Memo

From	**Dr Chris Hickey**
To	Charles Horrell, Otago Regional Council
CC	
Date	14 July 2016
Subject	Oceana Gold: Comments on s92 response

This memo provides comments on the responses provided by Oceana Gold to Otago Regional Council (ORC) to the section 92 (s92) information request relating to the extension of Macraes mine (Oceana Gold Application RM16.138). Specifically this addresses responses from Greg Ryder, Ryder Consulting (letter to John Bywater dated 8 July 2016) and from Brett Sinclair, Golder Associates (letter to John Bywater dated 13 July 2016).

I have specifically addressed the responses to the question I raised in my memo of 24 June 2016 and provide some general comments below.

General comments

Ryder

Sediment conditions. Dr Ryder states in relation to sediment conditions for ecological protection that "*I do not think they should be based on an aesthetic measure as these creeks are not used for recreational activities (they are very small, narrow and shallow) nor are they in areas that have easy public access*".

Response: In the absence of any national guidelines for ecological protection then I would suggest that the aesthetic guidance for either a 30% or a 50% change from background is a practicable approach. The optical clarity of the water is an ecologically relevant parameter as it relates to the ability of the fish to feed successfully. The absence of any sediment-related data precludes any assessment of the importance of baseline suspended sediment and clarity conditions.

Ecological monitoring. A plot of galaxiid abundance was provided (Figure 39).

Response: This data could potentially provide useful information for site-specific water quality thresholds if there was concurrent water quality monitoring data available for these sites. In various years the galaxiids show marked reductions in abundance between sites – indicating that some physical or chemical factor(s) are affecting abundance (some red lines added to Figure 39 below). Such an analysis may be a useful component of the site monitoring programme and the evaluation of potential effects for this proposed expansion.

Sediment monitoring data. Plot of turbidity versus flow in Deepdell Creek provided for monitoring prior to 1994 (Figure 2 in Golder response).

Response: I note that the upstream to downstream monitoring shows a lower turbidity on each sampling occasion for flows less than 100 L/s but higher turbidity for flows greater about 200 L/s. Is there a diluting flow between the upstream and downstream sites? Are the settling ponds overwhelmed or scoured at during high rainfall events?

This data provides the basis for some further analysis but does not provide a baseline condition for the Mare Burn system.

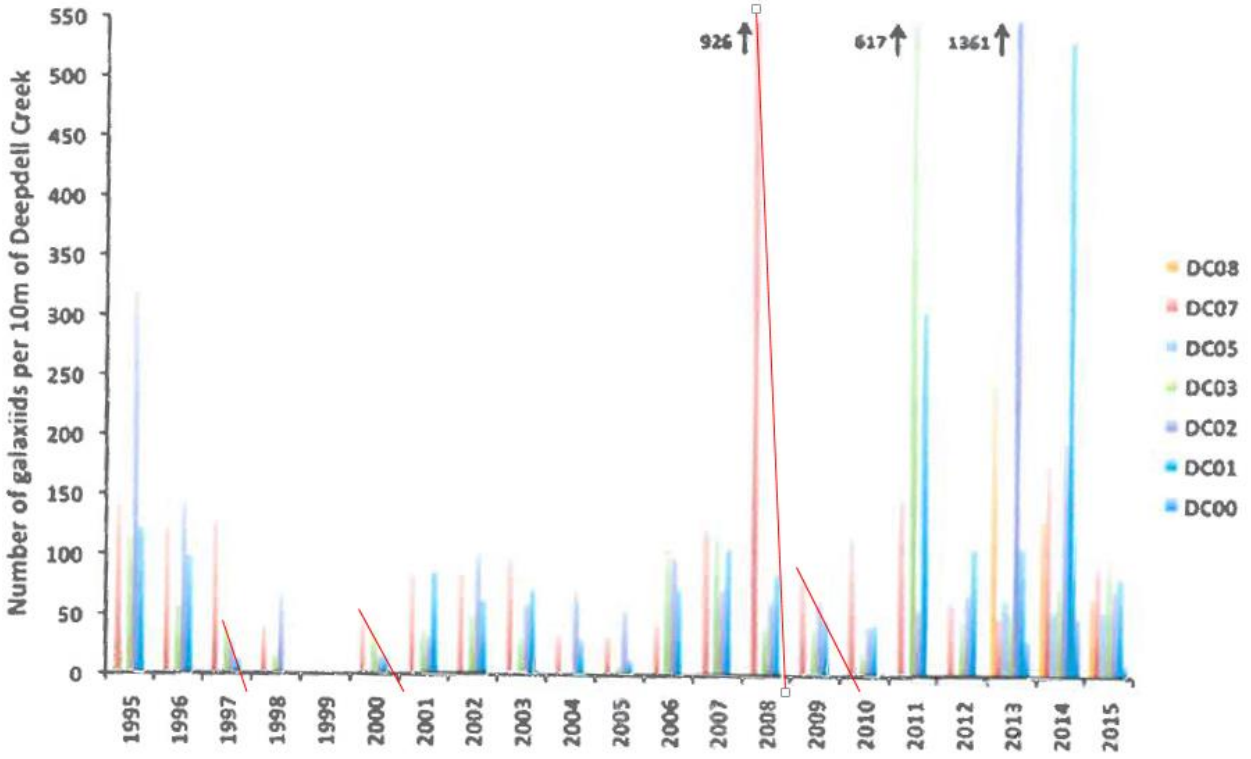

Figure 39 *Number of flathead galaxiids (per 10 m reach) found in summer surveys of Deepdell Creek, 1995 to 2015.*

Dissolved oxygen. Ryder suggests that some continuous monitoring for Coal Creek.

Response: I note that the Golder response provides more detail in relation to potential deoxygenation.

Golder Associates

Nutrients. The response acknowledges that the generation of ammoniacal nitrogen and nitrate nitrogen through the use of ammonia based explosives and the use of nitrogenous and phosphatic fertilisers applied to waste rock stack areas as part of site remediation activities (p2). Some historic nitrate (Figure 3), total nitrogen (Figure 4) and phosphate (Figure 5) data for Deepdell Creek provided. The nitrate data particularly shows numerous occasions with markedly elevated concentrations over what might be considered background levels for that site. Golder states that: "*OceanaGold is however not aware of any down-stream issues arising through excessive macrophyte or algal growth that may have arisen through the discharge of dissolved reactive phosphate to the receiving water bodies*." (p2)

Response: This does not provide any baseline concentration data for the Mare Burn catchment. The indicative data for the somewhat larger Deepdell Creek suggests that the potential for elevated nutrient concentrations warrants more detailed consideration. The statement on behalf of Oceanagold as being "not

aware" and "excessive" when no nutrient or nutrient effect-related monitoring (e.g., visual periphyton assessment) does not provide a robust assessment in relation to potential nutrient enrichment.

Electrical conductivity and sulphate. Some limited electrical conductivity (EC) and sulphate monitoring data is provided for Mare Burn (sites MB01 and MB02) since January 2015 (Figures 6 and 7) – together with superimposed flow data for Deepdell Creek.

Response: The reduction in EC during a high flow event is indicative of a point source discharge with dilution from runoff (diffuse sources) being markedly lower in concentration. Downstream dilution between MB01 and MB02 appears to be minimal.

The EC level is particularly high in Mare Burn with the level showing an increasing trend. This is largely mirrored by the sulphate concentrations. However, the maximal EC level of about 300 mS/m converts to a total dissolved solids (TDS) level of about 1920 mg/L [1].

While the measured maximum sulphate concentrations are around 80 mg/L, this is only about 4% of the TDS calculated from the EC. This is a surprisingly low percentage and raises the question as to what are the other ionic components of the TDS? Alternatively, could the EC measurement be as microS/cm? If so, the fraction of sulphate would be more sensible.

This issues relating to EC and TDS require further information and assessment.

Dissolved oxygen. More detail on potential deoxygenation provided (p10).

Response: This provides more detail and in acknowledging that there might be prolonged stratification and reduced DO and elevated dissolved iron concentrations. The additional detail of using a surface water withdrawal will go some way towards reducing potential downstream DO effects. More specific design and operational details would need to be in place as part of the consenting process.

Alternative discharge methods. I note that the potential for land discharge is addressed but that pumping, maintenance and long pipelines were noted as potential issues (p2). Given the relatively low minimum dilution downstream of the proposed dam (minimum 66% dilution, Item 19, p15), I would consider that the potential for land, or waste rock pile, irrigation during low flow (i.e., summer) periods should be further investigated. Ideally, a zero discharge might be achievable during low flow periods.

Conclusion

A summary of issues from the s92 information requested and response to comments received is provided in Table 1. Further comments on these issues is provided above.

Overall, I consider that the responses to the s92 information request is insufficient to address the issues raised in relation to future water quality issues in Mare Burn as a result of the proposed Macraes Mine expansion.

[1] Conversions: 100 microS/cm = 0.1 mS/cm; 10 mS/m = 64 ppm TDS. This TDS conversion is based on NaCl and will differ with other salt compositions. (http://www.lenntech.com/calculators/conductivity/tds_engels.htm).

Table 1. Summary of issues for s92 information requests and response to comments received

Information requested	Comment		s92 Responses	Comment
Provide background monitoring information on Mare Burn clarity (i.e., turbidity, suspended sediments, black disk clarity) to provide base flow and flood conditions.	Background information on the receiving water clarity is required to establish compliance conditions.		N	Some data provided for Deepdell Creek. No clarity data.
Provide background monitoring information on Mare Burn nutrient (nitrogen and phosphorus) concentrations under base flow and flood conditions.	Background nutrient data is required to assess likelihood of periphyton blooms.		N	Some historic data provided for Deepdell Creek.
Provide background monitoring information on Mare Burn electrical conductivity and sulphate concentrations under base flow and flood conditions.	Background EC data is required to assess likelihood of toxicity criteria exceedance based on anticipated add to background compliance conditions.		Y	Some recent data since January 2015 for EC and sulphate. Discrepency between EC and sulphate for ions balance.
Provide an indication on the likelihood of compliance with potential ecological compliance conditions under base flow and flood-flow conditions. Will multiple compliance criteria be exceeded under specific circumstances and if so for what duration? Note that a cumulative exceedance plot is not sufficient for this analysis as it does not distinguish between large numbers of multiple exceedances and fewer long-duration (i.e., chronic) exceedances.	This is to establish the likelihood of multiple stressors resulting in cumulative adverse effects on downstream communities.		N	Not assessed. Maintain that stock watering use is appropriate compliance criteria.
Provide an assessment of whether the proposed Coal Creek freshwater dam will stratify and the likely period of seasonal stratification.	Based on the proposed depth of the dam (30 m) it is anticipated that prolonged seasonal stratification will occur.		Y	Improved assessment.
Provide an assessment of whether the proposed Coal Creek freshwater dam will deoxygenate and, if so, whether it will result in elevated iron, manganese, ammonia or sulphide concentrations.	Information on predicted COPCs should stratification occur.		Y	Mention of iron and removal in settling ponds.
If the proposed Coal Creek freshwater dam will deoxygenates, provide predictions of concentrations of contaminants downstream at MB02 in Mare Burn.	Prediction information of downstream concentrations for COPCs.		N	
If the proposed Coal Creek freshwater dam will deoxygenates, provide predictions of dissolved oxygen at site MB02 ad a compliance assessment with NPS-FM standards for DO.	NPS-FM standards assessment.		N	Limited downstream dilution at low flow with dam addition. May be low DO issues.
If the proposed Coal Creek freshwater dam deoxygenates, will mitigation measures, such as aeration be used to destratify and ensure aeration above critical thresholds?	Mitigation and management responses.		N	Not address for aeration. Surface water take proposed.
Provide ecological protection guidelines suitable for application to compliance monitoring site MB02	A comprehensive suite of parameters and guidelines for ecological compliance is provided in Table 3 of this report.		N	
Provide an updated assessment of compliance with the ecological guidelines at site MB02	This should repeat modelling work as provided in Appendix A (Golder Associates 2016) for an extended suite of parameters.		N	Not assessed. Maintain that stock watering use is appropriate compliance criteria.
Provide information on predicted suspended sediment and turbidity levels in pit lake and at downstream compliance sites	No information is currently provided either for existing pit lakes (e.g., Fraser Pit) or for receiving water background concentrations.		N	Some data for Deepdell Creek.
Provide an updated assessment of compliance with the NPS_FW standards for nitrate and ammoniacal-N at site MB02. This assessment should include an add to background approach to establish predicted concentrations downstream of the monitoring site.	No information is currently provided for potential effects on receiving water standards for nitrate and ammonia toxicity.		N	Some data for Deepdell Creek.
Provide an assessment of the potential for elevated nutrient concentrations, wither from the pit lakes, waste rock storage or from the Coal Creek freshwater dam to result in increased downstream perihyton blooms.	No information provided on the likelihood or otherwise of nutrient stimulation of periphyton growths. Based on NPS-FM standards for attribute classes.		N	Some data for Deepdell Creek and observations.
Provide a specific assessment of the likely compliance with the hardness-adjusted ecological protection guideline for sulphate at site MB02 both during operations and following mine closure. If significant exceedance of this sulphate guideline occurs then information on the distance downstream for a compliance point should be provided.	The proposed ecological compliance conditions for sulphate is markedly lower that the stock watering guideline currently used. Given the predicted concentrations the ecological guideline will be exceeded for long periods. Information on the downstream distance for compliance or treatment measures should be provided.		?	No hardness data. Insufficient information.
If pit discharge and waste rock discharges are likely to result in dissolved arsenic concentrations comparable with those in the Frasers Pit (Golder Associates 2016, Appendix A, Table A3) then speciation information for arsenic should be provided.	Elevated arsenic concentrations will require consideration of total and dissolved arsenic and speciation. Site-specific arsenic guidelines may require toxicity testing of locally relevant species should potential arsenic toxicity be identified as a significant issue.		N	Not addressed.
Provide information on the water hardness in Mare Burn suitable for use in applying hardness-adjusted metal and sulphate toxicity guidelines.	Information required to establish site-specific compliance conditions for metal and sulphate.		N	
Provide flow hydrographs for: (i) site MB01; (ii) MB02 (existing); and (iii) MB03 after freshwater dam inflows.	Information to assist in establishing the seasonal variability in flow and duration of intermittent flow at MB01. Provides basis for wastewater dilution calculations.		Y	
Provide predicted wastewater dilutions for the above monitoring sites.	Information on available dilutions indicated likely exceedance risk for contaminants exceeding acute or chronic guidelines.		Y?	Dilution addressed but not in relation to ecological guidelines.
Provide information on proposed chemical dosing and general management for sediments (e.g., first flush management, treatment ponds).	This anticipates that suspended sediment concentrations and associated turbidity may be significantly elevated relevant in receiving waters. As such, some treatment systems will be required to meet anticipated receiving water compliance criteria - particularly during construction phase. Continuous turbidity monitoring at site MB02 and adaptive management relating to this data may be required.		Y	No treatment. Settling ponds.
Provide further information on the seasonality of the "water deficit" for the stormwater management. Will this just be in summer or a whole year deficit?	Engineering Geology (2016) report a "water deficit" for the existing operation and that water is pumped from the Taieri River to provide additional process water.		Y	