment assumes that Waikaka Stream is a sink for groundwater, however it is more likely to be both gaining and losing throughout the affected reaches. There is currently an upward vertical hydraulic gradient. It is unclear what the effects of reversing this gradient and depressurising the confined aquifers will be.

Minimal groundwater quality data for a very limited range of parameters has been provided without any discussion of sampling protocols, locations, depths, times and no measurement of field parameters. It is therefore very difficult to determine whether

this data is representative of current groundwater and stream water quality. Sampling methodology can significantly impact the water quality of samples.

In general, the groundwater report seems to have been completed without checking for consistency with the finalised mining methodology, geotechnical report or Acid Mine drainage report.

Without seeing the proposed rehabilitation plan within the application, and without improved site conceptualisation, it is difficult to assess what the long-term effects on Waikaka Stream will be. The entire 3-layer aquifer system will be homogenised by the works to the base of the pit, which will result in no areas of greater transmissivity through the profile.

The AEE by Town Planning group states that the Waikaka Stream diversion will not be lined in order to replicate the natural conditions of shallow groundwater losses, however these surface water-groundwater interactions have not been investigated.

I have provided a summary table of the questions asked and my assessment of the response to my questions below.

Question	Response assessment
1. Given that the groundwater abstracted will be primarily returned to the Waikaka Stream, with significant delay and a significant distance from the take, and that at least 10% of water will be lost in processing, can you please demonstrate why the take should be considered non-consumptive?	Definition of non-consumptive will be required from a planning perspective. Given that most of the water will be abstracted from deeper levels, it is unlikely that it would have discharged directly to Waikaka Stream in this location and the ultimate receptor is unknown. It therefore cannot be considered non-consumptive. It is agreed that the AEE accounts for non-consumptive take
2. The naming of observation wells, pump test sites and pumping test data is difficult to follow and doesn't appear to be consistent (or exclusive) and there are no clear maps of the pumping test setups, or clear tables that summarise each pumping test. There are no summaries of the bores present, their screen depths, and the lithology they are targeting. Can you please provide a clear summary of all of the available data, and their corresponding appendices? The two bore logs provided for those called 'Main bores' have a maximum depth of 22 m.b.g, and none of the monitoring piezometer logs seem to be any deeper than this. Given that the maximum depth of excavation is to be 50 m, this data is not adequate to conceptualise the site. The data provided in the Aquafirma report is also poorly documented.	Additional work has been completed to summarise and understand the information provided. There are no screen depths provided for the piezometers or construction details for the pumping bores for any of the Aquafirma tests in the Excel spreadsheets provided or WK logs provided, however the Aquafirma report (Section 2.3.1) states that the screened intervals were no more than 2 m, which is inconsistent with the additional information regarding screened intervals provided in Point 3 of the s92 response. This would influence the pumping test interpretation in Aqtesolv. The assumption of the saturated thickness of 10 m used in the pumping test analysis is not well justified from the available information. Each of the tests have been of short duration (24 hours) and have only tested the response of the lower layer of basal wash, not the entire stratigraphy. Given that there will be an open pit, this seems to be an oversight. The connectivity of the lower layer with the upper layers will be created by the open pit, regardless of the overlying stratigraphy. Only one test was completed at an assumed depth of (37 m.b.g) at the northern end of the site No testing/monitoring has been completed on the true left bank of the Waikaka River. Minimum aquifer test requirements for a groundwater take require pumping at the proposed maximum rate. It is acknowledged that this cannot be achieved without the construction of the mine pit.

Question	Response assessment
3. Dewatering calculations are presented for an initial mine pit of 100 m x 50 m pit. This is not consistent with the Mining Methodology report (Attachment H) that anticipates a much larger pit (170 x 100 m) at the pit base. Can you please update calculations accordingly?	Provided explanations are adequate.
4. Calculation of peak dewatering rates seems to be based on an equivalent radius of the established pit (Table 4.2). However, the entire length of the pit will need to be dewatered (500 m). Can you please explain how this calculation allows for dewatering of the entire pit, or alternatively update the calculations to ensure dewatering of the entire pit?	Provided explanations are adequate.
5. The mining methodology assumes that stormwater will be diverted into the mining pit from across the site. Can you please confirm whether pumping and discharge rates account for this?	The response says stormwater will not be diverted into the mining pit.
6. Please provide continuous water level logging data for nested piezometers targeting the different aquifer levels within 50 m of the stream in conjunction with Waikaka Stream water level monitoring to assess the relationship with the stream, at both ends and central to the proposed works. Please also review the water level data that has been collected by Waikaka Gold from their existing monitoring sites and update the assessment accordingly.	

Question	Response assessment
7. Please provide measures of streambed conductance of Waikaka Stream to improve the understanding of the hydrogeological connection between Waikaka Stream and the aquifers.	For an application of this scale, with this level of effects, it is reasonable to expect further investigations to have been completed to conceptualise the site, including continuous water level monitoring in groundwater monitoring bores around the site and in close proximity to Waikaka Stream. No investigations have been completed on the true left side of Waikaka Stream. Connectivity between groundwater and surface water has not been investigated. The assessment assumes that Waikaka Stream is a sink for groundwater, however it is more likely to be both gaining and losing throughout the affected reaches. There is currently an upward vertical hydraulic gradient. It is unclear what the effects of reversing this gradient and depressurising the confined aquifers will be. To date, the s92 RFI responses only considers the need for dewatering and stream depletion calculations from the perspective of dewatering and discharge, but not the overall environmental impacts of diverting a river, destroying the streambed, homogenising the aquifer and then restoring the river. The groundwater effect considerations are far greater than that of a standard groundwater take. The AEE by Town Planning group states that the Waikaka Stream diversion will not be lined in order to replicate the natural conditions of shallow groundwater losses, however these have not been investigated at all. Rehabilitation of the stream requires a deeper understanding of surface water-groundwater dynamics.
8. Please provide actual pumping data from the L&M operations if available and assess the significance of this information relative to the actual mining operations that occurred.	No additional validated information provided

Question	Response assessment
9. The geological model provided by T & T (2022) in their geotechnical assessment (Attachment J) is very different to that provided within the groundwater report. Please reconcile the data provided.	To demonstrate the validity of this discussion, it would be helpful to provide a clear comparison of the models and sensitivity analysis with respect to the differences. The mining methodology report also states that the Waikaka Quartz Gravels average 3 m thick. This is in contrast to the description on p6 of the gravels being 10 m thick, which was the saturated thickness value used for the pumping test analysis. This difference will impact on the analysis of aquifer parameters, and hence assessment of effects.
10. When confined layers are depressurised, storage comes from gravity drainage, how will this alter flows into the pit?	Response is adequate.
11. Stream depletion calculations were completed assuming that the mine pit would be at least 50 m from the stream, however the mining methodology states that the buffer will be 30 m. The assessment states that the physical site data shows that the stream connection is poor, however this has not been justified with the data, and also is at odds with the rehabilitation strategy suggested (which states that the new channel will be in complete connection with sediments). The assessment is also based on a pumping rate of 8.1 L/s. It is unclear whether this assessment accounts for the full dimensions of the mine pit at the surface (which will be much larger than the pit base due to the required battering slopes). After stream diversions have occurred and stream lengths have been reinstated, it is expected that streambed conductance will be greatly altered, but mining will still continue. What effect will this have on stream depletion?	The response states that "Additionally, the same materials (both for stream bed and immediate adjacent sediments), are proposed to be utilised to form a similar connection to groundwater that pre-existed." As there have not been any investigations regarding groundwater - surface water interactions, it is unclear how this can be achieved. Assumptions are based on limited water level measurement and do not account for seasonal variation in dynamics. Testing has focussed on the basal wash and demonstrating a lack of connection with upper layers, which will change due to mining.

Question	Response assessment
12. Please provide adequate assessment of groundwater quality in terms of water quality sampling of each of the aquifers including documentation of sampling protocols, locations, depths, times and measurement of field parameters. Please assess groundwater quality for the full range of contaminants that may be expected in this environment (MWM have identified Al, As, Cd, Cr, Co, Cu, Pb, Mn, Ni, Se, and Zn as contaminants of concern).	No further information provided. The information previously provided was not considered adequate to provide an assessment of groundwater quality across the site, hence the request. Without adequate documentation, sampling cannot be assumed to have followed standard methodologies. MWM had recommended that further work be undertaken to understand effects to water quality "based on the conceptual site model and flow rates from various materials and mine domains. The data indicates the identified contaminants (from the column leaching tests) should be analysed as part of any monitoring programme including baseline studies and future potential project effects." The water quality data provided two samples from a pump bore and two from a piezometer during 2021 and 2022. It is not clear which bore or piezometer was sampled. Sampling protocols used when sampling groundwater can greatly affect sampling results. Further, samples were not analysed for all of the parameters recommended by MWM.