Annexure 14:

Responses to s92 requests prepared by MWM in respect of geochemical matters

MINE WASTE MANAGEMENT
GREENROAD GROUP

301E Blenheim Road,
Christchurch 8041, New Zealand

T. +64 3 242 0221
E. admin@minewaste.com.au

MEMORANDUM

Recipient:	Dean Fergusson – OceanaGold Limited
From:	Paul Weber – Mine Waste Management Limited
Date:	26 August 2024
Document Number:	J-NZ0229-M-008-Rev0
Document Title:	Response to S92(1): Consent Application Number RM24.184

OceanaGold (New Zealand) Limited (OceanaGold) submitted an application (RM24.184) to the Otago Regional Council (ORC)for activities relating to the Macraes Gold Mine (Macraes) Phase 4 Stage 3 Project.

REQUEST FOR INFORMATION

Processing of Resource Consent Application RM24.184 has included technical audits by GeoSolve Limited, Torlesse Environmental Limited, E3 Scientific Limited, and Specialist Environmental Services Limited. A request for additional information (RFI) under section 92(1) of the Resource Management Act 1991 has been made to OceanaGold on 24 July 2024.

This memorandum provides responses to the RFI in respect of geochemistry matters and was requested by OceanaGold on 25 July 2024 (Table 1).

Table 1. s92 Request for Information (RFI) in respect of environmental geochemistry matters

s92 RFI#	SUB-CATEGORY	QUESTION
4.1	Geochemistry, Water Modelling, and Groundwater	The Shake Flask Extraction data has been used to simulate water quality from the saturated waste rock mass. There is some confusion around data in Table 23 vs Table 17 in terms of units, concentrations and if maximums or averages were ultimately used in the model (MWM, 2024). Please clarify. Can you please explain why the shake flask extraction method using deionised water is appropriate for simulating leaching in this scenario? Can you please confirm the use of the data (mg/kg or mg/L) and how this is then used with the model?
4.2	Geochemistry, Water Modelling, and Groundwater	The Strata Geoscience technical reviewer suggests that high concentrations of antimony in the XRF data is an issue, and the shake flask extraction data also suggests this may be an issue, though there is limited monitoring data for antimony. Please discuss why it is not considered a possible potential contaminant of concern (PCOC) and whether future monitoring should include antimony?
4.14	Geochemistry, Water Modelling, and Groundwater	Can you please provide more information regarding the water quality datasets used to derive the water quality source terms for the surface water quality modelling?
5.3	Surface Water and Aquatic Ecology – Frasers and Innes Mills Open Pit	The water quality data contained in Appendix F suggests there is a high probability of copper causing significant adverse effects at MC02 and more than minor effects at NB03 during closure and after closure. To what extent does the current proposal contribute to long-term copper concentrations (i.e., what are the modelled concentrations under a scenario where the proposed activities do not occur)?

RESPONSE TO RFI 4.1

RFI:

"*The Shake Flask Extraction data has been used to simulate water quality from the saturated waste rock mass. There is some confusion around data in Table 23 vs Table 17 in terms of units, concentrations and if maximums or averages were ultimately used in the model (MWM, 2024). Please clarify. Can you please explain why the shake flask extraction method using deionised water is appropriate for simulating leaching in this scenario? Can you please confirm the use of the data (mg/kg or mg/L) and how this is then used with the model?*"

This request is related to the MWM Report (2024) and the report by Strata Geoscience (2023)

Response

The data provided in Table 17 (MWM, 2024) is average data from the shake flask extraction (SFE) tests in mg/L (i.e., concentration). However, as described in Section 4.4 of our report (MWM, 2024) the following data reduction steps were applied:

- Average values were calculated for the backfill and in-situ samples in both the oxic and anoxic tests. This provides four values per contaminant (Table 17: MWM, 2024).
- Average results were compared for the oxic and anoxic conditions, selecting the maximum value for each parameter (with the exception of pH, where the minimum was chosen).
- The average value of the two maxima was selected. The resulting average was used as the source term for waste rock backfilled into the pit lakes (mg/kg).

Details of the SFE test are provided in Appendix D of the MWM (2024) report – Material Characterisation Methodology. Essentially 25 g of material is mixed with 250 mL of water and then the SFE test is undertaken.

Deionised water is used because it provides an aggressive extraction process, which generally generates the maximum mobilisation of contaminants. Using deionised water as the reactant medium is an industry standard approach (e.g., DER[1], 2015) . The purpose of the test is to understand what contaminants can be mobilised once materials are wetted. If site water was used it might retard the full mobilisation of contaminants (e.g., due to solubility constraints: gypsum precipitation for instance), deionised water is therefore a conservative approach.

The SFE data provided in Table 23 (MWM, 2024) is average data from the shake flask tests in mg/kg (i.e., load). A weight/weight basis was used to determine the full load that could be mobilised from waste rock once it was saturated by the rising pit lake (in the modelling process).

The modelling approach is also conservative as the waste rock stack is not comprised of lab test sized materials (i.e., < 6 mm in diameter). The load (mg/kg) would be much lower if larger particle sizes of waste rock were considered due to specific surface effects.

[1] *Department of Environmental Regulation*

RESPONSE TO RFI 4.2

RFI:

"*The Strata Geoscience technical reviewer suggests that high concentrations of antimony in the XRF data is an issue, and the shake flask extraction data also suggests this may be an issue, though there is limited monitoring data for antimony. Please discuss why it is not considered a possible potential contaminant of concern (PCOC) and whether future monitoring should include antimony?*"

This request is related to the MWM Report (2024) and the report by Strata Geoscience (2023)

Response

pXRF data was used to identify whether contaminants were elevated in project materials. Data shows that one waste rock sample from the SPIM[2] area and two waste rock samples from Coronation area had a GAI[3] > 3, which is considered elevated (Table 18: MWM, 2024). Table 19 (MWM, 2024) shows that ore from Golden Bar and Innes Mills is also elevated in Sb. It is important to note that elevated contaminant concentrations do not necessarily mean elevated mobility. Furthermore, the reliability of such pXRF data close to the limit of reporting (LOR) can be less reliable due to background and scatter effects.

Note: there is a reporting error in Table 23 (MWM, 2024) that shows the SFE source term for Sb to be 264 mg/kg. Unfortunately, in reporting the data from the model the SO_4 concentration of 264 mg/kg has been mixed up with the Sb concentration of 0.143 mg/kg. We confirm modelling did use the correct concentration for SO_3 and Sb.

To demonstrate the risks of elevated Sb in site water bodies is low, the following datasets are provided:

- Sb data for the Deepdell North Backfill, which had dissolved Sb concentrations of 0.0003 mg/L (Table 7: MWM, 2024).
- Sb data for tailing storage facility (TSF) SP11 (from 2006 to 2022) was 0.001 mg/L (Table 8: MWM. 2024).
- Sb data is provided (Table 21: MWM, 2024) for Golden Bar Pit (0.003 mg/L) and Coronation Pit (0.037 mg/L).
- Sb data is available (Table 22: MWM, 2024) for underdrain water from the TTTSF[4] collection sump (0.0011 mg/L); SP10 TSF combined seepage outlet (0.0077 mg/L); and Frasers East WRS (0.0032 mg/L).
- Sb data is available (Table 23: MWM, 2024) for Fraser West Silt Pond and Murphy's Creek Silt Pond (0.0011 mg/L) and North Gully East (0.0076 mg/L).
- Additional data are available from the TTTSF and the MTI as shown below in Table 2 for total Sb. No dissolved Sb data are available, only Total Sb which may contain sediment. Results indicate that:

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[2] *Southern Pit Innes Mills – Note: the rocks associated with SPIM are not part of the current consent application.*

[3] *Geochemical Abundance Index (Förstner et al., 1993).*

[4] *Top Tipperary TSF*

- 21 samples obtained from 2001 to 2002 all reported 0.1 mg/L total Sb, which suggest this was the limit of reporting rather than a measured results; and
- Three samples in December 2008 all had 0.25 mg/L total Sb, which also suggests a LOR issue.

Table 2. Sb (total) data (mg/L) for the TTTSF (2016 – 2022) and MTI (2001 – 2016)

LOCATION	COUNT	MIN	MAX	AVE	MED
TTTSF	9	0.00068	0.0187	0.00852	0.0061
MTI	231	0.0004	0.25	0.016	0.0011

A review of recent water quality guidelines (B.C. Ministry of Water, Land and Resource Stewardship, 2023) suggests a chronic limit of 0.074 mg/L, which also indicates the risks for Sb is low across the mine domains assessed above[5]. Available monitoring data indicate that Sb is generally an order of magnitude lower than 0.074 mg/L.

Generally, if any parameter is within 50% of the adopted trigger limits (e.g., resource consent limits or the ANZG (2018) guideline limits, etc) they are considered elevated and ongoing monitoring is recommended to confirm trends and/or potential hazards. This approach is similar to using 50% of maximum acceptable value (MAV) for drinking water where it is used as a screening level for follow up action (Ministry of Health, 2018). Given the long-term datasets available and the maturity of the Macraes operation (i.e., new waste and ore characteristics are consistent with what has been mined since the beginning of Macraes in 1990) new water quality risks are unlikely to emerge, and MWM believe compliance monitoring for Sb is not required.

RESPONSE TO RFI 4.14

RFI:

"*Can you please provide more information regarding the water quality datasets used to derive the water quality source terms for the surface water quality modelling?*"

This request is related to the GHD Reports. MWM has been asked by OceanaGold to comment on water quality datasets used in its modelling processes (surface water locations) and estimated water quality from mine domains that will discharge to the receiving environment.

Response

A variety of surface water quality datasets have been used to derive water quality source terms for geochemical modelling of pit lakes. For instance:

- Golden Bar Pit Lake Model: Natural baseline water quality has been obtained from monitoring location GB02 (see Appendix J and Attachment A that appendix for data).
- Coronation Pit Lake Model: Rehabilitated catchment water quality has been determined from monitoring location DC08 (see Appendix L: MWM, 2024).

[5] Excluding the uncertainty associated with the total Sb within MTI

- FRIM[6] Pit Lake Model: Rehabilitated catchment runoff water quality has been determined from water monitoring site NBWRRF[7] (see Appendix M: MWM, 2024).

MWM (2024) has also determined the water quality for a number of mine domains that could discharge to the receiving environment including waste rock stacks and pit lakes:

- MWM (2024) has provided water quality data for WRS seepage that reports to a number of surface water locations. The derivation of water quality for each WRS is provided in Appendix I (MWM, 2024) and is a conservative assessment of WRS seepage water quality, reliably reflecting the current WRS heights.
- Water quality models have been developed for the following pit lakes. These models are used to forecast future discharge water quality. The following models are available:
    - Golden Bar Stage 2 Pit Lake (Appendix K: MWM, 2024).
    - Coronation Stage 5/6 Pit Lake Model (Appendix L: MWM, 2024).
    - FRIM Pit Lake Model (Appendix M: MWM, 2024)

The other datasets are addressed by GHD.

RESPONSE TO RFI 5.3

RFI:

"*The water quality data contained in Appendix F suggests there is a high probability of copper causing significant adverse effects at MC02 and more than minor effects at NB03 during closure and after closure. To what extent does the current proposal contribute to long-term copper concentrations (i.e., what are the modelled concentrations under a scenario where the proposed activities do not occur)?"*

This request is related to:

- Appendix 13: GHD Report - Water quality and balance modelling and
- Appendix 22: Ryders - Water quality and ecology assessment.)

MWM has been asked to provide information on the source of Cu.

Response

A source of Cu is likely to be from the oxidation of sulfide minerals within waste rock stacks, pit voids, and from the processing of ore to extract gold.

The following datasets are available:

- Innes Lake Pit Lake water quality during 1996 – 2004 ranged from 0.0008 to 0.001 mg Cu/L (Table 6: MWM, 2024).

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[6] *Frasers / Innes Mills*

[7] *North Branch Waikouaiti River Ross Ford*

- Deepdell North Backfill water quality during 2001 – 2022 ranged from 0.0005 to 0.002 mg Cu/L (Table 7: MWM, 2024).
- Other pit lakes are shown in Table 21 (MWM, 2024) and ranged from 0.00057 - 0.001 mg Cu/L.
- Seepage water quality from waste rock stacks is shown in Table 25 (MWM, 2024) and ranges from an average of 0.0009 – 0.0041 mg/L with Cu being slightly higher when SO_4 is elevated (Figure 4, Appendix I: MWM, 2024), although the relationship is very weak (due to very low Cu values). These data are reproduced below in Figure 1 and show that generally higher values are seen for higher sulfate concentrations.

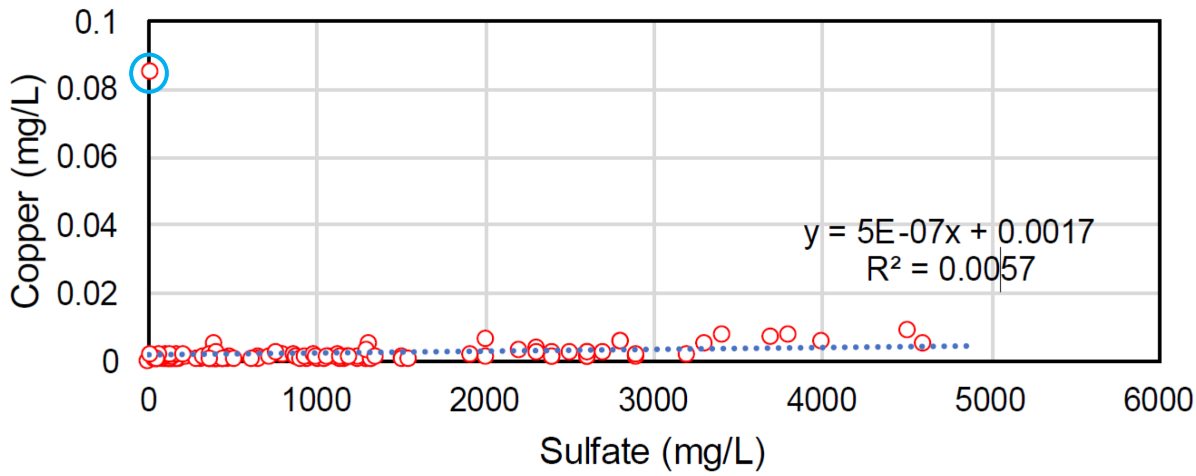

Figure 1. Cu versus SO4 for WRS seepage water quality

Source: MWM, 2024: Appendix I – Figure 4

Note: there is one anomalous result (circled) that is likely to be an analytical / reporting / data entry error.

- TSF underdrain water quality (Table 8: MWM, 2024) shows that Cu can be elevated compared to pit lakes:
  - MTI (1991 – 2022): 0.029 mg/L average.
  - SPI (2006 – 2022): 0.00498 mg/L average.

The water quality compliance limit for Cu is 0.009 mg/L in accordance with an assumed hardness of 100 mg $CaCO_3$/L (i.e., conservative as hardness is generally higher in mine influenced waters at Macraes). Most data presented above is lower than this limit.

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