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)

Summary Statement and Rebuttal Evidence of Jens Haaye Rekker

2 February 2024

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Summary of evidence

1 My full name is Jens Haaye Rekker, I am principal hydrogeologist at Kōmanawa Solutions.

2 I am contributing technical, groundwater and science information to inform this Hearing at the request of TiGa Minerals and Metals Ltd (**TiGa MM**). I have previously provided a Statement of Evidence dated 19 January 2024. My qualifications and experience are set out in that statement of evidence.

3 I repeat the confirmation given in that statement that I have read and agree to comply with the Code of Conduct for Expert Witnesses in the Environment Court.

Summary

4 I have set out the hydrological, hydrogeological (groundwater) and water chemistry setting of the Barrytown Flats, concentrating on lands making up the application before you. I was responsible for field investigations, monitoring network set-up, creek and groundwater field testing, focused trials into water infiltration, groundwater modelling and assessment reporting that has been presented to the public, submitters, peers and commissioners.

5 Field investigations were undoubtedly less complete through the inability to access the two properties either side of Nikau Farms' property, however we made use of remote sensing and publicly available data to fill in those gaps. The water bodies and subsurface conditions of the areas available to us were intensively investigated and monitored.

6 My understanding of the hydrological and groundwater systems associated with this application after all of the above work, is they are dynamically stable and relatively robust to hydrological shocks.

7 The hydrological state of the Barrytown Flats is normally in water surplus and more readily adapted to the shedding of water.

8 We know from climate records of the West Coast littoral, among other means, that rainfall deficit is a rare and brief state for soils, creeks, wetlands and underlying groundwater systems along the Coast.

9 Put another way, the Barrytown Flats do not have a dry temperature climate with frequent, lengthy and distinct dry spells or droughts, such as found in parts of New Zealand behind the rain-shadowing ranges. It is in such other parts of the country that much of the water resource management instruments of allocation limits, minimum flows, residual flows, or minimum water levels have been developed.

10 From this perspective, the detailed assessment, mitigation measures specified and indicated outcomes have a high probability of success in preventing loss of flow or decline in water levels, beyond natural variation, in any part of the subject areas. Inherent protective factors include the degree to which hydrological systems are fully and regularly topped up, and the tendency to resist any damaging drainage.

11 Groundwater chemistry, especially in the shallow compartments below the water table are also indicative of stability and weak, slow groundwater exchange with adjoining parts of the hydrological cycle.

12 Deeper groundwater compartments or layers are less concentrated with respect to constituent dissolved metals. The deeper compartments are also predicted to provide a greater share of groundwater pumped out of the pits, thereby lessening the mixed concentrations with respect to metals and phosphorus entering mine water.

13 Mine water that would be routinely released from the mine's Wet Concentration Plant would become a resource for applying to the ground or directly to affected water courses. Whatever surplus left over from applications as infiltration, injection or augmentation, would be further treated and released into Canoe Creek Lagoon. In extreme circumstances, the Canoe Creek infiltration basin would be available to receive treated excess mine water and release it in a manner that is protective of water quality.

14 The currently projected rates of mine water pumped to the Plant are substantially less than the projections made and included in the documentation in April 2023. The reasons for the difference are the progressive refinement of knowledge and the reduction in related uncertainty allowed by continued field investigations since that date.

15 It would seem that properties used in the assessment leading up to April last year were excessively conservative, as is appropriate in such circumstances. Equally, it is appropriate in the scientific assessment context to adjust the properties or inputs used in assessment with the arrival of new information.

16 The result is the assessment made and the pumping projections included in my evidence are the most appropriate ones and could be considered the 'best information available at the time' in the context of NPS-FM 2020.

17 Furthermore, the avoidance of sensitive areas in the first years of mining, mitigation structures and monitoring network outlined in the application documents are to some extent premised and sized on the expectation of greater impact on the groundwater or connected hydrological systems. This provides some assurance that the mitigations and monitoring are adequate to the task assigned to them for the proposed sand mining project.

18 For the same token of minimising effects, reliance on Canoe Creek as a source of water course flow augmentation is no longer considered necessary. The residual role of the Canoe Creek gallery is for operational purposes of filling the mine water systems at the start or resumption of processing.

19 In considering the longer-term impacts of mining activities at the Nikau Farms' property I am reminded that the life of the mine is comparatively brief (5 - 7 years), and the final act of mining is rehabilitation of the affected land to the original agricultural use in substantially the same state as it began. The hydrological and water quality assessments, responsive mitigation and monitoring are founded in field investigations, ongoing monitoring and trials of proposed mitigation systems. The possession of this knowledge has allowed a significant reduction in uncertainty concerning the function of such systems and provided me with confidence that the current proposals will meet high standards of environmental protection.

Rebuttal

20 Since the submission of my evidence, I received a copy of the Statement of Evidence for Dr Brian McGlynn of E3 Scientific for the Langridge family, dated 25 January 2024.

21 In Paragraphs 16 and 23, Dr McGlynn states that is not his intention to critique the application documents relating to hydrology, water quality, modelling, water management or ecology. Instead, Dr McGlynn states his evidence is to provide a high(er) level assessment of potential impacts.

22 Indeed, the subsequent evidence beginning at paragraph 25 includes a 'General Hydrologic Setting'. The primary model proffered for interpreting the Paparoa Range – Barrytown Coastal Flats landscape is 'mountain-front hydrology'. In summary, this hydrology comprising the associated geomorphology is characterised into three elements:

(a) Water accumulation in mountain catchments,

(b) Percolation into deep groundwater flow paths in the mountain block,

(c) Net loss of stream flow to shallow groundwater at the mountain-front recharge zone, and

(d) Valley bottom or coastal plains exhibiting upward groundwater hydraulic gradients and net gaining stream reaches.

23 However, it is the penultimate and final elements of mountain-front hydrological setting that do not apply to the Paparoa Range – Barrytown Flats situation.

24 Dr McGlynn suggests that the Barrytown Flats are analogues for the 'mountain-range recharge zone' and 'Valley bottom or coastal plains. These models of geomorphology are inappropriate to apply to the Barrytown Flats due to the unique depositional history of the sediments beneath the Flats and the geology of the Paparoa foothills.

25 As Dr McGlynn states in paragraph 25 and I detail in more depth in Section 2.4.2 of the hydrological assessment document, the coastal flats were formed in the last 10,000 years (Holocene) in a marginal marine environment from sediments brought to the proto-coast line by long-shore drift. This differs substantially from the alluvial or colluvial depositional environments envisaged in the mountain-front hydrological concept.

26 As marginal marine sediments, the Barrytown coastal sediments have a highly complex sedimentological history, including transgression of the sea, deposition of high energy beach slope sands with minor gravels, regression of the coastline followed by over-draping with fluviatile gravels and clays, and ultimately the formation of low energy swampland deposits, all occurring in a relatively narrow depth range in response to changes in sediment supply, seismic crustal rises or falls, and small changes in relative or global sea levels.

27 The transition from foothills to the coastal flats also differs from the mountain-front concept since at Barrytown the transition is markedly abrupt as a buried sea-cliff cut or eroded into siltstone of the Blue Bottom Formation. It is thought the drop-off could reach 20- to 25 metres in height.

28 The pre-Holocene geology at Barrytown is also relevant to the contrast with the mountain-front concept since the foothills and headwaters of Deverys Creek and Collins Creek are based in the siltstone or muddy sandstone of the Blue Bottom Formation. This low permeability geology precludes the percolation of deep groundwater flow paths in the mountain blocks from having any influence on the coastal flats.

29 In our hydrological characterisation of the transition from the foothill parts of the Colins Creek catchment to the coastal flats, we found little to no evidence of the loss of creek flow in the zone that Dr McGlynn would characterise as the mountain-front recharge zone.

30 We also found a hard and distinct separation between Collins Creek and the underlying groundwater system imparted by clay-rich aquitard materials. Furthermore, we considered that there were reasonable grounds for inferring that surrounding springs and Kahikatea Wetlands were similarly perched over the main groundwater system in their respective areas.

31 These distinctions are relevant since undertaking a high-level assessment relies on selecting the correct landscape – hydrological analogue. I discuss the employment of the landscape – hydrological analogue in Dr McGlynn's critique of the application documents on hydrology, ecology or water quality further below.

32 In the context of materials management in the proposed mining operation, Dr McGlynn in his paragraph 20 states that "non-mineral concrete tailings would be left on the site and used to fill pits … (with) unsorted and scrambled tailings with strongly altered geochemical, water storage and transport characteristics". Dr McGlynn's representation of the materials handling practices proposed is strongly at odds with the description provided in the Project Description and the evidence in chief of Mr Stephen Miller, particularly where Mr Miller describes the methodological emplacement of processed tailings in the wake of the mine with a cyclone system followed by the placement of overburden, subsoil and soil materials separated and temporarily stockpiled in preparation for restoration.

33 In paragraph 23, Dr McGlynn engages in a philosophical discussion of environmental modelling, stating "models … are merely hypotheses and almost certainly wrong". The modelling profession, in my reading of it, accepts this criticism of modelling, but frequently extends the statement to "all models are wrong, some are useful"[1]. Models of all types are developed, utilised and relied upon by society as an important tool in extending human knowledge, despite all models being imperfect.

34 The limits of precision, accuracy and reliability of groundwater models are an active area of mathematical and general scientific enquiry, especially among hydrogeologists and groundwater engineers who use them.

35 Dr McGlynn takes particular aim at MODFLOW, which was developed as a computer algorithm in the late 1970s and is to some extent considered a core groundwater model or industry standard model system. MODFLOW is so useful and so widely used that it has been re-developed in software at least two dozen times from 1979 to 2023.

36 Dr McGlynn states that "Models such as MODFLOW can be self-fulfilling prophecies and are sensitive to almost countless assumptions, data and model limitations, …". This statement could be paraphrased as saying a groundwater model is only as good as the competence and care that goes into its preparation. I agree with the bulk of the modelling profession that groundwater models if

[1] George E. P. Box (1976) *Science and Statistics*. Journal of the American Statistical Association, 71:356, 791-799. https://doi.org/10.1080/01621459.1976.10480949

inappropriately configured are likely to provide poor precision, accuracy or reproducibility of results.

37 To avoid misuse or misconfiguration of groundwater models an elaborate system of modelling methodology has been developed within the modelling community that includes explicit assumptions, conceptual models, calibration, parameter optimisation and balanced model prediction. Whether any choice in modelling methodology is considered, the more conservative choice is favoured unless there is evidence a less conservative choice can be made. The Australian groundwater modelling guidelines are the most proximal example[2].

38 The groundwater models used in the Barrytown mineral sand mining proposals were developed in accordance with accepted industry practice and would conform, to the extent relevant to the Australian guidelines.

39 Paragraph 28 C of the evidence concludes that "any change to subsurface water levels, hydraulic gradient, water quality, and subsurface alluvium/colluvium/soil architecture in the area will likely impact local springs, streams, and creeks". This is a statement that lacks meaning, since the degree of impact is the sole live question in the assessment of hydrological, groundwater or water quality effects.

40 In paragraph 29, Dr McGlynn emphasises that impacts will be "unpredictable". Furthermore, he reiterates that "Mining will undoubtedly change the (hydrological) system" and "hydrological and ecological conditions in the area will be permanently altered and natural conditions and dynamics sacrificed".

41 Permanent alteration to natural conditions or dynamics relating to hydrological phenomena are highly unlikely since the hydrological systems at Barrytown are dynamically stable. That means the systems are in constant flux, while stable in terms of long-term trend. Even if the five to seven year life of the sand mine is considered long, the hydrological system is more likely to continue along its longer term trend lines because the long-term water balance swings continually between deficit and surplus thereby resetting the system.

42 It is also not possible to discern from Dr McGlynn's evidence how he has arrived at the above conclusions. Indeed, apart from advancing a general hydrologic setting as 'mountain-front hydrology', the conclusions cannot be drawn from the AEE hydrological assessment documents or the assessments of Gary Bramley or myself since these assessments would not lead Dr McGlynn in the that direction.

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[2] Barnett et al, 2012, *Australian groundwater modelling guidelines*. Waterlines report, National Water Commission, Canberra

43 It is my professional opinion that it is feasible to assess the degree of impact of the proposed mining on the surrounding hydrological systems within bounds of acceptable uncertainty. Indeed, these assessments can be assisted, but not replaced, by the use of groundwater hydrological models.

44 Paragraph 33 of Dr McGlynn's evidence concludes that "water quality in receiving springs, streams, and wetlands would likely be compromised by turbid water and other water quality constituents bound to transported materials (e.g., heavy metals)".

45 Dr McGlynn makes no mention of the use of bunding and water treatment to prevent the release of turbid water into natural waters contained within the proposal documentation. Indeed, these systems were outlined in the hydrological assessment documents, including the Water Management Plan. In groundwater, turbidity coarser than 1 micron was found in West Coast based research not to extend beyond 40 metres movement through recent West Coast sediments[3]. Therefore, the manifestation of turbidity in spring waters is precluded due to their location significantly more distant than 40 metres.

46 In paragraph 39, Dr McGlynn says many things about the drainage network in the general area of the Application Site, but concludes the "Therefore, any changes to groundwater levels and quality will manifest in stream and wetland conditions." This conclusion is far too sweeping to have merit in the assessment of hydrological effects.

47 Paragraph 40 states that Canoe Creek "could be adversely affected by any surface or subsurface discharge of mining related water".

48 Injection trials found that the underlying groundwater was effectively isolated from significant hydraulic connection with Collins Creek due the confirmed intervening presence of thick measures of clay-rich subsoils. These clay-rich subsoils in vertical thicknesses greater than 3 metres were tracked in creek margin drilling investigations for much of the course of Collins Creek from SH6 to nearly Canoe Creek Lagoon.

49 The water chemical composition of shallow groundwater in the Application Site is also very different to the composition of Collins Creek.

50 Canoe Creek downstream of SH6 is also perched on an alluvial fan as outlined in the hydrological assessment documents. It is not in any way influenced by subsurface flows from the mining activity area, except for the Canoe Creek

[3] Thorpe, H. 1990. Movement of fine sediment through a natural alluvial gravel. Research Report No. 234, Geophysics Division, Department of Scientific and Industrial Research, Wellington, New Zealand.

Infiltration Basin in the lowest 100 metres from the coastline. No surface water connection exist between the mining area and Canoe Creek.

51 No discharge of mining activity related water could enter Canoe Creek other than the aforementioned infiltration basin.

52 Dr McGlynn, in fact, does engage in a critique of the application materials on hydrology. As amplified in his Summary (paragraphs 62 to 65), he ventures the following opinions on the hydrological, ecological and water quality assessments:

(a) There are significant uncertainties in the subsurface architecture, flow fields and geochemistry,

(b) Assessment of effects on wetlands are only possible following a minimum level of wetland assessments, inside and outside of the Application Site,

(c) It will not be possible to restore the hydrologic and chemical functioning of the mined ground,

(d) Any change in subsurface conditions and altered flow would affect local streams and wetlands in unpredictable ways, and

(e) If mining is to proceed as proposed, hydrological and ecological conditions in the area will be permanently altered and natural state lost.

53 It is difficult to accept that Dr McGlynn can make these conclusions on the basis of a scientific high-level assessment based in concepts of geomorphological and hydrological occurrence.

54 Dr McGlynn's statements in evidence frequently mention uncertainty as a reason to doubt that site conditions are adequately evaluated, effects adequately assessed, or the proposed mitigations adequate to resolve adverse effects.

55 The quantification of uncertainty is assuredly a necessary and difficult field of science, especially as it relates to large-scale natural, biogeochemical and hydrological systems that do not include convenient labels or fixed input values.

56 However, Dr McGlynn fails to state at what point the management of uncertainty would be adequate to make assessments, which might allow him to state whether the application documents on hydrology or water quality have reached this threshold with reasonable authority.

57 Instead, it is my opinion that Dr McGlynn's criticisms of the hydrological findings in the application documents and my evidence, lack substance.

Conclusion

58 The hydrological and other water-related assessments and plans in the applications provide a balanced and adequate basis for considering the proposals for sand mining at Barrytown by TiGa Minerals & Metals Ltd.

Jens Rekker

Dated this 2nd day of February 2024