Technical Review

To:	Shay McDonald	**Date:**	4/03/2024
Authority:	Otago Regional Council	**Ref:**	24012.5B
Consent:	RM22.111 Technical Audit for Oceana Gold Limited Macraes Phase 4 (MP4) expansion		

From	**Role in Audit**	
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1 Project Summary

Oceana Gold Limited are intending to apply to ORC for the consents needed to expand their gold mining activities at Macraes Flat, North Otago. The expansion activities are referred to as Macraes Phase 4 (MP4) and include:

1. Life of mine tailings storage Frasers Pit (Frasers Tailings Storage Facility -FTSF) and development of the open pit mining extensions in the Innes Mills Open Pit (IMOP);
2. An expansion of the Coronation Pit with waste infilling of the Coronation North Open Pit (situated approximately 4 km to the northwest of IMOP);
3. An expansion of the Golden Bar Pit and the associated Golden Bar WRS (situated approximately 6 km to the southeast of IMOP); and
4. Rehandle of ~5.4 Mt of waste rock from the rehabilitated Northern Gully Waste Rock Stack to the Golden Point Pit

MP4 will include consents relating to discharges to land, air and water, and for the water activities such as damming, diversion and taking and using ground and surface water.

ORC has engaged e3S to provide a technical review of the reports provided, relating only to terrestrial ecology, groundwater and geochemistry.

2 Audit Questions

2.1 Hydrogeochemistry & Groundwater

FOR ALL AUDITORS TO ANSWER	
Q:	Is the technical information provided in support of the application robust, including being clear about uncertainties and any assumptions? Yes, or no. If not, what are the flaws?
R:	For the most part, the models are well documented and assumptions have been clearly stated. It is important to understand the difference between the groundwater modelling and surface water modelling. The groundwater modelling was run to - estimate pit inflows for current and expanded scenarios - Simulate groundwater recovery after the conclusion of the proposed expansion – Undertake solute transport modelling during groundwater recovery. Groundwater modelling does not allow for capture of waste rock seepage in silt ponds ie. Waste rock seepage all migrates within groundwater. This is the opposite to the conceptualisation in the water balance model, whereby waste rock seepage is assumed to be captured in silt ponds and managed via the mine water management system then discharged via overflow or stored in pits, and is therefore not included as a constant baseflow input to streams. This means that the groundwater modelling is more likely to overpredict long-term groundwater concentrations, but that the surface water modelling may underpredict contaminant concentrations during low flows. From my understanding, the groundwater models are run with the assumption of mine closure conditions – rehabilitated waste rock stacks etc. Modelling of WRS relies on infiltration rates of 29 mm/year which are equivalent to the expected groundwater recharge rate across the site for the rehabilitated surfaces. This is expected to underestimate the discharge during the operational phase. Groundwater models have been run assuming mine closure conditions, and therefore short term (during mining) effects are less certain and cannot be compared with the surface water

	model. This means they may adequate for long-term predictions, but not for short term predictions i.e the 20 year predictions. In the water balance modelling, the groundwater model outputs are only used for the inflows into and out of the pits in terms of flows (not quality). Groundwater models have been calibrated in steady state based on very limited datasets. Calibration groundwater level data provided without dates of measurements. Some of this data provided in Annexure 4: Responses to s92 requests prepared by GHD Appendix B shows 20 m increase in groundwater levels since measurement began.
Q:	Are there any other matters that appear relevant to you that have not been included? Or is additional information needed? Please specify what additional info you require and why. Please explain.
R:	Clarification regarding the water level measurements that groundwater models were calibrated to – are they one-off measurements from a specific date or are they are statistic?). Are they likely to be a reflection of the steady state conditions? Climate change modelling was included for the surface water balance modelling, but not for the groundwater modelling. Waste rock stacks are one of the key sources of contamination. Concentrations of contaminants from waste rock stacks used in the models are based on a relationship from average waste rock stack height. A table of current surface area, volume and average heights for each of the waste rock stacks proposed should be provided with assurance that the models have used these updated values.
Q:	If granted, are there any specific conditions that you recommend should be included in the consent?
R:	The GHD s92 response (Feb 2025) provides significant recommendations for monitoring that have now been included in the updated AEE. In addition to the stated plume monitoring, groundwater monitoring should be installed within expected plume movement towards Clydesdale Creek from Golden Bar WRS, and in the vicinity of plume migration for Coronation North WRS and Trimbells WRS.

	Continuous groundwater level monitoring is limited to a very small area between the MTI and Golden Point Pit. It is recommended that the coverage of continuous water level monitoring is increased, particularly in the areas of contaminant movement. Consent conditions should include a requirement to update groundwater modelling and contaminant transport based on groundwater monitoring of water levels and quality, including validation of groundwater transport times, as recommended by the GHD reports.

E3 Scientific

HYDROGEOCHEMISTRY and GROUNDWATER

Relevant reports:

- AEE
- App. 8 – MWM (2024) Macraes Mine Phase 4.3 Environmental Geochemistry Assessment
- App. 9 – Strata Geoscience (2023) Peer Review of MWM report
- App. 11 – GHD (2024a) Coronation – Surface and Groundwater Assessment
- App. 12 – GHD (2024b) Golden Bar – Surface and Groundwater Assessment
- App. 13 – GHD (2024a) Stage 3 – Surface and Groundwater Assessment
- App. 14 – GHD (2023) Golden Bar Dewatering Assessment
- App. 30 – WGA (2024) MPIV Water Management Technical Documents Review Summary

Appendices 8 and 9

Q:	Based on the information provided, do you agree that waste rock at Macraes is generally non-acid forming, with low sulphide sulphur, and is unlikely to generate acid rock drainage. Please explain.
R:	Waste rock sampling across the site concludes that waste rock is generally non-acid forming. This is in agreement with water quality monitoring data from the site as well.

Q:	Based on the information provided, do you agree that that the key contaminants of concern for the project are arsenic, nitrogenous compounds (due to ammonium-nitrate-based blasting residues), and sulphate, with Fe, Zn, and Cu (and Pb) also being of concern due to their occasional elevation? Please explain.
R:	Based on the available information these do appear to be the key contaminants, however given the high concentrations of sulphate and the likelihood of reducing conditions within groundwater, sulfide concentrations may also be significant. This question has been discussed within MWM's s92 response (4/02/2025). Anoxic conditions favouring the production of sulfides are likely in tailings storage facilities seepage waters. It is noted within this discussion that if seepage waters are passively treated to reduce sulphate concentrations, further treatment will be required to remove sulfides. The possibility of anoxic groundwaters was dismissed without further justification. Given that there are high iron concentrations in some groundwaters, this statement does need further justification. Further to this, iron and sulphate reduction may occur concurrently when the available iron-oxide has low solubility. A question raised about the possibility of antimony was clarified within the s92 RFI response from MWM.
Q:	The MWM report describes a relationship between the average height of a WRS and sulphate concentrations in WRS seepage. Is sufficient information provided to understand the robustness of this relationship? Please explain.
R:	Yes, the model has conservatively used maximum sulphate concentrations to derive the relationship.
Q:	Forecasted sulphate concentrations were used to derive the concentrations of other contaminants to create source terms for WRS seepage for pit lake water quality modelling. Is sufficient justification provided as to the suitability of these source terms? Please explain.
R:	Yes, these have been justified where a linear relationship exists. However, median values have been used for other PCOCs where there was no

	relationship e.g. As, NO_3, Cu. Given that pit lake waters will be mixed, using median concentrations is reasonable.
Q:	Based on the information provided in the application, is the hydrogeochemical modelling robust? Are the inputs, assumptions, and limitations clearly stated and justified? Is the model appropriate for use in this situation? Please explain.
R:	Clear conceptual models have been provided within the documentation with source term data explained. Sensitivity analysis has been completed for elements of the modelling, such as the impact of groundwater inflows to the pits being contaminated etc, which helps to improve confidence in the models.
Q:	Are there any critical deficiencies in the MWM report that would mean that it cannot be relied upon by GHD in their groundwater reports? Has the MWM report incorporated the recommendations of the Strata Science peer-review?
R:	Mostly, although there is no 25th and 75th percentile pit lake model runs. Former ABA data was not compared, although it is consistent with known information for the mine that it is non-acid forming.
Q:	The MWM report describes a series of potential source control technologies to prevent the oxidation of sulphide minerals and to prevent mobilisation of oxidation products. Based on the information provided, do you agree that advective ingress of oxygen into WRSs is the dominant mechanism for oxygen transport into a WRS? Please explain.
R:	This would be true until saturation occurs, however oxygen will continue to be transported dissolved in rainwater and seepage water. Modelling has been completed based on current projections of waste rock stack seepage waters.

Q:	Based on the information provided, do you consider that the source control options outlined in the MWM report would be effective in reducing oxygen ingress and minimising water ingress and subsequent mobilisation of oxidation products at this site? Please explain.
R:	The MWM report provides some evidence based on comparison of models for Coronation North and actual water quality results that there may be up to 60% reduction in sulphate concentrations from waste rock stacks however this needs further investigation with flow data. It is likely these techniques may provide reduction in oxygen ingress and water ingress.
Q:	The MWM report describes a series of potential passive and active measures for the management and treatment of mine impacted waters. Has the Applicant been clear (in the AEE) about which source control methods they are adopting, or not adopting, the reasons for this, and the way in which these will be implemented e.g. immediately vs in adaptive management plans? Do you consider that the methods adopted will be sufficient to ensure that effects on groundwater are no more than minor? Please explain.
R:	Source control methods are focussed on minimising the oxidation of sulfide minerals and subsequent transport of oxidation products, and are therefore mostly focussed on management of waste rock stacks. The MWM (2024) report states that these source control methods were used in the construction of the Coronation North Waste Rock Stack and the preliminary results have been promising. Passive and active treatment measures are focussed on contaminant removal from water once contaminants have been mobilised. These measures are mostly focussed on surface water effects rather than groundwater effects e.g. controlled discharge and dilution dams, however do have the potential to benefit groundwater quality due to groundwater – surface water interaction. Some of the solutions such as injection into underground mine workings and irrigation to land are likely to be detrimental to groundwater quality. Treatment of lake waters such that contaminants are precipitated out of solution would provide some benefits to groundwater concentrations of arsenic. It is not clear where or how these measures would be incorporated into the mine water management.

	S92 response to Q1.4 states that water from Murphy's silt pond will have passive treatment systems in place to reduce sulphate concentrations by 30%. It does not specify which ones are likely to be used, or address the subsequent need to manage sulphides generated from sulphate reduction. The response recognises that further testing and field trials are required to be able to quantify the water quality improvement that can be achieved by these methods. It should also be noted that the journal paper referenced by MWM in Annexure 1, Appendix 33 (Zak, et. al, 2020) states that there is "little data available within the first decade after construction…It is, therefore, unclear how the performance of these systems change over time with respect to organic C availability…Similarly, the long-term fate of immobilised S remains uncertain. Precipitation of unstable iron monosulphides has been widely reported…but formation of stable pyrite (in its mineral form) has not." Further response was provided to Q1.10 regarding treatments in which the Water Quality Management Plan, and its adaptive nature is discussed. This again specifies the need for further testing of passive treatment systems to manage mine water. The WQMP provided as Annexure 1 to the S92 FRI response does not commit to any definite active or passive methods. The implementation timeline does not include any fixed dates, and for the most part provides mitigation options, but does not confirm which have or haven't been used across the site and when they were implemented. Whilst many of the activities have been completed or are nearing completion, there is still no clear timeline or confirmation of which mitigations are to occur. It is stated that further work is required to develop Trigger Action Response Plans.
Coronation	
Q:	Is the conceptual flow model for the Coronation site appropriate?
R:	In general, the conceptual flow model for the Coronation site seems appropriate. Catchment maps have been provided in Appendix A-3 of Appendix 11 for current and future seepage flows. It seems unlikely that the catchment areas for the Maori Hen Silt Pond and Trimbles silt pond are as large as shown. Future flows from the Coronation North Pit WRS are not captured by any silt ponds. Note however, that it seems that capture in the silt ponds was not assumed for the groundwater model, only for the water balance model which assumes all WRS seepage is captured.

	It is not clear from s92 responses whether the Coronation North Pit waste rock stack will become a pit lake or a waste rock stack above the ground, however the groundwater model assumes that there will be a waste rock stack above the ground, not a pit lake spilling. The surface water model only assumes WRS seepage from the above ground portion of the WRS (and therefore I assume that the WRS height used for contaminants in the surface water model is only the above ground portion. It is not clear what WRS height is used in the groundwater model or if this reflects the whole depth of the WRS.
Q:	Numerical groundwater model and contaminant transport model – are the inputs, assumptions, and limitations clearly stated and justified? Is the model appropriate for use in this situation? Please explain.
R:	Assumptions, inputs and limitations are mostly stated and justified. The groundwater model does not allow for capture of seepage in silt ponds which is assumed conservative, however: • Groundwater recharge is applied at the same rate to all units, which may not be appropriate for waste rock stacks • A very small (0.0001 mg/L) background sulphate concentration (aquifer and rivers) was applied to all layers simulated in the groundwater model. • It seems that the Coronation North Pit WRS is not modelled as a contaminant source to its base, only within Layer 1 of the groundwater model. • It is assumed that water quality does not deteriorate further through the Trimbells WRS which is a significant assumption. The further use of the Coronation WRS, Coronation North WRS and Trimbells WRS as indicated in the updated AEE may change the contaminant loading in the model, which would increase the contaminant loads into the catchment. This needs to be clarified.
Q:	Based on the results of the modelling, are the identified risks, mitigations, conclusions, and recommendations reasonable? (In particular, with respect to the predicted reduction in groundwater contributions to the Mare Burn Creek flows due to pit dewatering and the migration pathway of the groundwater contaminant plume.) Please explain.

R:	This needs further clarification. It does not seem that dewatering of Coronation North Pit has been included within the modelling for the purposes of calculating reductions in groundwater contributions to the Mare Burn Creek, although dewatering is listed as an activity in Table 4.1 of the AEE, and further mining of Coronation North Pit has now been identified as an activity. This should be further clarified. In addition, it is not clear whether the backfilled Coronation North Pit will be a pit lake that spills into the Coal Creek catchment, or whether the extent of the backfilled pit has been considered as a WRS.
Q:	Based on the information provided in the application, do you agree that the adverse effects on groundwater at the Coronation area are as described in the technical reports? Please explain.
R:	Further consideration of the deterioration of water quality through the Trimbells WRS, and within the Coronation North Pit WRS has been provided in Annexure 1, Appendix 33. The dewatering of Coronation North Pit may not have been considered in the flow reduction modelling. Further clarification regarding the treatment of the Coronation North Pit WRS, Trimbells WRS and Coronation North WRS in the model is required to be confident regarding these adverse effects now that a further stage of mining of Coronation North Pit has been identified as viable under existing consents. The impacts on groundwater quality are indicated to be low based on the migration of a sulphate plume, however the GHD report acknowledges that "Groundwater monitoring (both water level and water quality) along the predicted path of the contaminant plumes is recommended to be undertaken utilising existing and new groundwater bores. This will provide calibration of the groundwater and surface water models and more certainty on the overall effects." (Appendix 11).

Q:	Are there any statements made within the AEE about groundwater effects at the Coronation site that are not supported by the technical reports? Please explain.
R:	No, the AEE has been updated to reflect the reports and responses to s92 RFIs
Q:	Are there any recommendations relating to groundwater at the Coronation site (that you consider to be of importance) made in the technical reports that are not included within the AEE? Please explain.
R:	GHD made the following recommendations within their report that is not included in the AEE with respect to Coronation: • Groundwater monitoring (both water level and water quality) along the predicted path of the contaminant plumes is recommended to be undertaken utilising existing and new groundwater bores. This will provide calibration of the groundwater and surface water models and more certainty on the overall effects.
Q:	Has sufficient justification for the assumption that "…*advective flow of oxygen through the WRS is limited/prevented via the saturation of the WRS toe (or similar)*…" been provided (relating to Trimbells WRS)? Please explain.
R:	The saturation of the toe of the WRS is assumed to provide a natural advective barrier or the pit lake side. However, a toe drain and buttress on the Trimbells Gully side of the WRS is proposed by EGL (2024b) for the purpose of stability which may also be further adapted to prevent advective flow of oxygen into the basal zone of the WRS. MWM (Appendix 33, Annexure 1) provided calculations of the change in water quality that would occur from the flow of water from the Trimbells WRS if all of the stored sulfate along the basal flow path was mobilised by pit water seepage in addition to the sulphate mobilised by vertical infiltration. The flow of water through the WRS is likely to reduce the concentration of sulphate in the seepage water, but significantly increases the load of sulphate by 63%.
Q:	Has the applicant clearly described a groundwater monitoring programme relevant to the Coronation site? Is the proposed monitoring consistent with recommendations in the technical reports provided with the application? Do you consider that the monitoring is appropriate (frequency, locations, parameters)? Is it clear how any proposed monitoring will be

	used/incorporated into future management plans to manage adverse effects on groundwater? Please explain.
R:	No, the applicant considers the current monitoring programme adequate, however it remains poorly documented. There is very limited groundwater monitoring around the Coronation area, and half of the bores have been destroyed. There is no groundwater monitoring around Coronation North. The GHD report recommended "Groundwater monitoring (both water level and water quality) along the predicted path of the contaminant plumes is recommended to be undertaken utilising existing and new groundwater bores". Additional monitoring recommendations have now been included in 6.2.1 of the updated AEE, however there is no clear recommendation for improved groundwater monitoring in the Coronation area.
Golden Bar	
Q:	Is the conceptual flow model for the Golden Bar site appropriate?
R:	The conceptual flow model is appropriate as it considers inputs and outputs to water balance model adequately.
Q:	Numerical groundwater model and contaminant transport model – are the inputs, assumptions, and limitations clearly stated and justified? Is the model appropriate for use in this situation? Please explain.
R:	The inputs, assumptions and limitations are mostly clearly stated. However, the surface water model uses recharge of 92 mm/year through the WRS, whereas the groundwater model uses 29 mm/year. In this instance, not all of the WRS stack catchment reports to the silt pond so this may be significant. The groundwater model (Appendix 12) is calibrated to a very small dataset with groundwater levels measured in 2016 only adjacent to the open pit and one single bore hole 2 km away. It is unknown whether groundwater levels had stabilised post-mining at this time (note that the model suggests groundwater levels adjacent to the pit may not be stable 400 years after mining ceases). However, groundwater inflows to the have been calibrated to observed pit water levels in 2010-2011, which gives some confidence in the inflow modelling into the pit. Note that the calibration for the WBM doesn't assess whether there is a statistical relationship between the measured and modelled data for surface water quality (GHD, Appendix 14), however the percentile statistics

	indicate that the model may be conservative for higher sulphate concentrations for the dewatering process.
Q:	Based on the results of the modelling, are the identified risks, mitigations, conclusions, and recommendations reasonable? In particular, with respect to the predicted negligible reduction in groundwater contributions to McCormicks Creek and Murphys Creek flows due to pit dewatering and the migration pathway of the groundwater contaminant plume. Please explain.
R:	The identified risks are reasonable, however there is no discussion regarding the uncertainty inherent in the modelling. The predicted negligible reductions in groundwater contributions to McCormicks Creek and Murphy's Creek flows are reasonable, given the calibration of groundwater levels to measured pit water levels. It is, however, best practice to provide both calibration and validation of a model using different time periods of data. Note that there are no modelled exceedances of water quality criteria at GB01/GB02 because these locations currently do not have compliance criteria for sulphate or nitrates. In particular, sulphate concentrations at GB01 are anticipated to be very high. No mitigations or recommendations were proposed at this time in Appendix 12. The AEE states "Mitigation of the Clydesdale WRS water quality downstream of the silt pond is proposed to ensure Murphys Creek contaminant levels are acceptable and compliance at NB03 is maintained." There will be significant contaminant movement into Clydesdale Creek between GB01 ad MC02 in groundwater than is unlikely to be captured in the Clydesdale Creek silt pond. The WBM uses recharge of 92 mm/year through the waste rock stack based on pit lake water quality and estimates a higher load of sulphate into the creek. Depending on the management of the silt pond, this may still predict lower concentrations during low flows than might be anticipated by the groundwater modelling if the same recharge rate was applied to the waste rock stack.
Q:	Based on the information provided in the application, do you agree that the adverse effects on groundwater at the Golden Bar area are as described in the technical reports? Please explain.

R:	The percentage reduction in baseflow is calculated across all the drain flow across the whole model domain, not in the area of effect. In reality the percentage will be higher where the effect is occurring. It is possible that this may be more significant in drier conditions. Given the very limited data, there will be significant uncertainty around these numbers. The recharge rate applied to the groundwater model will impact the results. If the calibration of the pit inflow model indicated that the recharge through the rehabilitated WRS is 92 mm/year, this will have a big impact on contaminant transport outcomes.
Q:	Are there any statements made within the AEE about groundwater effects at the Golden Bar site that are not supported by the technical reports? Please explain.
R:	No.
Q:	Are there any recommendations relating to groundwater at Golden Bar (that you consider to be of importance) made in the technical reports that are not included within the AEE? Please explain.
R:	The groundwater report (Appendix 12) recommends monitoring (both water level and water quality) or existing and additional monitoring wells in the wider vicinity of the proposed pit extension and the WRS as well as near McCornmicks Creek and Murphys Creek prior to and during mining to give greater certainty around the model results. These recommendations have not been made in the updated AEE.
Q:	Has the applicant clearly described a groundwater monitoring programme relevant to the Golden Bar site? Is the proposed monitoring consistent with recommendations in the technical reports provided with the application? Do you consider that the monitoring is appropriate (frequency, locations, parameters)? Is it clear how any proposed monitoring will be used/incorporated into future management plans to manage adverse effects on groundwater? Please explain.
R:	No, the AEE only recommends 'continued monitoring of groundwater'. The only bore that has been consistently monitored in conjunction with the Golden Bar site is the control bore. The GHD s92 response to monitoring does not include Golden Bar in the discussion, however as noted above, the groundwater report (Appendix 12) recommends monitoring (both water level and water quality) or existing and additional monitoring wells in the

	wider vicinity of the proposed pit extension and the WRS as well as near McCornmicks Creek and Murphys Creek prior to and during mining to give greater certainty around the model results.
App. 13 GHD 2024 Stage 3 Surface and Groundwater (FTSF, IM, and cumulative effects)	
Q:	Draindown model for the TTTSF – are the inputs, assumptions, and limitations clearly stated and justified? Is the model appropriate for use in this situation? Is the comparison with the MTI/SP11 valid? Please explain.
R:	Yes, this model appears to be an acceptable method for estimating ongoing seepage from the TTTSF, and provides reasonable results in comparison to measured seepage from MTI and SP11. Tailings water is assumed to be diverted to FROP for 20 years after closure, but after closure it is assumed this is managed in a different manner. Note that within the surface water model, it is assumed that this continues to be captured and treated.
Q:	Numerical groundwater model – are the modifications to previous models, the inputs, assumptions, and limitations clearly stated and justified? Is the model appropriate for use in this situation? Please explain.
R:	Note that the Back Road Waste Rock Stack was not included in the groundwater modelling. Surface water modelling was updated to include this, but not the groundwater modelling. The groundwater level calibration data presented in Appendix D does not have any dates of when the data was collected and whether it is a statistic of the water level data or a single measurement. Recharge rate of 29 mm year is applied evenly across the model.
Q:	Based on the information provided in the application, do you agree that the adverse effects on groundwater at the Frasers/Innes Mills/TTTSF area, and cumulative groundwater effects across the Macraes site, are as described in the technical reports? Please explain.
R:	Models assume no existing plume. This may be appropriate for long term estimates, but not for short term (20 years) given the operation of existing site.

	BRWRS has not been included in the groundwater modelling. The reduction of baseflow (3.3 L/s) to rivers is calculated across the whole model domain, and was calculated to be a loss of 3 L/s at DC07. The reduction of baseflow to smaller creeks (represented as drains) may be 11L/s, but it is not clear where these impacts will occur. Note that this models a reduction in water that can flow into the creek as baseflow, not the water that can be lost to the aquifer from the creek. Surface water modelling assumes that seepage from tailings facilities continues to be captured and treated, but it is not clear how this will occur. The draindown model assumes that it is captured and returned to FROP for 20 years and then managed alternatively. It is assumed that seepage from the FRIM pit lake through FWRS is pumped back to the pit lake and is not accounted for in Murphy's Creek. Note that the groundwater modelling outputs are not all directly used in the surface water modelling (only those from TTTSF to Cranky Jims Creek and to Deepdell Creek, and the interactions with the pit lakes. However, the outputs were compared and adjusted where required. In general the WBM is considered conservative. However, the cumulative effects modelling assumes that seepage from the silt ponds can be collected and pumped back to FROP to achieve compliance conditions. If however, much of the load from the WRS is reporting to surface water as baseflows downgradient of the silt pond, as may be the case downgradient of Clydesdale Silt pond, these impacts may be greater during low flows (see discussion around Golden Bar modelling).
Q:	Are there any statements made within the AEE about groundwater effects at the Frasers/Innes Mills/TTTSF area, or about the wider site, that are not supported by the technical reports? Please explain.
R:	The AEE does not recognise that the groundwater modelling has not been updated to include the BRWRS.
Q:	Are there any recommendations relating to groundwater at Frasers/Innes Mills/TTTSF area, or about the wider site, (that you consider to be of importance) made in the technical reports that are not included within the AEE? Please explain.

R:	Additional recommendations have now been included in the updated AEE which further considers water quality issues at the site, and the need for additional monitoring.
Q:	Has the applicant clearly described a groundwater monitoring programme relevant to the Frasers/Innes Mills/TTTSF area, and the wider site (for cumulative effects)? Is the proposed monitoring consistent with recommendations in the technical reports provided with the application? Do you consider that the monitoring is appropriate (frequency, locations, parameters)? Is it clear how any proposed monitoring will be used/incorporated into future management plans to manage adverse effects on groundwater? Please explain.
R:	GHD have made further recommendations regarding monitoring that have now been incorporated into the updated AEE (see earlier questions and my comments). In general, there is no clear statement regarding minimising adverse effects on groundwater based on monitoring, only minimising effects on surface water.
Q:	Are the conclusions and recommendations as to groundwater management reasonable? Are there any aspects on which you disagree? Please explain.
R:	There is limited discussion regarding managing groundwater. There seems to be some discrepancy as to whether seepage from TSF will or won't continue to be collected more than 20 years after mining ceases, however this will be important. It is recognised that management/sealing of historic workings is required to reduce effects on groundwater.

FOR ALL AUDITORS TO ANSWER	
Q:	Is the technical information provided in support of the application robust, including being clear about uncertainties and any assumptions? Yes, or no. If not, what are the flaws?
R:	Yes, the technical information is robust for most aspects, although the findings of the invertebrate assessment is limited by methodology and timing of the survey. The technical information is clear about the uncertainties and assumptions.

Q:	Are there any other matters that appear relevant to you that have not been included? Or is additional information needed? Please specify what additional info you require and why. Please explain.
R:	I am of the view that most of the ecological values of the MP4 Project Components have been well characterised and the effects generally understood. The invertebrate assessment is an exception as the assessment has considerable limitations. The outstanding element is the proposed resource consent conditions. These will be extensive and really need to be drafted prior to the hearing as the detail will be critical in determining whether the impacts can be managed adequately and that the councils can monitor the consent effectively. I note the MP4 Ecological Impact Management Plan is a high level document. It does not provide the detail as to how each of the mitigation, remediation, offset or compensation measures will be implemented. All of these elements will require objectives, clearly set out implementation measures, monitoring requirements and adaptive management strategies to ensure they meet the consent conditions.
Q:	If granted, are there any specific conditions that you recommend should be included in the consent?
R:	Clearly the MP4 project will result in significant ecological disturbance, particularly to lizard populations and but also indigenous vegetation, birds and invertebrates. In order to address these effects, OGL proposes the development of the Murphys Ecological Enhancement Area (MEEA). I understand OGL is in the process of drafting resource consent conditions that directly address the implementation of the MEEA. It will be critical that the consent conditions provide councils with the confidence that the implementation, monitoring, and long term management can be achieved. I understand OGL will provide a suite of consent conditions for review prior to the hearing. The consent conditions are critical to provide surety that all the measures set out in section 10 of the IMP (avoidance, mitigation, remediation, offset and compensation package) can be delivered and maintained over the long term.

2.2 Terrestrial Ecology

E3 Scientific	
TERRESTRIAL ECOLOGY **Relevant reports:** • **AEE** • **App. 15 – Ahikā (2024) Assessment of Effects on Vegetation & Avifauna** • **App. 16 – Ahikā (2024) Ecology Impact Management Plan** • **App. 17 – Bioresearches (2024a) Herpetofauna Survey & Assessment** • **App. 18 – Bioresearches (2024b) Lizard Management Plan** • **App. 19 – Bioresearches (2024c) Invertebrate Survey & Assessment**	
Questions relate to all areas of the site	
Q:	Are the impacted areas (native vs exotic vegetation, riparian vegetation, wetlands, lizard habitat, etc.) clearly, accurately, and unambiguously described/mapped to an acceptable level of detail? Please explain.
R:	Yes, the vegetation communities are mapped well and the bird and lizard and invertebrate species present seem well characterised. OGL sharing the GIS shapefiles is very helpful to understanding the scope of the project and the distribution of vegetation communities within the impacted areas.
Q:	The boundary of ecological impact is set out as the footprint of the project plus a 100 m buffer. Do you consider this to be an appropriate zone in which to consider effects? Please explain.
R:	Yes, the 100 metre buffer seems reasonable given the nature of the activity and the species present. I understand this distance is consistent with previous applications. It is unlikely effects on avifauna, lizards and invertebrates and indigenous vegetation would occur outside the 100 metre buffer.
Q:	Has the applicant clearly and unambiguously described which mining activity will have which adverse effects on each aspect of terrestrial ecology e.g. is it clear how much tussock land will be lost from the Golden Bar pit extension vs the Golden Bar WRS extension vs the dewatering of the pit? This is important because each council (ORC, WDC, DCC) can only consider effects that relate to activities requiring authorisation from that council. For example, ORC can consider the loss of vegetation associated with the WRS extensions (because these require discharge permits), or effects on natural

	inland wetlands (as directed by NES-F), but not effects from the open pit extensions (because a land use consent is not required from ORC). In the end everything needs to be assessed but the info needs to be presented such that each council can consider effects relevant to them.
R:	Yes, almost all of the adverse effects are within the Waitaki District Council. The s92 response clarified that the only area of interest in the DCC is associated with 700 square metres of tussock grassland within the buffer zone of the Coronation North backfill area.
Q:	Is it clear from the information provided whether the riparian (or other) vegetation lost includes the areas of Clydesdale and Golden Bar Creeks that will be reclaimed, or Trimbells WRS downstream of the toe buttress at the Trimbells WRS seepage outlet (see AEE section 3.7.3)? Please explain.
R:	Yes, the GBWRS will be placed on the Clydesdale Creek but Golden Bar Creek appears to not be affected by the WRS. The application is not explicit about disturbance associated with deposition of waste material near the confluence of the Moari Hen and Trimbells Creek. It does appear possible from aerial photographic review that there may be vegetation that is effected by the deposition of waste material.
Q:	Are the effects on terrestrial vegetation described sufficiently? Please explain.
R:	Yes section 5 of the Ecological Impact Assessment provides sufficient detail of the vegetation communities impacted by the MP4 project. The assessment sets out the impacted communities within each of the project areas and also provides areas of disturbance.
Q:	Are the effects on birds described sufficiently? Please explain.
R:	Yes, I consider the effects on birds is suitably characterised. The Ahika report traverses the species that are present in the zone of influence and a walk through of the sites was completed to record the bird species present. The GBWRS is the area of most concern as this area supports NZ Pipit and possibly the eastern falcon.
Q:	App 15 excludes assessment of Northern Gully WRS and Coronation pit lake spill channel. Do you consider that additional assessment is required for these areas? Please explain.
R:	This information was provided in the s92 response.
Q:	Does the on-site survey for flora and avifauna methodology as set out in section 4.4 of Appendix 15 use appropriate (best practice) methods?

R:	The floristics and vegetation survey methods are well set out in the Ahika report and this was supplemented by plans showing the areas that were traversed on foot. The survey recorded plants of interest (notably at risk species) and these are shown on the plans provided in the report. Ahika also provided an assessment of abundance of the plant species recorded. I consider the methods used will have appropriately characterised the floristic values of the project area. The avifauna survey work (consisting of a single walk through) appears reasonable for the nature of the bird species likely to be present. Additional surveys would have been helpful at different times of the day and year to determine if there is variability in species present and bird numbers. Notwithstanding this point, the information provided is sufficient given the experience Ahika has in surveying birds in the Macraes area.
Q:	Is the assessment of ecological values done in accordance with best practice (including accurate application/categorisation of significance criteria in accordance with relevant planning documents)?
R:	The ecological assessment uses all of the tools available to consider the value of vegetation communities and species that may be impacted by the MP4 project. This includes utilising the threatened environment classification, naturally uncommon ecosystems, and conservation status of indigenous vascular plants, avifauna, herpetofauna and invertebrates. The report also addresses the significance assessment criteria set out in a range of documents including the WDC and DCC district plans, the NPS-IB, the Partially Operative Otago Regional Policy Statement (POORPS) and the proposed Otago Regional Policy Statement (pORPS). A summary of the significance assessment is set out in Table 8 of the Ahika (2024a) Assessment of Effects report. I generally agree with findings of the assessment against the significance assessment criteria. Importantly, Ahika finds that all of the indigenous vegetation communities proposed to be cleared contain values that meet the criteria that are set out in the relevant planning documents.
Q:	Appendix 15 notes limitations including not taking into account seasonal variation or inter-annual variation in abundance or site use by some species. To what extent does this limit confidence in the results? Does this uncertainty

	translate into the offsetting/compensation set out in the ecological impact management plan? Please explain.
R:	Given my understanding of the vegetation communities that would be impacted by the mining expansion I do not think there would be significant seasonal variation should botanical survey have been completed at a different time of the year. The survey was undertaken in Autumn which may have made the identification of some grasses difficult. Notwithstanding this point Ahika staff have significant botanical experience in the Macraes area, therefore I consider the botanical assessment will have a high level of accuracy. The avifauna survey work (consisting of a single walk through) appears reasonable for the nature of the bird species likely to be present. Additional surveys would have been helpful at different times of the day and year to determine if there is variability in species present and bird numbers. Notwithstanding this point, the information provided seems reasonable given Ahika's experience in bird observations in the Macraes area.
Q:	Has the Ecological importance assessment and impact (effect) assessments been undertaken in accordance with industry best practice guidelines? Please explain.
R:	The ecological importance assessment utilises all the standard tools to characterise ecological value as set out in section 4 of App 15. The impact assessment utilises the EIANZ guidelines. While the efficacy of the guidelines are debated by ecologists, they remain the only nationwide guidance on ecological impacts assessment. I therefore consider the EIANZ impact assessment an appropriate framework to consider ecological effects.
Q:	Based on the information provided, do you agree with the ecological impacts of the project on terrestrial vegetation and avifauna as set out in section 6 of Appendix 15? Please explain. If you disagree with any parts of the effects assessment, please clearly identify and explain the areas of disagreement.
R:	The ecological effects assessment is based on an assigned ecological value and the magnitude of the disturbance to each ecological element assessed. While I agree with the assignment of ecological values there is a reasonable amount of uncertainty regarding the magnitude of effect. This is acknowledged in the Ahika assessment where it addresses confidence in the assessment. In many cases the confidence in the assessment is characterised as moderate or moderate-low. Additional analysis would have been helpful

	to understand the extent of vegetation communities or prevalence of species in order to reach a stronger conclusion on the magnitude of effect. More detailed mapping of riparian vegetation, wetlands and tussock grassland would improve confidence in the assessment.
Q:	Has the ecology impact management plan been prepared in accordance with industry best practice (including effects management hierarchy)? Please explain.
R:	The IMP is relatively high level Management Plan rather than a plan that sets out the details of how the individual elements of the mitigation, remediation, offset and compensation package will be achieved. This is recognised in the IMP in section 10.5.7. The detail of these management plans will be critical and all will need council approval if they are not provided for through the application process.
Q:	Has the effects management hierarchy (of the NPS-FM as required by the NES-F in relation to wetlands and as required by NPS-IB for indigenous biodiversity) been applied correctly for all impacted areas? Is it clear to you whether this includes the impacts on riparian vegetation associated with the proposed river reclamations?
R:	Yes, the effects management hierarchy has been applied in accordance with the NPS-IB. It is unclear if avoidance of riparian vegetation was considered by OGL. Currently the effects are addressed through compensation activity within the MEEA. This includes weed control and planting of 500 plants in stream margins in the lower reaches of the MEEA. This would appear to be the only option if the effect on riparian vegetation is unavoidable.
Q:	Is the proposed compensation for the loss of indigenous habitat and species in the Innes Mills, Coronation, and Golden Bar areas in accordance with the requirements set out in the NPS-FM, NPS-IB, operative and proposed regional plans, and district plans? Please explain.
R:	Yes, the various proposed compensation measures are consistent with the guiding principles in regulatory documents. This is addressed in Section 11 of the IMP.
Q:	Is any aspect of the proposed effects management incorrectly presented as another type of effects management in the relevant effects management

	plans or AEE? (E.g. is any offsetting more correctly described as compensation, in whole or part?). Please explain.
R:	No, I consider these matters are accurately assigned in the application and subsequently in the s92 responses.
Q:	The DCC plan provides assessment guidance that in assessing the appropriateness of any proposed biodiversity offset or environmental compensation, that Council will consider the Guidance on Good Practice Biodiversity Offsetting in New Zealand (NZ Government, 2014). Does any offsetting of compensation proposed by OGL not meet or exceed this guidance (or any subsequent NZ guidance considered to supersede the aforementioned guidance)?
R:	The offsetting and compensation is consistent with elements of the *Guidance on Good Practice Biodiversity Offsetting in New Zealand* however, it does not include a Biodiversity Offset Management Plan. This would set out the objectives and methods, key roles and responsibilities, adaptive management and monitoring processes and provisions for stakeholder participation. I consider the lack of detail that would be included in a BOMP is a core matter that needs to be addressed. Implementation of the long suite of or remediation, mitigation, offset and compensation measures is critical and documents that support implementation would be really helpful for the assessment process.
Q:	In your opinion, does the application adequately demonstrate that the Murphys Ecological Area will be successful in the establishment and maintenance of indigenous species and habitat? Are there any deficiencies or areas of concern that you can identify? Please explain.
R:	Partly. Installation of the predator proof fence, removal of pests and destocking the exclusion area will achieve gains in biodiversity through less pressure on lizards and birds and assisting the recovery of existing indigenous vegetation. However, the arrangements for how the area is to managed long-term is necessary in order determine whether the gains are likely to be maintained. I understand the governance arrangements will be addressed in consent conditions along with more detailed implementation measures. This information is required to assist the councils understanding on whether the MEEA will meet its objectives.

Q:	Based on the information provided, do you agree with the description of the adverse effects of the project on lizards? Do you agree with the nature and magnitude of the effect identified, including cumulative effects? Please explain. If you disagree with any parts of the effects assessment, please clearly identify and explain the areas of disagreement.
R:	The nature of the adverse effects are adequately described. The scale of habitat loss for MP4 is described on Pg40 Herpetofauna Survey document as being <1% of OGL Macraes landholdings and <0.5% of Macraes ED. Cumulative effects are discussed in Bioresearches Herpetofauna Survey which notes the mining operation has impacted over 2000 ha of the land. It also notes that a number of threatened lizard species that were historical present have declined to extinction or near extinction in recent decades (section 4.3.3 of the report). Notwithstanding this discussion it is unclear how this issue has been considered in the magnitude of effect assessment. It would be useful to see a description of the proportion of lizard habitat impacted prior OGL activity alongside that in the current application and any other lizard habitat loss known in the ED.
Q:	Do you consider that the lizard management plan sets out appropriate salvage and relocation protocols and an appropriate monitoring programme? Please explain.
R:	Overall agree, rationale sound, monitoring of geckos should be included. The report clearly sets out the difficulties with establishing gecko populations however requiring surveys to determine presence should be incorporated into the monitoring schedule.
Q:	Are the effects on invertebrates described sufficiently? Do you agree with the nature and magnitude of the effect identified, including cumulative effects? Please explain.
R:	The value of the invertebrate assessment is undermined by the timing of the survey and the collection methodologies used. This is well described in the Bioresearches report (See section 3.1.3). Cumulative effects have been discussed in the impact assessment but it is unclear how this has been incorporated into the assessment. Notwithstanding the above, given the information available I agree with the characterisation of the ecological values and the magnitude of effects assigned to the various project components.

Q:	Do you agree with the recommendations made in section 5 of the Invertebrate Survey and Assessment? Please explain.
R:	Yes, I agree with the recommendations although they are high level. Some of these matters are addressed in the IMP such as the salvage of host plants of the nationally vulnerable *Orocrambus sophistes* and research into invertebrate community response to habitat protection.
Q:	Are there any statements made within the AEE about terrestrial ecological effects at any impacted site that are not supported by the technical reports? Please explain.
R:	The statements generally reflect the findings of the technical assessment. I do however note that in section 5.6.9 the AEE states that "*For the most part, the MP4 Project is assessed as having a low or moderate effect on the terrestrial ecological features examined by Ahika.*" I disagree with this statement as the wrongly characterises the ecological effects. The Golden Bar WRS will result in a high level of effect on tussock grassland, lizards, invertebrates and this is the largest area of disturbance with the MP4 project.