**Before the Independent Hearing Panel**

| | |
|---|---|
| **In the Matter** | of the Resource Management Act 1991 (**RMA**) |
| **And** | |
| **In the Matter** | of an application to the Gore District Council and Environment Southland for resource consents to establish and operate a gold mining activity near 972 Waikaka Road, Chatton North, Southland |
| **Reference** | APP-20242608 (Environment Southland)<br>LU 24035 (Gore District Council) |

---

**Evidence of Thomas Brendan Heller on behalf Waikaka Gold Mines Limited**

**Groundwater Take and Discharge (Hydrogeology and Geochemistry)**

**Dated 17 November 2025**

---

## Introduction

1. My full name is Thomas Brendan Heller and I am a Director of Environmental Associates Limited, an environmental consultancy based in Dunedin.

2. I hold the qualifications of New Zealand Certificate in Engineering (Civil) and a National Diploma of Science majoring in surface water and groundwater resources from the Otago Polytechnic, Central Institute of Technology, and the New Zealand Qualifications Authority. I hold a Certificate in Management from the New Zealand Institute of Management and a Master's Degree in Environmental Science completed with first class honours from the University of Otago.

3. I have over 40 years' experience working in surface water and groundwater resource evaluation. A considerable amount of that time has been spent on hydro-geologic and water quality assessment relating to water allocation and land use issues. I have also been involved with technical aspects of groundwater and surface water policy development for the Regional Plan: Water for Otago, the Regional Freshwater Plan for Southland and the Land and Water Regional Plan for Canterbury.

4. I have been instructed by Waikaka Gold Mines Limited (the "**Applicant or WGML**") to provide independent technical assessment/evidence of its proposed mine dewatering and discharge activities and the associated effects upon groundwater and surface waters in relation to their application for resource consents from the Gore District Council ("**GDC**") and Environment Southland ("**ES**").

5. I am familiar with the WGML Waikaka Stream valley site, having been involved with more recent aquifer test site selection, groundwater quality site sampling and overall site appreciation. Additionally, the reporting work undertaken by the previous mining company (L and M Mining), along with the more recent test drilling undertaken by WGML, has provided a very robust picture of the sub-surface environment and hydraulic relationship to surface water features.

6. Similar mine dewatering and discharge activities (to that of WGML), that I have been involved with include the L & M Earnscleugh project where I was the Otago Regional Council hydrogeological AEE auditor and technical expert for the joint regional and district council hearing at Alexandra. I was also employed by Waikaia Gold Limited as hydrogeologist in assessment and presentation of their required dewatering proposals and associated environmental effects, to a joint regional and district council hearing at Invercargill. More recently I have provided technical assessment for the Kokiri Lime mine dewatering proposal at Roxburgh, and Hawkeswood Mining Limited alluvial mine dewatering (and discharge) at Millers Flat, both authorised by joint regional and district council hearings at Alexandra and Millers Flat respectively. I have also been involved with some smaller mining operations in Central Otago and Southland, in provision of groundwater and discharge technical assessments accordingly.

7. Although this is not a hearing before the Environment Court, I record that I have read and agree to and abide by the Environment Court's Code of Conduct for Expert Witnesses as specified in the Environment Court's Practice Note 2023. This evidence is within my area of expertise, except where I state that I rely upon the evidence of other expert witnesses as presented to this hearing. I have not omitted to consider any material facts known to me that might alter or detract from the opinions expressed.

## Evidence Preparation

8. In preparing this evidence I have focussed on the following documents:

   a. Waikaka Gold Mines Limited – Resource Consent Application and Assessment of Effects on the Environment (the WGML application), prepared by Town Planning Group (2024). This includes the supporting Groundwater Take and Discharge Technical Report by Environmental Associates Limited (2024) and associated reference documents, and the R J Hall & Associates River Engineering Report (2024) and Preliminary Site Investigation Report by Geosciences Limited (2022).

b. Consent Application Technical review documents and correspondence prepared in response and presented to ES.

c. The relevant submissions received by ES in relation to the WGML application.

d. The ES section 42A report and corresponding Review Evidence of Ms Alexandra Badenhop, and

e. WGML hearing evidence relating to planning, mine development and operation, and including management and control measures that are proposed to be implemented

## Scope of Evidence

9. This evidence will address the following:

   a. The mining proposal brief in the context of the required site dewatering, discharge and other related water management activities associated with the mine.

   b. A summary of the nature of groundwater (and surface water) at the site.

   c. An overview of the effects associated with mine dewatering.

   d. An overview of the effects associated with discharge of mine dewatering water to land/water.

   e. Discussion of items in relation to stream diversions and re-instatement that are important in maintaining stream-groundwater continuity and stream flow.

   f. Discussion of proposed conditions of the water permit to take groundwater and discharge consent to discharge water to land/water.

   g. Relevant matters, and where there are any outstanding aspects, arising from ES recommendations as outlined in the staff s42A report and associated review evidence.

h. Response to groundwater (related surface water), and discharge issues raised by submitters, and

i. The main conclusions of this evidence.

10. For brevity, I do not repeat matters already adequately addressed in the section 42A report. Similarly, I will cross reference the contents of the groundwater and discharge technical report, which formed part of the application for consent and/or responses to requests for further information where appropriate, rather than repeating it within this evidence.

## Overview and Executive Summary

11. The existing environment and scope and scale of the proposed WGML mine dewatering and discharge to land/water activities, inclusive of the type and scale of effects, do not appear to be in overall disagreement between ES and the applicant. However, there were some aspects of the WGML proposal that still remained unclear to the s42A Report writer. Every effort has been made to provide further information (as requested) to reasonably satisfy ES with respect to the WGML proposal.

12. The proposed groundwater take and discharge to land/water activities for mine dewatering and management purposes are able to be undertaken in conjunction with the proffered conditions of resource consents (which include appropriate monitoring, compliance reporting and mitigation measures), without causing any more than a minor effect upon the receiving environment in all cases.

13. The key potentially measureable effects upon the environment of the WGML mining proposal are summarised as follows:

a. Possible water-well level reductions which can be mitigated by provision of a temporary alternate water supply option by WGML. Although any well yield failure is most unlikely to eventuate;

b. A small amount of stream depletion of the Waikaka Stream which will be more than offset by the discharge of mine dewatering water to the stream; and

c. An introduction of a small amount of sediment and metal/semi-metal parameters with the discharge water to Waikaka Stream. Although, upon suitable mixing with the stream flow, the effect will be within the ES lowland hard bed and other appropriately identified water quality limits and likely not measureable.

14. There is no indication from the groundwater quality monitoring data for the deep confined aquifer (which includes the wash layer), that there is any significant potential for increased concentrations of metals or semi-metals within the groundwater discharge to Waikaka Stream, from acid forming and/or oxidation processes/conditions. Typically, the concentrations of applicable parameters are very low and are all within NZ Drinking Water Standards. Dr Paul Weber provides additional specific evidence to address potential for any Acid and Metalliferous Drainage at the WGML site.

15. From a groundwater-surface water interaction perspective any Waikaka Stream diversion channels (and re-instated channels), are able to be constructed so that hydraulically, any potential for stream leakage and flow loss is mitigated. This is otherwise addressed in evidence of Mr Ramon Strong for Waikaka Stream diversions and original channel re-instatement.

16. There is no evidence to suggest that the proposed mine pit dewatering will lead to any aquifer or aquitard compression, resulting in loss of storage and potential subsidence of property and around buildings.

## Assessment of Effects

17. This section of evidence provides the decision panel with a background to the requested groundwater take (for mine dewatering) and discharge of mine dewatering water to land/water activities. It also provides a focus on any specific associated environmental effects of undertaking those activities. Additionally, the evidence provides a specific focus on any

(significant) outstanding matters that may be required to be resolved for the WGML proposal.

## Mining (groundwater take and discharge) Proposal

18. The proposed WGML groundwater take is solely for mine dewatering and mine pond water level management purposes. The abstracted water is proposed to be discharged to land whereby after retention and treatment facility, the abstracted water will discharge to the Waikaka Stream.

19. It is proposed to fully dewater the active mine pit to below the resource “wash” layer which is located at approximately from 20 m to 50 m below land surface. This will be undertaken progressively via a series of pumps and internal drains. Whilst the requested maximum rate and volumes of mine dewatering water (including any storm water contribution from the immediate area of the mine), are not in contention, the typical or nominal rate of dewatering (groundwater abstraction), is assessed to be in the range of 21.5 L/s to 34.7 L/s depending on location and status of the mine.

20. The requested maximum rate and volumes of groundwater take to maintain dewatering of the mine pit area have been based on steady state dewatering methodology, rather than periodic peak rate pumping, which provides for better facility to mitigate any effects of the discharge of that water, which is further discussed below.

21. Monitoring of the groundwater take (and discharge), rates and volumes will be with a continuous logging water meter (and data logger), appropriately located within the pipe infrastructure at prior to any treatment facility. There are effectively no measureable losses of the discharge water as it receives treatment and then discharges to the Waikaka Stream. Therefore, in my opinion one meter should adequately suffice for both activities.

22. The requested groundwater take for mine dewatering purposes, does not at any time, provide for an increase to any associated groundwater levels for the unconfined water table aquifer or deeper confined aquifers. The abstraction provides for the complete opposite effect, which is a transient

and temporary aquifer head or water level reduction, and of which is specific to each aquifer occurrence (as discussed further below).

23. The abstracted mine pit water (groundwater) is then pumped or conveyed to surface settling pond or settlement areas, which includes for volumetric storage and gravel filtration of the groundwater. Flocculent may also be used to provide treatment and polishing of the discharge water prior to discharge to the Waikaka Stream.

24. The above activities (dewatering take and discharge) are standard industry practise within many mining situations similar to that of the WGML proposal, and the effects are well understood.

## Groundwater Environment

25. Hydro-geology at the WGML site has been characterised by many L&M Mining Limited and WGML lithologic drill holes spread across the site, which provide very good control upon depth and occurrence of sub-surface strata.

26. Additionally, multiple aquifer tests which include dedicated pumping wells and associated monitoring piezometers, have been performed at the WGML site, which included three L and M Mining Limited tests and more recently, two additional WGML tests.

27. To assist the Commissioners I have prepared a simplified hydro-geologic section (**Appendix A**), detailing typical sub-surface strata occurrence at the proposed WGML site in relation to land surface level and the Waikaka Stream.

28. Whilst there is a more detailed appreciation of sub-surface strata occurrence given in the Application Groundwater Technical Report, broadly, there are three aquifers present at the WGML site, which are:

    a. A shallow thin upper water table aquifer consisting of silty gravels and in some cases, old mine tailings which are typically deposited above the water table.

b. A moderately deep discontinuous and relatively thin intermediate confined aquifer consisting of silty-clay gravels, and

c. The deep confined aquifer of increased thickness consisting of more permeable sandy/silty quartz gravels and which contains the target "wash" zone for resource recovery.

29. As shown on **Appendix A**, the intervening strata between the deep confined aquifer, the intermediate confined aquifer, and the water table aquifer, consists of low permeability clays, which effectively do not transmit water. The deep confined aquifer also rests above impermeable Tertiary basement materials.

30. Aquifer testing at the site has provided very good consistency in resulting aquifer hydraulic parameters for the main deep confined aquifer, which contains the target "wash" zone for resource recovery.

31. The other aquifers encountered at the test locations (namely the upper water table aquifer and the intermediate confined aquifer), had very small saturated thicknesses and were unable to be pumped (they essentially could not yield any water for conventional aquifer testing purposes). Although, piezometers were placed to ascertain any hydraulic connection between aquifers.

32. The aquifer testing/investigation has confirmed very low aquifer water yield from the upper water table aquifer and the intermediate confined aquifer, although a low to moderate yield (of a few litres per second), was obtained from the deep confined aquifer. The main contribution of water for the proposed WGML mine pit dewatering proposal is sourced from the deep confined aquifer (drainage). This is reflected in the requested (conservative) rate and volumes of groundwater abstraction for the proposed mining activity.

33. Along with the large amount of drill hole data, the aquifer test sites for both L and M Mining Limited and WGML, confirms that there is no connection of the deep confined aquifer and/or the intermediate confined aquifer, to each other, and to the upper water table aquifer. There is absolutely no

data or information that suggests otherwise. This is agreed by the s42A report writer(s).

34. Groundwater quality for the deep confined aquifer or “wash” layer (for the majority of the requested groundwater abstraction for mine dewatering), has been characterised from water quality sampling and analysis undertaken by the previous mining company (L and M Mining Limited), and WGML.

35. The groundwater quality monitoring consisted of 3 samples taken over the period of January 1997 to March 1998 (for L and M Mining Limited), and 4 samples taken over the period of December 2021 to September 2025 (by WGML).

36. For both the L and M Mining Limited and WGML groundwater quality sampling, all parameter results were relatively consistent over time (particularly for metals and semi-metals concentrations), and of which showed that potential contaminant concentrations were all invariably low (refer to the Groundwater Quality Table at Section 2.7 in the L and M Mining Report of Aquafirma, and Table 5.3 in the Groundwater Take and Discharge Technical Report).

37. The groundwater quality results also showed that the mine dewatering water would be generally within NZ Drinking Water Standards, and that apart from the suspended sediment and incidental coliforms generated from within the mine pit, the water could technically be suitable for human consumption.

38. Whilst Dr Paul Weber will provide evidence specific to the study of potential acid and metalliferous drainage for the WGML proposal, the <u>groundwater quality results</u> for metals and semi-metals concentrations, confirm that there is limited potential for the groundwater take and associated discharge to be modified by changes in pH and/or oxidation state.

39. Further discussion of the mine dewatering water discharge quality is provided below in evidence.

## Surface Water Environment

40. Waikaka Stream bisects the proposed WGML mining area, which is a relatively modest waterway having a 7-day mean annual low flow (MALF) of approximately 277 L/s and a median flow of approximately 1,070 L/s occurring at the WGML site.

41. The stream water levels (and flow) are congruent with the surrounding unconfined water table levels. That is, over the length of reach for Waikaka Stream that occurs within the WGML site, stream water levels reflect the local water table level. On this basis, it is conservatively expected that the stream is an overall sink for groundwater, and that there is unlikely to be any sub-reaches of the stream that lose water to the adjacent water table aquifer.

42. The above hydro-geologic profile encountered at the WGML site is significantly different to that of a typical alluvial gold mining operation whereby the entire depth of cut for the mine pit and any associated pond, would be in close or direct connection with any adjacent surface waterway. In this instance (for the proposed WGML mining site), there will continue to be no direct (or indirect) connection of the intermediate and lower confined aquifer occurrences to surface waters, with a very limited stream depletion effect upon the Waikaka Stream with excavation through the upper water table aquifer.

43. The surface water quality of Waikaka Stream is typical of the ES lowland hard bed waterway classification, with low to moderate nutrient concentrations, periodically elevated bacterial counts (typically from rainfall events), and generally low although sometimes moderate metals concentrations (refer to Table 5.3 on Page 32 of the Groundwater Take and Discharge Technical Report). This would otherwise not be unexpected for this type of surface waterbody.

## Effects of Groundwater Abstraction for Mine Dewatering

44. The potential effects of the proposed WGML mine pit pond groundwater abstraction (for water table and other aquifer head lowering and mine pond level management), are as follows:

    a. Temporary and transient reduction of operational water levels in any existing wells located in proximity of the WGML mine site with lowering of water table levels and confined aquifer head.

    b. Temporary and transient stream flow depletion of the Waikaka Stream with groundwater drainage resulting from excavation through the upper water table aquifer for the mine pit extent, and

    c. Long term effect upon aquifer integrity with excavation and replacement of materials.

**Impact upon wells**

45. The potential impact of the WGML mine dewatering proposal upon wells located in proximity of the mine site, has been conservatively assessed on the basis of maximum required level reduction and associated groundwater abstraction for the lifespan and makeup of the mine pit. The Groundwater Technical Report provides further detail of this assessment which is consistent with ES Land and Water Plan Groundwater Appendix requirements, and of which shall not be repeated within this evidence.

46. From the above assessment, there were two shallow water table aquifer wells within a radius of 554 m of the extent of the mine site that could be affected by more than a 0.1 m drawdown effect. There were no wells identified in the intermediate confined aquifer to a radius of 1,539 m from the extent of the mine site that may be affected by more than a 3.5 m lowering of head. For the deep confined aquifer layer, 11 wells were identified within a radius of 6,908 m from the mine site extent that could incur a potential lowering of head of in excess of 5.0 m. The baseline head displacement criteria was calculated consistent with ES Land and Water Plan Groundwater Appendix requirements.

47. The drawdown analysis was undertaken on a very conservative basis, and particularly when considering the significant potential radius of displacement associated with the deep confined aquifer.

48. Irrespective of the conservative drawdown assessment undertaken, any significant head reduction in proximal wells causing compromise of water supply would be most unlikely.

49. However, any alternative water supply arrangements (if required) will be assessed on the basis of advanced (well) water level monitoring in conjunction with WGML dewatering levels and flows. This will provide a good indication of wells that may actually be affected by the dewatering, to what extent that effect may manifest, and if the existing water supply is likely to be compromised and requires an alternative option.

50. The proposed conditions of consent for alternative water supply arrangements and monitoring, identify previously authorised common practice in relation to provision of continuity of water supply.

**Stream depletion**

51. The transient and temporary lowering of the upper water table aquifer with excavation and water table drainage to the mine pit, will likely give rise to some stream depletion effect upon Waikaka Stream (flow). Although, overall with the discharge of the mine pit dewatering water to Waikaka Stream, there will be an overall temporary net gain of flow in the stream over the lifetime of the mine.

52. Updated stream depletion calculations were provided to ES in relation to a change of minimum operational buffer zone distance from the mine pit to Waikaka Stream from 50 m to 30 m, and further assessment based on the Jenkins model which does not require input of a stream bed conductance value (for comparison to the Hunt model approach). The conservative calculations showed that the WGML mine pit extent, potentially produces a stream depletion effect upon the adjacent Waikaka Stream of between 1.5 L/s to 3.8 L/s. This water would drain into the mine pit and be pumped

(discharged) along with other groundwater contribution from the confined aquifers, to the Waikaka Stream.

53. The above stream depletion calculations are further discussed in the Groundwater Technical Report and both ES information responses, and have been undertaken in accordance with the criteria specified with the Groundwater Appendix of the Land and Water Plan for Southland.

54. Whilst the return of water to Waikaka Stream provides for an overall gain in flow, for the stream reach adjacent to the WGML mine site, it is plausible that a transient and temporary effect of stream depletion (of up to 3.8 L/s), may develop within that reach nearest the dewatering abstraction.

55. However, the temporary stream depletion effect is only approximately 1.4% of stream flow at the 7-day mean annual low flow and will be otherwise more than offset by the returned mine pit discharge water.

**Aquifer Integrity**

56. Whilst the previously reported effects of the WGML mining proposal upon aquifer integrity (within the Groundwater Technical Report), are not fully agreed between the applicant and ES, sufficient mitigation measures are proposed to minimise any possible effect of that nature.

57. For the back-fill materials replacement (for the transient mine pit void), similar clay strata will be used to recreate the low permeability zone between any lower confined aquifers and the water table aquifer. Previously excavated upper water table aquifer gravels and silts, including old tailings where they exist, will be reformed above the clay strata in a similar manner to that which currently exists. This is normal practice for mining activities of this nature. A condition of the land use consent could accommodate the above mitigation. However, this methodology would be better suited within the Environmental Management Plan.

58. The final mine pit void (open pond) will reach a steady state water level consistent with the existing deeper confined aquifer head, and local water

table level. This will provide for continuity in relation to attaining pre-mining aquifer water levels across the WGML site.

**Effects of Discharge of Groundwater to Land/Water**

59. In summary, the identified effect of discharge of the WGML mine pit dewatering water to land/water (Waikaka Stream), is a temporary and minor amount of turbidity/sediment and metals/semi-metals concentrations, which beyond the 60 m mixing zone, would be fully compliant with ES water quality standards for lowland hard bed waterways and other applicable standards relating to protection of instream ecology.

60. Any mine pit pond sediment is a result of excavation and mine operation within the pit extents. Whilst there are no other significant contaminants associated with the mining process or that are associated with the mine pond water, additional parameters are proposed to be monitored, which are further discussed below in evidence.

61. Additionally, there will be minimal seepage to the water table aquifer from sediment buffering ponds due to low permeability materials being used for pond creation, and the mine pit itself provides a positive head displacement toward the mine, which ensures that there is no migration of mine pond water into the aquifer(s).

62. To easily assess groundwater (discharge) quality, I have prepared a summary table of all deep aquifer, average sampling results over time from the WGML deep monitoring piezometer (**Appendix B**). There is very good consistency with sampling of the deep aquifer over time, which is also consistent with the previous groundwater quality results obtained by L&M Mining Limited (for the same deeper/older aquifer/groundwater).

63. Referring to **Appendix B**, groundwater quality result reporting criteria is identified and noted below the summary table. The reported results are compared to NZ Drinking Water Standards, ES lowland hard bed stream limits (where available), measured concentrations or counts within Waikaka Stream water quality (where information is available), and in comparison to potential for acidification and/or oxidation recognising any

increased contaminant concentrations and favourable eH/pH conditions (eH = oxidation state).

64. The outcome from the groundwater quality data (**Appendix B**), is that for the extensive suite of parameters measured, all but four parameters (Turbidity, Arsenic, Iron and *E.coli*), comply with NZ Drinking Water Standards, the ES lowland hard bed limits, and upon discharge and mixing with Waikaka Stream, will be consistent with existing stream water quality.

65. Whilst there were no *e.coli* found within the groundwater samples, rounding the result to half of the detection limit exceeds the NZ Drinking Water Standards. Otherwise, *e.coli* counts are not expected to be of environmental significance within the discharge of groundwater from the mine pit to Waikaka Stream.

66. In **Appendix B,** Arsenic, Iron and Turbidity are highlighted and I respectively address firstly the Arsenic and Iron discharge water quality parameters in turn as below.

67. Arsenic (As) concentrations found in the groundwater are relatively low and invariably meet NZ Drinking Water Standards. The As concentration is almost an order of magnitude less than the respective NZ Drinking Water Standard. Whilst As concentrations within the discharge upon mixing with Waikaka Stream water may not (in all circumstances), alter the stream As concentration by less than 10%, the resulting As concentrations will invariably be very low.

68. Iron concentrations in the groundwater discharge would exceed NZ Drinking Water Standards (for taste and colour), although the latest groundwater quality monitoring results suggest that upon mixing with Waikaka Stream flow, the resulting concentration of iron would not exceed 10% of the existing stream concentration or cause stream concentrations to exceed 1 mg/L. Additionally, the concentrations of iron only pose a risk of short term and limited extent of visual staining (although that is unlikely within the stream). It is also expected that iron concentrations within the groundwater discharge will reduce significantly with the proposed settling and treatment processes (particularly with addition of flocculent). WGML

propose to monitor iron concentrations in the discharge water over time for ongoing reporting and compliance purposes.

69. Turbidity (and suspended solids), as above, are considered to be the main groundwater discharge parameter(s) that if not treated, could give rise to short term and reach specific effects upon the Waikaka Stream. **Appendix B** presents the turbidity parameter as not meeting the ES lowland hard bed water quality limit solely based on measured turbidity within the groundwater and considering the potential impact of active mining processes on the groundwater discharge.

70. However, WGML propose the following treatment and mitigation measures to significantly reduce the quantum of turbidity and suspended solids in the final discharge to Waikaka Stream:

    a. The discharge will be moderated by the steady state dewatering provision adopted by WGML as opposed to intermittent and peak rate groundwater abstraction.

    b. Multiple settling ponds will be created with gravel filtration which provides for a significant residence time to allow both filtering and deposition of suspended sediment to occur.

    c. Lastly, flocculants may be used to provide for additional suspended sediment and turbidity reduction within the discharge water to essentially polish the discharge prior to entering Waikaka Stream.

71. The above treatment and mitigation measures have successfully worked in the past with other similar mining applications. Upon discharge to the Waikaka Stream and beyond the zone of reasonable mixing, the proposed activity is expected to fully meet the ES lowland hard bed stream water quality limits.

72. WGML are proposing to provide ongoing reporting and compliance provision with periodic discharge, upstream and downstream Waikaka Stream monitoring, and monitoring of turbidity/suspended solids measurement (via sensor) at those locations. This will provide suitable data for which to ensure calibration of the turbidity sensors, and for compliance

and performance monitoring for the discharge and any stream water quality change respectively.

73. Additionally, to address concerns within the s42A staff report, WGML propose discharge water quality monitoring reporting and compliance, which includes for a comprehensive suite of parameters (including those identified by the staff s42A report), and will be undertaken as follows:

    a. Continuous monitoring of turbidity, suspended solids, temperature, and pH, for the discharge and at least downstream of the discharge (in Waikaka Stream), at the extent of the 60 m mixing zone.

    b. Continuous monitoring of electrical conductivity for the discharge.

    c. Weekly monitoring of TSS, turbidity, temperature, pH, EC, Fe, Mg, SO4, Co, Al, Cu, Pb, Ca, DOC and Zn, for the discharge and 10 m upstream and 60 m downstream in Waikaka Stream.

    d. Periodic assessment and compliance reporting of the water quality results to ES.

    e. Periodic review of discharge quality monitoring parameters and frequency on the basis of variance in results obtained.

74. Lastly, **Appendix B** provides for parameter indication (from groundwater quality results), of the potential for acid forming and/or oxidising conditions to occur in relation to any discharge of mine dewatering water.

75. In all cases for all parameters measured the groundwater quality provides minimal indication of any potential for acid forming and/or oxidising conditions and consequently increased concentrations of metals and semi-metals within the groundwater and respective discharge. All concentrations of applicable parameters are very low.

76. Additional to the above assessment, is that the groundwater sample results obtained were for an oxidised sample in all cases. Also the associated pH measured is relatively neutral at an average of 6.58 pH units. This means that there is unlikely to be additional change in groundwater quality from pH/eH modification for the dewatering discharge.

77. Total Alkalinity (ALKT) concentrations in the dewatering groundwater (at above 50 mg/L), for any significant volumes of flow, will serve to resist change in pH and minimise the risk of oxidation occurring. The ALKT acts as a buffer to keep pH stable and resist change in oxidation state.

78. ALKT within deep groundwater at the WGML site, whilst has not been specifically measured (by WGML), is most likely to be in excess of 50 mg/L. This level of ALKT is referred to from reference to deep groundwater at the WGML site in the Environment Southland SOE Groundwater Quality Report (2010).

79. Also, L&M groundwater quality monitoring for Bicarbonate from three deep wells at the site, resulted in concentrations of 79 mg/L, 87 mg/L and 101 mg/L respectively. ALKT is made up from mainly Bicarbonates, Carbonates and Hydroxide, in which the L&M Bicarbonate results strongly suggest ALKT to be in excess of 50 mg/L.

80. Invariably the groundwater quality data confirms that the balance of measured parameters in the groundwater discharge are of very low concentration, and do not give rise to any significant potential for acidification and/or oxidation of contaminant parameters.

**Stream Diversions and Re-instatement**

81. Mr Ramon Strong presents evidence on the overall nature and detail of stream diversions and stream channel re-instatement activities proposed by WGML, and an associated flood hazard assessment. Within this evidence I briefly discuss the maintenance of stream-groundwater continuity and preservation of stream flow for the proposed stream diversions and channel re-instatement activities. This was also addressed within the application (groundwater) technical report.

82. I note that within the RJ Hall Report - design and cross-sections, there is specific level and dimension control for the diverted and reinstated stream bed and channel banks and berms respectively.

83. Both the diversion channels and channel reinstatement are designed to replicate current bed invert levels and gradient. Bed invert level achievement is most critical to provide for continuity of stream flow and relationship to local water table level. That is, continuity of stream flow will be maintained by replication of existing bed levels in relation to adjacent water table levels. Additionally, locally available silty-gravels may be utilised for replication of bed materials.

84. The diversion channels (and re-instated channels) will be constructed so that hydraulically, any potential for stream leakage is mitigated. This is much preferred to relying upon a constructed stream bed liner which is invariably difficult to get correct, and risks additional potential for stream flow losses.

85. The above methodology and measures will sufficiently address continuity of stream-groundwater interaction and retention of flow within the Waikaka Stream.

**Proposed Conditions of Resource Consents**

86. The conditions that ES have identified for the groundwater take and discharge activities, that require additional consideration appears to only be Conditions 38 and 50 in the application conditions set. These relate to monitoring wells for detecting drawdown in neighbouring wells (Condition 38) and monitoring and compliance for the discharge to Waikaka Stream, with some additional parameters being proposed for inclusion with the proposed monitoring suite (Condition 50).

87. For Condition 38, WGML propose to directly monitor existing water wells identified by the drawdown assessment within the Groundwater and Discharge Technical Report, throughout the mining activity. These wells will be monitored at least monthly (with access permission from the landowner), to determine a satisfactory working drawdown for each well, and if well levels are affected by the WGML dewatering to an extent that the water supply may be compromised. Sufficient baseline monitoring will be undertaken and the monthly monitoring will provide sufficient

advanced indication of water supply state. Each well will have different operational and hydraulic function, and hence, specific monitoring of each well is required to establish the above water supply continuity. WGML have a range of options in provision of an alternative water supply if any wells are temporarily disrupted by water level decline from the WGML dewatering activities.

88. For Condition 50, WGML have proposed to monitor, report and comply with a range of environmental parameters (inclusive of that indicated by the s42A Report). It would be difficult to collect baseline discharge water quality without actually undertaking the dewatering activity. However, stream baseline data will be collected as part of the compliance monitoring, as upstream (baseline) sampling is provided for within the proposed monitoring.

89. I consider that the proposed WGML discharge monitoring fully addresses the items raised by the s42A report in respect of the range of parameters measured and the efficacy of the sampling regime.

## Matters raised by the Officer's report

90. The following items are discussed within this evidence to address any outstanding matters in relation to the ES s42A Report, and the Review Evidence of Ms Alexandra Badenhop in connection with the requested WGML groundwater take and discharge to land/water activities.

**Aquifer Occurrence and Hydraulic Connection**

91. Within Section 3.3 of the s42A Report, there was mention of uncertainties with aquifer occurrence and groundwater connectivity within the sub-surface profile and in relation to surface waters.

92. However, in evidence above I confirm that there is no inter-connection of deeper or intermediate layer groundwater, and no connection of those aquifers to the water table aquifer and/or surface waters. The only connection to surface waters would be from drainage of the thin upper unconfined water table aquifer (from mine excavation), which I have

appropriately accounted for with a conservative stream depletion assessment.

93. Aquifer occurrence, whilst is intermittent for the intermediate confined aquifer, the deep confined and shallow unconfined aquifers appear to be relatively consistent, and in general, conform to the generalised hydro-geologic profile which I have previously discussed in evidence.

94. Ms Badenhop (on behalf of ES), confirms in evidence at Paragraph 6.2, that she agrees there is no connection of the lower confined aquifers to the upper water table aquifer or surface waters.

**Groundwater Quality**

95. Groundwater quality assessment was also raised within the s42A report, and there is some apparent concern around the deep aquifer groundwater quality results obtained.

96. The groundwater quality sample results for both WGML and L&M Mining (the previous mining company), collectively cover all of the parameters identified by ES with previous information requests. Additionally, as discussed in evidence above, there is very good consistency across all sampling locations, and over time (for WGML and L&M Mining sample sites), in respect of the groundwater quality results.

97. The deep confined aquifer is of Tertiary origin, and groundwater flow paths from recharge outcrop areas are large (additionally discussed below in evidence), meaning that residence time and strata-water interaction will be sufficiently buffered, resulting in a relatively consistent groundwater quality. This is as opposed to an aquifer that is acutely surface connected, with likely lower dissolved parameter concentrations, although with a much greater variability in results.

98. In relation to groundwater quality monitoring, some concern was raised about sampling protocols within the evidence of Ms Badenhop. This issue has been fully responded to in ES information responses, that detailed all of the sampling information required. Otherwise, I can confirm that the

monitoring has been appropriately and reasonably undertaken, with provision of Certified Laboratory Reports, and as above, resulting in a very good consistency of results.

99. At Section 3.3.43 of the s42A report, a list of parameters and discussion around mine discharge water quality monitoring is provided. I can confirm that all of the suggested parameters (apart from As), and discharge quality monitoring have been incorporated into the proposed WGML discharge water quality monitoring, that will form a condition of resource consent.

100. On the basis of Dr Weber's findings that As is not a parameter that is considered to be of any concern at the WGML site, and the very low As concentrations as monitored within the deep confined groundwater, I consider that monitoring of As within the dewatering discharge is not required.

**Existing landfill**

101. The s42A report at 3.3.49 identified an existing landfill in the vicinity of the WGML site located on the true left bank of Shepherds Creek. The report considers if any additional monitoring should be undertaken by WGML in respect of the mining proposal.

102. A landfill investigation was undertaken and reported by Geosciences Limited (2022), in respect of that site. The report did not identify soil contaminants adjacent to the landfill that were of significance. Albeit, contaminants within the soil were present, although in relatively low concentrations.

103. The landfill is located at nearer the margins of the valley floor and is expected to be located above the water table. The Geosciences Report noted that the landfill is positioned within unsaturated alluvial materials including old mine tailings.

104. If the landfill was leaching contaminants to the local water table, that would already be reflected (dispersed) within existing local water table aquifer, and to some degree, surface water located in close proximity to

the landfill. The WGML mine path position and activities will be set back from the landfill extent by at least 30 m.

105. Whilst in exceptional circumstances the mine dewatering may potentially intercept some partially contaminated groundwater from the landfill (as part of water table drainage to the mine pit), this would be a very small dispersed component of the overall water balance for the mine dewatering discharge. This would constitute no greater effect than the current status quo with respect to the receiving environment. WGML are already proposing to monitor and report a comprehensive range of potential contaminants.

106. This will also be suitable to monitor and report any plausible effect of any landfill leachate (in however a small quantity and low concentration), being drawn into the mine, treated and then discharged to the Waikaka Stream.

107. The above monitoring, reporting and compliance already sufficiently addresses any plausible potential interaction with the local landfill. Any additional specific monitoring in relation to the landfill occurrence would only be a duplication of the currently proposed monitoring.

**Monitoring of Al in Backfill Materials**

108. At 3.3.79 in the s42A Report, possible monitoring of Al contamination of land from the disposal of residual flocculent sediments is mentioned. This is a by-product of the proposed WGML discharge treatment facility and is not otherwise inconsistent with other mining activities of this nature and many municipal drinking water supply backwash discharges. The solids containing Al will be mixed with backfill materials and disposed of back into the mine pit void.

109. Typically Al (as total extractable aluminium), of over 10 mg/kg in soils, with a commensurate soil pH of < 5 pH units, can give rise to effects upon soil productivity and crops (Reference – Hill Labs NZ Technical Note, 2010). However, WGML are proposing to deposit the backfill-mixed flocculent sediments at depth, and not within the upper soil profile. This will ensure that the backfill materials overall have a low Al content, which by the

nature of the sub-surface profile, will be unable to migrate. It is also most unlikely that the backfill materials (clays) would have a pH of less than 5 pH units.

110. WGML are proposing to monitor and report Al within the dewatering discharge to Waikaka Stream. In my view, this activity (land disposal), can be satisfactorily undertaken without any risk of environmental effect, and therefore, monitoring of Al in the backfill is not required.

**Stream Alteration Effects**

111. The s42A Report also raises concerns with possible effects on stream flows with temporary stream bed diversion or permanent replacement, citing continuity of stream bed and materials, and local water table levels. I have discussed this aspect of the WGML proposal above in evidence, in which I confirm that any temporary or permanent stream bed facility will replicate bed materials, and bed invert levels in relation to the local water table level. This will ensure no loss of water from the Waikaka Stream to the unconfined aquifer. The temporary and permanent replacement stream bed methodology will be as indicated and undertaken to specific levels and bed/berm design outlined in the RJ Hall Report, which already forms part of the application and specifications for the activity.

**Aquifer Compression and Subsidence**

112. Ms Badenhop's evidence at Paragraph 7.6 introduces the possibility of potential aquifer compression, loss of storage and subsidence within 500 m of the WGML site, which has potential to affect neighbouring properties. This is presented as being a result of deep confined aquifer dewatering and consequent reduction in <u>total aquifer head</u> for the mine operation.

113. Effects of aquifer compression, loss of storage and subsidence for confined aquifer displacement or head reduction, only results within unconsolidated or poorly consolidated aquifer-aquitard strata. The 10 m thick confined aquifer consists of fine materials – silts, sands, clays and small gravels, with a relatively low storage value. The overlying material is clays and some fine silt, with no plausible aquitard drainage or transmission of water upon

pumping the confined aquifer (from the aquifer test results). There is no water within the overlying materials and the strata is not compressible (from on-site test drilling results).

114. Any potential for aquifer compression would only be within the confined aquifer itself, and as previously discussed, the consolidated materials and low storage indicates that any resulting compression would be extremely low, if at all possible <u>only</u> where aquifer head or pressure is reduced to below the top of the aquifer (or below the bottom of the confining layer).

115. This is as opposed to a reduction in <u>total aquifer head</u>, as this is only a measure of head within the confined aquifer. It does not indicate water within overlying layers.

116. Consistent with aquifer drawdown (or displacement) provided within the Groundwater and Discharge Technical Report at Page 18, I have calculated the distance from the mine pit (during steady state dewatering), for a reduction in the deep confined aquifer head to below the top of the aquifer.

117. During annual steady state dewatering, confined aquifer head will not reduce to below the top of the aquifer outside of a 244 m radius of the mine pit. A reduction in confined aquifer head to 50% of the aquifer thickness, occurs at a radius of only 94 m from the mine pit.

118. On the basis of the mechanisms of potential aquifer compression, loss of storage and subsidence, and with the above calculation(s) of confined aquifer head reduction away from the proposed WGML mine dewatering activity, I consider the risk to neighbouring property and the aquifer itself, to be extremely low. In short, the cone of depression for the deep confined aquifer from WGML mine dewatering, will rise steeply away from the mine pit to above the top of the aquifer, and whilst the balance of the cone will extend out to a reasonable distance, it will be sufficiently above the top of the aquifer and of a much lesser displacement or drawdown effect.

119. I therefore do not agree with Ms Badenhop's evidence that the proposed activity could lead to subsidence within 500m of the mine pit boundary,

and that this would have significant effects on neighbouring assets. Any aquifer compression is extremely unlikely to occur outside of, and within the short radius of potential depressurisation of the deep confined aquifer below the overlying confining layer.

120. Ms Badenhop's comment at Paragraph 7.7 follows on from aquifer compression and subsidence. As above, any effect of aquifer compression and consequent subsidence is extremely unlikely and therefore will have no measureable effect upon the general aquifer functioning. However, this is notwithstanding excavation of the aquifer (solely for the mine pit extent), and replacement of materials, which will be of a similar nature, but technically, not identical.

121. Ms Badenhop's comments at Paragraphs 8.1 and 8.2 have either been addressed within the Groundwater and Discharge Technical Report, or have been addressed within information responses. The deep confined aquifer has no apparent outflow path within any reasonable distance of the WGML site. If any monitoring well logs indicate a significant thickness of clay, then that does not indicate any increase in the saturated thickness of gravels for the shallow aquifer.

**Barometric Efficiency**

122. Ms Badenhop's evidence at Paragraph 8.3 mentions barometric efficiency, and this is the relative change in atmospheric pressure head to that of a corresponding change in hydraulic head measured in an aquifer. It is usually around 0.5 m, +/- 0.25 m, for fully confined aquifers. This is variable and only relates to the barometric pressure recorded at any time. However, change in total aquifer (hydraulic) head for the deep confined aquifer at the WGML site is primarily dominated by rainfall infiltration events in the recharge outcrop zone for the aquifer. The closest outcrop zone is at a higher elevation and is at least 5 km's away from the WGML site. This is further discussed in the Groundwater and Discharge Technical Report (at Page 7).

123. Rainfall infiltration events at the aquifer outcrop zone result in an almost instantaneous increase in pressure head, which essentially provides the main variability in aquifer head or level, as measured at the WGML site within the WGML monthly manual monitoring data.

124. Thus, and as reiterated in evidence above, the head variability in the confined aquifer is not from any immediate surface connection, or connection to any other aquifer or surface waters.

**Aquifer Drawdown and Management**

125. At Paragraph 9.1, Ms Badenhop states that the groundwater take may significantly affect water levels within bores and springs up to 6.9km away. I have addressed effects on wells/bores above in my evidence. It is agreed that the potential drawdown within the deep confined aquifer could be wide-ranging. However, the assessment is very conservative as per the methodology specified in the ES Land and Water Plan Groundwater Appendix, and does not take into account any disconnection or constrained flow pathways for the aquifer. There is no apparent effect upon any springs as the aquifer is deep and confined with no obvious discharge points.

126. I have already discussed in evidence above, the items raised by Ms Badenhop at Paragraphs 9.2 to 9.4.

127. I have also presented above in evidence, discussion of groundwater quality effects raised by Ms Badenhop at Paragraph 10.2.

**Matters raised by submitters**

128. There are two current submissions that raised specific concerns for water take and discharge to land/water related issues or effects of the WGML mining proposal. These submissions are specifically addressed in turn as below in evidence.

129. **Fish and Game New Zealand (Southland Region)** indicated that the proposed weekly monitoring of discharge quality (turbidity) was inadequate for assessing effects of sediment from mining operations on

visual clarity (of the Waikaka Stream). More frequent and/or event based monitoring was necessary to provide an accurate picture of effects and to ensure appropriate management responses. That the applicant should prioritise minimising the amount of sediment discharged to the Waikaka Stream from mining activities, rather than merely meeting any existing discharge standards.

130. The WGML discharge monitoring frequency outlined within the application for resource consents, indicated weekly sampling. I consider that weekly water quality sampling is suitable for the purposes of compliance monitoring with the additional continuous turbidity and suspended solids monitoring proposed by WGML and addressed above in evidence.

131. In addition to weekly sampling of the discharge and Waikaka Stream (upstream and downstream of the discharge), a continuous turbidity sensor will be located at the immediate point of discharge to Waikaka Stream and 60 m downstream within the stream at the extent of the mixing zone. Provision for locating a continuous turbidity meter upstream is also possible. This will continually monitor discharge quality (turbidity) post treatment and just prior to discharge to the stream, as well as in-stream. This is similar to what was employed at the Waikaia Gold site for discharge of mine dewatering water to the Waikaia River. This will provide for continuity of discharge monitoring, with the weekly physical sampling providing for ongoing calibration of the turbidity sensor and in assessment of baseline upstream and downstream water quality compliance.

132. WGML will provide monitoring and reporting to ensure compliance with the discharge.

133. **The Department of Conservation** were concerned about the mining proposal impacts upon groundwater and surface water quality, particularly in relation to sediment production and potential for acid mine drainage.

134. As discussed above within this evidence under "***Effects of discharge of groundwater to land/water***" there are proposed mitigation measures to be put in place for WGML to control any sediment production from mine pit excavation and management, within the proposed discharge to

land/water. Such that the suspended sediment content of the discharge water is expected to be very low, will not affect groundwater, and will not be discernible within the Waikaka Stream at beyond the allowable mixing zone (for the discharge). Whilst the discharge is expected to meet ES requirements for discharges to a surface water environment, it is most likely that with the proposed mitigation (treatment), the discharge will typically result in nil to only a small measureable difference in suspended solids for the Waikaka Stream.

135. As with the Fish and Game New Zealand submission (as above), ongoing compliance and performance of the discharge will be reflected in the proposed sampling and continuous turbidity monitoring data.

136. As identified above in evidence there are no other groundwater quality parameters monitored (that would be reflected in the discharge), that would either exceed ES requirements for discharge (quality) to surface waters, be above any NZ Drinking Water Standards, or may give rise to any significant effect of acidification and/or oxidation processes causing elevated contaminant concentrations. However, WGML have proposed to provide for ongoing monitoring and reporting for indicator metals and semi-metals within the discharge water.

137. As also identified above in evidence, for any Waikaka Stream diversion channels or stream re-instatement, local silty gravels should be utilised for stream bed materials with the stream channel. The channel should also be replicated for level and continuity of the local water table aquifer, to preserve in-channel flow and stream-groundwater interaction. Introducing a clay liner to the stream-bed is difficult and overly risks non-replication of the current stream-groundwater hydrologic conditions.

## Conclusions

138. There appears to be some reasonable agreement between the WGML application information and that of the s42A Report writer(s), on aquifer hydraulic parameters, hydraulic connections, dewatering rates and effects of drawdown (albeit conservative). There appears to be no disagreement

on the potential effects of the proposed WGML mine dewatering discharge upon Waikaka Stream water quality. However, there are some concerns raised by the s42A Report writer(s) around groundwater quality and appropriate monitoring and reporting with respect to discharge of mine dewatering water to the Waikaka Stream.

139. The main outstanding concern (as above) has been fully addressed within the modified and proffered condition of consent which presents a comprehensive parameter monitoring suite, continuous and weekly monitoring intervals, appropriate monitoring locations, and reporting.

140. There were some other issues raised by the s42A Report, and some raised within the evidence of Ms Badenhop, that were not echoed in the s42A Report, that I have addressed above within this evidence. Where appropriate I have identified where the issues raised, can be accommodated and be dealt with by way of the environmental management plan as opposed to conditions of resource consent(s).

141. Otherwise, for additional items raised mainly in respect of Ms Badenhop's evidence that were not echoed in the s42A Report, I have discussed the relevance of those items in relation to any plausible effects of the requested WGML mining activities. Whilst I consider Ms Badenhop's additional items raised to be worth noting, there do not appear to be any associated measureable effects in relation to those matters.

142. For completeness, I have endeavoured to address any/all outstanding items raised by the s42A reporting, and that of submitters, within this evidence.

143. Within this evidence, it is re-iterated (consistent with the Groundwater and Discharge Technical Report), that effects of the WGML mine dewatering and discharge proposal, will either be small to not-measureable and/or can be fully and efficiently mitigated.

**Thomas Brendan Heller**

Dated 17 November 2025

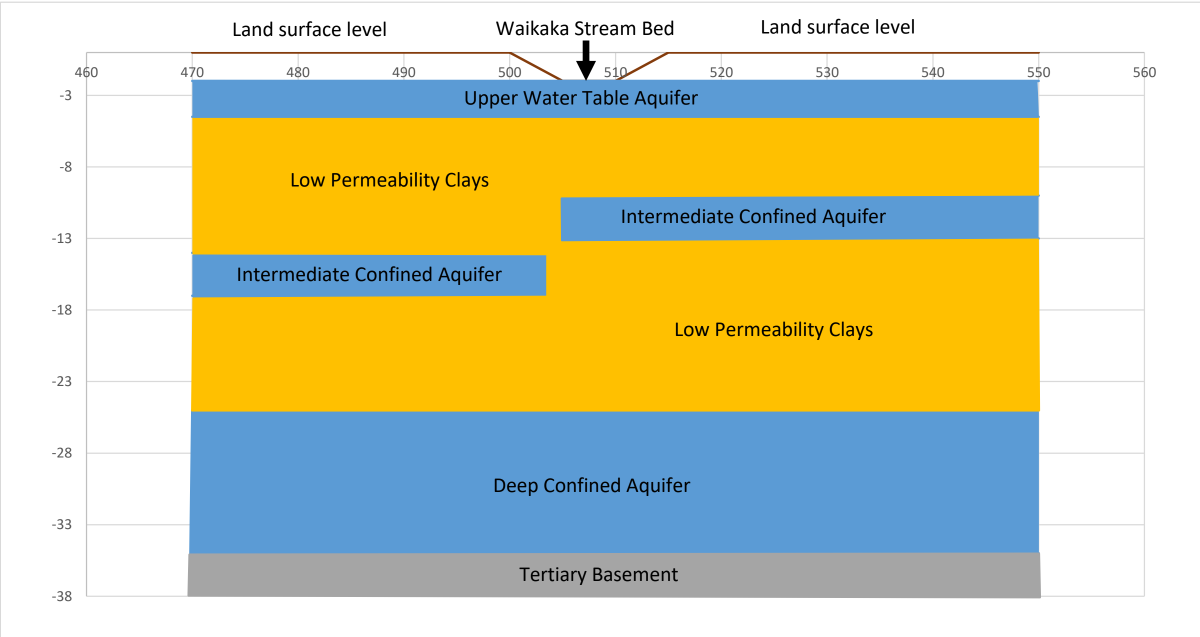
**Appendices:**

Appendix A – WGML Hydro-Geologic Profile (schematic)
Appendix B – Deep Aquifer Groundwater Quality (table)

**Appendix A** – Simplified Hydro-geologic Section Profile for Sub-surface Strata Encountered at the Proposed WGML Mine Site Area.

Relative horizontal distance is given in metres.

Relative vertical distance is given in metres below land surface.



# WGML Deep Confined Aquifer (including wash layer) – Groundwater Quality Monitoring Results

| Parameter monitored | EC (uS/cm) | Nitrate-N (mg/L) | pH (pH units) | Turb (NTU) | Al Total (mg/L) | As Total (mg/L) | B (mg/L) | Cl (mg/L) | Cd Total (mg/L) |
|---|---|---|---|---|---|---|---|---|---|
| Average value | 219.33 | 0.061 | 6.58 | 23 | 0.742 | 0.0031 | 0.0005 | 11 | 0.00017 |
| NZ Drinking water standard limit | 1000 | 11.3 | | 2.5 | 1 | 0.01 | 2.4 | 250 | 0.004 |
| ES lowland hard bed stream limits | | | 6.5 to 9 | 10% | | | | | |
| Within 10% of upstream water quality | Y | Y | Y | N | | N | | | |
| Potential for eH/pH change | Low | N | Low | N | Low | Low | N | N | Low |

| Parameter monitored | Ca (mg/L) | Cr Total (mg/L) | Co Total (mg/L) | Cu Total (mg/L) | Fe Total (mg/L) | Pb Total (mg/L) | Mg (mg/L) | Mn Total (mg/L) | Ni Total (mg/L) |
|---|---|---|---|---|---|---|---|---|---|
| Average value | 10.63 | 0.000575 | 0.00053 | 0.000775 | 4.4 | 0.00062 | 5.46 | 0.1973 | 0.0005 |
| NZ Drinking water standard limit | | 0.05 | | 2 | 0.2 | 0.01 | | 0.4 | 0.08 |
| ES lowland hard bed stream limits | | | | | | | | | |
| Within 10% of upstream water quality | Y | | | | Y | | Y | | |
| Potential for eH/pH change | N | N | Low | Low | Low | N | N | N | N |

| Parameter monitored | Hg Total (mg/L) | K (mg/L) | SO4 (mg/L) | Se Total (mg/L) | Na (mg/L) | DRP (mg/L) | P Total (mg/L) | Zn Total (mg/L) | NH3-N (mg/L) | e.coli (MPN/100 mL) |
|---|---|---|---|---|---|---|---|---|---|---|
| Average value | 0.0000025 | 1.15 | 5.2 | 0.0025 | 20.95 | 0.025 | 0.48 | 0.0015 | 0.03 | 5 |
| NZ Drinking water standard limit | 0.007 | | 250 | | 200 | | | 1.5 | | <1 |
| ES lowland hard bed stream limits | | | | | | | | | 0.18 | 1000 |
| Within 10% of upstream water quality | | Y | | | | | Y | | Y | |
| Potential for eH/pH change | N | N | Low | N | N | N | N | Low | N | N |

Notes:

1. Results are average for all monitoring undertaken at the WGML deep monitoring piezometer

2. Non-detection values have been treated as half of the detection limit

3. Sample results for 18 January 2022 sampling have been omitted due to pumping issues and resulting high turbidity sample obtained