BEFORE THE FRESHWATER HEARINGS PANEL

IN THE MATTER of the Resource Management Act 1991

AND

IN THE MATTER of submissions on the Proposed Otago Regional Policy Statement 2021: Freshwater Planning Instrument

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EVIDENCE OF DEBBIE CLARKE

FOR OCEANA GOLD NEW ZEALAND LIMITED

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INTRODUCTION AND BACKGROUND

1 My name is Debbie Clarke.

2 I have worked at the Macraes Gold Project (**MGP**) since April 1996. I am currently employed by Oceana Gold (New Zealand) Limited (**OceanaGold**) as a Senior Environmental Advisor at Macraes Mine. I have been employed in this position since 2014 and prior to that I was an Environmental Projects Advisor.

3 In my role I am responsible for site environmental related matters including monitoring, rehabilitation, heritage, ecology, reporting, consent compliance, management plans and ensuring OceanaGold continues to maintain a high standard of environmental excellence and fully complies with all applicable statutory requirements, in order to leave a positive legacy at the end of mine life.

4 I am authorised to give this evidence on behalf of OceanaGold.

5 I have a Bachelor of Science (Environmental Science).

OUTLINE OF EVIDENCE

6 OceanaGold has asked me to provide evidence on the following topics:

a. An overview of the general operations and environment at Macraes;

b. How freshwater is essential to the Macraes Mine, and the company's approach to its management;

c. Climate change;

d. Use of water for farming at Macraes; and

e. Methods used to allow fish migration.

MACRAES MINE

7 In Otago, OceanaGold owns and operates New Zealand's largest gold and silver mine. The mine is located in East Otago, in the area around Macraes Flat. Most of the mine is within the Waitaki District, however

part of the mine (around the Coronation North pit) is within the Dunedin City boundary. The Macraes mine has operated since 1989 and the Macraes goldfield is a world class mineral resource.

8 The company holds more than 200 resource consents for the Macraes mine, mostly granted by the Otago Regional Council, but also land use consents issued by the Waitaki District and Dunedin City Councils. This includes resource consents for water takes and discharges, diversions and damming which are issued by the Otago Regional Council.

9 The Macraes mine comprises a mix of underground and open pit mines, depending on the nature and location of the mineral resource, as well as overburden rock stacks, a large freshwater storage reservoir, a processing plant, several tailings storage impoundments, and associated roads and other infrastructure.

10 The Macraes area has a variable rainfall, and at Macraes evaporation exceeds rainfall hence the area operates in a net water deficit. Macraes imports more water onto the site for processing purposes than is directly discharged into the receiving environment.

11 Mining is locationally constrained, which means that it needs to be located where the mineral deposits are found. Naturally occurring surface and groundwater frequently co-locates with important mineral resources (and in many cases partly explains why the minerals are where they are - especially in the case of fluvial deposits). This means that a necessary part of mineral development involves diversions and dewatering to allow minerals to be accessed and also to separate clean water from contact with ground disturbed by mining activities as much as possible to protect water quality. Because of this, and the scale of the operations, mining the precious mineral resources of the Macraes goldfield at times unavoidably impacts on freshwater resources.

DR RYDER'S REPORT

12 Dr Greg Ryder has been working in the Macraes area since the mid to late 1980's and has extensive knowledge of the aquatic ecology and

surface water quality in the Macraes area. He has prepared a report which is attached to my evidence as **Appendix 1**.

13 In his report he says that the benthic invertebrate community of Deepdell Creek has stayed broadly similar over time, and is representative of that found in other creeks. Overall, he has found that invertebrate diversity is generally similar at monitoring sites, however those downstream of the mine have lower diversity. In his opinion some of this may be attributable to the effects of mining, but he says it is difficult to differentiate the effects of mining from other rural land uses.

14 He also concludes that the mine has not had any material effect on the water quality of the Shag/Waihemo River, however nitrogen (principally nitrate) is increasing.

15 Dr Ryder has been unable to find any evidence that Macraes mining activities in the headwaters of tributaries of the Shag/Waihemo, Taieri or Waikouaiti rivers are adversely affecting ecological values further downstream. He says that the mine's footprint is still relatively small compared to the sizes of these catchments, and the cumulative effects of the various land use activities in the catchments remain the dominant force affecting water quality, hydrology and downstream ecology.

16 There has been a loss of habitat (including spawning habitat) for the flathead galaxias and kōura although he says that this has been mitigated to some extent by a number of covenants set up in nearby catchments and the funding of trout barriers in other catchments.

17 Dr Ryder does not consider that mining operations have affected fish passage.

RESOURCE CONSENTS

18 Mining operations at Macraes Mine interact with freshwater (as defined in the Resource Management Act 1991) in a variety of ways.

Processing plant

19 Freshwater is essential for ore processing. OceanaGold has a permit to take water from the Taieri River at up to 200 litres per second,

however in reality OceanaGold is limited by the pipeline and pumping infrastructure to a maximum take in the order of 85-90 litres per second. This water is pumped to OceanaGold's Lone Pine Reservoir (**Reservoir**) where water is stored, and then supplied to the processing plant and also used for staff and contractor showers and toilet facilities. Some water is treated to be used for drinking water.

20 The Reservoir is essential to ensure OceanaGold has access to a secure supply of good quality freshwater, because there have been dry periods when OceanaGold is unable to pump water from the Taieri. OceanaGold has participated in a rostering agreement with the Strath Taieri Water Users Group during dry periods to have some security of supply, but there have also been times when OceanaGold has stopped taking water altogether. The processing plant operates 24 hours a day, 7 days a week and the water supply to the processing plant needs to be continuous. The Processing Plant cannot operate at a variable speed or rate to match water availability, it needs the right amount of water for all the processing circuits to function optimally. Stopping and re-starting the plant isn't just uneconomic due to downtime, but also leads to problems with variability in the ability to process the ore properly when the plant re-starts.

21 Between 80 and 90% of the water used in the Processing Plant is recycled from the tailings water. Although there is a significant cost in pumping water from the Taieri River, there isn't really any opportunity to increase the amount of recycled water used because if there are sediments in the water being used it can distort the gold processing cycle and it isn't possible to recover all the water as some is consumed or lost in the process.

Dust suppression

22 Water is also used at Macraes Mine as a dust suppressant, on haul roads, other earthworks area and on the tailings impoundments. The tailings (which are a by-product of processing ore) are deposited as a slurry, however if they dry out they can create dust. Therefore there is a sprinkler system to reduce the risk of this.

Closure

23 At closure, some completed pits are designed to be filled with water to form pit lakes. In this way water is used to both protect water quality by limiting exposure of mineralised rock to oxygen, and to ensure long term stability of pit slopes.

24 Whilst pit lakes and other standing water can provide some visual amenity, water that collects on top of the tailings dams and the pit lakes is not designed for contact recreation and cannot be expected to meet contact recreation standards. The process of filling a pit lake naturally can take hundreds of years and recreation access isn't possible for stability and safety reasons.

Monitoring

25 There are over 150 monitoring sites at Macraes Mine. Some are monitored for consent compliance, however there are additional sites which OceanaGold monitors for its own records. Monitoring is monthly at most sites with some additional parameters monitored quarterly. For water quality monitoring OceanaGold collects the water samples which are sent to external laboratories for analysis for specified parameters.

26 Monitoring has been a part of modern-day mining at Macraes Mine since 1989, and therefore there is a lot of data held for the site.

27 There are some difficulties with monitoring, for example in the pits, you move the point of water take as mining in the pit moves around and this makes comparisons difficult. Also, with the tailings impoundments, as you are consistently adding water (via the continuously applied tailings deposition) and simultaneously taking water from the decant pond to return to the Processing Plant for re-use, plus have losses and inputs via drains and sumps so actual takes cannot be measured.

Resource consents

28 OceanaGold holds a variety of water related consents for the following purposes:

a. Surface water takes. In addition to the water take from the Taieri River, water which collects in pits is surface water. OceanaGold has permits to take water from pits for dewatering purposes.

b. Groundwater takes. OceanaGold has groundwater takes for the purpose of pit dewatering, and to ensure the water is managed in relation to the underground workings.

c. Water diversion. Overland water is protected by diversions around the open pits and waste rock stacks. There is also a consent to divert the North Branch of the Waikouaiti River. Some of these diversions are likely to be permanent.

d. Discharges to water and to land where it may enter water, for examples discharges of tailings and waste rock, and discharges of water from open pits to water (eg water from the Frasers open pit is discharged into the North Branch of the Waikouaiti River and Murphys Creek).

CLIMATE CHANGE

29 Macraes Mine is very aware of potential effects of climate change. As far as I am aware, modelling of climate change is incorporated into technical reports produced for the Mine.

FARMING

30 OceanaGold doesn't farm any land itself, however the majority of its approximately 13,500 ha landholding at Macraes is farmed by leaseholders.

31 There is no reticulated water supply or community water scheme at Macraes outside of the Macraes Village. Providing water for stock is the most important issue.

32 Silt ponds may be able to be left at closure for stock water, and diversions retained to ensure water continues to flow to where it is needed.

CONCLUSION

33 At Macraes OceanaGold manages water against a wide range of closely monitored parameters, both in terms of water takes and water

discharges. We also dam and divert water as an essential part of continuing to operate. We have an expected mine life that will have achieved 40 years of continuous mining by the end of this decade, using a processing plant that has consistently operated at rated capacity, 24 hours of the day, 365 days of the year, throughout most of that time. Our water use is both highly productive and also consistent.

34 Long-term discharges to the receiving environment have been modelled through successive rounds of consenting in all three catchments spanned by the mine's operations. The results of that modelling, with the benefit of long-term regular monitoring at in excess of 150 water quality monitoring points has provided data to inform the model and give us confidence that water quality can be managed both while the mine is operating and post-closure (as Dr Ryder explains further in his report).

35 What is clear is that our ability to take, discharge and manage water at Macraes will require continuing flexibility, and the ability to access a range of short-term and long-term water management tools. Some water dams (both tailings impoundments and freshwater dams) and diversions are likely to be permanent.

Appendix 1 – Report by Dr Greg Ryder

Report by Greg Ryder

1.1 My name is Gregory Ian Ryder. I am an Environmental Scientist based in Dunedin since 1979, currently working for myself. I graduated from the University of Otago with BSc. (First Class Honours) (1984) and PhD. (1989) degrees in Zoology. Both my honours dissertation and PhD. thesis focused on stream benthic invertebrate communities in Otago streams and rivers, including the Shag/Waihemo and Taieri river catchments. Since then, I have worked mostly as an independent consultant specialising in assessing the effects of various activities on surface water quality and aquatic ecology throughout Aotearoa New Zealand. I have presented evidence as an expert witness at numerous council hearings, plan or plan change hearings, boards of inquiry, EPA and WCO hearings, and Environment Court hearings. I am a member of the New Zealand Freshwater Society, accredited under the Making Good Decisions Program to sit on RMA hearing panels (chair certification), and since February 2020 a Board member of the Environmental Protection Authority.

1.2 I have worked on a number of projects relating to mining and gravel abstraction, including alluvial gold mining and hard rock gold mining. These include aquatic investigations and surveys associated with existing gold mining in the Fraser River catchment (Central Otago), Waikaia River catchment (Southland), Macraes District (North Otago), Waihi District (Waikato), proposed lignite mining in the Waituna catchment (Southland), Tuakitoto-Kaitangata area (South Otago) and Hawkdun area (Central Otago), and hard rock gold mining in the Snowy River catchment (West Coast).

1.3 OceanaGold asked me to prepare evidence for the Freshwater Planning Instrument parts of the Proposed Otago Regional Policy Statement on the freshwater ecology of the Macraes Mine area. I am going to be overseas and am unavailable for the hearing, therefore I am providing a short report which will be attached to the evidence of Debbie Clarke.

1.4 Although I am not giving evidence, and this is not before the Environment Court, I have followed the Environment Court's Code of Conduct for Expert Witness. I confirm that the issues in this report are within my area of expertise and that I have not omitted to consider material facts known to me that might alter or detract from the opinions expressed.

Experience with monitoring of OceanaGold mining operations.

1.5 My association with the Macraes Gold Mine area goes back to the mid 1980s when I was undertaking my PhD degree at the University of Otago. I was subcontracted by Fish and

Game Otago (then the Otago Acclimatisation Society) to assist them with baseline surveys of the aquatic ecology of the area, prior to the commencement of open pit mining. These surveys were undertaken at the request of the then owners of the mining licences in an independent capacity. The work included fish and benthic macroinvertebrate surveys and general habitat assessments, macroinvertebrate sample processing and data interpretation. After resource consents for mining were granted, the mine owners then commenced a detailed freshwater monitoring programme in 1990, and my personal involvement in the monitoring programme re-recommenced in 1995. My previous company has been monitoring surface waters of the area since then and I still take an active role in assessing the data associated with that monitoring programme.

1.6 The freshwater ecology monitoring programme at the Macraes Mine area is probably the most extensive and long-term of its kind in Otago and Southland, and possibly the South Island, and has provided me with opportunities to observe the freshwater ecology of the area under a broad range of climatic conditions, ranging from wet years with frequent floods, to very dry years, when sections of creeks have dried up for months on end. Consequently, I have gathered an extensive knowledge of the aquatic ecology and water quality of surface waters of the Macraes area.

1.7 A brief overview of the Macraes Mine site and the freshwater features present.

1.8 When I first started working in the Macraes area back in the mid to late 1980's, the landscape was dominated by an extensively farmed agricultural landscape (beef, deer, sheep and some cropping) with some visual evidence of historic mining activities (e.g., old pits filled with water, pockets of processed rock piles, water races and a stamping battery adjacent to Deepdell Creek). At the time, there was some exploration drilling taking place, but it was relatively minor in the context of the rural farming landscape described above. Today, the landscape is dominated by mining infrastructure, with several large open pits (some active, some no longer active and filled or filling with water), several large rehabilitated and active waste rock stacks, large tailings ponds and freshwater reservoirs, haul roads, a processing plant, various depot and office facilities, and realigned public roads.

1.9 The current gold mine straddles catchments that drain into the Shag/Waihemo River, Taieri River and Waikouaiti River. The mine area lies largely on plateau-type land. Tributaries within, adjacent to and immediately downstream of the mine's footprint are generally small, with relatively steep gradients, and lie within deeply incised valleys with rocky outcrops. Their habitat is characterised by schists gravels, slabs and bedrock with occasional small pools.

1.10 Deepdell Creek is the largest surface water feature in the Macraes area. It is contained within a confined channel that is surrounded by steep-sided land throughout most of its length. Riparian vegetation is dominated by pasture grasses, broom and matagouri, with occasional tussocks and *Carex* sedges along the margin. Shading is common due to the incised channels, steep topography and overhanging riparian vegetation. Stock and pig disturbance of the banks is evident in many places and has been the case since I can remember. Deepdell Creek is a tributary of the Shag/Waihemo River.

1.11 In summer and autumn, the flow in Deepdell Creek can drop significantly, and some sections can be devoid of surface water, however, even under these low flow conditions, the creek is punctuated with occasional very slow moving sections providing refuge for aquatic life.

1.12 Monitoring over several decades now shows that the benthic invertebrate community composition at Deepdell Creek is nothing unique and is currently dominated by snails, chironomid larvae and various Trichoptera (caddisfly larvae – an insect group), with lessor contributions from small crustaceans, mayfly larvae (another insect group) and worms. This assemblage is broadly similar to that observed over many years of monitoring. Benthic invertebrate health index scores are typically indicative of 'poor' to 'fair' water quality using the narrative terminology of Stark and Maxted (2007). This ranking reflects the dominance of taxa (e.g., chironomid larvae and snails) that are relatively insensitive to poor water quality and habitat conditions, including elevated algae and plant biomass.

1.13 Generally speaking, the invertebrate community of Deepdell Creek is representative of that found in other creeks that are monitored in the area around the mine, which is not surprising, given they have similar physical characteristics and drain catchments with similar elevations, climate, land use activities and vegetation cover.

1.14 The fisheries of these local catchments have always been characterised by low species diversity and a dominance of the non-migratory indigenous Taieri flathead galaxias (*Galaxias depressiceps*). Monitoring in Deepdell creek over many years has indicated that the galaxias population is large (although can fluctuate widely in density) and resilient to algae blooms, disturbance (e.g., large floods and stock damage), changes in water quality and drought conditions.

1.15 The Taieri Flathead galaxias is also abundant in small tributaries of Deepdell Creek, and in tributaries of the adjacent Mare Burn and Tipperary catchments, where mining is also taking place in the headwaters. They are less abundant in headwaters of the Waikouaiti and Cranky Jims catchments, and reasons for that are not clear to me.

1.16 The Taieri flathead galaxias has been classified by the Department of Conservation as 'Threatened – Nationally Vulnerable', with criteria C (3) (moderate population, with population trend that is declining, total area of occupancy ≤ 100 ha (1 km^2), predicted decline 10–50%) and the qualifiers 'Conservation Dependent' and 'Data Poor' (Dunn *et al.* 2018[1]). It is remarkable in its ability to recover as a population following droughts, large floods and other disturbances, and to me it is a stand-out feature of local creeks in the Macraes area. It has a relatively narrow geographical distribution and is only found in Otago.

1.17 Brown trout and longfin eel (tuna) have occasionally been caught in Deepdell Creek since regular monitoring commenced in the 1990s, however they are uncommon. This is probably due to limited access from downstream populations in the Shag catchment (Deepdell Creek often flows underground in a short section downstream of the mine footprint) and frequent low flows in summer provide limited habitat availability. These species are also uncommon or absent in surrounding tributaries. Longfin eel are classified by the Department of Conservation as 'At Risk – Declining' (Dunn *et al.* 2018).

1.18 Freshwater crayfish or kōura (*Paranephrops zealandicus*) are common and widely distributed the Macraes Flat area. Their relatively high abundance in these creeks is surprising given that habitat appears limited by a lack of flow and wetted area at times, particularly during late summer and into autumn. A lack of predators (trout and birds – both restricted by a lack of suitable foraging habitat and, in the case of trout, upstream passage) and good cover amongst the schist slab substrate may in part explain the success of crayfish at Macraes. *Paranephrops zealandicus* has been classified as 'At Risk – Declining' using New Zealand Threat Classification System (NZTCS) criteria (Grainger *et al.* 2018[2]).

1.19 What effects have been observed on freshwater ecology?

1.20 Modern mining has resulted in the loss of a number of small first order tributaries in the Deepdell, Cranky Jims, Mare Burn, Tipperary and Waikouaiti North Branch catchments, with a consequential loss of habitat for stream fauna and flora communities. It has been estimated that the length of streams lost as a result of the mining operation could be as high as about 58 km if ephemeral gullies and seepage areas are included[3] although the exact amount is very uncertain given the lack of record keeping in earlier years and less

[1] Dunn, N.R., Allibone, R.M., Closs, G.P., Crow, S.K., David, B.O., Goodman, J.M., Griffiths, M., Jack, D.C., Ling, N., Waters, J.M. and Rolfe, J.R. 2018. Conservation status of New Zealand freshwater fishes, 2017. New Zealand Threat Classification Series 24. Department of Conservation, Wellington, New Zealand.

[2] Grainger, N., Harding, J., Drinan, T., Collier, K., Smith, B., Death, R., Makan, T. and Rolfe, J. 2018. Conservation status of New Zealand freshwater invertebrates, 2018. New Zealand Threat Classification Series 28. Department of Conservation, Wellington, New Zealand.

[3] Stream networks protected through covenants developed by OceanaGold amount to approximately 17.6 km in length.

accurate mapping techniques. The benthic invertebrate communities of these lost tributaries were typical of communities found in farmed catchments throughout Otago and contained nothing that was special or unique. These tributaries, and other surface waters in the area, at least since I have been working in the area, have always suffered from occasional algal blooms and droughts, and have been affected by local farming practices. Nonetheless, habitat has been lost through modern day mining.

1.21 Overall, invertebrate diversity is generally similar between Deepdell Creek monitoring sites, but downstream sites (i.e., downstream of the mine) generally have lower diversity than other sites. The lower diversity is likely to be influenced by the frequent loss of surface flow at this site, some differences in physical habitat, and potential effects associated with farming and mining activities in the upstream catchment. It is difficult to differentiate the effects of mining from other rural land use practices and the influence of local habitat.

1.22 Some of these tributaries provided habitat for Taieri flathead galaxias, kōura and a few brown trout and tuna. Taieri flatheads and kōura would have been relatively common in these tributaries, however these species remain common throughout waters within and adjacent to the current mine footprint, although less common on the Waikouaiti catchment side.

1.23 As remains the case today, these tributaries were not protected from stock (and feral deer and pigs) access and so were subjected to disturbance through bank erosion, bed disturbance and inputs of organic material (dung, urine, etc.). They had also been subject to historic mining activities, as evidenced by relics of diversion channels (races), pits, rock piles and dams. Water transfers across catchments, as a result of historic mining practices, may have been responsible for the population of flathead galaxias in the Macraes area being regarded as a 'hybrid' species, having a different genetic make-up.

1.24 Has the mine caused a reduction in ecological values downstream in the Shag/Waihemo, Waikouaiti or Taieri river catchments?

1.25 Because the Macraes mine straddles the three major catchments listed above, there is potential for effects on downstream water quantity, water quality and stream ecology in all three catchments. In 2020, I undertook an analysis of the nutrient status of the Shag/Waihemo River downstream of the Deepdell Creek confluence as a part of the Macraes Deepdell North consent application process. I examined long-term monitoring data (2004 – 2020) for the Shag/Waihemo River monitoring site at Craig Road, which is located approximately 15 km downstream from the Macraes mine. Overall, I found that

concentrations of total phosphorus (TP) and dissolved reactive phosphorus (DRP, which is readily taken up by algae) were decreasing over time, and that ammoniacal nitrogen concentrations were very low and did not appear to be increasing or decreasing over time.

1.26 In contrast, the trend analysis indicated that total oxidised nitrogen (TON, which is the sum of nitrate and nitrite) and total nitrogen (TN) were both increasing, however they remained within their respective NPS-FM 2020 NOF A bands for ammonia and nitrate toxicity.

1.27 In June 2023 I checked the LAWA website[4] for the latest water quality 5-year trend analysis for this monitoring site. It reports that water clarity at Craig Road is 'very likely improving', turbidity is 'likely improving', TN, nitrate-N, DIN[5], TON and TP[6] concentrations are all indeterminate (i.e., neither improving or degrading), ammoniacal-N is 'very likely improving' and DRP is 'very likely improving'. *E. coli* is also 'likely improving' although the presence of this contaminant is highly unlikely to be related to mining operations at Macraes.

1.28 The LAWA monitoring programme does not monitor sulphate at Craig Road, however it is monitored regularly further upstream at Loop Road by OceanaGold, where there is a consent compliance limit of 250 mg/L. Current sulphate concentrations at this monitoring site are well below the compliance limit, and usually less than 50 mg/L.

1.29 Based on the above findings, I find that the mine has not had any material effect on the water quality of the Shag/Waihemo River, however nitrogen (principally nitrate) is increasing.

1.30 The closest regular monitoring site in the Taieri River downstream of the Mare Burn catchment is Sutton, however, at approximately 47 km downstream, it is too far downstream to provide any meaningful assessment of the effects of mining in the Mare Burn catchment on Taieri River water quality. However, it is worth noting from the LAWA website that the 5-year trends at this site for ammoniacal-N, DIN, DRP and TP are all 'likely improving'. That is not to imply this site is pristine, but rather there is no evidence to suggest that it has been degraded any further as a result of recent mining operations in the Mare Burn catchment.

1.31 The Otago Regional Council has a water quality monitoring site on the lower Waikouaiti River at the confluence with the north and south branches. Again, this site is a significant

[4] Land, Air, Water Aotearoa: https://www.lawa.org.nz/

[5] DIN = dissolved inorganic nitrogen, which is the sum of ammonia-N, nitrate-N and nitrite-N.

[6] TP = total phosphorus.

distance downstream of the Macraes mining operation in the headwaters of the North Branch (approximately 50 km). A recent analysis of water quality trends at this site (Ozanne 2020[7]) indicates that most water quality attributes that are monitored (ammoniacal-N, nitrate-N, DRP and *E. coli.*) are in the NPS-FM 2020 NOF bands A or B, with an improving trend for DRP but a degrading trend for turbidity.

1.32 I have been unable to find any evidence that Macraes mining activities in the headwaters of tributaries of the Shag/Waihemo, Taieri or Waikouaiti rivers are adversely affecting ecological values further downstream. The mine's footprint is still relatively small compared to the sizes of these catchments, and the cumulative effects of the various land use activities in their respective catchments remain the dominant force affecting water quality, hydrology and downstream ecology. Some loss of habitat (including spawning habitat) for the flathead galaxias and kōura undoubtedly has occurred, although this has been mitigated to some extent by a number of covenants established in similar nearby catchments and the funding of trout barriers in other catchments with at risk roundhead galaxias populations (a species that has a greater threat risk classification than the Taieri flathead galaxias). I do not consider mining operations have affected fish passage. All mining is undertaken in headwaters and generally there is no upstream catchment that fish require access to for spawning or rearing. The major culvert in Deepdell Creek under the haul road to the Coronation Mine was replaced in recent times following a major flood, and was positioned in a manner to enable fish to move up and down it. Notwithstanding that, there are barriers (dams, waterfalls and naturally dry sections) further downstream in Deepdell Creek, Mare Burn and Tipperary Creek that prevent or at least partially restrict upstream fish passage. These, along with periodic dewatering of sections during drought events, have probably been beneficial to the local Taieri flathead galaxias populations in restricting passage and the establishment of local brown trout populations.

1.33 It is unlikely that any aquatic species have been lost as a result of mining.

1.34 Methods that have been employed to mitigate effects.

1.35 Through my involvement in resource consent projects at Macraes, I am aware that OceanaGold has avoided, where possible, certain areas or avoided adverse effects and undertaken mitigation, offsetting and compensation, some of which were described in the previous paragraph. Consents granted for the Macraes Gold Mine are usually accompanied by a suite of mitigation initiatives. Mitigation initiatives that have addressed effects on surface waters include:

[7] Ozanne, R. 2020. State and Trends of River and Lake Water Quality in the Otago Region 2000-2020. ORC report.

- The protection of tussock grasslands and scrublands outside of the mining area. While not directly related to surface waters, they indirectly protect their associated surface waters through the protection of their immediate catchment (e.g., stock removal, reduction in fertilizer use).
- Avoidance and fencing of wetlands where practicable. A number of wetland areas have been deliberately avoided and protected, and, cumulatively, this will assist in maintaining and enhancing water quality.
- Sediment and erosion management plans, including the use of silt ponds and other sediment control measures to ensure compliance with water quality standards. These are standard practice at the Macraes Gold Mine and help mitigate the effects of mining.
- The augmentation of flows into Deepdell Creek and Mare Burn with clean water sources. This approach has been consented to mitigate the potentially toxic effects of elevated contaminant concentrations (primarily nitrate and sulphate – which are natural compounds produced from the waste rock (schist) stacks) and to prevent nuisance algae build-up downstream.
- Enhanced protection of other non-migratory galaxias populations off-site (e.g., constructing barriers to prevent trout invasion). In collaboration with the Department of Conservation, catchments outside of the Macraes area that support threatened, non-migratory species, including species that are more vulnerable than the Taieri flathead galaxias, have been identified and targeted for barriers to protect against invasion of predatory species, particularly brown trout.
- Implementing methods to build waste rock stacks so that the leaching of contaminants such as nitrate and sulphate are reduced. These have been implemented successfully at the mine.
- Removing kōura and fish from sections of creeks about to be affected by mining and translocating them to unaffected reaches prior to construction.
- Including conditions to ensure that contaminants associated with construction in and around waterways (e.g., diesel, lubricants) are kept away from watercourses and bunded.
- The requirement for measures to reduce the risk of nuisance aquatic weed/algae being introduced into the catchment through machinery and personnel (e.g., *Didymosphenia geminata* - didymo). Didymo has been recorded in the Shag River catchment, but has not been recorded in the upper Deepdell Creek catchment. I understand that OceanaGold complies with notices and guidelines issued by Biosecurity New Zealand regarding didymo.

1.36 These mitigation measures have been generally successful in protecting the aquatic communities of local surface waters, and there is always potential for additional

mitigation measures to maintain and enhance these communities.

Greg Ryder

28 June 2023