Before the Hearing Commissioners
appointed by the Grey District Council and
West Coast Regional Council

Under	the Resource Management Act 1991
In the matter of	Resource consent applications by TiGa Minerals and Metals Ltd to establish and operate a mineral sands mine on State Highway 6, Barrytown (RC-2023-0046; LUN3154/23)

Statement of evidence of Michael George Fitzpatrick

19 January 2024

Applicant's solicitors:
Alex Booker/Alex Hansby
Anderson Lloyd
Level 3, 70 Gloucester Street, Christchurch 8013
PO Box 13831, Christchurch 8140
p + 64 27 656 2647
alex.booker@al.nz

anderson lloyd.

Qualifications and experience

1 My full name is Michael George Fitzpatrick.

2 I hold the degrees of BSc in Chemistry from Waikato University (1985) and PhD in Chemistry from the University of Otago (1989).

3 I have been a scientific consultant for 31 years and work primarily in the areas of environmental chemistry, analytical chemistry, medical chemistry and toxicology. I have been a director of Mike Fitzpatrick Consulting Ltd since 2003. I have been associated with Ecological Solutions Ltd since 2011 and I conduct all my environmental consulting via them.

4 My previous positions were Chief Scientific Officer at Feedback Research Ltd (2003-2011), Principal Environmental Chemist at Golder Associates (NZ) Ltd and Kingett Mitchell Ltd (1997-2011), Lecturer in Analytical and Environmental Chemistry at the University of Auckland (1995-1997), and Consultant Analyst at Grayson and Associates and Allan Aspell and Associates (1993-1995).

5 My role in relation to TiGa Minerals and Metals Limited's (**TiGa**) application to establish and operate a mineral sands mine at SH6 Barrytown (**Application and Application Site**) has been to provide advice in relation to discharge water quality, and effects on surface water quality and aquatic biota. I was engaged by TiGa via Ecological Solutions in February 2023, and have worked closely with the project hydrologists and ecologists to ensure an integrated solution which would protect water quality and aquatic life.

6 My assessment is based upon the proposal description attached to the evidence of Ms Katherine McKenzie as Appendix 1.

7 In preparing this statement of evidence I have considered the following documents:

(a) the AEE accompanying the Application (Kōmanawa Solutions Limited, 2023a).;

(b) additional hydrology assessments and water sampling undertaken since the lodgment of the Application by Mr Jens Rekker and Mr Zeb Etheridge of Kōmanawa Solutions Limited that relate to water quality;

(c) submissions relevant to my area of expertise;

(d) the statements of evidence on hydrology, geochemistry, water quality, and ecology prepared by Mr Jens Rekker, Mr Mark Roper, and Dr Gary Bramley.

(e) a 13 October 2023 memo of Mr Jens Rekker entitled, 'Revision of Assessed Pit Seepage Rates and pumped Groundwater Metals Concentrations in the light of recent Injection & Infiltration Trials' (Kōmanawa Solutions Limited, 2023b).

8 At the time I prepared this evidence I had not visited the Application Site.

Code of Conduct for Expert Witnesses

9 While this is not a hearing before the Environment Court, I confirm that I have read the Code of Conduct for expert witnesses contained in the Environment Court of New Zealand Practice Note 2023 and that I have complied with it when preparing my evidence. Other than when I state I am relying on the advice of another person, this evidence is within my area of expertise. I have not omitted to consider material facts known to me that might alter or detract from the opinions that I express.

Scope of evidence

10 I have prepared evidence in relation to:

(a) the existing environment of the Application Site relating to surface water and groundwater quality;

(b) the key findings of my assessment of effects;

(c) matters raised by submitters to the Application;

(d) matters raised in the West Coast Regional Council's (**WCRC**) and Grey District Council's (**GDC**) staff reports (reports issued under s42A of the RMA); and

(e) proposed conditions of consent.

The existing environment

11 I have reviewed the existing, i.e., baseline, surface water quality of the Northern Drain, Collins Creek, Canoe Creek, and Canoe Creek Lagoon (Kōmanawa Solutions Limited, 2023a), which generally exhibit near neutral pH, low conductivity, low to moderate hardness, and low turbidity. At times the turbidity in Canoe Creek Lagoon is moderately elevated.

12 Median concentrations of metals and metalloids are generally undetectable or low across all surface water sites monitored and generally meet relevant surface water guideline value concentrations.

13 Ammoniacal-nitrogen and nitrate-nitrogen concentrations at the freshwater sites positions them within the NPS-FM Attribute State A. Elevated phosphorus

concentrations in the Northern Drain and the Collins Creek upstream site positions within Attribute State D, whereas the Collins Creek downstream site is within attribute State B.

14 I have also the reviewed baseline groundwater quality data (Kōmanawa Solutions Limited, 2023a; Kōmanawa Solutions Limited, 2023b), which generally exhibit near neutral pH, low conductivity, and low to moderate hardness.

15 Groundwater metals and metalloid concentrations show variation across the bore sites sampled. Iron concentrations are elevated, as are manganese concentrations, albeit to a lesser extent; this is not unusual for New Zealand groundwaters. Concentrations of aluminium, arsenic, chromium, copper, nickel and zinc are low to moderate, which requires consideration with respect to the discharge of groundwater to surface waters and the potential for effects on aquatic biota.

16 Some bores exhibit moderate ammoniacal nitrogen concentrations and all bores exhibit moderate phosphorus concentrations.

Assessment of effects

17 The application proposes to discharge treated groundwater, derived from sand extraction activities, to the Northern Drain, Collins Creek, Canoe Creek, and Canoe Creek Lagoon.

18 I consider I have sufficient information to assess the effects of the proposed treated groundwater discharge on the aforementioned surface waters.

19 In addition to my review of surface water and groundwater quality data provided by Kōmanawa Solutions Limited, I have considered the processes described by Kōmanawa Solutions Limited that will are designed to mitigate effects of the proposed groundwater discharge on surface water quality (Kōmanawa Solutions Limited (2023a).

20 I have assessed the effects of discharging treated groundwater to the Northern Drain, Collins Creek, Canoe Creek, and Canoe Creek lagoon, and whether resultant quality will meet required surface water standards. I did this via the ion-pair association aqueous model, PHREEQC (USGS, 2021).

21 The model mixed treated groundwater with the respective surface waters at baseline quality in conservative ratios, i.e., those that reflect higher discharge volumes versus lower receiving surface water flows, which result in conservative, or worst-case, concentration estimates in-stream.

22 Groundwater quality was derived via mixing deeper groundwater with shallower groundwater in the ratio 80:20 (Kōmanawa Solutions Limited, 2023b). Deeper

groundwater quality was based on the IW-01 bore, and shallower groundwater on the maximum of the shallower bores (refer Kōmanawa Solutions, 2023a, Appendix 2).

23 Treated groundwater data was then derived by adjustment to a hardness of 150 g/m^3 (as $CaCO_3$) and pH 8.0, respectively, which are realistic targets for the proposed treatment ponds, via lime dosing, and site drains, via limestone rip-rap, or similar.

24 Baseline surface water quality is based on median values (refer Kōmanawa Solutions, 2023a, Appendix 3).

25 Mixing of process water sourced from groundwater and receiving waters was based on conservative estimates of surface water dilution, being those provided by Kōmanawa Solutions Limited (2023a). The various modelled scenarios were as follows.

26 Canoe Creek: treated clean process water mixed with Canoe Creek downstream water in a 1:15 ratio applicable to median flows and a 1:5.3 ratio applicable to MALF conditions.

27 Collins Creek: treated clean process water mixed with Collins Creek upstream water in a 1:2 ratio, i.e., worst-case augmentation.

28 Northern Boundary Drain: treated clean process water adjusted to a hardness of 150 g/m^3 directly into the drain with zero dilution, i.e., worst-case.

29 Canoe Creek Lagoon: treated clean process water mixed with Canoe Creek Lagoon water in a 1:2 ratio, i.e., worst-case.

30 Accordingly, the estimated post-mixing metals/metalloids concentrations and pH in Canoe Creek, Collins Creek, Northern Boundary Drain, and Canoe Creek Lagoon are presented in Tables 1-5, respectively, which are updated from those reported by Ecological Solutions (2023).

31 Modelling indicates that discharges at the stated ratios, with hardness and pH adjustments, of treated groundwater to receiving waters, also at median water quality, will not result in exceedances of relevant metals/metalloids guidelines, which are designed to protect aquatic biota. Therefore, I expect no effect on aquatic biota due to metals/metalloids.

32 In addition, modelled average ammoniacal-nitrogen concentrations in the receiving waters situates them within either the NPS-FM (2020) A or B-bands and no attribute state change for ammoniacal-nitrogen is expected in any of the receiving waters modelled. I expect no effect on aquatic biota due to ammoniacal nitrogen.

33 Modelled nitrate nitrogen concentrations situates receiving waters within the NPS-FM (2020) A-band and I expect no effect on aquatic biota due to nitrate nitrogen.

34 There is no expected change from the current NPS-FM (2020) dissolved reactive phosphorus (DRP) attribute states for Canoe Creek, Canoe Creek Lagoon, or Northern Boundary Drain. There is potential for a change in the DRP attribute state at the Collins Creek downstream site, from the B-band to the D-band, but the treatment of groundwater via combined settlement, flocculation and clarification, as required, will result in the reduction of DRP concentrations such that either no change, or an improvement, will be realised.

35 I have not modelled visual clarity in the receiving waters but I have given consideration to the NPS-FM, noting that the proposed consent conditions stipulate visual clarity will meet relevant NPS-FM attribute states. The attribute state grading, which is based on River Environment Classification (REC) and requires a minimum record length of at least five years of at least monthly samples (NPS-FM, 2020), has not yet been undertaken for the receiving surface waters subject to the proposed discharges.

36 I note that generic visual clarity numeric attribute states are not defined for the surface waters that are the subject of the proposed discharges, which are 'cool, extremely wet' systems. However, ANZECC (2018) has developed 80-percentile default turbidity (a surrogate for visual clarity) guideline values (DGVs) for such systems, viz., 2.1 NTU for 'cool, extremely wet, hill' (CX-H) systems, and 2.6 NTU for 'cool, extremely wet, low elevation' (CX-L) systems.

37 Baseline turbidity data indicates Collins Creek, Canoe Creek, the Northern Drain, and Canoe Creek do not meet the relevant ANZECC 80-percentile DGVs – this is likely due to the stream catchments being subject to large sediment inputs during periods of rainfall.

38 The proposal to control suspended solids and turbidity discharges via combined settlement, flocculation and clarification, as required, is standard mining practice that is able to achieve low turbidity values under day-to-day operating conditions. Hence, I consider such discharges should not result in elevation of receiving water turbidity values beyond baseline ranges.

39 From the evidence of Mr Ridley, I note the high degree of both automated and manual turbidity monitoring that is proposed, such that turbidity discharges can be adequately controlled. In situations where discharge turbidity values do not meet the proposed 20 NTU limit, discharge to land via the Canoe Creek infiltration basin will occur.

Matters raised by submitters

40 I understand that submitters have raised concerns about water quality. I consider the proposed discharges will not result in exceedance of any applicable guidelines.

Proposed consent conditions

41 The consent conditions that relate to water quality are provided in the evidence of Ms McKenzie at 25.2. Specifically they are based on relevant NPS-FM (2020), USEPA, ANZECC (2000), or ANZECC (2018) guidelines.

42 It should be noted that I consider the NPS-FM ammoniacal nitrogen guidelines are useful for defining attribute states but overly conservative and unfit for purpose with respect to understanding potential toxicity of ammoniacal nitrogen to aquatic biota, for which my preference is the USEPA (2009) ammonia criteria. I also note that there are draft ANZECC ammoniacal nitrogen guidelines (ANZG, 2023a), which are in the post-submission stage, that are less conservative than the current NPS-FM. I have reviewed the draft ammoniacal nitrogen guidelines and they do not change my conclusions regarding the potential effects of ammonia in the proposed treated groundwater discharge, i.e., I expect no effects on aquatic biota.

43 I note there are draft ANZECC copper guidelines in the post-submission stage (ANZG, 2023b), and draft ANZECC zinc guidelines that are in the pre-draft stage (ANZG, 2023c); these are not considered official guidelines values by the Australian and New Zealand governments. I have reviewed both draft guideline documents and do not consider they change my conclusions regarding the effects of either copper or zinc in the proposed treated groundwater discharge, i.e., there are no expected effects on aquatic biota.

44 I consider the water quality parameters in the proposed consent conditions at 25.2 are appropriate and that their thresholds are protective of aquatic biota in the receiving surface waters, and that the thresholds can be met following the proposed treatment of groundwater.

45 I consider the proposed discharges to surface water will fulfil the requirements of the RMA section 107(1)(d), in that it will not result in any conspicuous change in colour or visual clarity.

Conclusion

46 I consider the application, which includes a proposal to discharge treated groundwater derived from sand extraction activities, to the Northern Drain, Collins Creek, Canoe Creek, and Canoe Creek Lagoon, will not result in exceedance of relevant water quality guidelines, which are designed to protect aquatic biota.

47 Important are the treatment measures proposed by the applicant, such as appropriate using detention ponds, settlement, flocculation and clarification, as required, which will serve to settle solids, and reduce turbidity levels and metal/metalloid and nutrient concentrations, and the ability to discharge turbid water to an infiltration basin, if required.

Michael George Fitzpatrick

Dated this 19 day of January 2023

References

ANZECC (2000). Australian Water Quality Guidelines for Fresh and Marine Water. Australian and New Zealand Environment and Conservation Council, Agriculture and Resource Management Council of Australia and New Zealand.

ANZECC (2018). Australian and New Zealand Guidelines for Fresh and Marine Water Quality: https://www.waterquality.gov.au/anz-guidelines

ANZG (2023a). Draft toxicant default guideline values for aquatic ecosystem protection: Ammonia in freshwater. Australian and New Zealand Guidelines for Fresh and Marine Water Quality. Australian and New Zealand Governments and Australian state and territory governments, Canberra, ACT, Australia.

ANZG (2023b). Draft toxicant default guideline values for aquatic ecosystem protection: Dissolved copper in freshwater. Australian and New Zealand Guidelines for Fresh and Marine Water Quality. Australian and New Zealand Governments and Australian state and territory governments, Canberra, ACT, Australia.

ANZG (2023c). Draft toxicant default guideline values for aquatic ecosystem protection: Dissolved zinc in freshwater. Australian and New Zealand Guidelines for Fresh and Marine Water Quality. Australian and New Zealand Governments and Australian state and territory governments, Canberra, ACT, Australia.

Ecological Solutions (2023). Barrytown mineral sand ecological effects assessment.

Kōmanawa Solutions Ltd. (2023a) Barrytown Mineral Sands Mine Hydrological Impact Assessment. Report No: Z22004_1-Rev prepared for TiGa Minerals & Metals Pty Ltd, Christchurch. 115 pages, including appendices.

Kōmanawa Solutions Ltd. (2023b). Memorandum titled Revision of Assessed Pit Seepage Rates and pumped Groundwater Metals Concentrations in the light of recent Injection & Infiltration Trials, dated 13 October 2023, prepared by Mr Jens Rekker.

NPS-FM (2020). National Policy Statement for Freshwater Management 2020, Ministry for the Environment.

USEPA (1986). Quality criteria for water. United States Environmental Protection Agency Office of Water EPA 440/5-86-001 May 1986.

USEPA (2007). Aquatic life ambient freshwater quality criteria - copper. 2007 revision. United States Environmental Protection Agency Office of Water EPA-822-R-07-001 February 2007.

USEPA (2009). Draft 2009 Update Aquatic Life Ambient Water Quality Criteria for Ammonia - Freshwater. United States Environmental Protection Agency Office of Water EPA-822-D-09-001 December 2009.

USEPA (2018). Final aquatic life ambient water quality criteria for aluminium 2018. United States Environmental Protection Agency Office of Water EPA-822-R-18-001 December 2018.

USGS (2021). PHREEQC Version 3: https://www.usgs.gov/software/phreeqc-version-3.

WCRC (2014). Regional land and water plan. West Coast Regional Council, May 2014.

Table 1: Canoe Creek at Median Flow modelled surface water quality parameters, post-mixing – dissolved fraction.

Parameter	Canoe Creek Median flow	Guideline
pH (pH units)	7.7	6-9[A]
Hardness (as $CaCO_3$)	33.5	NA
Aluminium	0.0029	0.40-0.71[B,C]
Arsenic	0.0006	0.013[D,E]
Boron	0.005	0.94[F]
Cadmium	< 0.00005	0.0003[C,D]
Chromium	< 0.0005	0.0046[C,D,G]
Copper	< 0.0001	0.0039-0.0079[C,H]
Iron	0.027	1.0[I]
Lead	< 0.0001	0.0057[C,D]
Manganese	0.0042	1.9[C]
Nickel	< 0.0005	0.015[C,D]
Zinc	0.0019	0.011[C,D]
Ammoniacal-N	< 0.001	≤ 0.06[J]
Nitrate-N	0.064	≤ 1.0[K]
Phosphorus[L]	0.015	> 0.006 and ≤ 0.010[M]

Notes: units g/m^3; [A]WCRC (2014); [B]USEPA (2018); [C]hardness and pH as stated, Dissolved Organic Carbon (DOC)=2.5 g/m^3 for aluminium 2.0 g/m^3 for copper; [D]ANZECC (2000) default trigger; [E]As(V); [F]ANZECC (2018);[G]Cr(III); [H]USEPA (2007); [I]USEPA (1986); [J]NPS-FM attribute A annual median, pH adjusted; [K]NPS-FM attribute A annual median; [L]modelled as dissolved reactive phosphorus; [M]NPS-FM attribute B median.

Table 2: Canoe Creek at MALF modelled surface water quality parameters, post-mixing – dissolved fraction.

Parameter	Canoe Creek MALF	Guideline
pH (pH units)	7.8	6-9[A]
Hardness (as $CaCO_3$)	46.3	NA
Aluminium	0.0030	0.72-1.2[B,C]
Arsenic	0.0007	0.013[D,E]
Boron	0.005	0.94[F]
Cadmium	< 0.00005	0.0005[C,D]
Chromium	< 0.0005	0.0073[C,D,G]
Copper	< 0.0001	0.0079-0.0138[C,H]
Iron	0.055	1.0[I]
Lead	< 0.0001	0.012[C,D]
Manganese	0.0074	1.9[C]
Nickel	< 0.0005	0.025[C,D]
Zinc	0.0030	0.018[C,D]
Ammoniacal-N	< 0.001	≤ 0.03[J]
Nitrate-N	0.072	≤ 1.0[K]
Phosphorus[L]	0.035	> 0.021 and ≤ 0.030[M]

Notes: units g/m^3; [A]WCRC (2014); [B]USEPA (2018); [C]hardness and pH as stated, Dissolved Organic Carbon (DOC)=2.5 g/m^3 for aluminium 2.0 g/m^3 for copper; [D]ANZECC (2000) default trigger; [E]As(V); [F]ANZECC (2018);[G]Cr(III); [H]USEPA (2007); [I]USEPA (1986); [J]NPS-FM attribute A annual median, pH adjusted; [K]NPS-FM attribute A annual median; [L]modelled as dissolved reactive phosphorus; [M]NPS-FM attribute B 95percentile.

Table 3: Collins Creek modelled surface water quality parameters, post-mixing – dissolved fraction.

Parameter	Collins Creek	Guideline
pH (pH units)	7.9	6-9[A]
Hardness (as $CaCO_3$)	74.0	NA
Aluminium	0.015	1.4-1.7[B,C]
Arsenic	0.0010	0.013[D,E]
Boron	0.009	0.94[F]
Cadmium	< 0.00005	0.0008[C,D]
Chromium	< 0.0005	0.012[C,D,G]
Copper	< 0.0001	0.015-0.031[C,H]
Iron	0.084	1.0[I]
Lead	< 0.0001	0.023[C,D]
Manganese	0.017	1.9[C]
Nickel	< 0.0005	0.040[C,D]
Zinc	0.0020	0.029[C,D]
Ammoniacal-N	0.020	≤ 0.02[J]
Nitrate-N	0.049	≤ 1.0[K]
Phosphorus[L]	0.070	> 0.018[M]

Notes: units g/m^3; [A]WCRC (2014); [B]USEPA (2018); [C]hardness and pH as stated, Dissolved Organic Carbon (DOC)=2.5 g/m^3 for aluminium 2.0 g/m^3 for copper; [D]ANZECC (2000) default trigger; [E]As(V); [F]ANZECC (2018);[G]Cr(III); [H]USEPA (2007); [I]USEPA (1986); [J]NPS-FM attribute A annual median, pH adjusted; [K]NPS-FM attribute A annual median; [L]modelled as dissolved reactive phosphorus; [M]NPS-FM attribute D median.

Table 4: Northern Boundary Drain modelled surface water quality parameters, post-mixing – dissolved fraction.

Parameter	Northern Boundary Drain	Guideline
pH (pH units)	8.0	6-9[A]
Hardness (as $CaCO_3$)	155	NA
Aluminium	0.0022	1.2-1.6[B,C]
Arsenic	0.0019	0.013[D,E]
Boron	0.006	0.94[F]
Cadmium	< 0.00005	0.0018[C,D]
Chromium	< 0.0005	0.024[C,D,G]
Copper	< 0.0001	0.039[C,H]
Iron	0.31	1.0[I]
Lead	< 0.001	0.075[C,D]
Manganese	0.036	1.9[C]
Nickel	< 0.0005	0.087[C,D]
Zinc	0.0045	0.063[C,D]
Ammoniacal-N	0.070	> 0.006 and ≤ 0.051[J]
Nitrate-N	0.066	≤ 1.0[K]
Phosphorus[L]	0.17	> 0.018[M]

Notes: units g/m^3; [A]WCRC (2014); [B]USEPA (2018); [C]hardness and pH as stated, Dissolved Organic Carbon (DOC)=2.5 g/m^3 for aluminium 2.0 g/m^3 for copper; [D]ANZECC (2000) default trigger; [E]As(V); [F]ANZECC (2018);[G]Cr(III); [H]USEPA (2007); [I]USEPA (1986); [J]NPS-FM attribute B annual median, pH adjusted; [K]NPS-FM attribute A annual median; [L]modelled as dissolved reactive phosphorus; [M]NPS-FM attribute D median.

Table 5: Canoe Creek Lagoon modelled surface water quality parameters, post-mixing – dissolved fraction.

Parameter	Canoe Creek Lagoon	Guideline
pH (pH units)	7.7	6-9[A]
Hardness (as $CaCO_3$)	113	NA
Aluminium	0.0072	0.73-1.1[B,C]
Arsenic	0.0012	0.013[D,E]
Boron	0.039	0.94[F]
Cadmium	< 0.00005	0.0008[C,D]
Chromium	< 0.0005	0.011[C,D,G]
Copper	< 0.0001	0.0087-0.015[C,H]
Iron	0.54	1.0[I]
Lead	< 0.0001	0.024[C,D]
Manganese	0.010	1.9[C]
Nickel	< 0.0005	0.040[C,D]
Zinc	0.0032	0.029[C,D]
Ammoniacal-N	0.074	> 0.05 and ≤ 0.43[J]
Nitrate-N	0.094	≤ 1.0[K]
Phosphorus[L]	0.093	> 0.018[M]

Notes: units g/m^3; [A]WCRC (2014); [B]USEPA (2018); [C]hardness and pH as stated, Dissolved Organic Carbon (DOC)=2.5 g/m^3 for aluminium 2.0 g/m^3 for copper; [D]ANZECC (2000) default trigger; [E]As(V); [F]ANZECC (2018);[G]Cr(III); [H]USEPA (2007); [I]USEPA (1986); [J]NPS-FM attribute B annual median, pH adjusted; [K]NPS-FM attribute A annual median; [L]modelled as dissolved reactive phosphorus; [M]NPS-FM attribute D median.