Before the Independent Hearing Panel

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

Evidence of Ramon Ross Dungey on behalf Waikaka Gold Mines Limited

Ecology and Water Quality

19 November 2025

Introduction

1. My full name is Ross Gordon Dungey.

2. I have 45 years' experience in the field of freshwater biology and fish and wildlife management. I hold a BsC in zoology and a diploma in freshwater biology from Otago University.

3. I am the director of Ross Dungey Consulting, a position I have held for 27 years.

4. My previous work experience includes aquatic biology assessments for various hydro and irrigation schemes in Otago, Canterbury, West Coast, and Marlborough, gold mines in Otago and Southland, and field contributions to various instream studies on minimum flows with Cawthron Institute in Otago and Southland (NREI studies) on the Lindis, Upper Clutha, Manuherikia, Aparima, Oreti, and Waiau Rivers.

5. I currently conduct instream assessments in support of consent applications and monitoring mostly in Otago Rivers and Lakes, and some conservation work on Otago non-migratory galaxiids. Galaxiid studies in which I have been involved comprise population assessments, tagging, and monitoring studies for four galaxiid species (Eldons, Dusky, Gollum, and Longjaw) for the Department of Conservation in Otago, species distribution of galaxiids on the Waimea Plains for the Department of Conservation in Southland and galaxiid distribution and protection/enhancement in Otago for the Otago Regional Council. I frequently encounter galaxiids when surveying streams in support of resource consent applications. I have had extensive experience in identifying key habitat components supporting fish and wildlife in freshwater habitats as these are key to maintaining, enhancing, and restoring fish and wildlife populations. This began with studies on the lower Waitaki Hydro scheme (for the New Zealand Electricity Department) in the early 1980's and continues through to present day. From 1986 to 1998 I was a field officer with Otago Fish and Game where I was heavily involved with habitat identification, enhancement and protection.

6. I was instructed by Waikaka Gold Mines Limited (the '**Applicant**') to provide an aquatic ecology survey of the water bodies affected by the Proposed Waikaka Gold Mine for evidence in relation to their application for resource consents from the Gore District Council ('**GDC**') and Environment Southland ('**ES**').

7. I have visited the site on many occasions, mostly in the summer of 2021-23, but also several times since where I conducted electrofishing, netting, habitat assessments, riparian vegetation cover checks, wetland habitat checks, observations of fish behaviour, and temperature recording, variously in the ponds, ditches, Shepherds Creek, and the Waikaka Stream. I estimate I have spent 20 days in the field.

8. In preparing this evidence, I have reviewed the Application documents relevant to my evidence; the submissions made by Fish & Game and the Department of Conservation; and those parts of the section 42A report addressing ecological matters, including the evidence of Mark Hamer.

9. I have also reviewed and relied on the following documents:

   a. The consent application documents;

   b. The evidence of Mr Heller and Mr Weber

   c. The New Zealand and international literature on freshwater ecology and habitat tolerances and preferences of freshwater fish and invertebrates.

   d. New Zealand Freshwater Fish Database

   e. Hydrology and flow records available on the ES website.

   f. The National Policy Statement for Freshwater (NPSFW 2020).

   g. Stream habitat assessment protocols, Harding et al 2009 and EIANZ Guidelines 2018

   h. Protocols for Sampling macroinvertebrates in wadeable streams, Stark et al 2001,

   i. International literature on Stream Rehabilitation procedures. Robins et al 2024,

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

Scope of Evidence

11. My evidence will address the following:

    a. A description of the existing aquatic ecological values in the Waikaka Stream, Shepherd's Creek, ditches and ponds within and adjacent to the proposed Gold Mine;

    b. An assessment of the effects of various aspects of the proposal on ecological values;

    c. The approach to, and feasibility of, stream rehabilitation;

    d. Recommended mitigation and conditions of consent, including identification of key habitat features and biotic indices that can be monitored to assess the success of rehabilitation procedures;

    e. Assessment against the effects management hierarchy;

    f. Response to submissions and the ES s 42A Report.

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

Overview and Executive Summary

13. I prepared an Aquatic Ecology and Surface Water Quality Assessment (the 'Ecology Report'), dated February 2021, that was submitted with the

Application. I note that this report was prepared in the context of WGML's first mining proposal, which was subsequently reduced in scale, and so there are references to ponds that are outside the mining footprint of the consent proposal that are no longer proposed. I also prepared a letter dated April 2025 that was submitted in response to a request for further information (the 'RFI response letter') and a second letter dated May 2025 in response to some matters on which further clarification was requested (the 'May 2025 letter').

14. I have assessed the existing ecological values and water quality in the Waikaka Stream, ponds and ditches in the proposed mining footprint.

15. The section of the Waikaka Stream within the proposed mine site is an unusually good example of a lowland stream which supports a healthy population of stream fish species, longfin eel, upland bully, and brown trout. This is largely because of the benefits of an extensive and protected riparian zone which include shade/temperature control, cover, channel stability/less actively eroding stream bank, and terrestrial food sources to fish. These habitat components, with some additional improvements such as screened and therefore clean gravels, can be relatively easily incorporated into a new channel which would re-create productive fish habitat/freshwater ecosystem. For Shepherds Creek and the ditches, extensive macrophyte growth smoothers sections of the existing channels and therefore currently limits productivity.

16. The drainage ditches provide some limited habitat for Gollum galaxiids. This habitat will be recreated as mining proceeds. The ponds variously provide habitat for long and shortfin eels, perch, and trout. Freshwater lobster were occasionally located in the Big Pond.

17. The effects of the mining activity will be associated with the loss of the existing channel for a specified length of river for the duration of each diversion. There are a total of 4 diversions of the Waikaka Stream and one of Shepherds Creek, each for an anticipated period of approximately 1 year. During these times, fish will occupy the diversion channels although probably at a lower density than in the existing river.

18. Conditions on water quality of discharges and the timing of works will protect habitat outside mixing zones and not compromise fish migrations.

19. I have proposed measures to rehabilitate habitat to replicate existing river features. With those measures in place and appropriately monitored and managed, a recovery of the fish and invertebrate populations to levels supported by the existing river is fully expected.

Existing Ecological Values

20. I undertook surveys of the Waikaka Stream, ditches and ponds within and near to the proposed mine footprint in the summers of 2021-23 and the results are reported in the Ecology Report. For convenience, I summarise briefly the existing ecological values and water quality of these waterbodies. A fuller description is provided in Appendix A to my evidence.

Waikaka Stream

21. The water quality as assessed by the macroinvertebrate community index (SQMCI), a standard method also used by ES, is "poor". However, under a variation on that method, MCI, the Waikaka Stream rates as "good". Using the water quality standards for ES, "lowland hard bottom streams", the Waikaka Stream fails on water clarity and SQMCI. From an ecological perspective, water quality is compromised by fine sediment that clogs riffles and high nutrient levels that would predispose the stream to nuisance algae growths were it not for the extensive shading provided by the willows along the banks. There are elevated levels of E.coli below the confluence with Shepherds Creek.

22. The Waikaka Stream supports a healthy fish fauna, namely longfin eels, brown trout, and upland bullies. All these species have the full range from juvenile to adult indicating stable and viable populations. Gollum galaxiids can occasionally be found in the river but are more common in the adjacent minor waterways.

23. Using EIANZ values, all waterways rate as high because of the presence of longfin eels and Gollum galaxiids however habitat quality varies

dramatically, with high grade habitat in the Waikaka Stream and low grade in the ditches, Shepherds Creek and some ponds. The Waikaka Stream sets the standard for rehabilitation.

24. Using EIANZ guidelines, the Waikaka Stream rates as high by virtue of its representativeness as a lowland stream with extensive protected riparian zones, the presence and abundance of longfin eels, a regionally important recreational fishery (brown trout), and a diverse and abundant macroinvertebrate community.

25. Mr Harry Stocker for the SRC advises that a willow removal program is underway in the Waikaka Stream catchment and SRC paused this program in the subject reach given the developing plans from the Applicant. Mr Stocker notes that it is SRC Catchment Operations staff preference that willows along the Waikaka Stream within the application site footprint are removed as early as possible and preferably in the first year of operation. From an ecological perspective my opinion is that the removal of willows along the Waikaka Stream creates serious problems, such as removal of shade (temperature and macrophyte/algae growth control), overhead cover, undercut banks, root mat resistance to erosion, and a terrestrial food source. The willows are a major positive habitat component the loss of which would have serious consequences for the aquatic ecology. Management of willows is a much less damaging strategy and would maintain much ecological integrity.

Shepherds Creek

26. Shepherds Creek is a highly modified (channelized) enriched small stream where macrophytes and channel instability limit habitat and the "life supporting capacity" of the waterway. Fish numbers are expected to be low as a consequence of poor habitat but this is difficult to confirm because of extensive macrophytes growth that limits open water and light penetration. I have not undertaken a fish survey in Shepherd's Creek and instead have assessed likely values on the basis of those present in the Waikaka Stream and the ditches in which longfin eels, bullies, galaxiids, and brown trout are present.

27. Mr Hamer states that he observed gollum galaxiid fry in Shepherd's Creek. I have not personally observed any on the (approximately 4) occasions that I have visited Shepherd's Creek. However, given I observed a small number of Gollum galaxiids in the Waikaka Stream and the ditches, I consider it likely that they are also present in Shepherd's Creek.

28. Using EIANZ guidelines, Shepherd's Creek rates as high because of the likely presence of longfin eels and Gollum galaxiids.

29. Shepherds Creek offers opportunity to improve existing habitat substantially simply by plantings that will provide shade that will limit temperature and light both of which favour macrophytes, algae, and elevated temperatures.

Ponds

30. I originally assessed 8 ponds, however only three of these are within the mine footprint. These are referred to as Ponds 2, 6 and 7 in my original report.

31. Pond 2 has poor water quality with zero clarity and high levels of ammonia and nutrients. It supports a population of shortfin eels ("not threatened"). With regard to EIANZ guidelines, Pond 2 rates as low.

32. Pond 6 supports both longfin and shortfin species of eel and has the best water quality of any of the ponds. There are galaxiids present in parts of the Pond 6 outlet stream. Its proximity to the river and the permanent connection to the river probably explain the presence of both eel species here. With regard to EIANZ guidelines, Pond 6 rates as high based on the presence of longfin eels ("at risk and declining").

33. Pond 7 has good water clarity and a population of shortfin eels.

Ditches

34. The ditches have poor water quality with elevated levels of nutrients. Some of the ditches are mostly dry while the two main ditches may have permanent water but sometimes at very low flow.

35. There are 4 species of fish located in the ditches - trout and bullies are rare, longfin eels occasional, and gollum galaxiids relatively common. The lack of adult galaxiids suggest some limitations on habitat that control all fish abundance in the ditches. Over time, a small degree of habitat variability develops in the ditches as variable flows create some limited variation in depth and velocity and the bank vegetation establishes. Periodic cleaning of the ditches to maintain their drainage capacity reduces habitat variability and the capacity of these habitats to support fish populations. The very low flows characteristic of the ditches likely also means they experience high water temperatures during summer that promote observed rampant plant growth and stress the fish present.

36. According to EIANZ guidelines, the ditches rate as high by virtue of the presence of galaxiids and longfin eels, however on the basis of habitat quality they are poor.

Effects on Waikaka Stream and Shepherd's Creek

Construction and sediment effects

37. Construction of diversions has the potential to generate sediment. However, diversion channels are to be constructed in the dry except for when the connection is made and the channels stabilised before water is diverted into the channel. Management measures to minimise sediment generation are critical to minimising effects on ecological values.

38. To minimise disturbance during commissioning of new diversion channels, I recommend that diversion of flow be undertaken in a stepwise manner over three approximately equal tranches, progressively increasing the proportion of flow entering the new channel. This approach allows fish to naturally redistribute and minimises the erosion potential associated with a large flush of water. Extending the diversion process over 6-10 days will reduces ecological stress and maximises the natural redistribution prior to full flow diversion.

Temporary diversion channels

39. Temporary diversion are short-term features and they will not be constructed to the same standard as the final rehabilitated channels. They will not exist long enough for riparian vegetation to establish. The temporary diversion channels will have lower habitat value than natural stream channels.

40. To mitigate this, the Applicant is proposing conditions that require temporary diversion channels to include key habitat features that can be constructed and/or relocated from other channels, including pools and shallow riffle areas, boulders to create hydraulic variation, gentle meanders where practicable, and in-channel fish-shelter elements, such as securely anchored LWD (large woody debris). The diversion channels will be invaded by fish from upstream and downstream and the installation of these features will enhance their ecological carrying capacity.

Fish passage and migration

41. During the development of the stream diversions there will always be fish passage provided - at no point will the river be blocked off and a barrier to migration in place. Diversions will be conducted during mid to late summer, a time when migrations are generally not occurring. Migrations occur when large numbers of fish move usually to spawning grounds or as juveniles returning from the ocean. There are other generalised movements such as brown trout juveniles redistributing on freshes to alleviate crowding from spawning/rearing locations. Migration characteristics are summarised in table 7.

Table 1 *migration characteristics of fish species associated with the Waikaka Gold Mine.*

Species	Migrations	Direction	Timing	Direction	Timing
Brown Trout adult	Yes	Upstream	April-June	Downstream	Sept-Nov
Brown Trout juvenile	Yes			Downstream	March-May
Brown Trout Fry	No				
Longfin adults	Yes	Downstream	Apr-June		
Longfin Juveniles	Yes	Upstream	Sept-Nov		
Shortfin adults	Yes	Downstream	Apr-June		
Shortfin Juveniles	Yes	Upstream	Sept-Nov		
Upland Bully	No				
Gollum Galaxiid	No				

42. Brown Trout spawning occurs in the winter/spring outside the earthworks period November-March. Therefore I do not consider there will be adverse effects on trout spawning.

Fish salvage

43. The diversion of stream sections will require fish salvage. Fish that do not leave of their own volition will be assisted using methods suited to fish size and location, to the nearest suitable habitat so as to minimise stress. A fish salvage plan is to be developed when the project begins, by a suitably qualified ecologist.

44. The fish salvage procedure involves recording details of the salvaged species and numbers. A key component of the salvage operations will be the recording of fish salvaged and released as this is the basis of the population in the new channel. It is this core group that will provide the initial colonisers in the rehabilitated channel and they will be monitored (population characteristics) to measure the success of the rehabilitation.

45. Diversions are to be conducted in the December - April period as weather conditions allow. Cool temperatures are less stressful on fish. At this time of the year all species are mature enough to be fully mobile which facilitates salvage.

Summary

46. The effects of the diversions will be a temporary loss of aquatic habitat but the rehabilitation provides the means to recreate existing habitat for the Waikaka Stream and improved habitat in Shepherds Creek.

Effects on Ponds

47. Ponds 2, 6 and 7 are to be mined through and so there will be a loss of this habitat value. Ponds are not proposed to be replaced in their current locations however the Applicant expects a terminal pond may eventuate. I recommend this terminal pond has a similar area, planted margins, and a variable depth profile, to provide offset for the loss of pond habitat.

48. Procedures for establishing pond/wetland habitats are well known and advice can be sought from organisations such as Fish and Game who have experience and provide support for such habitat establishment.

49. There are many local ponds that would be suitable for the relocation of eels within the ponds 2, 6 and 7 before they are impacted by mining.

50. Ponds will initially be lost but are easy habitats to recreate and will provide habitat for longfin eels in particular.

Effects on Ditches

51. The mining proposal requires the progressive removal and realignment of several on-site ditches that currently support gollum galaxiid populations. Galaxiids will be salvaged from the ditch habitats as the mine proceeds. Salvaged fish will be relocated to existing ditch habitat or to a reconstructed ditch which has had time to develop to similar quality of habitat. Timeframe of habitat “maturity” relates to the frequency of cleaning the ditches/drains.

Provided the habitat to which the fish are relocated is of a similar quality to their existing environment, I expect there to be limited adverse effects.

52. The western drain realignment will be undertaken at the start of the project and other ditches within the site will be unaffected at this time. Galaxiids in the western drain could be relocated to other drains on site where there is suitable habitat and I would expect this relocation to be successful. As mining progresses, other drains on site will be progressively removed and galaxiids within these drains could either be relocated to the new western drain or other local ditches that are unaffected by the works. I understand that the time between the completion of the western drain realignment and the impact on other drains on site will be approximately 1 year, giving time for some vegetation, shelter, (habitat) to develop in the realigned western drain.

53. The Department of Conservation's submission expresses concerns for the impact of December diversions on galaxiids. However, galaxiid spawning occurs in spring, and juvenile fish are mobile by December, as are most species, so December to February is in my opinion the best time for ditch diversions to be undertaken with minimal impact on fauna. Ditch diversions could be undertaken during the autumn / winter but would require fish to be salvaged first. It is important to note that the diversions will be done in sequence, and not all at once, and this reduces the scale of disruption and potential impacts. It also means there are alternative locations to which relocation can occur and allows for selection of the most hospitable environment at the time, thereby maximising the prospects of successful relocation and minimising potential loss of fish.

54. I also note that the ditches are regularly cleared of weeds by farmers and in my opinion this is far more impactful on the galaxiids than the Applicant's proposed ditch diversions.

55. The length of the new ditches is slightly longer than the existing ones, so there is "no net loss" of ditch habitat for Gollum galaxiids.

56. The ditches are likely to remain as marginal habitat because they are classified as drains and can be cleaned out to maintain their drainage capability.

Rehabilitation of the Waikaka Stream and Shepherd's Creek

Rehabilitation objective and baseline data

57. The rehabilitation aims to establish as good or better habitat than currently exists by careful attention to the habitat features that create the existing habitat and the improvement of some features that are currently in limited supply.

58. The work I have completed provides baseline data on key habitat and biotic indices to assess the rehabilitation channel in comparison with the old channel. Key habitat features include, pool/run/riffle ratios, substrate size distribution (gravels cobbles and boulders to provide a range of habitat features), shade coverage, fish and invertebrate populations.

59. The Applicant has committed to additional ongoing ecological monitoring between the commencement of mining and the first impact on the Waikaka Stream (in year 4) to provide additional baseline data. I support this. There will be some delay in the rehabilitated stream channels reaching full productive capacity as it will take some time for algae and invertebrates (fish food) to establish completely and a generation cycle of fish production to occur, although this will be aided by fish moving into fresh habitat of their own accord.

60. The success of the rehabilitated channels can be assessed on the basis of the habitat measures and biotic indices recorded in the existing habitats of the streams such as species of invertebrates present and their abundance. Similarly for the fish, species, density and size range, will be relevant to assessing the success of rehabilitation.

61. As native trees are slow growing, high maintenance, and of variable success, willow planting will be critical to achieve similar habitat characteristics

required to support the same fish populations as are currently present in the Waikaka Stream.

Habitat quality as the indicator for rehabilitation success

62. As discussed above, the existing habitat has been assessed and measured and will be the baseline against which habitat in the rehabilitated channel can be assessed, with a view to achieving a similar standard for this new channel. Fish and invertebrate populations have similarly been defined. It will be important to record details of the salvage process, particularly any mortalities, as these fish form the basis of the new population and any shortfall needs to be assigned to a program. The reason for this is that correct identification of reasons for lower performance of the rehabilitation channel can only be corrected if the cause is known.

63. Guidelines in the international literature list the three main systems for providing “channel structure and instream cover” as:

    a. Weirs *across the channel* to create dammed pools upstream and scour pools below.

    b. *Mid channel placements* of materials to create scour holes and velocity refuges.

    c. *Bank placements*, especially on the outside of corners.

64. There are examples of these features (a & b), creating pool/riffle structure, in the natural and rehabilitated channel for Waikaka Stream. Examples of (c) can be found on the Mataura River where large woody debris (LWD) has been created by tying felled willows to the bank where they have provided fish habitat and erosion protection/resistance.

65. Identification of key habitat features can be based on where fish are to be found, for example;

    a. Adult trout are in pools with abundant shade and undercut banks created by willows

    b. Juvenile Trout are found in cobble/gravel riffles

c. Eels are located in pools with heavy shade cover, log jams, overhanging willows, undercut banks, and boulders used for crossings and erosion control, during daylight. At night they move to riffles to feed.

d. Upland bully are located in shallower pools, small backwaters, and riffles.

66. Key habitat features then are;

   a. Riffles with coarse gravel and cobbles
   b. Undercut banks
   c. Overhanging vegetation-grasses, shrubs, willows
   d. Large woody debris (LWD)
   e. Deep pools
   f. Boulder clusters

67. Of the above features, all are relatively easy to create except for the undercut banks. These have developed in an incised channel where willow root masses stabilize the banks against erosion. LWD is a recognised habitat feature in streams and a major component in stream rehabilitation and to a degree provides a temporary feature until undercut banks establish.

68. Consent conditions should include reference to the same habitat features recorded in the assessment of the Waikaka Stream habitat, as noted above.

Monitoring parameters

69. The assessments made of the existing habitat define the design parameters for the rehabilitated channel and also highlight some areas where habitat can be improved. The addition of some backwaters will improve habitat diversity, as will increasing the proportion of pools and riffles. Habitat components are discussed above. Monitoring of fish and invertebrate populations will be the measure of project success when it can be shown these populations are present in the rehabilitated channel at the same or higher levels than currently exist.

70. The habitat ecological features and biotic indices measured were:

   a. Fish species - density, size range
   b. Invertebrate species - density, biotic indices (MCI, EPT, number of taxa);
   c. Water quality - nutrients, sediment, pathogens
   d. Stream dimensions - pool/riffle/run proportions
   e. Substrate - size and distribution
   f. Riparian vegetation, cover
   g. Shade
   h. Undercut banks
   i. Pond surface area

71. I consider that measurement of the above indices will provide a good approximation of the progression of habitat, ecological, and water quality restoration in the Waikaka Stream and will be able to be compared to the pre-mining ecological state of the Waikaka Stream.

Opportunities

72. The key to successful rehabilitation is to mimic those habitat features/parameters of the existing channel and enhance some features currently in short supply. Existing habitat is of good quality so we have a well-defined format to follow in recreating habitat. Additional features, referred to in the literature, relate to restoring natural river form and features such as backwater habitats, meanders, riparian vegetation, and "hinging" or LWD, (Manual of River Restoration Techniques. 2020)

Limitations

73. There are some ecological factors beyond the control of the Applicant's operation, for example, water quality and fine sediment sources from upstream. Both these currently compromise existing habitat quality. Fine sediment already clogs the interstitial spaces in riffles thus limiting food

producing capacity, small fish habitat and spawning habitat. The discharge from Shepherds Creek also spikes the E-coli count and probably nutrient levels.

Feasibility

74. There is an abundance of information describing river restoration techniques and the problems NZ rivers and their occupants face are universal. River restoration programs in the UK, Europe, and North America describe correcting the same issues faced in NZ where rivers have been channelized and riparian vegetation removed. This loss of habitat variability, along with water abstraction, and land-use based sources of sediment and pollutants compromise habitat world-wide. The techniques used to correct this habitat loss are universal. To use brown trout as an indicator species, they were introduced from overseas, thrive in New Zealand rivers, suffer the some of the same problems as in their region of origin, but respond to the same habitat restoration techniques.

75. World-wide, salmonids, eels, mayfly, and stonefly for example, occupy freshwater and are broadly responsive to similar habitat interventions.

76. I note that Mr Hamer expresses "low confidence" that the objectives of the streambed rehabilitation can be achieved. By contrast, for the reasons above, (para 83 & 84), I am confident that the rehabilitation approach will be successful, particularly having regard to features in Para 73 to 78 that were assessed on the existing Waikaka River, and them being replicated in the rehabilitation channel.

Recommended mitigation / conditions of consent

77. The habitat features described above in para 56 are essential indicators to ensure that the rehabilitation objective is achieved. Therefore, ongoing monitoring of these both before the diversions and during the rehabilitation phase are necessary to ensure the restoration of aquatic habitat.

78. I have read the proposed conditions appended to Ms Collie's evidence that describe the rehabilitation techniques, monitoring regime, requirements for

detailed design and a management plan to set out all the requirements. I support these. I anticipate the River Diversion set of conditions will require methods of fish salvage, recording, managing effects on fish, and rehabilitated habitat to be appropriately addressed.

Water quality monitoring

79. Mr Weber and Mr Heller set out recommended monitoring parameters for water quality in their evidence.

80. The table below sets out international discharge limits for metals likely to be associated with the mine.

Parameter	Monitoring Type	Monitoring Frequency	Limit mg/L	Reference
Turbidity	Compliance	Continuous		
TSS	Compliance	Weekly		
pH	Compliance	Continuous		
Fe	Compliance	Weekly	<5000	USEPA
Co	Compliance	Weekly	<300	Diamond et al 1992
Al	Compliance	Weekly	55	ANZEC 95% eel protection
Cu	Compliance	Weekly	.002	USEPA
Pb	Compliance	Weekly	.001	USEPA
Zn	Compliance	Weekly	0.03	USEPA

Effects Management Hierarchy

81. The effects management hierarchy is an approach set out in the NPSFM whereby adverse effects are avoided where practicable; then minimised where practicable; then remedied where practicable; then more than minor residual adverse effects may be offset; or failing that, compensation is provided if appropriate.

82. In this case, effects on aquatic ecosystems have been avoided by decisions as to the scale and progression of the proposal. The project as I originally assessed it has been significantly reduced as a result of consultation and further consideration by the Applicant.

83. Minimisation of effects of the mining for aquatic habitats include,

84. A rehabilitated stream post mining based on parameters describing existing habitat

85. Ongoing monitoring to measure success of rehabilitation and make corrections based on the monitoring.

86. Maintaining a flow at all times to allow for fish movement upstream or downstream.

    a. Maintaining a flow at all times to allow for fish movement upstream or downstream

    b. Avoiding instream work during critical times to minimise impacts on migration, spawning, incubation

    c. Staged diversions to spread the impact and therefore reduce severity

    d. Sediment control measures during construction

    e. The addition of LWD, large woody debris for erosion control and fish cover

    f. Screened gravels/cobbles on newly constructed channel beds

    g. The addition of boulder clusters at pressure points to resist erosion and provide eel habitat in particular

    h. Additional habitat types such as backwaters

    i. Salvage of fish from channels in the mine path

    j. Internationally recognised limits on metals in discharge waters

87. In terms of minimising effects, I acknowledge there will be a time lag from the point of rehabilitated channel construction to where full carrying capacity is achieved. This is as a consequence of the time for the food web

to establish in the new habitat and for invertebrate and fish species to colonize and features such as riparian vegetation/shading to develop to provide benefits similar to the mature riparian zones on the Waikaka Stream.

88. NIWA studies (Collier et al 2002) recorded initial invertebrate colonisation within a few weeks/months for some species and up to a year for others limited by repeat disturbance and initially unsuitable habitat. In the case of the rehabilitated channel colonisation that should be much more rapid because prime habitat is immediately available and there is an immediate source of colonisers, suited to that habitat, drifting in from upstream existing habitat.

89. LWD and boulders clusters will, in the early stages, provide the habitat substitute for undercut banks that will take much longer to develop.

90. Given that habitat is prime from the start, life cycle generation times will vary for insects up to a year and for fish 1-3 years based on time to reach reproductive maturity.

91. Carrying capacity will be limited by habitat quality and a key controlling factor here is likely to be shade as that habitat component will take the longest to establish - 3-5 years. I therefore consider adverse effects will be remedied within 5 years.

92. Measures to offset unavoidable impacts during the mining period, are, backwaters, cleaner gravels, pool/riffle ratio, LWD, boulder clusters, extended off-site riparian fencing planting, and creation of additional eel habitat. These measures are offered in the conditions of consent and plans and I consider them adequate to provide for the re-establishment of habitat matching the quality of the present Waikaka Stream. If these same measures are applied to Shepherds Creek then a significant improvement over what is currently there should result.

Submissions

Fish and Game New Zealand

93. I have reviewed the submission received from Fish and Game New Zealand (the 'F&G submission').

94. The F&G submission had questions about several aspects of the ecological assessment. I have met with F&G to discuss these points and there is now general agreement and no outstanding issues related to the ecological report, in particular the timing of instream works being confined to the period November to March inclusive.

95. At part (b) of the F&G submission, it is stated that the Waikaka Stream once had a more meandering form and that the Waikaka Stream as it exists today has been channelised and straightened and that there is less habitat variability than a more naturalised stream. I agree that this is the case.

96. I have suggested that backwaters are created in the rehabilitation channel plan. They are a habitat type currently in limited supply but are valuable for habitat variety and can be easily constructed within the floodplain footprint. Most fish species presently in the Waikaka Stream will make use of additional backwater habitat. Anglers in particular know the value of backwaters for feeding adult brown trout.

97. In relation to point (c) of the F&G submission, I noted that rock rip rap is present in some locations on the Waikaka Stream and eels are very abundant in this habitat. I support the use of rip rap for its obvious contribution to channel stability and fish habitat, eels in particular. The "rip rap" I refer to is a 40m section of stream bank with substrate size varying from 190-1180mm and a mean size of 570mm. After having this clarified, I understand that F&G have no objection to the use of such "rip rap". I consider that rock rip rap and large woody debris (LWD) will be ideal for use in creating habitat and channel stability in the rehabilitated stream.

98. Point (e) of the F&G submission discusses the need for a fish passage and migration assessment. All instream/diversion works are scheduled for the period approximately November to March at which time there are no migrations occurring but in addition to that at no time will the river be dammed and there will always be fish passage available in one or other channels.

99. Spawning surveys of the reach to be diverted in the winter prior to diversion would help fine tune this schedule and minimise the risk to newly hatched fry and allow specific gravel distribution in the rehabilitated channel to recreate lost spawning habitat.

100. I consider that conditions of consent requiring that instream works are carried out within the timeframes (November to March inclusive) are necessary to ensure protection of freshwater fish migrations, spawning habitat and spawning/incubation. This time frame is agreed with F&G.

Department of Conservation

101. I have reviewed the submission received from the Department of Conservation (the '**DoC submission**').

102. The DoC submission seeks additional information on the potential presence of indigenous or at-risk native species in the waterways connecting the disused mining ponds with the Waikaka Stream. I checked these waterways on several occasions during the ecological surveys and most were dry most of the time and so provided no permanent fish habitat. However, the presence of fish in the ponds clearly demonstrated there is connection at some point, most likely during floods and freshes. The one channel that has permanent water connects pond 6 to the Waikaka Stream. This channel is heavily overgrown with macrophytes making any capture of fish difficult. It is reasonable to assume that the same species present in the pond and the river will be represented in the connecting channel albeit at lower densities as the habitat is compromised by the macrophytes. Subsequently four minnow traps were set in the pond 6 outlet stream (November 2025) and confirmed the expected presence of upland bully and galaxiids.

103. Effects on freshwater species and habitat are temporary and will be managed with the reconstruction of the rehabilitated channel incorporating many key elements of quality habitat as identified in the ecological report.

104. The DoC submission raises concerns about the effects on fish passage. Fish passage will always be available as the flow in the Waikaka Stream will continue in either existing, diversion, or rehabilitated channels. Works will be timed to avoid major migration periods so there is little likelihood that fish migrations will be disturbed.

105. In relation to galaxiid population characteristics, I have worked on galaxiid populations from other sites/previous studies, for example Nevis river tributaries. (appendix A, Galaxiids). A key difference with the "ditch" populations is the quality/permanence of the Nevis catchment habitat that supports multiple generations of galaxiids. Adults reach 110mm in spite of very harsh winter conditions. No large adults were seen in the Ditches.

106. Para 21 of the DoC submission concerns a Fish Management Plan. The Rehabilitation plans required by the Applicant's proposed conditions should include proposals to remedy or offset for any permanently lost pond habitat and any delay in habitat restoration. Ponds are to be recreated at completion of mining and can be ceded with fish from ponds not disturbed/outside the mine.

Response to s42A Report

107. I have read Mr Hamer's evidence and respond as follows.

108. At paragraph 7 Mr Hamer observes that the diversion channels will be shorter in length than the existing stream resulting in a loss of habitat. I agree that the diversion channels are shorter, however they are temporary. As such, any loss of habitat is temporary.

109. Also at paragraph 7 Mr Hamer states that the rehabilitation channels "only cover enough area to provide no net loss rather than enhancement". The rehabilitation channels fit within the available space matching the existing channel area. For the Waikaka Stream there is little opportunity to enhance habitat above the high quality that already exists. The addition of some backwaters will increase habitat diversity and therefore enhancement at a small level. For Shepherds Creek there are considerable opportunities for enhancement as current habitat is degraded.

110. The habitat features that contribute to quality habitat have been measured and monitoring will demonstrate the degree to which they are replicated in the rehabilitation channel allowing for fine tuning of those features.

111. Shepherds Creek provides poor quality habitat, that is, it lacks critical components that the Waikaka Stream has and so its rehabilitation will be modelled on the much better habitat quality of Waikaka Stream.

112. Mr Hamer at para 8, refers to a "lack of consideration of magnitude of effects". Detailed measurements of key habitat components including measures used in regional council "State of the Environment " monitoring, have been made of habitat in the Waikaka Stream. These form the baseline for stream rehabilitation. Effects are dealt with in Effects Management Hierarchy section of my evidence above at para 93.

113. Building those components into a rehabilitated stream with some improvements such as screened gravels and backwaters will ensure stream habitat capable of supporting a similar aquatic community.

114. It is agreed that Shepherds Creek has high ecological values based on the likely presence of galaxiids and longfin eels, however it is degraded habitat where much of the stream bed is smothered by macrophytes thus severely limiting its capacity to support freshwater fish species.

115. At paragraph 14, Mr Hamer refers to my description of the ditches as being "low value habitat". I should have described them as poor quality given the sparse fish and invertebrate populations, cleaning program, and rampant macrophyte growth. There were too few fish present to be able to conduct population estimates. Galaxiids in the western drain will be salvaged to existing habitat rather than newly created ditch that has not had the time to begin to develop habitat. The length of ditches is slightly longer post mining than now.

116. Pond habitat is relatively easy to create and there is local support/advice on this. It is now clear that with mine plans being finalised that ponds 2, 6, and 7 will be impacted and it is feasible that a similar area of pond can be

recreated post mining. Pond 6 is classified as high value because of the presence of longfin eels.

117. In response to Mr Hamer's paragraph 17, ponds, ditches, and Shepherds Creek are all to be realigned so the focus is on rehabilitation using identified key habitat features and improving on those issues that limit habitat suitability. I do not agree that the effects on these ecological values of these features has not been assessed. Where these water bodies exist within the mine path they will be temporarily lost but replaced with as good or better habitat post mining. Shepherds Creek stands to benefit the most as it is currently in the worst condition and will be enhanced by riparian shading and bank stability. In the medium term there will be no overall effect as habitat becomes fully restored and improved.

118. Upstream migration of juvenile longfin eels is referred to in paragraph 20 of Mr Hamer's evidence. No such eels were encountered in our surveys over the course of summer so they are at least at very low density at this location. There will not be any time when there is not upstream access available as there are no plans to dam the river. The improvement in habitat in the rehabilitated stream will likely benefit them as well as other species and life stages.

119. At paragraph 21, Mr Hamer refers to not being aware of successful examples of rehabilitation of the type proposed in New Zealand. There are few examples of stream rehabilitation in New Zealand - it is not something we commonly do. Overseas examples and habitat assessments are our guidelines. In this case, there has been extensive planning, design, and habitat assessment done to facilitate the rehabilitation process and a process is proposed which will require certification by ES. Monitoring will provide the measure of success and inform fine tuning to provide habitat to support the aquatic community.

120. At paragraphs 22-23, Mr Hamer discusses Shepherds Creek. There will be a temporary loss of 590m of the stream but the rehabilitation will restore Shepherds Creek to better than existing habitat conditions by including habitat features identified from the Waikaka Stream and modifying habitat

features that currently compromise habitat, eg shade, macrophyte limitation, improved fish passage.

121. At paragraphs 24 and 25, Mr Hamer discusses the Ditches. The ditches are to be diverted and subsequently replaced with a similar length of ditch. Galaxiids and eels salvaged will be transferred to existing habitat. The periodic cleaning of ditches to maintain their drainage capacity precludes options to improve them as fish habitat. Fish will not be released to a newly excavated ditch which clearly has no capacity to support translocated fish.

122. I note at paragraphs 26 and 27, Mr Hamer refers to "wetlands". There are no wetlands affected by the Application.

123. At paragraph 28, Mr Hamer refers to the wider network of waterways providing habitat for eels, trout, galaxiids and bully and koura (freshwater lobsters were rare and only found in the "Big Pond"). These species occupy a wide range of habitats of varying quality. Identification of key components is the basis of conservation measures in NZ and worldwide so critical aspects are well known, e.g., sufficient water of adequate quality, shade for temperature and algae regulation, clean gravels for invertebrate production, spawning, incubation, small fish habitat, channel stability, exclusion of fine sediments, to name a few. The efforts put into channel design, shape, dimensions, gradient, substrate, and riparian cover all demonstrate careful attention to what constitutes quality habitat able to support the existing aquatic community in the rehabilitated channel. This applies to Waikaka Stream and Shepherds Creek.

124. Monitoring of habitat features and biotic indices will measure rehabilitation progress and highlight areas needing fine tuning. An example of "fine tuning" might be planting of more/different species in the riparian zone to increase shading and control water temperature and algae growth.

125. I disagree that the assessment of effects is inadequate and that the proposed rehabilitation is insufficient to avoid significant adverse effects. All the waterbodies affected by diversions are to be reinstated with a suite of measures (as discussed) to restore and improve habitat. Monitoring will confirm this and steer the rehabilitation process by recording levels of

measured parameters for comparison with baseline values. The negative effects, enrichment in particular, that currently compromise fish habitat in Shepherds Creek will be strongly mitigated in the rehabilitated enabling an expanded area of suitable fish habitat.

126. Mr Hamer discusses the proposed rehabilitation plan from paragraph 31. Rehabilitation procedures are discussed in my evidence above. A similar process applies to the Waikaka Stream and Shepherds Creek. The rehabilitation plan uses the level of various habitat components as recorded from quality habitat in the Waikaka Stream to set the standard for other more degraded water bodies. The ditches do not have the same status as the streams and there is therefore less opportunity to enhance them.

127. In para 33 Mr Hamer references failures of rehabilitation projects. Some of the literature reviews these failures and identifies those points compromising success so they are able to be addressed. Failures were frequently related to political issues and a lack of follow up. This project is supported by extensive design, ecological investigation, monitoring and consent conditions to ensure its success. Abel et al, to whom Mr Hamer refers, dealt with a large floodplain river rather than a small stream but also noted that "River restoration is an active field worldwide and there is good potential for river restoration practitioners in NZ to draw on lessons from elsewhere, although there is also a need to tailor approaches to national and local contexts." We have carefully tailored our assessment of habitat features to describe a rehabilitated stream.

128. Ditches are part of the farm drainage system and do not have the same status as the streams. Allowable management of the ditches precludes the habitat restoration measures that could be applied if they were streams. As mentioned, with very low numbers of fish, population density assessments are difficult, however a rough estimate is 0.4 galaxiids per square metre. This was assessed in early summer when larger numbers are expected from recent spawning. A late summer estimate is likely to be lower and if the water way partially dries up and is subject to high temperatures then much lower. Estimates for Gollum galaxiids in permanent habitat such as the Nevis River tributaries range from 1.3-5.5 fish/m2.

129. In response to paragraph 36 of Mr Hamer's evidence, the rehabilitation is based on widely recognised habitat features universally measured to assess habitat quality and guide restoration of degraded habitats. The lack of their application in NZ does not mean they will be unsuccessful. Given the support behind the restoration/rehabilitation many of the pitfalls described in the literature can be dealt with. As well, it is an opportunity to monitor success of such an undertaking and fine tune it for New Zealand conditions. It has potential benefits for restoring other degraded habitats in New Zealand.

130. To fine tune the rehabilitation an adaptive management plan approach is required. This flexibility provides opportunity to respond to observed needs and changing responses to habitat features.

Conclusion

131. For the reasons set out in my evidence above, I am satisfied that while there will be some temporary adverse effects on aquatic habitat that currently exists in the affected environment, such effects have been minimised to the extent possible, and following rehabilitation measures, will be fully restored to as good as, or in some cases (particularly for Shepherds Creek) better than existing. I consider the conditions put forward by the Applicant to be suitably robust to ensure that the outcomes sought will be achieved.

Ross Dungey

Dated 19 November 2025

Appendix A - Ecological and water quality assessment results

Invertebrates

132. Invertebrates were surveyed predominantly with kick and surber samplers. Various biotic indices were used to describe the invertebrate community, compare to other streams, and establish a baseline against which future rehabilitation could be compared to measure the success of the rehabilitation.

133. The indices include EPT score (number of ephemeroptera, plecoptera, trichoptera genera present, that is mayfly, stonefly, and caddisfly), number of taxa, density, and 3 variations on the Macro Invertebrate Community Index program, MCI, SQMCI, and QMCI, table 1. Assessing the invertebrate community is a very good method of determining stream health as it provides a summary of prevailing conditions in the preceding months, as opposed to a spot check which for example water chemistry does.

Table 1, characteristics of invertebrate populations surveyed by surber sampler for the Waikaka River December 2021. Del=deleatdium, Pycno=pyncnocentria, potam=potamopyrgus, chiron=chironomid.

	EPT Taxa	**Density /m^2**	**# of Taxa**	**QMCI score**	**SQMCI**	**MCI**	**Major taxa**
Waikaka River 1 (low)	5 (43%)	69208	11.7	5.1	3.6	107.7	Mayfly, caddisfly, chironomid.
Waikaka River 2	5 (38%)	8500	13	3.98	3.5	103.1	Chironomid
Waikaka River 3	5 (42%)	7183	12	5.61	4.2	108.3	Mayfly, caddisfly.
Waikaka River 4	4 (34%)	6550	11.7	5.53	4.2	103.1	Mayfly, caddisfly.
Waikaka River 5	6 (43%)	9642	14	6.7	3.3	112.9	Mayfly
Waikaka River 6 (top)	7 (50%)	7775	14	6.11	3.5	107.1	Mayfly, caddisfly.

134. The invertebrate community generally ranks as good on these indices but there is a trend to decline with distance downstream perhaps as a consequence of the input from Shepherds Creek.

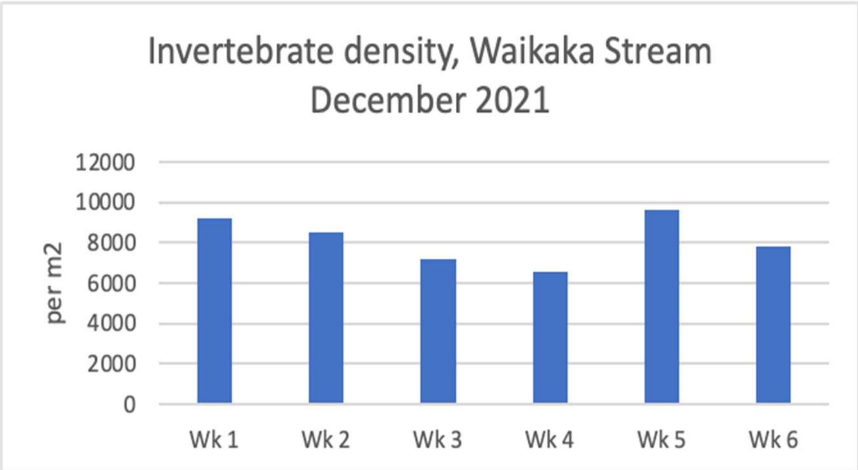

Figure 1, Density of invertebrates (numbers/m^2) at 6 Waikaka Stream sites. #6 upstream, #1 downstream.

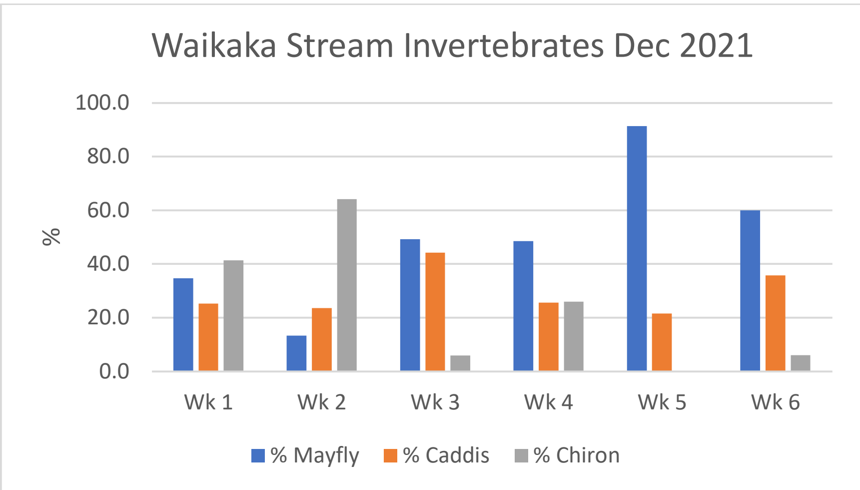

Figure 2, the relative percent of 3 major groups of invertebrates at the 6 Waikaka Stream survey sites. #6 upstream, #1 downstream.

135. MCI based invertebrate scores for habitat quality are shown in table 2.

Table 2, reproduced from Stark et al 2001, MCI score. Based on this the Waikaka stream rates as good for MCI and poor for SQMCI. ES uses SQMCI.

Table 6.1 Criteria for aquatic macroinvertebrate health, according to different macroinvertebrate indices (following Stark *et al.*, 2001)

Macroinvertebrate index	Poor	Fair	Good	Excellent
MCI	<80	80-99	100-119	>120
SQMCI	<4.00	4-4.99	5-5.99	>6

Fish.

136. Information on fish present was collected by electrofishing, fyke netting, minnow trapping, observation and anecdotes.

137. Five species of fish were recorded during surveys on the Waikaka Stream, 2 species of eel, bullies, galaxiids, and brown trout, table 3.

Table 3. Fish Species List.

Common Name	Scientific Name
Longfin eel	*Anguilla dieffenbachii*
Shortfin eel	*Anguilla australis*
Gollum galaxiid	*Galaxias gollumoides*
Upland bully	*Gobiomorphus breviceps*
Brown trout	*Salmo trutta*
Perch	*Perca fluviatillus*

Conservation status of fish, Dunn et al 2017

138. Longfin eels are **at risk** and declining and Gollum Galaxiids are **threatened** and nationally vulnerable.

Galaxiids

139. Galaxiids numbers in the ditches are usually very low and with a restricted size range. There is a distinct lack of large adults which suggests habitat is intermittent and /or predation pressure from eels limits size attained. Galaxiids are rare in the Waikaka Stream. There were insufficient numbers of galaxiids to be able to conduct diminishing return surveys for population density estimates. A comparison of density estimates from other Gollum

sites in particular the Nevis Valley shows where the Waikaka populations fit in. There are no references to population estimates for Gollum populations in the literature so I have used information from studies that I have conducted.

140. Minimum size in a fish sample depends on sampling time as if in early summer there will be large numbers of newly hatched recruits. In their first summer Gollum galaxiids reach approximately 35mm in length. By the end of their second summer 60mm is attained, for Nevis populations at least. Lowland populations (such as Waikaka) without severe winter temperatures likely grow a little larger so the fish captured in the Waikaka survey are probably about 2 years old. Older adults are largely absent. The table below shows population demographics of several Gollum populations.

Table 4, population demographics of Gollum galaxiids from Waikaka Gold mine site and Nevis Valley. Population Density Fish/m2 was assessed over a 50m stream reach in the Nevis catchment but over many metres of Waikaka ditch and stream.

Location/Creek	Size Range (mm)	Population Density Fish/m2	Sample Size	Mean Length (mm)
Waikaka Stream	18-58	Very low	18	33
Waikaka Ditches	54-76	Very low	24	62
Nevis Tin Hut 1	20-145	5.49	122	68
Schoolhouse	26-109	1.33	38	45
Yellow low	49-105	1.98	113	76
Potters low	23-113	1.87	126	63

141. The Waikaka galaxiid populations are sparse, have few mature adults, and show the effects of limited habitat and exposure to predation by eels and trout.

Longfin eels.

142. Longfin eels are present mainly in the river but both species of eel were present in Pond 6 and longfins were also present in the “Big Pond”. In the

river longfins range in size from 98-1000mm, juvenile to mature adult. Mean length was 602mm from a sample of 42 fish. In Pond 6 one specimen was measured at 1100mm.

Shortfin Eels.

143. These were the sole occupants of most of the small ponds (2,3,4,6,7) and ranged in size from 290-920mm. Mean length was 535mm for a sample of 28. None were captured in the river although they may be present there. The habitat separation of longfin and shortfin was pronounced. It may be related to differences in water quality tolerances as the small ponds are noticeable for their poor quality but also in part a habitat preference issue. Longfins are typically river fish while shortfins prefer coastal lowland streams and wetland habitats.

Brown Trout.

144. Trout are abundant throughout the river and provide a regionally significant recreational fishery. Adult trout were frequently seen cruising the large pools and feeding on willow grubs that had fallen from the overhanging willows. Young of the year trout are abundant in the riffle areas. The maximum size recorded was 580mm. The mean size of YOY trout caught in riffles was 56.5mm for a sample size of 138.

Upland Bullies.

145. These fish were abundant in riffle areas and ranged in size from 26-76mm. Mean size was 43.6 for a sample size of 748. Nest sites were commonly observed under cobbles in the riffles in the summer.

146. Population densities for these fish species from specific river sections are shown in the table below. Adult trout were estimated separately at “not less than” 21/km. This is very conservative because of the limitations that environmental conditions imposed on available methodologies to count them. Fish density for each species at various Waikaka Stream sites are listed in Table 5.

Table 5, population estimates based on diminishing returns(repeat passes), area fished, fish density fish/m^2, and total site density (all species) of 4 riffle areas in the Waikaka Stream. UpB=upland bully, LF=longfin eel, BT=brown trout. Est # = estimated number.

Site		**Est #**	**Area m2**	**Density**	**Total Fish Density**	UpB **Mean L(mm)**
3b	LF	3	134	0.02		
	UpB	174		1.3		42.8
	BT	28		0.21		
	Gx	7		0.05	1.58	
4a	LF	2	46.9	0.04		
	UpB	88		1.88		44.4
	BT	8		0.17	2.09	
4b	UpB	53	69.8	0.76		44.8
	BT	15		0.21	0.97	
6	LF	3	108.3	0.03		
	UpB	193		1.78		42.3
	BT	22		0.20	2.01	

Existing Water Quality

147. Water quality was sampled at a selection of river sites and the ponds and analysed by Water Care Ltd, Invercargill for E.coli, TSS, DRP, TP, Ammoniacal N, and NN. Additional field measurements were taken for Temperature corrected conductivity, salinity, and Total Dissolved Solids (TDS) with a YSI hand held meter. For the river TDS remained more or less constant as did TP. Ammonia and nitrate-nitrogen steadily increased from the top to the lower site. Nutrient levels in the ponds were similar except for Ammonia and nitrate-nitrogen which were elevated by up to 7 times and 30 times respectively in some ponds. The graphs below allow comparison between sites and river/pond habitats.

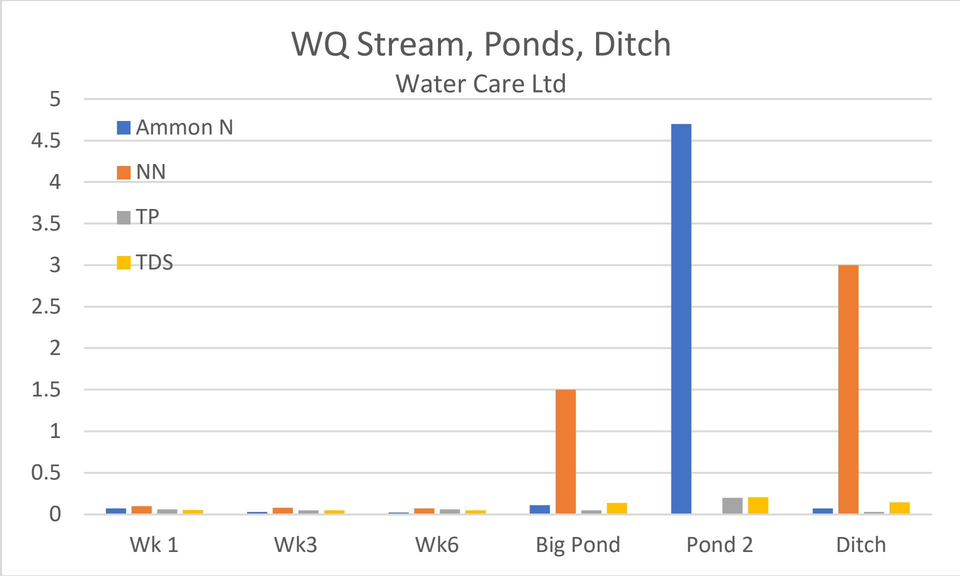

Figure 3, Water quality, ammoniacal nitrate, Nitrate Nitrogen, Total Phosphorous, and Total dissolved solids for pond and river sites.

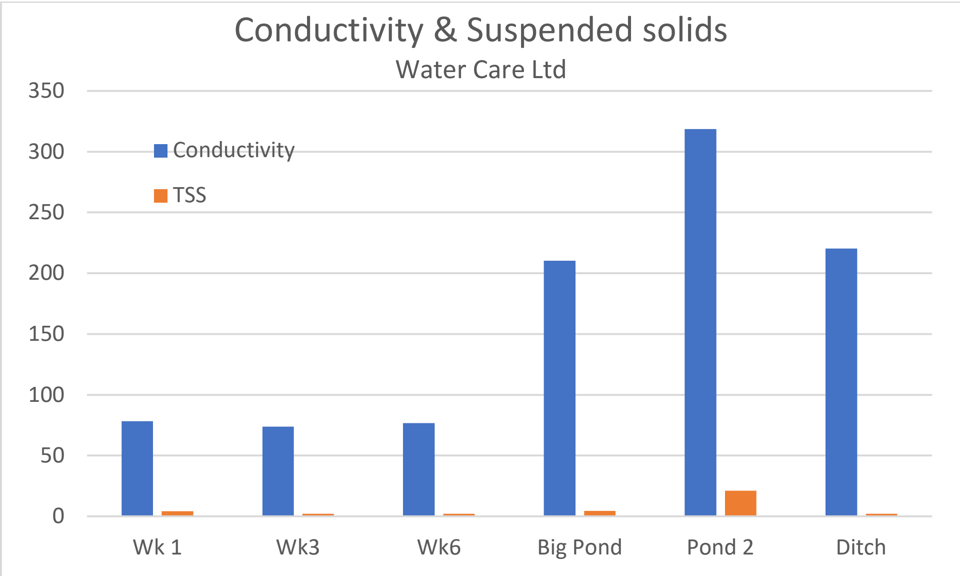

Figure 4, Conductivity and suspended solids for pond and river sites.

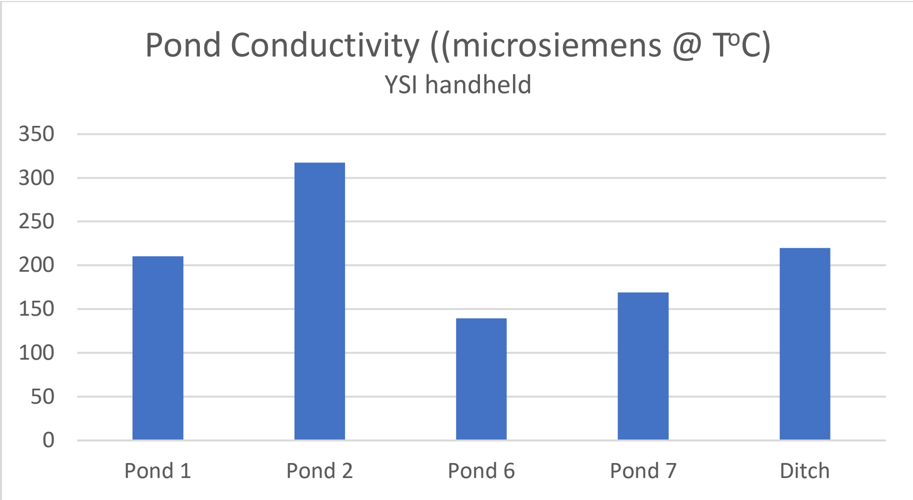

Figure 5, Conductivity for Pond and Ditch sites.

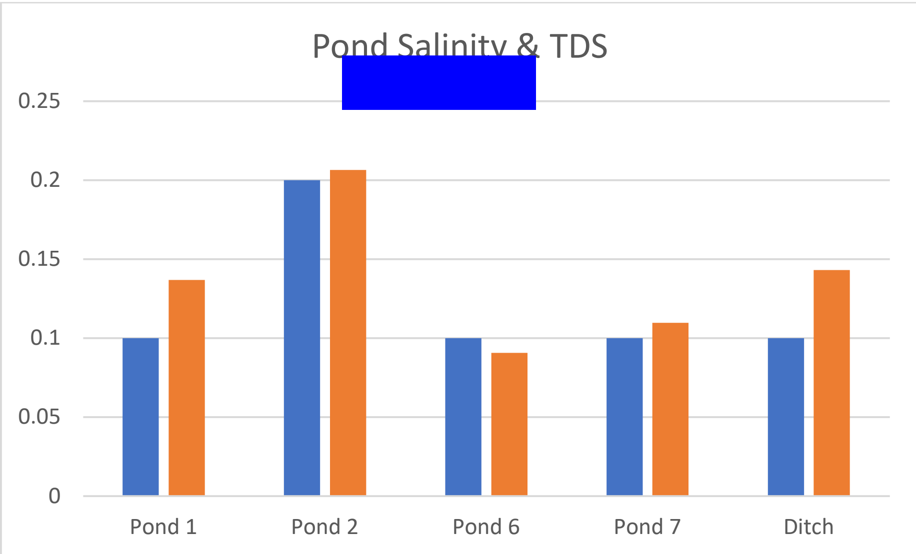

Figure 6, Pond salinity and Total Dissolved Solids.

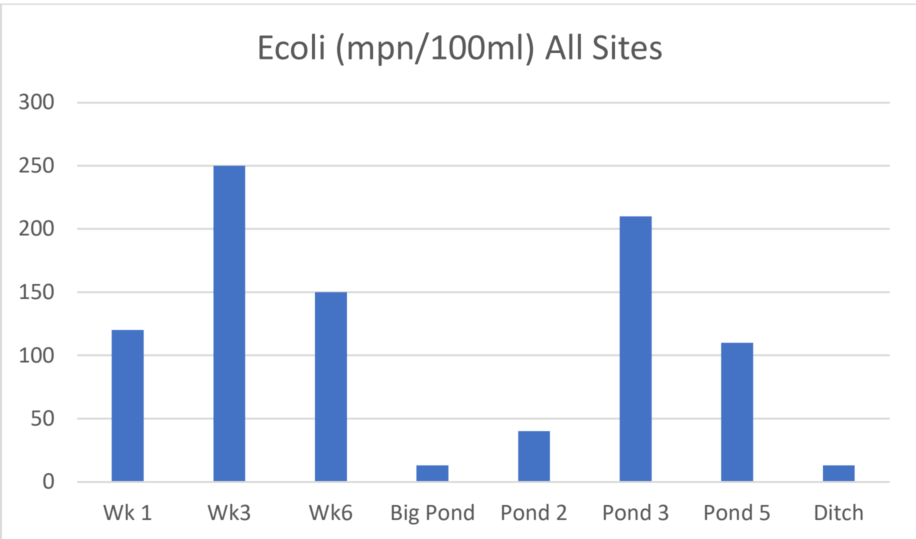

Figure 7, E-coli counts for waterways.

148. ES standards currently not met for Pond 2 for NH_3 and the Waikaka Stream for water clarity and the SQMCI.

149. Macintyre J, (2000) assessed water quality against ANZG (2018) guidelines and found that median values for Turbidity, Total N, NN, Ammoniacal N, TP and DRP failed to meet the guidelines in the Waikaka Stream.

Riparian Vegetation.

150. The riparian zone is currently well protected with almost total stock exclusion. The extensive tree cover, mostly willow but also a few exotics, provide extremely valuable shade and resistance to bank erosion. There are only a few locations where willow removal has facilitated bank erosion that provide an undesirable source of fine sediment to the river. The extensive vegetation cover plays a very valuable role in limiting sediment supply to the stream and providing shading that helps reduce temperature stress when low flows occur in summer. The willows are also an important habitat/source of terrestrial insects for fish food. Canopy cover is measured with a Densiometer. Site 5 has almost complete cover with very little view of the sky, site 1, 2 have clear view of the sky above the channel but still plenty of riparian shading when the sun is *not* directly overhead. Site 4b has no shade.

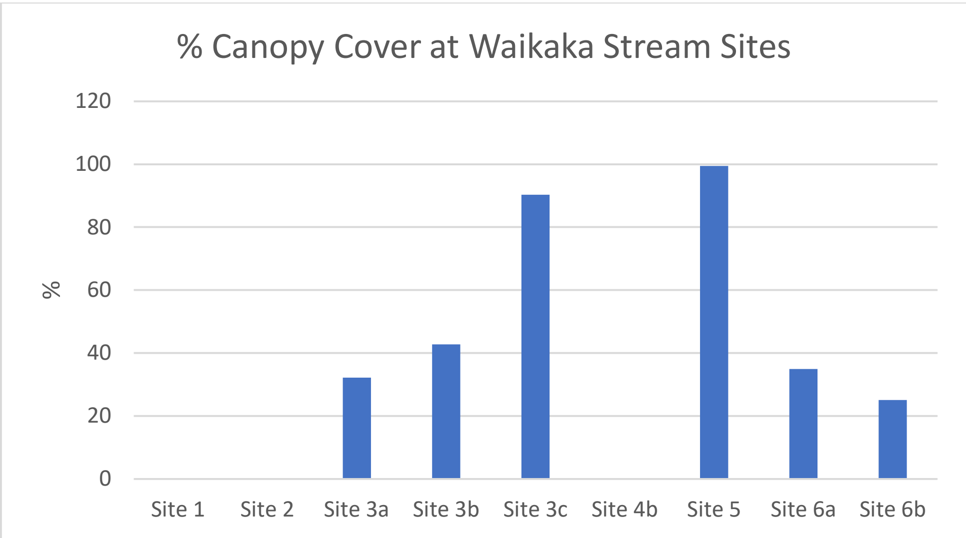

Figure 8, the percent canopy cover over Waikaka Stream.

Substrate

151. Riffle substrate size was measured by randomly selecting particles on the stream bed and measuring the long axis to the nearest millimetre. This process does not record the fine sediments that settle out and clog interstitial spaces between gravel/cobble size particles and therefore gives an optimistic description of substrate size when considering habitat. Riffles are the food production zones in a river and also the sites at which most spawning occurs for the main residents, bullies and trout. In ideal conditions particle size is coarse gravel to cobbles with little or no fine sediment. The interstitial spaces that provide for water flow over incubating eggs and refuge for the invertebrates can become clogged when too much fine sediment enters the water way.

Table 6, mean particle size at riffle survey sites, except site 5* which is a run with lower water velocity and has increased settling of finer particles.

Site	**Mean Size (mm)**	**Range (mm)**
Wk 1	41.3	11-115
Wk 2	53.1	12-170
Wk 3	42.3	4-144
Wk 4	62.3	12-212
Wk 5*	50.4	8-195
Wk 6	58.6	13-240

152. When the Waikaka stream bed is disturbed a distinct plume of fine sediment is seen. This indicates that the clogging process has begun and the likely source is from upstream areas where disturbed stream bank is actively eroding. Stream bank stability is critical to maintaining clean food producing and spawning sites. The rehabilitated channels will have clean gravels and cobbles used in their construction with the fines screened out, (pers comm N Becker). This is a big advantage for the new channels as it will provide an abundance of interstitial spaces for invertebrates, small fish, and clear water flow over and through spawning gravels, beyond what is available now.

Control of upstream sediment sources is outside the reach of Waikaka Gold Ltd.

153. There is a section of river bank, true left, between sites 3 and 4 where boulders have been previously used for historic crossing points. These boulders extend for and area of approximately 40m and average 570mm long axis, and range in size from 190-1180mm. They provide excellent habitat for eels in particular as was discovered during electro-fishing. I referred to these as “rip rap” which created some confusion and concern perhaps because of the use of this term to describe reinforcing at some bridge abutments. The two sites are quite different. I consider the boulders in the Waikaka Stream to be an important component in providing stable and secure habitat, for eels especially, and they should be used in the re-creation of habitat post diversion. They have the additional value of providing erosion resistant stream banks, very important in maintaining clean riffle gravels for food production, spawning habitat, and juvenile fish habitat.

Ponds

154. The Big Pond (or L&M Pond) had longfin eels, perch, brown trout, and lobster present. Ponds 2, 6, and 7 on my map support eels, ponds 2 and 7 have shortfins and both species are found in pond 6/The connections between pond and river are ephemeral except for pond 6. Water quality in the ponds is generally poor but eels typically have a high tolerance to this. Water clarity in some of the ponds was zero. Pond 2 has very high levels and Ammoniacal N and Dissolved inorganic N.

Galaxiids

155. Galaxiid numbers in the ditches are usually very low and with a restricted size range. There is a distinct lack of large adults which suggests habitat is intermittent and /or predation pressure from eels limits size attained. Galaxiids are rare in the Waikaka Stream. There were insufficient numbers of galaxiids to be able to conduct diminishing return surveys for population density estimates. A comparison of density estimates from other Gollum

sites in particular the Nevis Valley shows where the Waikaka populations fit in. There are no references to population estimates for Gollum populations in the literature so I have used information from studies that I have conducted.

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Yellow low	49-105	1.98	113	76
Potters low	23-113	1.87	126	63

158. The Waikaka galaxiid populations are sparse, have few mature adults, and show the effects of limited habitat and exposure to predation by eels and trout