IN THE MATTER	of the Resource Management Act 1991
AND	
IN THE MATTER	of an application for resource consents by **TIGA MINERALS AND METALS LTD**
AND	
IN THE MATTER	of a submission by the
	COAST ROAD RESILIENCE GROUP INC

Statement of evidence of Michael Garry Hill

For COAST ROAD RESILIENCE GROUP INC
Topic Radiation

Dated: 29 January 2024

Coast Road Resilience Group Inc

Email: coastroadrg@gmail.com

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INTRODUCTION

1. My full name is Michael Garry Hill. I am a retired scientist. I am an active member of the Barrytown community: a Civil Defence sub-coordinator and Barrytown Hall committee member. I volunteer for several community, conservation and environmental protection projects. The well-being and sustainability of the community and the environment are important to me.

2. I am a member of the Coast Road Resilience Group Inc. (CRRG). I have been asked by the CRRG to provide lay witness evidence in relation to radiation. I am not an expert in this matter and this report is not intended as expert evidence. I have prepared this statement of evidence for the CRRG in relation to this application.

3. I am familiar with the TiGa application site because I live on State Highway 6 approximately 1km to the south.

4. In preparing this statement of evidence, I have reviewed the following information:

   The applicant's AEE report; WCRC and Grey district S42A reports; Attachments P. T and U; Addendum 3.5 Radiation Peer Review; Statement of evidence – Mitch Ryan (metallurgy and radiation); Discussions with applicant's representatives; Documents relating to radiation contamination in the 2021 Gippsland Fingerboards sand mine application; Relevant documents from the Australian mining industry and the Australian Radiation Protection and Nuclear Safety Agency; New Zealand Radiation Safety Act (2016); Correspondence with the NZ Ministry of Health; International Atomic Energy Agency reports; World Nuclear Organisation website and reports; International Commission on Radiological Protection website; Academic papers referring to placer deposit geology on the Barrytown Flats and the West Coast; Academic papers on the long-term health risks of exposure to ionising radiation.

5. All documents and websites cited in the text are referenced at the end or in footnotes.

6. In addition to providing this statement in support of the CRRG, I also lodged a personal submission in relation to the TIGA Minerals and Metals Ltd application

CONTENTS

SCOPE OF EVIDENCE

1. This evidence focusses on ionising radiation as an environmental contaminant and the adequacy of measures proposed by the applicant to assess and monitor ionising radiation and associated health risks. Other CRRG members and expert witnesses will be providing evidence on other aspects of the application.

SUMMARY

2. The heavy mineral concentrate (HMC) which is proposed to be mined from the Barrytown Flats is mildly radioactive and can pose a threat to the health of communities living around the mine site, around HMC secondary separation plants and ports, and on all roads linking these areas, especially where the exposure is long-term as is the case for this proposed activity.

3. HMC mining of this nature (mineral sand mining for ilmenite, garnet and rare earth elements below the water table) has never been carried out in New Zealand.

4. The community is a major stakeholder in this proposed mining operation, from the mine site to the secondary separation plant and onwards to the export port. The community has a

fundamental right to feel secure in the knowledge that they, their families, plants, animals and the surrounding environment, will not be exposed to enhanced levels of ionising radiation at any time or place during or after the mining activity.

5. Community safety from ionising radiation can only be assured through a process that gathers appropriate background data on ionising radiation in the environment prior to mining; develops plans for measuring ionising radiation contamination during the life of the mine and at future mineral separation plants and export sites; and manages ionising radiation risk through appropriate best practice safety measures.

6. Independent sand mining radiation specialists exist offshore, notably in Australia. To my knowledge, no such experts exist in NZ.

7. Studies of placer deposit mining elsewhere suggests that ionising radiation threats come principally from air and ground contamination in wind-blown dust or gas (radon) that can be inhaled; or from dust settling on and around buildings and paddocks. Stockpiles of ore and HMC are important potential sources. Additional ionising radiation contamination risks come from water-soluble radioactive isotopes (e.g. radium).

8. NZ does not have appropriate legal safeguards and industry codes of practice in place to deal with radiation risks such as those that have been developed in Australia over 90 years of HMC mining.

9. The NZ Radiation Safety Act (2016) was developed with a focus on the use of radionuclides in healthcare (there was no HMC mining at the time). The threshold concentration for declaring relevant isotopes (e.g. U-238 and Th-232) radioactive under the act is 10-times higher than similar legislation in Australia or that recommended by International Atomic Energy Agency for sand mining.

10. The NZ Ministry of Health has acknowledged that the 2016 Act may not be fit for the purpose of heavy mineral concentrate mining. The Office of Radiation Safety is reviewing the act with this in mind.

11. In the absence of an NZ code of practice for managing ionising radiation risk, the company says it will adopt the Australian industry standard Code of Practice, but only when the NZ threshold for ionising radiation concentration has been exceeded. There is a risk of moral hazard[1] in this self-monitored compliance.

[1] Moral hazard: The lack of incentive to guard against risk when protected from its consequences.

12. The applicant has presented a brief submission on radiation levels from 3 bulked samples of heavy mineral concentrate and ore. These are insufficient for the purposes of reliably assessing mean radiation levels and their variability across the mine site.

13. The applicant has presented a minimal amount of environmental background radiation data from a single dosimeter placed at the proposed mine site for an indefinite time period. This is inadequate either as a baseline datum or as a base from which to develop an ionising radiation monitoring programme for the life of the mine.

14. Long-term scientific studies of radiation exposure have shown that there is no safe limit of exposure to ionising radiation. Existing legislated cumulative ionising exposure limits (1mSv[2]/year public exposure) are now considered by experts in this field to be much too high, especially for young people.

15. Best practice recommendations in Australia and New Zealand (Radiation Safety Act) require mine operators to take measures to minimise exposure of workers and the public to ionising radiation contamination which are as low as practicable and well below regulatory limits.

INTRODUCTION

16. Heavy mineral concentrate (HMC) is known to be mildly radioactive. The risk from ionising radiation in mineral sand mining has been an issue for proposed mining activities on the Barrytown Flats dating back over 30 years (Roberts & Whitehead 1991; Hoskin 2021) and is still current (see discussion warning of concentration of uranium, and thorium, containing minerals from Barrytown HMC in Wells & Haverkamp 2020). HMC mining as proposed in this consent application (mineral sand mining for ilmenite, garnet and zircon below the water table with a secondary separation plant) has never before been carried out in New Zealand and carries with it unique radiation risks (IAEA 2003, Table 28, p84).

17. There is widespread concern within the community over risks of ionising radiation exposure arising from this proposed mine. At least 34 opposing submissions mention this. The public is entitled to feel assured that, should this mining consent be granted, they will not be exposed to elevated levels of ionising radiation at any stage of the mining operation or its rehabilitation. This is particularly so for communities living adjacent to the mine, adjacent to any future mineral separation plant or along HMC/minerals transport routes.

[2] m = milli (one-thousandth); Sv = Sievert: a measure of the amount of radiation absorbed by a person—while accounting for the type of radiation and its impact on particular organs and tissues in the body— equivalent to one joule of energy per kilogram of mass.

APPLICANT'S RADIATION EXPERT EVIDENCE

18. The most recent expert evidence from the applicant on radiation levels (Ryan 2024)[3] provides measures of ionising radiation in bulk samples of 3 grades of HMC (high, medium and low) and (following preliminary separation) ionising radiation estimates in ore, HMC, slimes and tailings. I agree with the applicant's interpretation that these measures of ionising radiation are below the threshold in the Radiation Safety Act for requiring a source license.

19. The applicant (Ryan 2024, parag. 22) determines that the two measures of ionising radiation in these samples of HMC collected by different methods (see Ryan 2024 for details) are indistinguishable and that:

> *"While some degree of fluctuation in ionising radiation will occur due to ore body variation and potential process plant operational influence, these variations will not be significant, as exemplified by similar results between the two HMC samples from different origins within the Barrytown resource"*.

20. Despite the fact these are bulked samples and therefore the measures of ionising radiation will naturally trend towards an overall mean value for radiation at the mine site, only two samples have been analysed. From these, it is statistically impossible to determine whether these samples differ. Developing a sampling plan that will allow determination of unbiased estimates of ionising radiation in samples and the variability around those sample means is a job for a qualified statistician.

21. The statement in the applicant's final radiation report (Ryan 2024) of *"negligible levels of variance exhibited between the two HMC samples"* does not hold up to scrutiny for the same reason. The true variability in ionising radiation levels in the ore remains unknown. Thus this argument should not be accepted as a justification for the proposed consent conditions of quarterly sampling of HMC for radiation concentration.

22. Data from a similar sand mine in Australia provides a useful illustration of expected variability in radiation across a mine site. The radiation assessment report (134 pages) for the Fingerboard Sand Mine project in Gippsland, Victoria (Billingsley 2020) provides a reasonably comprehensive radiation assessment. The radiation report provides 'minimum' and 'maximum' levels of radiation content ($kBq.kg^{-1}$) in ore and HMC from a sample of ore, that differ by a factor of 3 (Billingsley, 2020; Table 11, p29). They quote the mining company Kalbar as saying "…*levels of uranium and thorium will vary in the ore mined*".

23. The applicant (Ryan 2024) has noted, correctly, that none of the samples tested would be categorised as radioactive under the Radiation Safety Act (2016). However, it is notable that the

[3] This document is incorrectly dated 19 January 2023

level of ionising radiation in the NZIMMR HMC sample (0.87 +/- 0.13 Bq/g) approaches the limit of 1 Bq/g which would, in Australia, be considered to be radioactive. The Radiation Safety Act (2016) is under review and has been shown to be potentially unfit for purpose for managing radiation risk in sand mining. See further discussion below [para. 35] and Appendix One.

MONITORING BACKGROUND RADIATION AT THE PROPOSED MINE SITE

24. The revised radiation expert witness statement (Ryan 2024) is silent on the measurement of background radiation levels using dosimeters. The applicant presents (AEE FINAL document para. 5.81) preliminary data from one of two dosimeters placed at the boundary of the mine site for 4 months. The other dosimeter failed to work. The AEE states *"It is expected that further data may be available before any hearing occurs for the proposal"*. No additional dosimeter data have been presented to date.

25. In spite of this dearth of data, and the fact these dosimeters are considered to be inappropriate for estimating atmospheric radiation contamination (Brian Lunt expert witness statement) the AEE continues (AEE para 5.81):

> *"Conditions of consent are proposed to monitor radiation levels at the boundary of the application site for the duration of mining to **confirm** that public exposure levels are not exceeded as a result of this activity."* [my emphasis]

26. This is an unfortunate choice of words. The applicant appears already to have made their minds up that radiation exposure at the boundary of the site will not be a public issue once mining has commenced. This view was reinforced by statements made by TIGA representatives during their public meeting on 10 October 2023[4].

THE NEED FOR INDEPENDENT ASSESSMENT OF RADIATION RISK and THE DEVELOPMENT OF A RADIATION PLAN

27. A heavy mineral sands mining proposal in Australia would be expected to present extensive baseline data (social, environmental and economic), identify key potential impacts and risks, and propose a comprehensive approach to mitigation and management of the identified impacts and risks arising from ionising radiation (Mudd 2021). A recent example is the Gippsland Fingerboards sand mine proposal (Billingsley 2020)[5].

[4] Robert Brand, CEO and John Berry, Project manager, TIGA. *personal communication. Barrytown Hall public meeting 10 October 2023*

[5] https://minefreeglenaladale.org/

28. The Australian Radiation and Nuclear Safety Agency (ARPANSA) has developed comprehensive codes of practice covering the management of radiation risk in the industry (ARPANSA 2005)[6]. No such code exists in NZ.

29. The issue of what constitutes radiation risk under the law raises further issues. The New Zealand Radiation Safety Act has a legislated level of ionising radiation from thorium (a component of monazite present in HMC and the main source of ionising radiation[4,] of 10 Bq/g[8]. This is 10-fold more than the legislated limit in Australia of 1 Bq/g (ARPANSA 2005) and the limit recommended by the International Atomic Energy Agency (IAEA 2014; 2023a and 2023b).

30. The NZ Ministry of Health has acknowledged that the 2016 Radiation Safety Act, which was developed with a focus on radiation risk in medicine, may not be fit for the purpose of heavy mineral concentrate mining (there was no placer deposit ilmenite mining in NZ at the time) and has requested the Office of Radiation Safety to review the act with this in mind, focusing on an assessment of the current regulatory situation for bulk quantities of material that may contain traces of naturally occurring radioactive isotopes, and on a desktop assessment of any radiological risk that may exist for bulk quantities of material that may contain traces of naturally occurring radioactive isotopes (Appendix 1: Correspondence from the Ministry of Health, June 2023). We await the outcome of these deliberations.

31. In the meantime, a precautionary approach is warranted when considering resource consent and, as the Ministry of Health correspondent suggests (Appendix 1), using the RMA process to ensure the risk to the public of contamination from ionising radiation from sand mines is eliminated.

DUST

32. In Australia, where sand mining has been carried out for 90 years, it has long been recognised that the most significant potential radiation problem is alpha particle radiation arising from thorium contamination in airborne dust (IAEA 2003), which may be inhaled:

    "*Dust control is therefore the most important objective in radiation safety for the titanium minerals industry"* (direct quote from World Nuclear Association website[9]).

33. As a result of this, and again quoting directly from the World Nuclear Association website:

    "*In Australia, the more precise identification of airborne radiation in mineral sands dry separation plants led to the introduction of voluntary codes of practice in 1980. These*

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[6] https://world-nuclear.org/information-library/safety-and-security/radiation-and-health/naturally-occurring-radioactive-materials-norm.aspx

[8] Bq/g = bequerels per gramme. A bequerel is one nuclear declay per second.

[9] https://www.world-nuclear.org/information-library/safety-and-security/radiation-and-health/appendicies/mineral-sands-appendix-to-norm-information-paper.aspx

codes were incorporated into protective legislation in 1982. The method of calculating permissible exposure levels was changed in 1984 and again in 1986. The result was an effective six-fold reduction in radiation exposure limits.

The industry responded with two major initiatives:
Engineering programs to reduce airborne dust in the dry separation plant.
Research programs to improve industry and community knowledge about airborne radiation.

Collectively, the titanium minerals mining companies in Western Australia have spent more than $30 million on engineering programs to improve dust control measures. As a result, average radiation levels have been reduced by more than 70%. Protective masks are no longer required for most plant operators. All new plant is designed to incorporate efficient dust control equipment."

34. I would welcome verifiable assurances that this level of dust and ionising radiation management is in place for the proposed site and stated as a condition if consent is granted.

35. A recent case (January 2024) of community exposure to HMC dust during high winds in Westport provides an instructive example[10]. West Coast Bulk Logistics (a Westland Mineral Sands company) allowed an exposed pile of HMC taken from its Okari Rd sand mine to be stored on the Westport wharf, where it dried out and was blown around by strong winds. According to a newspaper report, the dust filled gutters on buildings in the town hundreds of metres from the stockpile. The operations manager said the company was "....*stepping up its management plans because the West Coast was facing a windy summer*." This admission demonstrates a laissez-faire approach to compliance in the industry and a disregard for, or an ignorance of, ionising radiation risk in sand mining.

36. No mention is made in the article of the hazard arising from ionising radiation in the dust from inhalation or direct ionising radiation exposure. The company was not monitoring cumulative ionising radiation occurring at the wharf stockpile because it was not part of the consent conditions.

HEALTH RISKS ARISING FROM EXPOSURE TO IONISING RADIATION

37. There is no safe limit of exposure to ionising radiation (Ruff 2021). All instances of HMC dust inhalation pose a risk of ingestion of damaging ionising radiation. Likewise, contaminated dust deposition on surfaces carries a risk of ionising radiation exposure for persons in its vicinity. The effects of ionising radiation on the body are cumulative over a human lifetime.

[10] Westport News headline article 4 January 2024 "*Westport gets sandblasted*" Ellen Curnow.

Evolving understanding of the effects of ionising radiation on health

38. The following notes are taken from a submission to the Gippsland Fingerboard mine consent hearing in 2021 by Professor Tilman Ruff, an internationally-renowned Australian physician, academic and Nobel Laureate specialising in the public health impacts of nuclear technology. The Gippsland Fingerboards mine proposal has many similarities with the current consent application, notably having similar levels of ionising radiation in the ore (compare Billingsley 2021, table 11 and Att T or Ryan, 2024. Professor Ruff presented an expert witness statement to the Gippsland hearing which provided a detailed review of current knowledge of the risks posed by long-term exposure to ionising radiation (Ruff, 2021; Tilman Ruff personal communication January 2024). An on-line link to his submission is given in the reference list and Professor Ruff's unabridged 2-page 15-point summary is presented in Appendix 2. Some pertinent, unedited, quotes from Professor Ruff's document are given here:

> *"Any consideration of protecting workers and the public from the health risks of exposure to ionising radiation should consider not only regulatory requirements, but also the evolving current evidence regarding of those risks. Significant evidence has been accumulating in recent years which extends our understanding of radiation health risks and indicates that those risks are greater than previously assumed. The current regulatory standards for radiation protection – essentially 20 mSv maximum average annual permissible additional occupational exposure for workers and 1 mSv additional human origin non-medical exposure for members of the public - were established over 2 decades ago, before much of the current evidence became available. These standards are now arguably inadequate. They are not standards associated with no or with negligible risk."*
>
> *"Any and all levels of ionising radiation exposure, including doses far too low to cause any short- term effects or symptoms, are associated with increased risks of long-term genetic damage, a variety of chronic diseases, and increases in almost all types of cancer, proportional to the dose. There is no dose of radiation below which there is no incremental health risk. These excess risks persist for the lifetime of those exposed."*
>
> *"New evidence shows that radiation risks to health are greater than previously thought and are not adequately reflected in regulatory limits. Health risk exists below the maximum permissible doses for the public and for workers. Radiation health risks associated with chronic diseases approximately double the risks associated with cancer. Radiation health risks are 4 - 5 times greater for children than adults and 40% greater for women and girls than for men and boys at all ages. Young adults are more susceptible than older adults*."

"All aspects of project management should aim for radiation exposures for workers and the public which are as low as practicable and well below regulatory limits, and set action levels that would trigger prompt evaluation and response, with involvement of DHHS. I would recommend that the latter levels (including all exposure pathways) be set at around 1-2 mSv per year for workers and 0.1 - 0.2 mSv/yr for the public".

39. Professor Ruff's recommendation for annual regulatory ionising radiation exposure limits for the public are one-tenth to one-fifth of the legislated limit (1 mSv/year) in Australia and New Zealand. His findings are based upon his extensive experience and his review of peer-reviewed research articles in the public health literature (e.g. US National Academy of Sciences 2006; Kaatsch et al. 2008; Kendal et al. 2013; Olson 2019).

40. Taken at face value, Professor Ruff's comments support the conclusion that the current Radiation Safety Act is not fit for purpose for managing ionising radiation risks to the public associated with sand mining in New Zealand.

41. In its findings on the Gippsland Fingerboards placer deposit mining proposal, the Victoria Planning Panel (Planning Panels Victoria 2021) determined (para. 10.3.4. p144):

> *"Should the Project proceed control of dust must be an absolute priority and be demonstrated to be* ***achievable under all circumstances for the entirety of the Project life****, to mitigate risks for accumulation of potentially radioactive dust in houses and other structures, water tanks, and through uptake in plants and animals."* [11]
>
> *"Should the Project proceed, the RMP (Radiation management plan) should include dose trigger points* ***well below current maximum dose levels to drive early intervention and assessment if radiation levels trend upwards. This would represent a best practice approach.****"*
>
> *"Stockpiles present the greatest concentration of radioactive material in the process and present a risk for potential dispersal of material through the impact of wind, or through leachate."* [bold my emphasis]

42. These findings support the conclusion that a precautionary approach to managing radiation risk is warranted; that ionising radiation be acknowledged as a contaminant risk (see below): that advice be sought from independent health and environmental radiation specialists including the Office of Radiation Safety and community representatives; and that conservative thresholds be adopted when interpreting what is likely to be a more-than-minor environmental effect of ionising radiation contamination to the environment and the community under the RMA.

[11] The consent application was declined (Planning Panels Victoria 2021): https://minefreeglenaladale.org/

43. It should also be kept in mind that ionising radiation exposure risk is cumulative over a person's lifetime and the applicant has stated publicly that it wishes to mine the Barrytown Flats for 50 years[12].

44. The community neighbouring the proposed mine and along any HMC trucking routes and separation facilities, present and future, are key stakeholders in this process. As such, the community must be consulted throughout the process of gathering and evaluating data, developing radiation management plans, setting trigger points, and assessing risks associated with ionising radiation exposure.

45. I support the view of Brian Lunt that a decision on a consent cannot be made safely until adequate data have been gathered on background ionising radiation levels, and an independent assessment made of the environmental and community risks associated with contamination resulting from ionising radiation released by the proposed mining process. This process needs to engage council staff, the Office of Radiation Safety and community representatives.

RADIATION AS A CONTAMINANT

46. Section 9 of the Radiation Safety Act states:

> *"A person who deals with a radiation source must ensure that the magnitude of individual doses of ionising radiation to which a person may be exposed, the number of people subject to exposure, and the likelihood of exposures to ionising radiation are* ***as low as is reasonably achievable, taking into account economic, social, and environmental factors."*** [bold my emphasis]

The WCRC S42A report identifies radiation arising from mine operations and HMC transportation and export as an environmental contaminant under the Regional Land and Water Plan (Rules 71 and 91) and the Regional Air Quality Plan (Rule 16). It recommends that a single resource consent be sought to discharge ionising radiation to land, water and air (WCRC s42A parag. 57).

47. I support the conclusion that ionising radiation is a contaminant but wish to argue that separate resource consents be sought for discharge of ionising radiation to air, water and land. Justification for this is that the radiation contamination accruing to each part of the environment is quite different in its nature and pathway, as explained below.

[12] Tiga CEO quote in Greymouth Star article 6 September 2022

WATER CONTAMINATION

48. The proposed mine, if consented, will be operating below the water table. The release of water-soluble radioactive isotopes during mining poses an environmental contamination issue, especially from radon and radium. Radium (RA-226 and RA228) is constantly being produced by the decay of thorium and uranium in the HMC and these isotopes are water-soluble. They will be mobilised during disturbance of the ground during mining (Billingsley 2020). An additional potential problem arises from leaching of radium from stockpiled ore and HMC. Measurement and assessment of these processes should be an integral component of consent conditions and will require inputs from an expert in environmental radiation management.

49. Radium may be bioaccumulated and bioconcentrated by plants and animals. The half-life of radium-226 is 1600 years (Gad 2014). There is currently no maximum acceptable value for radium in the drinking water standards in New Zealand[13]. Levels of radium in water vary seasonally, requiring a minimum of 12 months monitoring (Billingsley 2020). Several other radioactive isotopes, including uranium and lead, may leach from mineral sands into surrounding ground and surface water (Billingsley 2020).

50. The applicant has not measured background radiation levels in water, nor evaluated the risk of contamination of groundwater or surface water by radioactive isotopes during mining. Neither have they put forward plans for monitoring ionising radiation levels in ground and surface water. By contrast, in Australia, the Gippsland Fingerboards proposal contains background analysis and discussion of radiation levels in ground water and surface water (Billingsley 2020; 2021).

AIR CONTAMINATION

51. As already noted, radioactive material is a contaminant in dust blowing off stockpiles of ore and HMC. Ionising radiation from alpha and beta particles and gamma radiation (principally from thorium (IAEA 2003, p84) are airborne risks through inhalation and/or following particle settlement and lodgement in structures such as houses (see also para 32 above).

52. This is a completely different contamination risk to that posed by water contamination from soluble radionuclides and will require a separate discharge consent under the Regional Air Quality Plan (Rule 16).

[13] Water Services (Drinking water standards for NZ) Regulations 2022
https://www.legislation.govt.nz/regulation/public/2022/0168/latest/LMS698021.html

GROUND CONTAMINATION

53. Ground contamination may arise from existing radioactive elements in the soils and placer deposits (e.g. from monazite) but it may also be enhanced by wind-blown dust that settles on the ground and is bioaccumulated in plants and potentially in animals and humans living amongst and feeding on the plants.

54. In summary, and taking guidance from Australian best practice (ARPANSA 2005: Billingsley 2020) I submit that assessment of background radiation levels is required for, but may not be limited to, the following:
    - Terrestrial gamma radiation levels;
    - Radionuclide content of surface soils;
    - Radionuclide content of surface and groundwater sources;
    - Radionuclide content of vegetation;
    - Ambient long-lived radionuclide concentrations in airborne dust; and
    - Ambient radon concentrations.

    And that these different radiation risks relate to separate ionising radiation contamination to air, ground and water.

SECONDARY SEPARATION PLANT

55. I agree with the statement in the GDC's s42A Officer's report (para.37)

    "*The proposal is stage one of the applicant's wider plans for mineral sand mining on the Barrytown Flats. No detail of the other stages are provided.' Many in the community are thus also stressed and worried about the potential future trajectory of this proposal and the impacts for the local community."*

56. While the current application relates only to the mining and processing of heavy mineral concentrate (HMC), the mining company is keen to present its plans to develop a secondary mineral separation plant on the West Coast. This is expected to increase financial returns 4-fold and is an integral part of its business plan[14],[15] and be operational within 5 years[16]. Secondary separation of HMC results in the creation of mineral concentrates and tailing residues having substantial levels of radiation from uranium and thorium-bearing minerals (IAEA 2003, Table 28).

57. Recent peer-reviewed academic publications measuring mineral content of Barrytown placer deposits have highlighted the potential risk from radiation arising from such concentrations,

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[14] Robert Brand, CEO and John Berry, Project manager, TIGA. *personal communication. Barrytown Hall public meeting 10 October 2023*

[15] TIGA RC Application AEE Final.pdf and Attachment R – Economic Assessment.pdf at https://www.greydc.govt.nz/06your-home/planning-and-resource-consents/notified-consents#toc-link-3

[16] NZ Petroleum and Minerals Mining Permit 60785 Decision Recommendation. Sourced as OIA request. 173pp.

including the need for careful disposal of waste residues containing monazite (see discussion in Wells & Haverkamp 2020 and Tay *et al.* 2021). The applicant does not mention this risk to themselves and the community, preferring instead to highlight and emphasize how the separation plant will maximise shareholder value.

CONCLUSIONS

58. The community impacted by this potential development has a right to feel secure in the knowledge that it will not be exposed to enhanced levels of ionising radiation contamination as a result of activities at this mine and during mineral storage, separation, transportation and export. As key stakeholders, community representatives need to be consulted at all stages of planning and decision-making for radiation risk evaluation.

59. Given the unique nature of this proposed mining activity in NZ, and

    - the lack of information in the public domain on the distribution and level of radiation in the ore across the proposed mine site,
    - the known ionising radiation contamination risks associated with HMC production and processing,
    - the fact that radiation exposure has no safe limits,
    - that in light of recent long-term studies, legislated safe limits for exposure to ionising radiation are deemed to be too liberal,
    - that there is an acknowledged lack of adequate legislated safeguards and codes of practice covering radiation contamination in the nascent titanium sand mining industry in New Zealand,
    - that the existing NZ legislation governing ionising radiation risk management (RSA Act 2016) is under review and
    - that there is a consequent exposure to moral hazard with regard to radiation safety monitoring by the applicant,

    an independent assessment of radiation risk at this site is warranted, carried out by a radiation expert with prior experience of assessing and managing radiation risk in ilmenite sand mining, and in consultation with the Office of Radiation Safety and community stakeholders.

60. To meet the requirements in the applicant's proposed conditions of consent (para 8.5 and 8.6), a detailed radiation safety plan would need to be developed by an independent expert in consultation with the Office of Radiation Safety and community representatives and included in the conditions of consent.

Michael Garry Hill
26 January 2024

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APPENDIX ONE: LETTER FROM THE MINISTRY OF HEALTH CONFIRMING A REVIEW BY THE OFFICE OF RADIATION SAFETY INTO THE REGULATORY SITUATION AND RADIOLOGICAL RISK FOR BULK QUANTITES OF MATERIALS WITH NATURALLY OCURRING RADIOACTIVE ISOTOPES.

Sent as an email attachment 19 June 2023

133 Molesworth Street
PO Box 5013
Wellington 6140
New Zealand
T+64 4 496 2000

Garry Hill

[email address removed]

Ref. H2023025614

Tēnā koe Garry

Thank you for your correspondence of 13 May 2023 to the Minister of Health, Hon Dr Ayesha Verrall, raising your concerns about the potential health implications of a proposed large-scale sand mine in your community. The Minister has asked that I respond to you directly. I appreciate you taking the time to write.

Health implications

I acknowledge your concerns about potential health implications for your community. In response, I can only address the matters on the radiological risks that you have raised.

The Office of Radiation Safety (ORS) is the team within Manatū Hauora – the Ministry of Health (the Ministry) responsible for the administration of Radiation Safety Act 2016 and the Regulation Safety Regulations 2016. The purpose of the legislation is to establish a framework to protect the health and safety of people and protect the environment from the harmful effects of ionising radiation while allowing for its safe and beneficial use. The legislation also enables New Zealand to meet some of its international obligations relating to protection, radiation safety and security, and nuclear non-proliferation.

I have been advised by ORS staff that they have not received, or been able to ascertain, any evidence of radiation harm being caused to the environment, or to the health and safety of people, as a result of mining activities in New Zealand that are similar in nature to the activities you have mentioned.

Having said this, I agree with your view that the mining activities you describe are known to involve raw material that is likely to contain traces of naturally occurring radioactive isotopes. I also acknowledge that mining activities may concentrate the levels of naturally occurring radioactive isotopes in products, or by-products, and that these practices give rise to potential radiation exposures that should be subject to regulatory control.

I am aware that the Ministry's Director for Radiation Safety (the Director) is preparing an assessment of the current regulatory situation for bulk quantities of material that may contain traces of naturally occurring radioactive isotopes (such as the situation you describe). The Director's assessment is due to be completed by the end of 2023.

I have also asked the Director to commence a desktop assessment of any radiological risk that may exist for bulk quantities of material that may contain traces of naturally occurring radioactive isotopes. The Director will include the information you have provided in both of these assessments. This assessment is due to be completed by the end of June 2024.

The outcome of these assessments will help to inform any further course of action, including any further consideration of changes to the Radiation Safety Act 2016.

Current regulatory situation

As you have alluded to, the mining activities you describe are already subject to the Resource Management Act 1991. My understanding is that this legislation has the purpose of ensuring that (among many things) activities do not damage the air, water, soil and ecosystems that we and future generations need to survive. The legislation is administered by the Ministry for the Environment and enables resource consents to be issued by local authorities which provide permissions for activities that affect the environment.

I also understand that mining activities are subject to regulation under the Health and Safety at Work Act 2015. This legislation's main purpose is to provide for a balanced framework to secure the health and safety of workers and workplaces.

Given this situation, you may wish to contact West Coast Regional Council and/or Grey District Council about the resource consent conditions that might be applied in the situation you mention.

Next steps

I have asked the Director to be available for you to discuss any of these matters further. The Director's contact details are:

Dr Andreas Markwitz

Director for Radiation Safety

Ministry of Health

Telephone: 021 564 019

Email: andreas.markwitz@health.govt.nz

Thank you again for taking the time to write. I hope this information is useful, and I wish you well.

Nāku noa, nā

Ruihua Gu

Acting Group Manager, Quality Assurance and Safety

Regulatory Services – Te Pou Whakariterite

APPENDIX TWO: Unedited Expert Witness Summary Statement by Professor Tilman A Ruff AO, physician, academic, distinguished radiation health expert and 2017 Nobel Laureate, to the 2021 hearing into the mining consent application for the Fingerboards sand mining project in Gippsland, Australia. Reproduced in full with Professor Ruff's permission.

The mining application has been declined. ***Emphasis has been added.*** See reference list for on-line link to the full report.

1 Feb 2021

Tilman A Ruff AO Expert witness statement: Radiation health impacts of proposed Fingerboards Mineral Sands Mine Project, Glenaladale, Victoria

Summary of Conclusions and Recommendations on Radiation and Health

1. New evidence shows that ***radiation risks to health are greater than previously thought and are not adequately reflected in regulatory limits. Health risk exists below the maximum permissible doses for the public and for workers.*** Radiation health risks associated with chronic diseases approximately double the risks associated with cancer.

2. ***Radiation health risks are 4 - 5 times greater for children than adults and 40% greater for women and girls*** than for men and boys at all ages. Young adults are more susceptible than older adults.

3. I found no mention in any project documentation I reviewed regarding monitoring or radiation protection measures for sites particularly relevant to children, such as schools, kindergartens, child care centres, playgrounds or sports facilities.

4. ***All aspects of project management should aim for radiation exposures for workers and the public which are as low as practicable and well below regulatory limits, and set action levels that would trigger prompt evaluation and response,*** with involvement of DHHS. I would recommend that the latter levels (including all exposure pathways) be set at around 1-2 mSv per year for workers and 0.1 - 0.2 mSv/yr for the public.

5. Radiation protection measures should be informed by age and gender differences in radiation health risks, and should address settings particularly relevant for children.

6. A major project which will run over more than two decades must consider the implications of global heating and factor them into its mine management.

7. ***To minimise the public health and environmental impacts of both routine and accidental releases of HMC during handling and transport, every effort should be made to minimise multiple handling and especially dust generating loading of HMC onto and off trucks, and onto ships from wharves, and open***

storage of HMC at the mine or on wharves or anywhere else. Every effort should also be made to minimise the number and distance of truck movements required to transport the HMC, and preferably to eliminate them altogether. The ideal would be for the HMC to be loaded via as closed a system as possible (eg a closed conveyor or pipe) directly into train-borne containers at or immediately adjacent to the mine site, containers which are then sealed and transported by rail to be shipped offshore.

8. As recommended by Dr Joyner and DHHS, all possible exposure pathways of workers and the public should be assessed and monitored, including through farm work and other types of prevalent local employment or other activites, and sampling of all agricultural products downwind and downstream of the planned mine, including not only vegetables and grain, but fish, and animal products in the form of both meat and dairy products. If any Aboriginal people harvest bush foods in areas potentially affected by the project, associated exposures should also be assessed.

9. All mine personnel should wear appropriate personal radiation dosimeters at all times on site.

10. ***All environmental and health relevant monitoring data during every phase of the mine's operation and rehabilitation should promptly be made publicly available.***

11. ***All consultative bodies established in relation to the mine should include representatives of community organisations.***

12. ***An adequate rehabilitation bond should be established*** to enable timely completion of remediation and rehabilitation to occur without substantial call on the taxpayer to foot the bill if the operating company is unable to complete this task in a timely and adequate way.

13. Project documentation currently uses the large and cumbersome unit of the Sievert (SV) for ionising radiation equivalent dose, for reasons that are not apparent. It would be clearer if this were changed to usual units which are much more clear, comprehensible and less error-prone in this context - milliSv or when appropriate microSv.