Review of soils and rehabilitation aspects of Fingerboards Environmental Effects Statement, Glenaladale, Victoria: Expert witness statement

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Review of soils and rehabilitation aspects of Fingerboards Environment Effects Statement, Glenaladale, Victoria: Expert witness statement

A. Acknowledgement of expert witness code of conduct

1. I have read the Guide to Expert Evidence provided by Planning Panels Victoria, and agree to comply with it; and

2. I have made all the inquiries that I believe are desirable and appropriate and no matters of significance which I regard as relevant have to my knowledge been withheld from the Panel.

B. Summary

3. Based on my review of sections of the Fingerboards EES (Point 20) related to soils and rehabilitation, it is in my opinion that:
    - The baseline assessment of soils is not reliable. There is insufficient information regarding soil sampling, methods, and results to be confident that sufficient baseline data has been collected as to understand the effects that the Fingerboards project may have on soils within and immediately adjacent to the project area.
    - The information provided on erosion in the project area is not complete. A survey of the exact locations of current erosion present at the site appears to not have been undertaken. Therefore, the actual or likely effects related to soil erosion have not been sufficiently identified or appropriately assessed as part of the EES.
    - The information provided on soil erosion potential in the project area is not complete. The discussion of dispersion potential and behaviour, and the role of organic matter and organic carbon in dispersion appears to be incomplete. Therefore, the actual or likely effects related to soil dispersion and erosion have not been sufficiently identified or appropriately assessed as part of the EES.
    - The information provided on subsoil manufacturing experiments can not be determined as being reliable. The methods are not reproduceable or repeatable, and there is insufficient discussion of experimental design and statistical methods. Therefore, a) the methods used to identify and evaluate the effects of

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the project in relation to soil rehabilitation are insufficient, and b) the actual or likely effects related to soil rehabilitation as part of the EES have not been sufficiently identified or appropriately assessed.

- The information provided on soils, overburden and tailings as part of rehabilitation and closure planning and criteria is not complete. There is a lack of certainty and clarity about how soil, manufactured soil, overburden and tailings will be used in rehabilitation, and thus it is currently unclear how the design criteria will be achieved.
- The information provided on the risks and mitigation strategies for soils, overburden and tailings as part of rehabilitation and closure planning is not complete. There is a lack of certainty and clarity about how the gaps and risks identified in sections of the EES have been included as part of the risk report and mitigation strategies. Therefore, it is in my opinion that the risks and associated mitigation measures proposed for soils, tailings and overburden as part of rehabilitation aspect of the risk assessment have not been thoroughly considered as part of rehabilitation planning for the project area.
- Tailings have been incorrectly assessed against the '*National Environmental Protection (Assessment of Site Contamination) Measure'* (NEP(ASC)M). Tailings are a waste, and should be characterised, assessed and managed as a waste.

This statement is subject to a range of limitations, including time, scope, parts of the EES included in the review and statement, subject areas reviewed etc.

C. Qualifications

4. I am an environmental regulation and soil scientist. My areas of expertise are a) understanding the nexus between science and regulation, and b) soil science. In relation to soil science, I specifically work in soil chemistry, organic material and waste application to soil, soil and plant nutrient dynamics, saline and sodic soils, erosion management, and rehabilitation and restoration of soils.

5. My expertise has been developed over more than 15 years of research and work experience, within universities, private sector, government and non-government organisations. I majored in land management during my undergraduate degree in Resource and Environmental Management, where I undertook all available courses at the time on land management and soils at the Australian National University. Following this, I undertook an Honours year at the Australian National University where my research focused on understanding the benefits and risks of dairy farm effluent application to soil as a function of time. During my Honours year in 2004-2005, I became a member of Soil Science Australia and I have maintained my membership since.

6. After graduating with an Honours degree, I worked in soil and environmental management for ACT Forests. This job included mapping soil and erosion in a post-bushfire catchment, developing new approaches to soil and environmental protection during logging operations, providing soil erosion and environmental protection training to staff, and implementing soil erosion management on-ground. I worked in this role for about 1.5 years until there was a restructure where ACT Forests was amalgamated into Environment ACT. Following this, I spent 8 months in the Solomon Islands teaching environmental management, and then 1 year at EarthTech as their soil scientist. My role at EarthTech was focused on erosion control and management in catchments, analysing and interpreting soil results for engineering solutions, and other soil related advice to the business. I resigned from this position to undertake a PhD.

7. My PhD topic was on soil science within the context of mine rehabilitation. I undertook research on the issue of small-scale variation in soil that occurs when soil is stripped from mine sites for later rehabilitation. This research included: developing a new framework for considering holistic mine site rehabilitation; a review into small-scale soil variation including sampling, analysis and statistics; sampling and analysing stockpiled soils at a mine site; undertaking glasshouse and laboratory experiments into rehabilitation of nutrient cycling in soils from a mine site using different amendments; and developing new approaches for analysing phosphorous and nitrogen contents of soils from mine sites. The soils studied in my PhD were from a mine site and were either sodic, saline or saline sodic in nature.

8. Following my PhD, I worked as a post-doctoral fellow at Monash University in the area of soil science. In this role I undertook research into organic amendment application to soils, and how the amendments altered soil chemistry and carbon, as well as plant health. This research was undertaken on dairy farms and revegetation areas on a range of soils, including sodic and saline sodic soils.

9. At the completion of my post-doctoral fellowship, I worked as a higher education teacher for 10 months prior to starting work as a Specialist Applied Scientist – Land and Groundwater at Environment Protection Authority (EPA) Victoria for 2.5 years. This role continued the use of my soil and land management skills, where I led scientific programs on

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waste application to land in a regulatory context (regulatory science) and was also responsible for providing technical advice to the business on waste application to land, waste soil, or land issues. This included reviewing Environmental Effects Statements for land, soil and waste issues, as well as mining rehabilitation plans.

10. Since July 2018, I have worked at Murrang Earth Sciences where I continue my work in soil and regulatory sciences. My recent work at Murrang Earth Sciences includes: erosion assessments and management plans for vegetation management sites, including sodic soils; soil analytical assessments and management plans for farms and private landholders, including sodic and saline sodic soils; undertaking reviews and assessments on waste application to land; and, developing resources about soil for clients and community.

D. Conflicts of interest

11. I am close friends with Mr Andrew Halliday who works in the Development Assessments Unit (DAU) of EPA Victoria, where he may on occasions work on some aspects of mining in the state of Victoria. We, Andrew and I, do not discuss this work in a professional or personal setting. As a courtesy for his own work, I have let Andrew know that I am providing an expert witness statement on an environmental effects statement.

12. I previously worked at EPA Victoria as Specialist Applied Scientist – Land and Groundwater. I believe I saw early plans for the Fingerboards project when I was employed by EPA Victoria, and I provided some advice to EPA Victoria based on the information provided at that point in time.

13. Dr Rob Loch, owner and employee of Landloch Pty Ltd, was engaged to undertake sections of the EES. I previously engaged Dr Rob Loch in 2005/2006 for erosion control advice within ACT Forests and supported his engagement in November 2008 for mine site rehabilitation and erosion control advice for the mine where I undertook my PhD research. His engagement added knowledge to my PhD research. I was offered a job by Rob Loch at Landloch in 2007, which I declined due to personal reasons. I have had minimal contact with Rob since finishing my PhD in 2012.

14. I also have a professional relationship with Dr Corinne Unger, author of the Rehabilitation Independent Peer Review Report (Attachment K of the EES), and to the best of my knowledge we last emailed in 2018.

15. Dr Laura-lee Innes, an employee of Murrang Earth Sciences and thus my colleague, has been engaged by EPA Victoria to undertake an expert witness statement with regards to the waste and radiation aspects of the Fingerboards Environment Effects Statement (the EES). I have in no way discussed any part of my findings presented herein with Laura-lee, and she has not discussed any part of her findings.

16. Dr Julia Jasonsmith, an employee of Murrang Earth Sciences and thus my colleague, has been engaged by Environmental Justice Australia (EJA) to undertake an expert witness statement with regards to the tailings aspects of the EES. As we have both been engaged by EJA, we have had some discussions of the technical information we have reviewed and have kept our interaction on these topics to a minimum. I have read part of Julia's expert witness statement, namely Sections A-D and F and we have both used the same pro forma for our statements.

17. This expert witness statement was peer-reviewed by Dr Kyle Horner, Principal Hydrogeologist of LOMAH. This peer review was undertaken as part of the Murrang Earth Sciences Statement of Performance to ensure the quality and accuracy of the information within this statement. All opinions presented, unless otherwise stated, are my own.

E. Instructions

18. Environmental Justice Australia, acting on behalf of Submitter No. 813, sought expert opinion regarding the soils and rehabilitation aspects of the '*Fingerboards Mineral Sands Project Environmental Effects Statement (EES) August 2020'* from Murrang Earth Sciences. Given my experience and skills outlined in Section C, I undertook this work as an employee of Murrang Earth Sciences.

19. Environmental Justice Australia provided a memo (Section I: Attachment B) to Murrang Earth Sciences, dated 17 December 2020. This memo instructed me as follows:

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We request that you undertake a review of the soils and rehabilitation components of the EES and prepare an expert witness statement providing your opinion on:
*The compliance of the soils and rehabilitation components of the EES (listed below) with the relevant evaluation objective in the Scoping Requirements (**Tab 1.1**):*

Technical Studies

*i. Landform, Geology and Soil Investigation (Technical Study, Appendix 1) (**Tab 2.3.1**)*
*ii. Rehabilitation Report (Technical Study, Appendix 20) (**Tab 2.3.2**)*
*iii. Soil Profile Reconstruction Studies 1 and 2 (Technical Studies, Appendices 21 and 22) (**Tab 2.3.3**)*

Chapters and Attachments

*i. Environmental and socioeconomic context (Chapter 8, Sections 8.1) (**Tab 2.1.3**)*
*ii. Closure (Chapter 11) (**Tab 2.1.4**)*
*iii. Environmental Management Framework (Chapter 12) (**Tab 2.1.5**)*
*iv. Draft Mine Rehabilitation Plan, from page 337 of the Draft Work Plan (Attachment B) (**Tab 2.2.1**)*
*v. Risk Report (Attachment F) (**Tab 2.2.2**)*
*vi. Mitigation Register (Attachment H) (**Tab 2.2.3**)*
*vii. Rehabilitation Independent Peer Review Report and Proponent Response (Attachment K) (**Tab 2.2.4**)*

a) The adequacy of the baseline data collected by the project proponent to confidently describe pre-development conditions (as relevant to soil and rehabilitation).
b) The appropriateness of the methods used to identify and evaluate the effects of the project (as relevant to soil and rehabilitation).
c) Whether the actual or likely effects in relation to soil and rehabilitation are identified and or appropriately assessed.
d) The adequacy of the proposed design and mitigation measures, including the design criteria and draft mine rehabilitation and closure plans.
e) Any other matters you identify which you consider relevant within the limits of your expertise.
f) Any appropriate qualifications or conditions that should be attached to findings or conclusions, such as uncertainties or gravity of threats or impacts.

As an expert you are able to consider any such material you consider relevant to your enquiry. Please identify in your report any further materials you consult outside of the briefed materials.

20. This expert witness statement is based on information in the Fingerboards EES technical reports related to soils and rehabilitation. This includes the following sections of the EES: Appendices A001, A020, A021, and A022; Section 8.1 of Chapter 8; Chapter 11; sections relating to soil and rehabilitation within Chapter 12, Attachment F, and Attachment H; Attachment K; Section 9 of Attachment B; and, Appendix C of Attachment B. Where necessary, I have utilised references to support or demonstrate points within this statement, and I have referenced them in the footnotes accordingly. I did not undertake

any field visits to the location of the proposed Fingerboards project as part of this expert witness statement.

21. Attachment K is titled '*Independent peer review of draft EES Chapter 11 Mine rehabilitation, decommissioning and closure*' and is dated 7 August 2019. It specifically reviews Chapter 11 of the EES, but I was unable to find a date for the version of Chapter 11 reviewed as part of Attachment K. For the purpose of my review, Chapter 11 '*Closure*' is dated August 2020. Appendix C of Attachment B, as the '*Draft Mine Rehabilitation Plan'*, is dated July 2020. Therefore, Attachment K appears to precede the versions of Chapter 11 and Appendix C of Attachment B of the EES that I was provided to review.

22. Prior to the expert witness statement, EJA requested a draft preliminary opinion report from myself. This report is titled 'Review of soil and rehabilitation aspects of Fingerboards Environment Effects Statement, Glenaladale, Victoria: Draft Expert Opinion Report' dated 15 October 2020 (draft opinion report). The draft opinion report was undertaken as a part of a high-level review to determine a) the robustness of the soil and rehabilitation aspects of the EES, particularly in relation to the '*Scoping Requirements for Fingerboards Mineral Sands Project Environment Effects Statement, March 2018'*, and thus b) whether or not the soil and rehabilitation aspects of the EES required further review. The review undertaken as part of the draft opinion report determined that there were aspects of the EES that required further investigation. Therefore, this expert witness statement is separate to the draft opinion report and elaborates on some of the specific soil and rehabilitation aspects identified as requiring further investigation.

F. Findings

F.1 Baseline soil information

23. It is my opinion that the information provided on the baseline assessment of soils in Appendix A001 of the Fingerboards EES, which I reviewed as part of this expert witness statement, is not reliable. There is insufficient information regarding soil sampling, methods, and results to be confident that sufficient baseline data has been collected as to understand the effects that the Fingerboards project may have on soils within and immediately adjacent to the project area.

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24. Appendix A001 refers to and uses information presented in its sub-appendices, numbered Appendix 2, 3 and 5. We will now refer to the appendices in Appendix A001 as sub-appendices using the same numbers as listed in Appendix A001 (i.e., Sub-appendix 1 is Appendix 1 of Appendix A001). We note Sub-appendix 5 does not exist in the version of Appendix A001 that I have reviewed, and that analytical data is in Sub-appendix 4. For the purpose of this expert witness statement, we assume Sub-appendix 4 is the appendix that should be referred to rather than Sub-appendix 5. Appendix A001 also includes some information on sonic core sampling in Section 5.4. Soil identification is discussed in Section 6 and sampling locations are depicted on Figure 7.

25. Methods used to undertake an investigation should always be included in reporting as part of standard scientific and technical practice. Methods provided in reports, investigations or scientific papers are generally either: a) standard methods that are documented elsewhere and are referred to in text; b) reproducible methods that are documented elsewhere and are referred to in text; or c) methods used are described in the report in a way that can be reproduced by the reader. Including methods in detail ensures that an investigation was undertaken in a robust and repeatable way, and so the reader can be confident that the information presented is reliable, relevant and adequate[1].

26. Additionally, results provided in reports, investigations or scientific papers are generally provided in a way that reflects the methods used. This is so the reader can be confident that the information presented is reliable, relevant and adequate[1].

27. For the field survey of soils in Appendix A001, Point 25 applies. For the purpose of undertaking field surveys of soils, an example of a standard approach is the '*Australian Soil and Land Survey Handbook*'[2]. Using a standard approach ensures that a soil field survey was undertaken in a robust and repeatable way.

28. For the classification and description of soils in Appendix A001, Point 25 applies. For the purposes of describing and classifying soils, the current standard approach in Australia is to

[1] Klimisch, H.J., Andreae, M., Tillmann, U. 1997. A Systematic Approach for Evaluating the Quality of Experimental Toxicological and Ecotoxicological Data. Regulatory Toxicology and Pharmacology. 25: 1–5.
[2] The National Committee on Soil and Terrain. 2009. Australian Soil and Land Survey Handbook. Third edition. Collingwood: CSIRO Publishing.

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use '*The Australian Soil Classification*'[3]. This description and classification tool was developed as a standard approach for the communication of different soil properties and soil types across Australia. The tool is intended to be used as a way to describe soils' unique properties or features that enable transfer of information or knowledge between experts in a meaningful way.

29. For the sampling of soils in Appendix A001, Point 25 applies. For the purposes of undertaking sampling of soils, the methods should generally be included in any written reporting so that they can a) be replicated, and b) the reader understands the exact protocol and how that explicitly relates to the analysis and interpretation of the data provided. Sampling procedures will vary dependant on the aim of the investigation.

30. For the purposes of analysing soils chemical, biological or physical properties in Appendix A001, Point 25 applies. Methods used for the chemical, physical or biological analysis of soil should generally be included in any written reporting so that they can a) be replicated, and b) the reader understands the exact protocol and how that explicitly relates to the analysis and interpretation of the data provided. Analytical procedures will vary dependant on laboratory protocols and the aim of the analysis. There are some standard analytical procedures available that can be used and referenced, for example '*Soil Chemical Methods – Australasia'*[4] and '*Methods of Soil Analysis: Part 3 – Chemical Methods*'[5].

31. Sub-appendix 2 of Appendix A001 includes the following information for the method for field survey of soils:
    - *The following soil auger profiles were manually bored using a 10cm diameter clay auger head, from 25-31 May 2017.*
    - *All eastings and northings recorded in GDA94 MGA Zone 55 format.*

32. The Sub-appendix in Point 31 does not present a) a standard method for the field survey or sampling of soils, and b) do not use a repeatable method for the field survey and sampling of soils. Therefore, the field survey and soil sampling do not meet the minimum

[3] Isbell, R.F. and The National Committee on Soil and Terrain. 2016. The Australian Soil Classification. Second edition. Collingwood: CSIRO Publishing.
[4] Rayment, G.E. and Lyons, D.J. 2010. Soil Chemical Methods – Australasia. ePDF. CSIRO Publishing.
[5] Sparks, D.L., Page, A.L., Helmke, P.A., Loeppert, R.H., Soltanpour, P.N., Tabatabai, M.A., Johnston, C.T., Sumner, M.E. 1996. Methods of Soil Analysis: Part 3 – Chemical Methods. Number 5 in the Soil Science Society of America Book Series. Reprinted 2009. Soil Science Society of America: Madison, Wisconsin, USA.

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methodological criteria set out in Point 25. There is insufficient information provided for the reader to reproduce this method in the field. Examples of missing information include: how locations were selected for the field survey and sampling of soils, vegetation at survey locations, soil profile descriptions including description of horizons and their depths, etc. This information, particularly soil horizons, is essential for describing and classifying soils. As an example, topsoil is usually described as A horizons (i.e., A1, A2, A1 and A2 etc) and subsoil is usually described as B horizons (i.e., B, B1, B2, B1 and B2 etc), and this is recorded along with the thickness of each horizon.

33. Sub-appendix 2 of Appendix A001 includes some soil classification information. For example, '*Auger ID: A1*' has *'Sodosol'* written next to it. I am making the assumption that '*The Australian Soil Classification*'[3] was used in the soil classification, as sodosols are defined as:

Soils with a clear or abrupt textural B horizon and in which the major part of the upper 0.2 m of the B2 horizon (or the major part of the entire B2 horizon if it is less than 0.2m thick) is sodic and not strongly acid. Hydrosols and soils with strongly subplastic upper B2 horizons are excluded.

34. In order to have sufficient information to determine that the soil is a sodosol using the '*The Australian Soil Classification*'[3], there needs be results of the analysis of the soil's sodicity and pH, and these data should be provided as results. This information is not provided as part of Sub-appendix 2 of Appendix A001. Using the documents in Point 20, I have been unable to locate analytical data used to describe the soil in Sub-appendix 2 of Appendix A001. Therefore, it is unlikely that the interpretation of the soil type in Sub-appendix 2 of Appendix A001 has been done in accordance with '*The Australian Soil Classification*'[3].

35. It is my opinion that the information provided in Sub-appendix 2 of Appendix A001 is not reliable[1] because it does not contain sufficient information so that a) the investigation can be replicated, and b) to allow the reader to explicitly understand the interpretation of the data provided (i.e., what data were used to determine the soil was a sodosol).

36. Section 5.4 of Appendix A001 describes the sonic coring of soils. In this section, there are no standard methods referred to for field survey, and those described are insufficient for the field survey and sampling to be repeatable. In addition, no specific methods have been

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provided for the chemical and physical analysis of these soils in either Section 5.4, Sub-appendix 3 or Sub-appendix 4 of Appendix A001.

37. It is my opinion that the information provided related to the sonic coring of soils in Appendix A001 is not reliable[1] because it does not contain sufficient information so that the investigation can be replicated.

38. Section 6 of Appendix A001 uses information in Sub-appendix 2, 3 and "5" (which I am assuming is actually Sub-appendix 4) of Appendix A001 to undertake soil classification. This section refers to '*The Australian Soil Classification*'[3] for the classification of soils, which is the standard approach. This section, however, relies upon information in the attached appendices that does not provide sufficient information to demonstrate that it is reliable (see Points 31 to 37). In addition, there very limited explanation as to how the results presented in Sub-appendix 2, 3 and 4 and Figures 19–21 of Appendix A001 were used to form the author's opinion of the soil types discussed in Section 6 of Appendix A001. Thus, it is unclear as to how the classification of soils has been done in accordance with the '*The Australian Soil Classification*'[3] method.

39. Section 6 of Appendix A001 refers to a Rosengren (2017) report. This report has not been provided as part of the EES and was not provided to me to inform this expert witness statement. The Rosengren (2017) report is relied upon in Appendix A001 to facilitate soil data interpretation and discussion of geomorphology. Appendix A001 states that the Rosengren (2017) report included geomorphology of the project area, as well as "*field descriptions of soil profiles from hand auger investigations from a range of locations on, or near, the project area by Andrew Long and Associates on May 30 and 31, 2017*". The Rosengren (2017) report also included discussion of wet seepage zones, according to Appendix A001.

40. As part of the field survey in Appendix A001, it appears that soil samples do not adequately represent soils on the slopes of the proposed Fingerboards project. Soil samples appear to be mostly from the plateau area (see Figure 18 in Appendix 001, as reproduced here below) with only a few soils sampled from the steep slopes. I assume from my interpretation of Figure 18 that locations 3, 4, SD 12, W6, 13 and SD01 were on steeper parts of the slope.

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These slopes are at higher risk of erosion than the plateau soils, and it is critical they are adequately surveyed for understanding the effects the project may have on these soils.

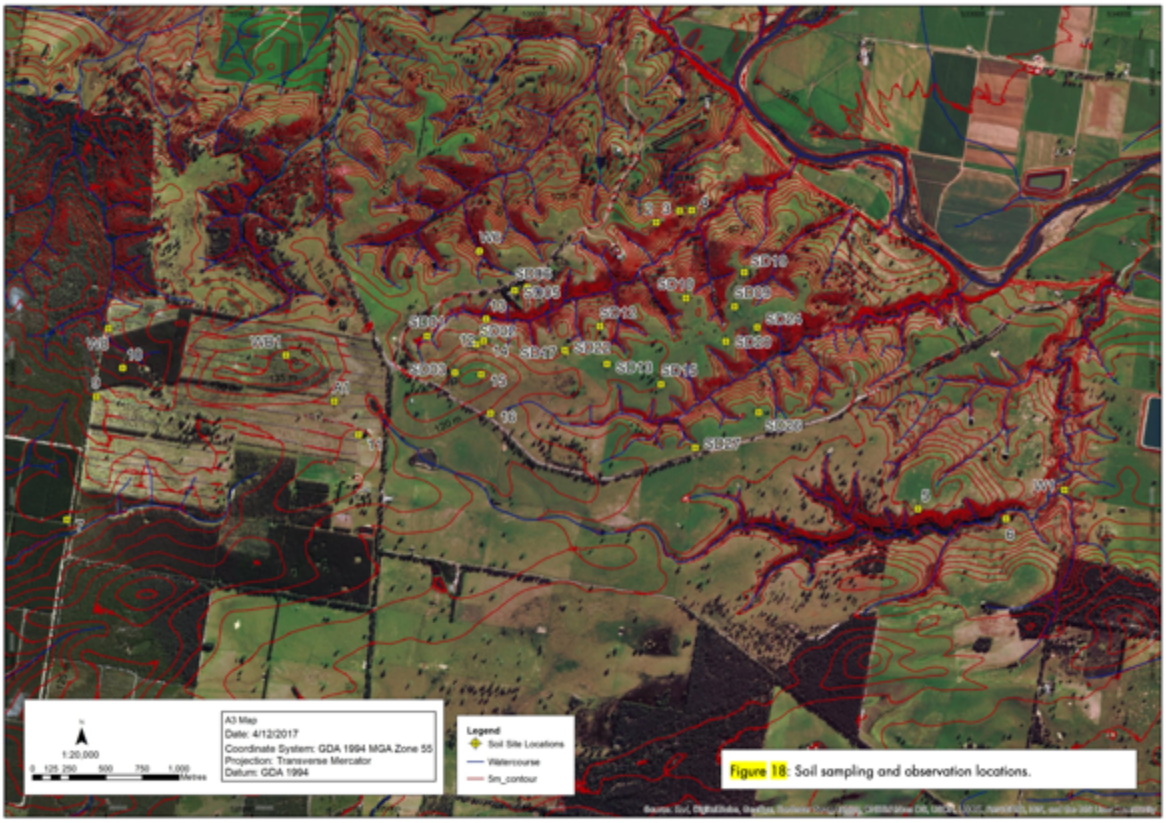

Figure of soil sampling and observation locations from Appendix A001 of the EES

41. As the field survey did not appear to access many of the steep slope areas, the soil descriptions in Appendix A001 may not be a true and accurate representation of the likely soil types on the slopes at the Fingerboards project. This is because soil types differ at the top, mid and bottom of a slope — this change in soil types with slope is known as a catena[6]. The topography should be considered as part of field survey methods, including the systematic approach to selecting locations for the field survey and sampling of soils as per Point 32. As there are insufficient methods provided in Appendix A001, it is unclear how topography and slope as part of a soil catena were considered in the soil survey for baseline data.

[6] Charman, P.E.V., Murphy, B.W. 2001. Soils: Their properties and management. Second edition, reprint. Oxford University Press: South Melbourne, Australia.

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42. As there is insufficient information related to the methods for the field survey, sampling, description and classification of soils, and laboratory analyses as provided in Appendix A001 of the EES, it is my opinion that the baseline data provided in the EES for soils are not reliable for understanding the effects the Fingerboards project may have on the soil within and adjacent to the project area.

F.2 Soil erosion in the project area

43. It is my opinion that the information provided on erosion in the project area in Appendices A001, A020, and A022, Attachments B and F, and Chapters 8 and 12 of the Fingerboards EES, which I reviewed as part of this expert witness statement, is not complete. A survey of the exact locations of current erosion present at the site appears to not have been undertaken. Therefore, the actual or likely effects related to soil erosion have not been sufficiently identified or appropriately assessed as part of the EES.

44. Chapter 8, Section 8.1.4.1 of the EES states tunnel erosion occurs at three locations:

Although not widespread, tunnel erosion occurs at three identified locations within the project area, including a large tunnel discharging into Perry Gully.

45. Chapter 8, Section 8.1.3.2 of the EES states there are two major slope failure sites:

Two major slope failure sites were recorded during field surveys, at Perry Gully and Lucas Creek.

46. Section 10.6 of Appendix A001 describes sheet erosion present on the project area:

Visually, the soil/grazing system in, and adjacent to the project area does not appear to be achieving high productivity, with low levels of biomass and signs of overgrazing (by either domestic or native animals) and sheet erosion (Figure 24), and there are a number of attributes and trends within the local landscape function that could be usefully addressed by rehabilitation works.

47. Section 10.6 of Appendix A001 uses Rosengren (2017) (see Point 39) to discuss gully heads. Gully heads are the part of a gully that is at the highest point in the landscape. They are also known as the vertical face at the top of a gully[7]. Section 10.6 of Appendix A001 specifically states:

As well, it is highly likely that clearing of Eucalypt vegetation for grazing has been responsible for increases in drainage to depth and has been a major cause of the wet seepage zones noted by Rosengren (2017) associated with gully heads high in the landscape. Those wet zones, together with potential for more widely distributed seepage into the drainage lines are of concern for drainage line stability. The seepage could simply render areas more susceptible to erosion, or could potentially cause tunnel erosion.

48. Section 11.2 of Appendix A001, in relation to erosion of swales, states:

Currently, the existing swales vary from stable to "beginning to erode". The development of scour in swales seems to be a function of their cross section (swales with broad parabolic cross sections (Figure 27) being more stable than swales with a more V-shaped cross section). There are also points where discharge of flow from swales to flow channels has been destabilised by presence of an overfall into the channel (Figure 28).

49. Section 5.2 of Appendix A020 states that there is undercutting at toes of slopes (Section 5.2 of Appendix A020):

Undercutting at the toe of some slopes appears to be a potential issue in one or two areas.

50. Section 7.1.1 of Appendix A022 states concerns with tunnel erosion in the project area:

Given concerns with respect to tunnel erosion in the general Fingerboards area, it would be preferable to avoid creating areas with high rates of deep drainage on the rehabilitated plateau.

51. Appendix C of Attachment B states that '*tunnel erosion is uncommon within the project area'*, and includes a map (Figure 5-2) of known tunnel erosion locations:

[7] Western Local Land Services. (N.D.) Stabilising active gully heads. NSW Local Land Services and Australian Government National Landcare Program. Available Online. Accessed 8 January 2021.

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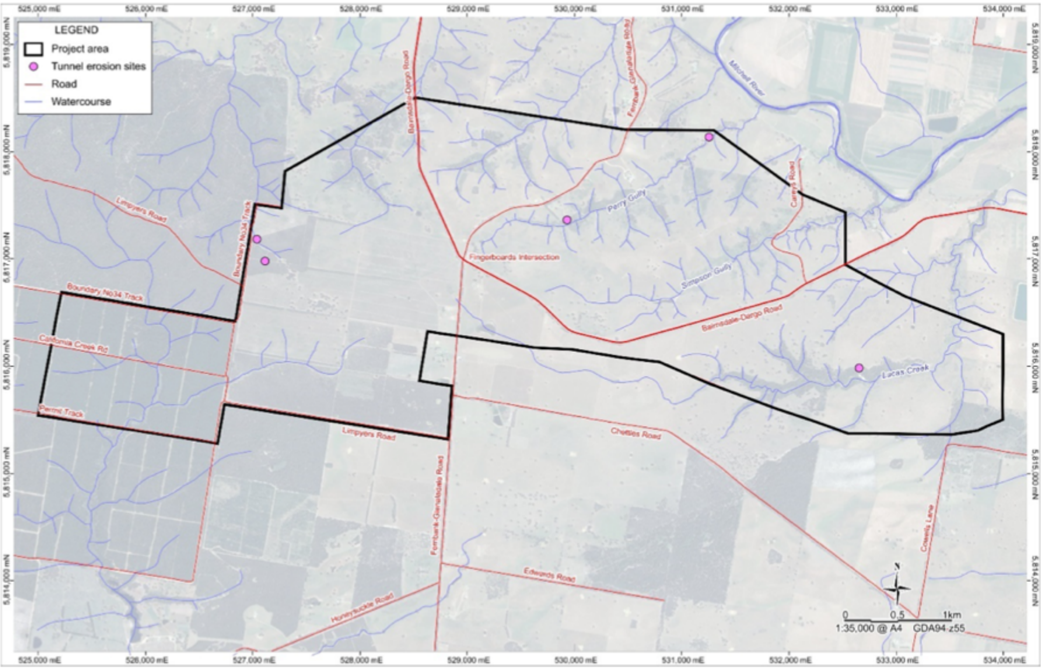

Figure 5-2: Map of project area showing locations of known tunnel erosion sites.

Map of five known tunnel erosion locations (as purple/pink circles) in the project area, taken from Appendix C of Attachment B of the EES

52. Attachment F of the EES discusses erosion risk and mitigation strategies. It includes the following statements from the Risk Register:

- Controlling erosion within gullies using primary and secondary sediment traps constructed at appropriate sites
- Potential effects of tunnel erosion downstream of the mine void boundary where soil treatment is not planned.
• The density of deep-rooted trees and shrubs will be increased in areas at risk from tunnel erosion by minimising the volume of seepage flows reaching valley slopes and channels (RH24).
• Grazing will be excluded in rehabilitated native grass woodland areas (Zone E) channels and riparian areas (Zone D) and on steeper valley slopes (Zone C) to maintain sufficient levels of vegetation cover and prevent disturbance of soils by trampling by livestock, thereby increasing stability and minimising erosion (RH25).
• Tree densities in areas planned for grazing land use, particularly in swale areas, will be increased to reduce deep drainage and seepage flows, and to maximise erosion stability (RH27).
• Appropriate erosion and sediment control strategies will be implemented to prevent gully erosion in areas adjoining the project footprint (TE23).

53. It is my opinion that the statements made in the Risk Register and the EES sections (Points 44 to 52) indicate that there is a) gully erosion present in the project area, some of which may impact offsite areas when the project is being undertaken, b) a known risk associated with tunnel erosion in the project area, c) a known risk associated with the erosion present

in the swale areas, and d) known sheet erosion and slope undercutting present in the project area.

54. Table 12.6 of Chapter 12 of the EES, which describes draft objectives and indicators for the environmental management framework (EMF), states two indicators as being:

Erosion extent and number of slope failures [I25].
Extent of erosion in rehabilitated areas [I44].

55. Point 54 indicates to me that understanding erosion at the site is critical in achieving EMF objectives. It is my experience that understanding the 'extent' of erosion, and thus using indicators to achieve objectives, requires knowledge of erosion extent and severity and ongoing monitoring to check the 'extent' of erosion in the project area and immediately offsite.

56. The quotes and map listed in Points 44 to 510 all discuss erosion present in the project area, and Chapter 12 specifically identifies erosion as an indicator as part of the EMF (Point 54). It is unclear if the sections of the EES listed in Points 44 to 51 or the other reports (i.e., Rosengren, 2017) are all correct, partially correct or incorrect. This is because the EES information summarised in each of these Points appears to either be inconsistent or only provides part of the information regarding the erosion present at the site. Each of these quotes and the map do, however, demonstrate that erosion is present in the project area.

57. It is my opinion that to provide accurate information regarding soil erosion, and thus the potential effects the project may have on soil erosion, a full soil erosion survey with appropriate methods and results should be reported as part of the EES. From reviewing the documents provided (Point 20) I am unable to find such a survey or map of all current active and inactive erosion present at the site. It is my opinion that a soil erosion survey should have been included in Appendix A001 as part of the soil baseline information, and the effects the project will have on erosion in the project area and offsite should have been discussed. Furthermore, for the environmental management indicators (see Point 54) to be achieved, there needs to be both a baseline survey of erosion and ongoing monitoring of erosion.

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58. Based on the documents reviewed (Point 20) I cannot determine what is a true and accurate representation of currently active and inactive erosion present in the project area. Therefore, it is my opinion that erosion has not been sufficiently identified or appropriately assessed as part of the baseline information for the EES, and thus whether or not the mine will increase the risk of erosion on or offsite has not been fully evaluated.

F.3 Soil erosion potential

59. It is my opinion that the information provided on soil erosion potential in the project area in Appendices A001, A020, A021 and A022, Attachments F and H of the Fingerboards EES, which I reviewed as part of this expert witness statement, is not complete. The discussion of dispersion potential and behaviour, and the role of organic matter and organic carbon in dispersion appears to be incomplete. Therefore, the actual or likely effects related to soil dispersion and erosion have not been sufficiently identified or appropriately assessed as part of the EES.

60. Appendix A001 includes chemical analysis of dispersion of overburden and soils and a discussion of the increased risk of tunnel erosion associated with dispersive soils (Sections 4.4 and 7.4.3 of Appendix A001). I have made the assumption that Section 7.4.3 refers to the sonic soil cores collected in Sub-appendix 3 of Appendix A001. Based on this assumption and whilst understanding the limitations to the data presented in Section 4.4 of Appendix A001 (see section F.1 above), I agree with the EES author's general assumption that the soil present is likely to be sodic and thus potentially dispersive.

61. Dispersion potential and behaviour of sodic soils is known to be associated with a range of factors, including exchangeable sodium percentage (ESP) and electrical conductivity (EC)[8,9]. The ESP and EC content of a soil therefore partially drives dispersion behaviour — the conditions under which soil dispersion will or won't occur. For example, there are sodic soils that potentially disperse with the application of mechanical work or those that disperse spontaneously, and these soils will have different EC and ESP concentrations[8]. It is my experience that when examining the dispersive nature of soils, the assessor needs to

[8] Sumner, M.E., Rengasamy, P. and Naidu, R. 1998. Chapter 1: Sodic Soils: A reappraisal. In Sodic Soils: Distribution, Properties, Management and Environmental Consequences. Ed. Sumner, M.E. and Naidu, R. Oxford Univerity Press: New York.

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consider dispersion behaviour in order to understand erosion potential, hazards and management options. An example of an assessment protocol for dispersion behaviour is included in '*Interpreting soil test results: What do all the numbers mean?*'[9]. From this reference, it is my understanding that soils that are potentially dispersive because they are a) prone to dispersion with the application of mechanical work, and/or b) prone to dispersion due to exposure to the environment (i.e., rainfall), are at greater risk of erosion with the application of mechanical work and soil profile exposure associated with mining operations[8,9]. It is my experience and understanding that soils that are spontaneously dispersive have severe management and erosion problems, and will be at risk of dispersion and erosion even with minor mechanical work or minor environmental exposure as a result of mining operations [8,9]. Therefore it is my opinion that understanding dispersion behaviour of soils is necessary to understand the effects mining may have on causing soil dispersion, and thus potential for erosion both on and off the Fingerboards area.

62. Some of the factors important for understanding the dispersion of soils includes EC, calcium, magnesium, and sodium contents of soils. These are all included discussed in Appendix A001. Organic matter and soil carbon are also crucial in understanding the stability and management of sodic and potentially dispersive soils[10,11]. According to Table 6 of Appendix A001, organic carbon was only tested on topsoil. Appendix A001 refers to organic matter and its role in topsoil dispersion briefly in Section 7.4:

Twelve of the topsoils in the project area have clay contents in the range 7- 10%, and – although not representing a significant risk of tunnel erosion, hardsetting would still be expected to be of concern for those soils, particularly when organic matter content is also low.

63. Appendices A001, A020, A021 and A022 discuss one or more aspect of dispersion, risk of erosion and tunnelling of soils and/or overburden, including the potential for offsite impacts. We note that the discussions between each Appendix are not necessarily identical. These Appendices, however, do not appear to have considered dispersive

[9] Hazelton, P. and Murphy, B. 2016. Interpreting soil test results: What do all the numbers mean? 3rd Edition. CSIRO Publishing: Australia.
[10] Wong, V.N.L., Greene, R.S.B., Dalal, R.C., Murphy, B.W. 2010. Soil carbon dynamics in saline and sodic soils: a review. Soil Use and Management. 26:2-11
[11] Nelson, P.N. and Oades, J.M. 1998. Chapter 4: Organic Matter, Sodicity and Soil Structure. In Sodic Soils: Distribution, Properties, Management and Environmental Consequences. Ed. Sumner, M.E. and Naidu, R. Oxford University Press: New York.

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behaviour of soils (i.e. Point 61), nor have they considered organic matter or organic carbon and their roles in subsoil dispersion.

64. Attachments F (Risk Report) and H (Mitigation Register) discuss the dispersion of soils as part of mitigation strategies only and not as a risk. This mitigation strategy is identical in both attachments as:

Gypsum will be applied in sufficient quantity to a depth of at least 500 mm as part of a constructed subsoil where material likely to disperse is placed (such as Haunted Hills Formation overburden or fines tailings); to reduce exchangeable sodium and magnesium to acceptable levels (ESP <4 and Ca/Mg ratio >0.5)

65. Based on the documents reviewed (Point 20) I have not been able to determine where the EES discusses dispersion potential and behaviour, nor any information on the roles of organic matter or organic carbon in soil dispersion and stability. Therefore, it is my opinion that the effects that the mine will have on soil dispersion and erosion potential of the soil (i.e, whether or not the mine will increase the potential of the soil to disperse and thus increase risk of erosion) have not been fully evaluated.

F.4 Soil rehabilitation

66. It is my opinion that the information provided on subsoil manufacturing experiments in Appendices A021 and A022 of the Fingerboards EES, which I reviewed as part of this expert witness statement, can not be determined as being reliable. The methods are not reproduceable or repeatable, and there is insufficient discussion of experimental design and statistical analysis methods. Therefore, a) the methods used to identify and evaluate the effects of the project in relation to soil rehabilitation are insufficient, and b) the actual or likely effects related to soil rehabilitation as part of the EES has not been sufficiently identified or appropriately assessed.

67. For the purpose of this section, Points 25, 26 and 30 above are relevant in relation to methods, reporting of results, reliability of data and analytical methods.

68. For this section of the statement (F.4) I am relying on the information and data available in Appendices A021 and A022 of the EES, which both utilise information from Appendix A001. I use this information as it is available to me as is, whilst understanding the limitations to

the information presented as discussed in Sections F.1 to F.3 of this statement. Therefore, the statements I make this this section should also consider the statements made in Sections F.1 to F.3.

69. The methods reported in Section 3.1.1 of Appendix A021 for soil profile reconstruction state:

Soil profiles were formed with a 70 cm depth of "subsoil" overlain by 20 cm of topsoil, with an overall profile depth of 90 cm.

70. The methods reported in Section 2 of Appendix A022 for soil profile reconstruction state:

This study used profiles formed with topsoil overlying "subsoils" formed of various materials or mixtures thereof.
The topsoil is a loamy sand taken from one location on the north east of the McMahon property (within the Kalbar mining lease area) and considered to be typical of what is found at the site. (Study of soils present on the project area (Landloch 2020a) found only slight spatial variation in topsoil properties.)

71. Due to issues detailed in Section F.1 and Point 32 of this statement, whereby the soil horizons were not included in soil descriptions, I was not able to determine how the topsoil used in the soil profile reconstructions described in Points 69 and 70 relate to the soils present at the site. I have been unable to find information in the EES (Point 20) that links the term 'topsoil' to the soil descriptions provided in Appendix A001. This is usually undertaken by describing soil horizons and recording their thickness which appears to not have been undertaken in this case (Point 32).

72. The methods reported in Section 3.2.1 of Appendix 021 in relation to soil rehabilitation state:

Subsoil blends used to form subsoils were a mix of fine and coarse tails as follows:

- *100% Coarse tails*
- *75% Coarse tails, 25% fine tails*
- *50% Coarse tails, 50% fine tails*
- *25% Coarse tails, 75% fine tails*

73. Tailings are used in the rehabilitation trials in Appendices A021 and A022. Section 1.1 of Appendix A021 and the Executive Summary of Appendix A022 states tailings are:

non-economic sand, silts and clay

74. Section 1.1 and 1.4 of Appendix A021 state that there will be both fine (<38 µm) and coarse (>38 µm but <2 mm) tailings used in the trial. Coase and fine tailings are also described Appendix A022, but only sand/coarse tailings are used in the trial in Appendix A022.

75. Section 2 of Appendix A021 states:

The coarse and fine tailings were produced when processing a 10 tonne bulk sample during 2017 metallurgical test work. The 10t bulk sample was taken from 7 inch diameter sonic cores from an area representing the first 5 years of production.

76. Section 2 of Appendix A022 states:

The sample of sand tailings used had been produced as part of processing during a 2017 metallurgical test. Bulk sample was taken from 7 inch diameter sonic cores from an area which will be mined during the first 5 years of production.

77. From Points 71 to 74, it is clear tailings are being used in the rehabilitation trials and how the tailings were obtained for the trial is described in Points 75 and 76. However, there are no details in Appendix A021 or A022 regarding the method the proponents intend to use for mineral extraction, and if this method was also used to produce the sample of tailings used in the rehabilitation trials (Point 75 and 76). It is thus unclear to me how the tailings used in the study are or will be representative of the tailings that will actually be produced as part of the Fingerboards project.

78. Given Points 25, 26 and 67–77, I would not be able to repeat or reproduce the experiments in Appendix A021 and A022 with the information provided, as I do not know a) what is representative of topsoil at the project site, b) how the tailings used in the experiments were generated, and c) if the tailings generated as part of metallurgical tests are representative of tailings that will be formed as a result of the project.

79. As I am unable to determine how the soil and tailings used in the rehabilitation trials in Appendix A021 and A022 relate to the project, I can also not determine the reliability, relevance or adequacy[1] of the results presented in relation to likely rehabilitation outcomes for the project area.

80. Experimental design can be described as the parameters under which an experiment is being conducted. Methods for experimental design provided in reports, investigations or

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scientific papers are generally either: a) standard designs that are documented elsewhere and are referred to in text; b) reproducible designs that are documented elsewhere and are referred to in text; or c) designs used are described in the report in a way that can be reproduced by the reader. Including experimental design methods in detail ensures that the investigation was undertaken in a robust and repeatable way and gives readers confidence that the information presented is reliable, relevant and adequate[1].

81. Section 3 of Appendices A021 and A022, although not identical, both describe aspects of experimental design related to column set up, treatments, vegetation, watering, harvests, and sampling. I have assumed that these experiments were undertaken in a laboratory or glasshouse based on the fact that columns were used, measurements were undertaken at the Landloch laboratory in Toowoomba, that Figure 6 in Appendix A022 and A021 (shown below) both appear to be in a glasshouse or grow-house structure, and Section 4.1 of Appendix A022 discusses greenhouse differences.

Figure 6: Condition of vegetation immediately prior to final harvest: clockwise from top left – 75%, 50%, 25% and 0% fine tailings in subsoil, all treatments fertilised.

Photo depicts column experiments in a glasshouse/grow-house structure, from Appendix A021 of the EES

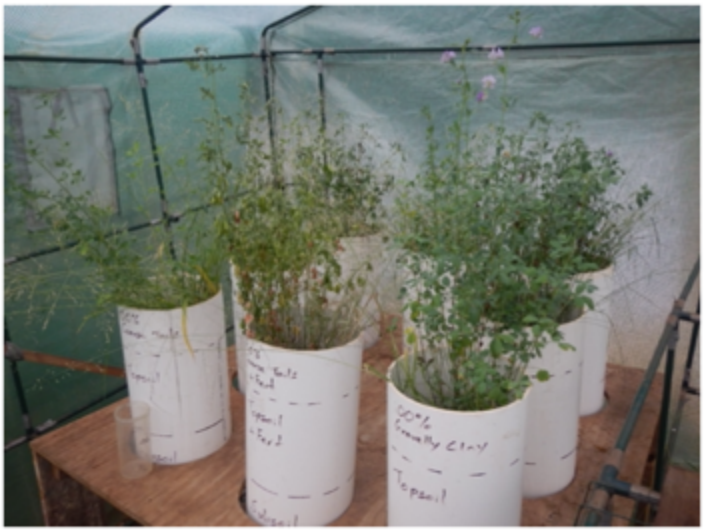

Figure 6: View of plant growth 5 days prior to harvest, showing significant water stress in some treatments.

Photo depicts column experiments in a glasshouse/grow-house structure, from Appendix A022 of the EES

82. It is my experience in undertaking and publishing scientific articles on glasshouse and laboratory-based soil and plant experiments that the following should be part of communicating glasshouse-based methods: glasshouse conditions (e.g. sunlight hours, temperature), treatments as a design including the controls and genuine replication (i.e., factorial or other statistically appropriate design), how conditions compare to in-field/on-site environmental conditions, how the use of materials in the trial will be reflective of the method used on-site (e.g. packing of materials in column), and how columns were placed in the glasshouse (e.g. randomised, blocked, constantly moved to manage variability in the glasshouse, etc). This information is crucial to allow the experiment to be reproduced (e.g. Point 25), and in its absence the reader cannot be confident that the information presented is reliable[1]. Furthermore, it is in my experience that records of a) how the columns were placed in the glasshouse, and b) the treatment design used are vital for undertaking the statistical analyses.

83. Information about a) glasshouse conditions and b) how columns were placed in the glasshouse/s does not appear to have been included in Appendices A021 and A022. As per Points 80 and 82, there is insufficient detail to determine that the experiments have been undertaken in a robust and repeatable way, and thus I can not determine if the information presented is reliable[1].

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84. It is my experience in undertaking and publishing scientific articles on soil and plant experiments that the statistical analysis methods should be part of communicating the experiment undertaken. This is the same for any methods used in an experiment (i.e., Point 25). This usually includes, but is not limited to, the type of statistical analysis undertaken, the software used, the factors and variables considered from treatment design, and error checking approaches. Like other methods, this information is crucial to allow the experiment to be reproduced (e.g. Point 25), and in its absence the reader cannot be confident that the information presented is reliable[1].

85. Experiments in A021 have been statistically analysed (Section 4.1) but the method for statistical analysis in Appendix A021 appears to be missing, and it is unclear what method was used and if this was appropriate for the experimental design. I know this because of the following statement in Section 4.1.1 and 4.1.2 of Appendix A021:

A statistically significant and large…

86. Analysis of Variance (ANOVA) is the statistical method that was used in the analysis of the experiments in Section 4 of Appendix A022.

87. From the information provided in Appendix A022, I have been able to assume that the experiment included four manufactured subsoils with +/- fertiliser and amendment to make 8 columns, and that these were duplicated (one set of 8 columns in each glasshouse, making 16 columns all together). Section 3.2.1.2 states that the rates of amendment and fertiliser varied depending on the manufactured subsoil type. From Appendix 6 of Appendix A022, it also appears that the manufactured subsoil types were compared with each other in the ANOVA. The information provided in Appendix A022 regarding treatment design is unclear (i.e., was this a factorial or other design, how were these treatments genuinely replicated, were treatments and/or soils compared as part of the design etc) and I was unable to find any information on how the treatment design was incorporated into the ANOVA for statistical analysis (Points 82 and 84).

88. As the information provided in Appendix A022 regarding treatment design is unclear and I was unable to find any information on how the design was incorporated into the ANOVA for statistical analysis (see Point 87), it is in my opinion that there is insufficient information provided in the methods (Point 25, 82 and 84) in Appendix A022 for the experiment and

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statistical analysis to be repeated, and in its absence the reader cannot be confident that the information presented is reliable[1].

89. From the information provided in Appendix A022, I was unable to find a statistical analysis method. As per Point 25 and 84, there is insufficient information provided in the methods for the statistical analysis to be repeated, and thus I can not determine the reliability[1] of the results included in Appendix A022.

90. Using Points 80 to 89, I found that there is only partial experimental design described in Appendix A021 and A022, no statistical methods provided, and both experimental and statistical methods are not reproduceable or repeatable. From this, I cannot determine that the information presented in either Appendix A021 or A022 is reliable[1]. Therefore, it is my opinion that a) the methods used to identify and evaluate the effects of the project are insufficiently described, and b) the actual or likely effects associated with the mining activities as related to soil rehabilitation have not been sufficiently identified or appropriately assessed as part of the EES.

F.5 Rehabilitation criteria and soils

91. It is my opinion that the information provided on soils, overburden and tailings as part of rehabilitation and closure planning and criteria in the Fingerboards EES, which I reviewed as part of this expert witness statement, is not complete. There is a lack of certainty and clarity about how soil, manufactured soil, overburden and tailings will be used in rehabilitation (Attachment B, Appendices A020, A021, A022, Chapter 11), and thus it is currently unclear how the design criteria (Chapter 11) will be achieved.

92. Section 9 of Attachment B of the EES states in relation to soils, manufactured soils, tailings and overburden materials (all together henceforth referred to as materials) being used as part of rehabilitation:

Mined cells will be progressively backfilled with coarse sand tailings and overburden and fines tailings, which will then be covered with formulated suboil mixes, and topsoil. It is expected that the time from overburden stripping to completion of rehabilitation and re-establish of agriculture is between 3 to 5 years.

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93. Section 9.4.4.1 of Appendix C of Attachment B states in relation to materials used in rehabilitation:

Mined areas will be progressively backfilled with coarse sand tailings, overburden and where designed, fines tailings. The resulting interim profile will be covered with overburden (including manufactured subsoil) and topsoil, and then rehabilitated. The time from overburden stripping to completion of rehabilitation planting is likely to be between three to five years.

94. Figure 2-3 of Appendix C of Attachment B has the following diagram which depicts rehabilitation as including layers of tailings, overburden and topsoil:

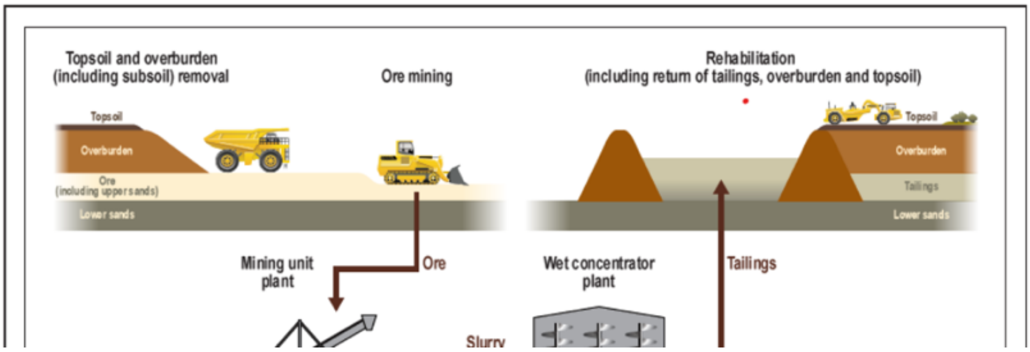

Figure depicting rehabilitation as including layers of tailings, overburden and topsoil, from Appendix C of Attachment B of the EES

95. Section 9.3 of Appendix C of Attachment B and Section 11.5.3 of Chapter 11 states in relation to backfilling of the mine void:

Mined areas will be progressively backfilled with coarse sand tailings, overburden and fines tailings. Fines tailings will be covered with overburden (including manufactured subsoil) and topsoil, and then rehabilitated.

96. Figures 9-4 and 9-5 from Appendix C of Attachment B depict cross-sections of the rehabilitated landform, including layers of tailings, overburden, and soils that will be used:

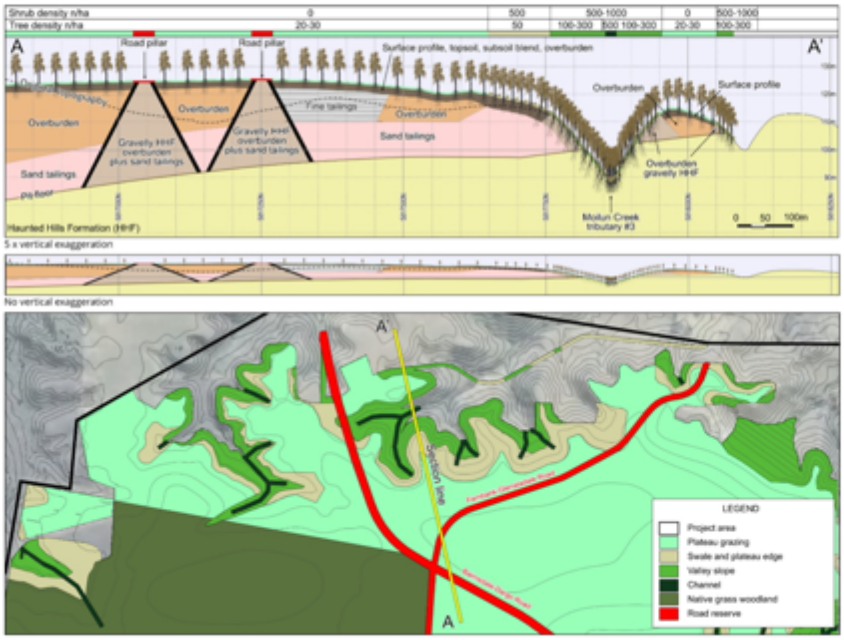

Figure 9-4: Schematic rehabilitation cross section – Moulin Creek Tributary #3

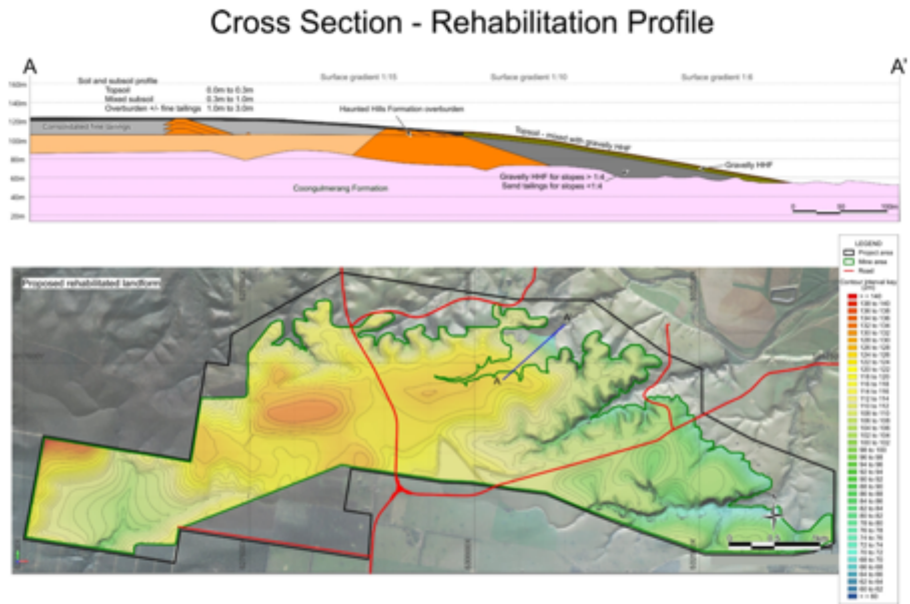

Figure 9-5: Schematic post-rehabilitation longitudinal section - Perry Gully

Two figures depicting rehabilitation as including different layers of tailings, overburden and topsoil, from Appendix C of Attachment B of the EES.

97. Figure 11.2 of Chapter 11 and Figure 16 of Appendix A020 are the same as Figure 9-4 above.

98. My understanding is that Figures 9-4 and 9-5 depict different possible cross-sections of material placement for rehabilitation dependant on location in a) landform and topography (i.e., slope), and b) the type of area to be rehabilitated (i.e., road or mine void).

99. The Executive Summary of Appendix A020 indicates that layers will be replaced in the order they are removed from the void after tailings are firstly placed back into the void:

Mining will move progressively, with topsoil and overburden layers being removed, hauled, then placed to the rear of the void in the same vertical order they were removed. After the topsoil and overburden removal, ore will be mined and, in steady state operations, the tailings from ore treatment will be placed back into the void in the form of sand tailings and fine tailings. In the early years of operation, fine tailings will be placed in an off-path tailings storage facility, but this will be replaced by in-pit tailings operations as the continuing mining operations present sufficient space to do so.

100. In relation to fine tailings, Section 6.2.3 of Appendix A020 states that:

fine tailings should be placed at a minimum depth of 3 min in the re-constructed profile…

(Mixtures of fine tailings with other materials may be placed closer to the surface, provided such mixtures are of appropriate permeability.)

101. Section 11.8.1.2 of Chapter 11 states that fine tailings will be:

either buried (encapsulated) or mixed with overburden or coarse sand tailings to form subsoils, significantly reducing the concentration of arsenic in such mixes. Encapsulated fines tailings will be covered by at least 3 m of overburden, manufactured subsoil and topsoil.

102. Section 7.10 of Appendix A020, Section 7.1 states in relation to fines tailings and encapsulation:

"As part of Site rehabilitation, the fines tailings will be either buried deeply (i.e. encapsulated) or mixed in a low ratio (probably 25:75) with overburden material to form subsoils, thereby ensuring that the concentration of Arsenic in such mixes will be approximately 12 mg/kg. It will then covered by a layer of 200–300 mm depth of topsoil, with the result that there will be no potential for Arsenic in subsoils of rehabilitated areas to have any significant impacts on either the environment or grazing animals."

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103. Points 92 to 99 above all discuss and display how materials (soils, manufactured soils, tailings and overburden) will be placed into the project area as part of rehabilitation. Some of these statements are the same or similar, whilst others are quite different. As an example, the quote in Point 92 does not talk about overburden being specifically below the manufactured subsoil, but Figure 9-5 presented in Point 96 shows that overburden (± fine tailings) will be placed in the top 3 m of the profile. This contrasts with Figure 9-4, which shows that overburden is included with topsoil and subsoil blends.

104. Points (100–102) discuss how fine tailings will be placed in deep encapsulation, at least 3 m deep in the rehabilitated landform. However, quotes in Points 92 to 99 specifically say fine tailings will be used in manufactured subsoil and Point 96 has a diagram that shows fine tailings may be placed in the top 3 m of the landform.

105. From Points 92 to 102, it is difficult to understand what materials will be placed in the area for rehabilitation, where and in what order. This is because a) there is inconsistency in how the materials are discussed in the EES in terms of their placement within the project area as part of rehabilitation, and b) the discussion of how materials placement interrelates with the minimum fine tailings depth of 3 m is unclear (e.g. if fine tailings should be at least 3 m deep, why are they discussed as being used in the top 3 m of the landform?). Therefore, it is unclear how materials are being used as part of the draft mine rehabilitation and closure plans, and how this translates to the closure target and criteria of "*Most appropriate material mix (of topsoils, overburden, tailings) is used in the upper layers (~ 1 m) of post-mining landforms*" as per Table 11.2 of Chapter 11 (Closure targets and criteria).

106. Appendices A020, A021 and A022, state that 20–30 cm of topsoil will be removed from the project area, but the rehabilitation experiments undertaken in Appendices A021 and A022 only use 20 cm of topsoil.

107. Section 11.5.3.2 of Chapter 11 states in relation to topsoil:

Topsoil will be stripped prior to mining and either stockpiled or transferred directly to nearby rehabilitation areas. Topsoil is likely to be stripped to a depth of 300 mm or to the depth of a heavy clay B horizon or gravel. This depth may vary according to existing landform and land use.

Where possible, all stripped topsoil will be directly placed on rehabilitation areas after the third year of operations, with no stockpiling of topsoil required.

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108. Section 9.4.4.3 of Appendix C of Attachment B states 20–30 cm (written as 200-300mm in the Appendix) of topsoils will be used in rehabilitation across the site.

109. Table 9-1 and Figure 9-2 of Appendix C of Attachment B assumes 30cm (written as 0.3 m) of topsoil is available in the project area:

Table 9-1: Life of mine materials balance

Material type	Mined material, m3	Required rehabilitation materials, m3
Topsoil (Surface to 0.3 m)	3535762	3535762
Overburden: Gravelly HHF	63930300	
Gravelly HHF: Road pillars		17798226
Gravelly HHF: Slope armouring		19690000
Gravelly HHF: Dam construction		993000
Gravelly HHF: Other void (bulk fill)		25449074
Subsoil and other overburden	162753402	
Surface profiling (above fine tailings)		22,558,111
Other void (bulk fill)		140195291
Ore	99933166	
Tailings		99933166
Total	**330152630**	**330152630**

Note: Volumes in table are shown as 'loose cubic metres', meaning that the swell factor has already been taken into account.

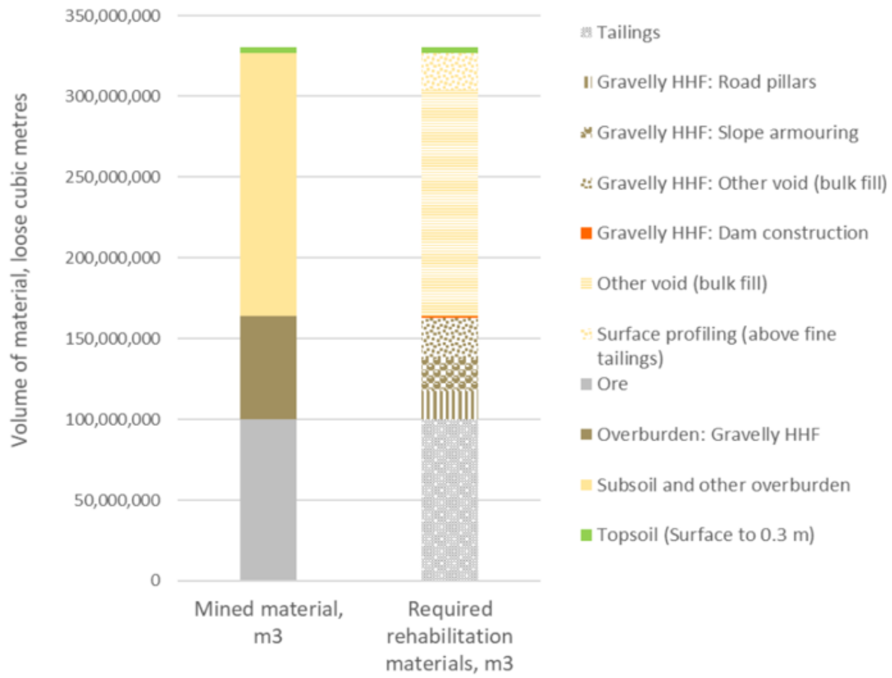

Figure 9-2: Life of project materials mass balance

A table and figure depicting that topsoil is 30cm across the minesite, from Appendix C of Attachment B of the EES.

110. From Points 106 to 109, it is unclear a) exactly how much topsoil will be used in rehabilitation planning (i.e. 30 or 30cm), and b) whether or not these numbers are an accurate reflection of the available topsoil at the site given the issues discussed in relation

to the reliability of soil baseline information as per Section F.1 of this statement. Understanding how much topsoil will be available for rehabilitation is crucial for determining mass balance and thus ensuring there is sufficient topsoil for successful rehabilitation. Therefore, it is unclear how much topsoil is available for mine rehabilitation and how this translates to the closure target and criteria of "*Most appropriate material mix (of topsoils, overburden, tailings) is used in the upper layers (~ 1 m) of post-mining landforms*" as per Table 11.2 of Chapter 11 (Closure targets and criteria).

111. Appendix A021 rehabilitation trials include 70 cm of manufactured subsoil with 20 cm of topsoil. The manufactured subsoils used were one of the four described:

- *100% Coarse tails*
- *75% Coarse tails, 25% fine tails*
- *50% Coarse tails, 50% fine tails*
- *25% Coarse tails, 75% fine tails*

112. Appendix A022 rehabilitation trials include 70 cm of manufactured subsoil with 20 cm of topsoil. The manufactured subsoils used were one of the four described:

- *100% Coarse tailings*
- *100% Gravelly HHF*
- *100% Sandy HHF*
- *50% Sandy HHF, 50% coarse tailings*

113. HHF is defined in Appendix A022 as:

…Haunted Hills Formation (HHF) overburdens for use as subsoils:
• Gravelly HHF, containing gravel ranging from fine to cobbles up to 200 mm in diameter.
• Sandy HHF.

114. Chapter 11 discusses manufactured subsoil in a few locations, and includes the following quotes:

The subsoil material will be composed of some combination of fines and coarse sand tailings, or overburden and coarse sand tailings. (section 11.5.3.3)

A manufactured subsoil will be used to augment topsoil to provide a more productive medium for plant growth in rehabilitated landforms. The subsoil will be a mixture of overburden and coarse sand or fines tailings. (section 11.8.3.3)

115. The first quote in Point 114 is consistent with Points 111 and 112, but the second quote suggests that subsoil may be used to augment topsoil. It is unclear if this means that manufactured subsoil will be used in place of topsoil at the site (i.e., to volumetrically

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increase the topsoil volume being used) or if it will be used to augment the development of a whole soil profile. The second quote in Point 114 also describes the manufactured soil differently — as a mixture of overburden and tailings — rather than as possible combinations trialled in Appendices A021 and A022, as discussed in Points 111 and 112.

116. Appendix A020 describes the manufactured subsoil in the same way as Section 11.5.3.3 of Chapter 11.

117. Appendix C of Attachment B describes the manufactured subsoil in the same way as Section 11.8.3.3 of Chapter 11.

118. Section 10.3 of Appendix A001 also discusses the potential to use '*slimes (high in silt and clay sized particles) from the mineral processing plant*' with overburden as part of a manufactured subsoil.

119. To me, it appears from Points 111 to 118 that the proponent has not decided upon an approach for manufacturing a subsoil. Furthermore, it is unclear whether or not the manufactured subsoil will be used to replace some of the topsoil at the site. Therefore, it is unclear how manufactured subsoils are being used as part of the draft mine rehabilitation and closure plans, and how this translates to the closure target and criteria of "*Most appropriate material mix (of topsoils, overburden, tailings) is used in the upper layers (~ 1 m) of post-mining landforms*" as per Table 11.2 of Chapter 11 (Closure targets and criteria).

120. Section 8.1.2.2 of Appendix C of Attachment B states that "*A 300 mm topsoil layer will be placed over the manufactured subsoil will provide a total effective depth for plant roots of at least 800 mm.*" This implies the manufactured subsoil layer will be 50 cm thick. Appendix C of Attachment B also states in Section 9.3.3: "*The subsoil material will be composed of a combination of fines and coarse sand tailings, or overburden and coarse sand tailings, which will be mixed and ripped (mechanically broken up) to form a subsoil layer approximately 0.6 to 0.8 m thick with suitable permeability and water holding capacity*." This implies the manufactured subsoil layer will be 60 to 80 cm thick.

121. Section 6.2.1 of Appendix A020 states the same manufactured subsoil depth as in Section 9.3.3. of Appendix C of Attachment B (i.e. 60 to 80 cm thick).

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122. Chapter 11 states the same manufactured subsoils depths as Appendix C of Attachment B (i.e. either 50 cm or 60 to 80 cm).

123. Manufactured subsoil depths used in the rehabilitation experiments in Appendices A021 and A022 were 70 cm. And Appendix A021 also states:

The subsoil material will be composed of a mixture of overburden and fine or coarse tailings, mixed and ripped to form a subsoil layer approximately 0.6 to 0.8 metre thick, with suitable permeability and water holding capacity.

124. To me, it appears that from Points 120 to 123 that the proponent has not decided upon how much manufactured subsoil material will be used at site (i.e., will they use 50 cm or 70 cm or 60 to 80 cm of manufactured subsoil). Understanding how much manufactured subsoil will be available for rehabilitation is crucial for determining mass balance and thus ensuring there is sufficient material for successful rehabilitation. This is especially important if trials are based on 70 cm of manufactured subsoil for effective rooting depth of plants (Appendix A022 and A021). Therefore, it is unclear how manufactured subsoils are being used as part of the draft mine rehabilitation and closure plans, and how this translates to the closure target and criteria of "*Most appropriate material mix (of topsoils, overburden, tailings) is used in the upper layers (~ 1 m) of post-mining landforms*" as per Table 11.2 of Chapter 11 (Closure targets and criteria).

F.6 Rehabilitation and mitigation strategies for soils

125. It is my opinion that the information provided on the risks and mitigation strategies for soils, overburden and tailings as part rehabilitation and closure planning in the Fingerboards EES, which I reviewed as part of this expert witness statement, is not complete. There is a lack of certainty and clarity about how the gaps and risks identified in sections of the EES have been included as part of the risk report and mitigation strategies. Therefore, it is in my opinion that the risks and associated mitigation measures proposed for soils, tailings and overburden as part of rehabilitation aspect of the risk assessment have not been thoroughly considered as part of rehabilitation planning for the project area.

126. For this section of the statement (F.6) I am relying on the information and data available in Appendices A001, A020, A021 and A022 of the EES. I use this information as it is available to me as is, whilst understanding the limitations to the information presented as discussed

in Sections F.1 to F.5 of this statement. Therefore, the statements I make this this section should also consider the statements made in Sections F.1 to F.5. In addition, I have also assumed that the mitigation measures in Attachment F and H are identical, as per Point 64.

127. As discussed in Points 111 to 114, fine tailings and overburden will likely be used in the manufactured subsoils for the rehabilitation of the project area.

128. Appendices A021 and A022 have included baseline characterisation of the tailings and overburden (see Appendix 1 within either Appendix A021 or A022). These characterisation approaches have similar issues related to methods as discussed in F.1 above. Therefore, the reliability of data related to the baseline characteristics of tailings and overburden cannot be determined. This is important, as it is my opinion that placement of tailings (coarse or fine) and overburden should represent a best practice[12] or at least a better option for rehabilitation compared to the natural subsoil. Therefore, their physical, chemical and biological characteristics should be better than the subsoil for rehabilitation and constructing a self-sustaining and resilient eco- or agroeco-system. This statement has been made separately to the statements made in F.7 below, specifically with regard to tailings management.

129. Section 5.7 of Appendix A020 describes the natural soil's limiting factors as follows:

Sodicity - Exchangeable sodium levels in surface soil are not particularly high (with a large proportion being <6%[4]). As well, the surface soil clay content is largely in the order of 10%, which is generally the lower limit at which clay dispersion is considered to be of concern. Nonetheless, the Electro-chemical Stability Index of the surface and sub-surface soil is low (less than the critical value of 0.05), indicating that there is some potential for dispersion and hardsetting because soil solution concentrations are very low.

Subsoil limitations – for both Podosols and Sodosols, the subsoils represent considerable constraints to productivity. For the Sodosols, the subsoils composed of dispersive clay are hardsetting and impermeable, preventing both root penetration and water entry, creating, effectively, a quite shallow soil. For the Podosols, root penetration to depth will be greater, but the chemical and physical fertility of the sandy/gravel layers will be low.

130. Section 4.4 of Appendix A001 describes the overburden, its risks and management as being:

[12] Earth Resources Regulation. 2020. Preparation of Rehabilitation Plans. Guidelines for Mining and Prospecting Projects. February 2020, Version 1.0. State Government of Victoria: Department of Jobs, Precincts and Regions.

Chemical properties of HHF overburden relevant to clay dispersion considerations are shown in Table 5. Importantly, the exchangeable cation data show both samples to have levels of sodium and magnesium sufficient to cause strong dispersion of clay within those materials.

Dispersive overburdens can be associated with increased risk of tunnel erosion, and typically require a range of management actions such as application and thorough mixing of appropriate rates of gypsum, and control of surface conditions to eliminate concentration and ponding of overland flows (Landloch 2004; 2006).

131. Section 2.1.3 of Appendix A021 states the following characteristics related to raw fine tailings (i.e., fine tailings with no amendments for rehabilitation):

The 100% fine tailings sample had a very low hydraulic conductivity, which would result in low drainage rates under typical field conditions (discussed in greater detail in Appendix 2).

132. Section 4.2.3 of Appendix A021 describes the manufactured subsoil where tailings have been used as:

Coarse and fine tailings mixtures gave subsoils that were highly variable in their properties, with uneven mixing of the coarse and fine tails leading to highly variable compaction and bulk densities.

However, subsoils with 75% fine tailings were observed to have a sealed layer formed on the outside of the subsoil profile within the columns (effectively at the point where subsoil was in contact with the PVC) (Figure 8).

133. Section 5.3 of Appendix A021 states in relation to tailings-based manufactured subsoil effectiveness:

However, one key change of interest is that ESP of the surface layer of the subsoil with a 75% fine tailings mixture declined irrespective of gypsum addition. This suggests that:
a) Gypsum addition to mixtures of coarse and fine tailings may not be necessary; but
b) If cations such as sodium leach easily, then the potential for fine tailings to retain nutrients (due to its CEC) may also be relatively poor.

Such subsoil materials may show initial depressions in growth (relative to profiles of coarse tailings, which are effectively, deep sand) during the period when plant roots are penetrating to depth, and then demonstrate yield advantages thereafter. The current data (Figure 4) suggest that initial growth could be depressed if subsoil saturated hydraulic conductivity is $\leq 5*10^{-4}$ *m/s (roughly equivalent to that of a 50:50 mixture of coarse and fine tailings).*

The level of initial growth depression that can be managed will depend on the degree to which the vegetation established can survive some initial waterlogging events, and may vary for vegetation species. (Lucerne, for example, is known to be relatively sensitive to waterlogging, though it is an extremely desirable component of revegetation seed mixes due to its deep rooting habit and likely impact on subsoil permeability.)

Time of year may also be important, and it may be more effective to establish vegetation when evaporative demand is sufficient to cause some profile drying (e.g., in spring) and thereby able to minimise potential for prolonged waterlogging.

134. Section 7.1 of Appendix A022 states in relation to using overburden as part of the manufactured subsoil:

In contrast, the various HHF “subsoils” showed some development of hard-set layers that could be of concern if they developed too strongly over time. It is likely that the methods recommended for managing the initial instability of HHF materials may be able to overcome that issue, but further research is needed.

135. Section 7.3.2 of Appendix A022 states the following in relation to using overburden as part of a manufactured subsoil:

Overall, use of HHF overburdens to form subsoils for rehabilitated areas will mean working with a more variable material than, for example, a mix of fine and sand tailings as investigated by Landloch (2020b). Nonetheless, there will be areas where HHF overburden is preferred (for example, gravelly or rocky material on some sloping areas).

In those cases, the HHF material to be placed as a “subsoil” should be sampled for analysis of key chemical properties (pH, Electrical conductivity, Chloride, and Exchangeable Cations). Some samples should also be taken for measurement of hydraulic conductivity, both with and without gypsum amendment, and some identification of suitable mixtures may be necessary if permeability is unacceptably low.

An appropriate sampling frequency will need to be assessed, but an initial frequency of approximately one sample per 15,000 cubic metres of overburden should be trialled. Decisions with respect to amendment, mixing, and any other management requirements should be made on the basis of the analytical data collected.

136. Section 7.1 of Appendix A022 states in relation to overburden and tailings based manufactured subsoils:

At one extreme, profiles with a coarse sand “subsoil” will not hard set, but will store little water, and most applied nutrients will rapidly leach through the profile and be lost. At the other extreme, subsoils high in unstable clay will become hard set, impermeable, and not able to be penetrated by plant roots.

Consequently, not only is it important to select appropriate mixtures to be placed as subsoils, but the management of those mixtures through the initial years of vegetation establishment will also be a key component of rehabilitation planning.

It is highly likely that the relatively short testing period used in the two studies carried out to date has not allowed time for potential long-term changes in subsoil and topsoil properties to fully develop. Although such changes are fairly predictable, it would, nonetheless, be desirable to have more definitive assessment of longer-term soil and ecosystem trends.

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Consequently, establishment of longer-term trialling of subsoil management options is strongly recommended.

137. Point 129 describes subsoil limitations as well as topsoil limitations, including dispersive clays, potential for hard setting and impermeability. Points 130, 134 and 135 demonstrate that the overburden (HHF formation) that is to be used in the manufactured subsoil is dispersive, with an increased risk of tunnel erosion, and will require management options and control of surface conditions related to water ponding and flows. The overburden is also hard-setting, is described as being a variable material, and may have low permeability. Points 131 to 133 describe the fine tailings to be used in manufactured subsoils as potentially having sealed layers and variable properties (e.g., compaction and bulk density) and very low hydraulic conductivity. Point 136 discusses some of the limitations associated with using an overburden and tailings mix as a manufactured subsoil, including water holding issues and nutrient loss.

138. The details summarised in Point 137 demonstrate that all materials, including the natural subsoils, have significant limiting factors. The issues described for all materials can affect the rehabilitation success and erosivity of the materials chosen. Using natural subsoil instead of tailings and overburden, however, may provide benefits (such as natural soil biology and organic matter) that have the potential to help establish plants on site. Following this, it is unclear to me why manufactured subsoils made from overburden and/or tailings (to be determined, as per Section F.5) are proposed to be used in rehabilitation in place of natural subsoils, and how this option is considered best practice[12].

139. I have not been able to find in the sections of the EES I reviewed (see Point 20) how the natural subsoil has been critically evaluated against the properties of tailings and overburden when choosing materials for rehabilitation. For example, I cannot find a critical examination of what characteristics make the tailings and overburden better for manufacturing a subsoil for rehabilitation compared or relative to the natural subsoil, and what are the relative advantages and disadvantages of the options. Following this, it is unclear to me why subsoils themselves weren't also evaluated as part of the trials in Appendix A021 and A022 for their relative effectiveness. Therefore, the purpose of using tailings and overburden in place of subsoils is also unclear to me (despite similar issues and risks in using these materials) and, thus, how this approach represents best practice or is

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'most appropriate' (Point 128). From the information provided, it is my opinion that the current approach does not meet the closure target and criteria of "*Most appropriate material mix (of topsoils, overburden, tailings) is used in the upper layers (~ 1 m) of post-mining landforms*" as per Table 11.2 of Chapter 11 (Closure targets and criteria).

140. Attachment F describes the risks specifically associated with soil rehabilitation as being:

Erosion (including surface erosion and tunnel erosion) of soil stockpiles and rehabilitated areas delaying and/or preventing successful rehabilitation.

141. Attachment F descries the mitigation measures for the risks associated with rehabilitation of soil, but not stockpiled soil, as being:

• The density of deep-rooted trees and shrubs will be increased in areas at risk from tunnel erosion by minimising the volume of seepage flows reaching valley slopes and channels (RH24).
• Grazing will be excluded in rehabilitated native grass woodland areas (Zone E) channels and riparian areas (Zone D) and on steeper valley slopes (Zone C) to maintain sufficient levels of vegetation cover and prevent disturbance of soils by trampling by livestock, thereby increasing stability and minimising erosion (RH25).
• Tree densities in areas planned for grazing land use, particularly in swale areas, will be increased to reduce deep drainage and seepage flows, and to maximise erosion stability (RH27).
• Gypsum will be applied in sufficient quantity to a depth of at least 500 mm as part of a constructed subsoil where material likely to disperse is placed (such as Haunted Hills Formation overburden or fines tailings); to reduce exchangeable sodium and magnesium to acceptable levels (ESP <4 and Ca/Mg ratio >0.5) (RH28).
• Revegetated areas will be fenced (electric fencing with multiple closely spaced tapes) to prevent damage by stock or kangaroos, where cost-effective to do so (RH29).
• Rehabilitation will be designed to ensure plateau tops are consistent in form to pre-mining landforms. Swales will be designed to be broad, U-shaped, no steeper than current stable drainage paths, and consistent in shape with the most stable drainage paths currently present (RH07).
• Rehabilitation activities will be timed in consultation with landholders and based on analysis of long-term rainfall patterns to maximise the rate of successful vegetation establishment and rehabilitation performance (RH10).
• Hydromulches or tackifiers will be used where appropriate to prevent erosion and the more effective use of incident rainfall by germinating seeds (RH11).
• Hydroseeding will be used in rehabilitation areas, where appropriate, to stabilise the soil surface and minimise erosion (RH12).
• Site/local experience will be considered when determining seed timings and rates to achieve maximum reliability of vegetation establishment. Seed will be re-applied at a later date in areas where rehabilitation performance does not meet established targets when suitable conditions, such as rainfall, are likely to occur (RH13).
• Rehabilitated areas will be irrigated where required to promote satisfactory performance and vegetation establishment (RH14).

142. The risks presented in Point 140 do not include the full risks of using overburden and tailings as part of a manufactured subsoils, as discussed and shown in Points 129 to 137. As Attachment F does not consider all the risks identified in other sections of the EES, it also does not consider the full range of mitigation strategies that are necessary to ensure successful rehabilitation (Point 141). An example of risks of manufactured subsoils and potential mitigation strategies that have been omitted is highlighted in Point 136 by the author of Appendix A022.

143. Appendices A021 and A022 determine that improving manufactured subsoil/topsoil fertility is essential for plant growth and for reducing risks of other soil-plant related issues such as waterlogging and improving soil structure and permeability. Some examples of where this is stated include:

Section 5.2.2 of Appendix A021

During the first growth period, when watering was carried out regularly, plant growth was highest for the fertilised profiles with the better-drained subsoils. It can only be inferred that during this period (when temperatures were lower and evaporation demand low), there was a plant growth benefit from better profile drainage, provided soil fertility was sufficient to support the increased growth.

Section 5.2.3 of Appendix A021

During the second growth period, there was a clear increase in biomass production with increasing proportion of fine tailings, and this response can only be attributed to the higher store of plant-available water in those subsoils with higher proportions of fine tailings.

Again, it appears that this response only occurred when fertiliser had been added and soil nutrient levels were sufficient to support higher levels of plant growth.

The lack of any apparent impact of waterlogging during this period is attributed to the penetration of the subsoils by plant roots. This would have developed over the full period of the study, and would have greatly increased the permeability and drainage of the finer-textured subsoils during the second growth period.

Section 5.4 of Appendix A021

Fertilisation is clearly important, and there is still some work to be done to optimise a fertiliser strategy.

Section 6.4 of Appendix A022

Biomass production of the fertilised and amended treatments was 35% higher than the that of unfertilised and unamended treatments over the two harvesting events.

Fertilisation will be an essential part of the rehabilitation works, the aim being to:
Promote strong early root growth and achieve full surface cover as quickly as possible;

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Maximise biomass production;
Improve soil structure and permeability; and
Increase organic matter and organic nutrient pools in soils, thereby increasing the sustainability of vegetation growth.
…..
At all times, separate (but complementary) fertilisation and amendment programmes should be prepared for topsoil and subsoil for each area to be rehabilitated.

Section 7.2 of Appendix A022

Both studies of profile reconstruction have shown large responses to fertiliser addition.

Short-term, rapid responses in terms of vigorous plant growth and rapid establishment of surface cover are an essential component of the rehabilitation and surface stabilisation process. However, it will also be important to establish sustainable soil/nutrient/vegetation systems that deliver the required levels of biomass production.

From the studies to date, it is concluded that the following recommendations should be addressed/considered in future rehabilitation studies or works:

At all times, separate (but complementary) fertilisation and amendment programmes should be prepared for topsoil and subsoil for each area to be rehabilitated, based on appropriate chemical analyses of topsoil and subsoil materials.

For topsoil, consideration should be given to:
- *Including additional N fertiliser in a slow release form such as coated urea so that soil N levels are not rapidly depleted by initial plant growth;*
- *Options for achieving sustainable increases in soil potassium levels; and*
- *Managing boron levels so that both deficiency and toxicity are avoided.*

A slight increase in lime application rates to topsoil may be justified to balance the acidifying effects of chemical fertilisers and to further reduce exchangeable sodium.

Further investigation of the reasons for the apparent lack of response to subsoil water holding capacity of the HHF materials is recommended.

A change in gypsum application methods for HHF subsoils as outlined in section 6.3.2 should be assessed for potential to minimise hardsetting at the surface of the HHF subsoil layer.

Compost inclusion in both topsoil and subsoil appears highly desirable and investigation of the use of higher rates is recommended.

144. In Attachment F, for the risks associated with fertility of soil and rehabilitation (Risk Number 8 of Agriculture and horticulture, Risk Number 6 of Rehabilitation, and Risk Number 8 of Rehabilitation), to the best of my knowledge no amendments or fertilisers for manufactured subsoils have been included as a mitigation strategy. In relation to topsoil, the mitigation strategy is:

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Where practicable, ameliorants such as organic mulches and fertilisers will be spread on in-situ topsoils prior to stripping to increase soil fertility (RH21).

145. Points 143 and 144 highlight, to me, that the risk and mitigation registers have not fully considered the fertility of topsoil and manufactured subsoil materials (as discussed in Appendix A021 and A022) as part of their rehabilitation risk analysis. Point 143 highlights in several places that in order for the manufactured subsoils to be effective as a plant media for rehabilitation, fertiliser is essential. Whilst there are limitations to the research undertaken in Appendices A021 and A022, based on both my understanding of soil-plant dynamics and more broadly the literature available in this field of research, I agree with the authors making a general assumption that the fertility of a soil is critical for plant productivity. Thus, a major risk to rehabilitation success and plant productivity (as agriculture and horticulture) is a lack of sufficiently fertile plant growing media (as topsoil and manufactured soils) for plant growth and plant establishment in both the short and long term. It is my assumption that any management strategies and gaps identified in other parts of the EES would be included in a risk and mitigation register to ensure that they are followed up and for the success of rehabilitation. However, insufficient information is provided to evaluate this assumption

146. Attachment F describes the risks associated with landform instability and erosion as being:

Excessive slope gradients on constructed landforms due to ground movement or landform instability leading to erosion or slope failure of constructed slopes

147. Attachment F describes the mitigation measures associated with landform instability and erosion as:

• All mined slopes adjacent to infrastructure will be surveyed to check they are within acceptable tolerances of specified slope designs (GEO04).
• Slopes of landforms will be constructed from Haunted Hills Formation gravel, particularly for slopes with a gradient of 1:3 or steeper. For slopes of 1:4 or flatter, dewatered, stacked and compacted coarse sand tailings can be placed within the outer zone of the slope, with Haunted Hills Formation gravel forming an armouring layer (GEO20).
• Haunted Hills Formation clay will be placed well within the landform away from the final landform slope profile to maintain slope stability (GEO21).
• Surface watercourses will be directed away from the landform during construction and operation, so rainfall does not pond or cause localised infiltration (GEO24).
• Rocks will be included in rehabilitated channel beds to increase critical shear of the bed, resist initiation of scour and increase channel stability to storm flows and minimise erosion (RH06).
• Rehabilitation will be designed to ensure plateau tops are consistent in form to pre-mining landforms. Swales will be designed to be broad, U-shaped, no steeper than current stable

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drainage paths, and consistent in shape with the most stable drainage paths currently present (RH07).
• Riparian vegetation will be established in rehabilitated flow channels to increase effective hydraulic roughness of the channels, reduce flow velocities, increase channel stability to storm flows and minimise erosion (RH08).
• High rates of vegetation establishment will be prioritised in rehabilitated flow channels (especially in the first three years of rehabilitation) to maximise surface cover and minimise erosion (RH09).
• The density of deep-rooted trees and shrubs will be increased in areas at risk from tunnel erosion by minimising the volume of seepage flows reaching valley slopes and channels (RH24).
• Tree densities in areas planned for grazing land use, particularly in swale areas, will be increased to reduce deep drainage and seepage flows, and to maximise erosion stability (RH27).

148. Section 7.3.2 of Appendix A022 states the following in relation to using overburden as part of a manufactured subsoil:

Overall, use of HHF overburdens to form subsoils for rehabilitated areas will mean working with a more variable material than, for example, a mix of fine and sand tailings as investigated by Landloch (2020b). Nonetheless, there will be areas where HHF overburden is preferred (for example, gravelly or rocky material on some sloping areas).

In those cases, the HHF material to be placed as a "subsoil" should be sampled for analysis of key chemical properties (pH, Electrical conductivity, Chloride, and Exchangeable Cations). Some samples should also be taken for measurement of hydraulic conductivity, both with and without gypsum amendment, and some identification of suitable mixtures may be necessary if permeability is unacceptably low.

An appropriate sampling frequency will need to be assessed, but an initial frequency of approximately one sample per 15,000 cubic metres of overburden should be trialled. Decisions with respect to amendment, mixing, and any other management requirements should be made on the basis of the analytical data collected.

149. Figures 9-6 and 9-7 from Appendix C of Attachment B show the overburden (as HHF Gravel) as being used over the top of tailings and/or mine waste in a sloped landform:

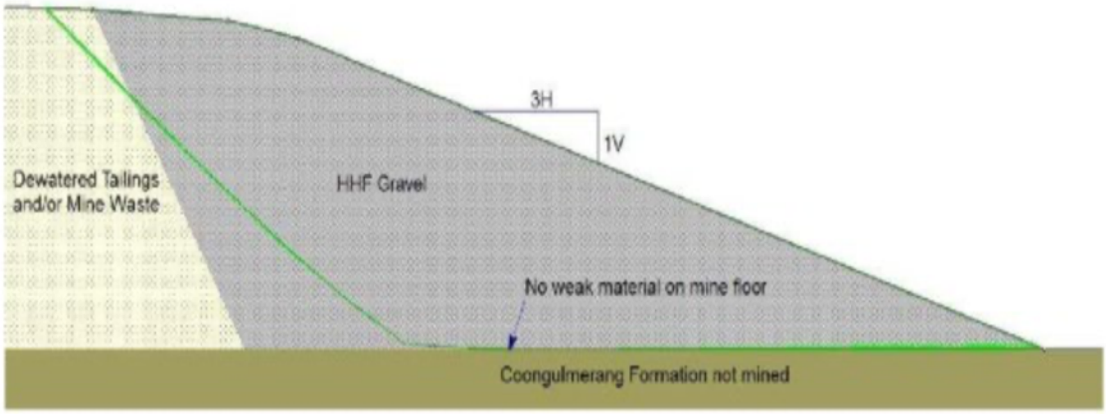

Figure 9-6: Schematic cross section showing cover near 1:3 slope (not to scale).

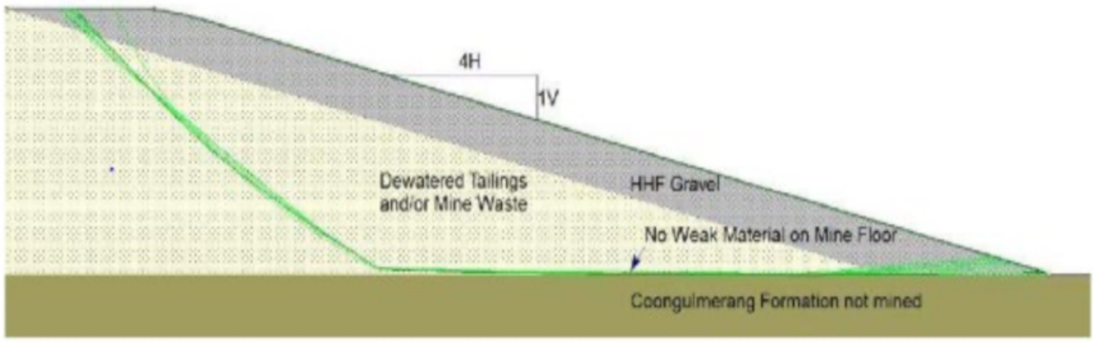

Figure 9-7: Schematic cross section showing cover near 1:4 slope (not to scale)

Two figures depicting HHF gravel (overburden) being used in slope formation as part of Fingerboards rehabilitation, from Appendix of Attachment B of the EES

150. EES quotes in Point 130 discuss how both types of overburden (gravel and sandy, as described in Appendix A022) are potentially dispersive and at risk of tunnel erosion, and that gypsum and control of surface conditions are required as management options where overburden is utilised. Point 148 shows that using overburden in rehabilitation should include analysis of material, and that gypsum, amendments, other management and mixes should be considered. Whilst some of these issues and actions have been considered in the risk assessment and mitigation measures (Points 146 and 147), not all the information from Appendix A022 has been included. For example, the specific risk of tunnel erosion with the use of the overburden is not identified in Attachment F, and not all the mitigation

measures described in Appendix A022, such as mixes, amendments and analysis of the materials, have been included.

151. Furthermore, it is unclear what is meant by the following mitigation strategy identified in Attachment F: “Haunted Hills Formation clay will be placed well within the landform away from the final landform slope profile to maintain slope stability (GEO21).” Firstly, Appendix A022 describes the HHF overburden as either sandy or gravelly (Point 112, as an example). Secondly, Point 149 depicts overburden as being part of the slope formation, without any topsoil or other materials included in the diagram. And finally, the two samples of overburden that were analysed in Appendix A022 both had dispersion issues and an increased risk of tunnel erosion (Point 130). Therefore, how the technical specifications from Appendix A022, the landform diagrams in Appendix C of Attachment B and the mitigation measures in Attachment F all fit together is unclear to me.

152. In Attachment F, a risk associated with using fine tailings in rehabilitation is described as:

Restriction of deep drainage due to hardsetting of backfilled fines tailings when dried affecting the growth of surrounding grass and trees.

153. In Attachment F, a mitigation strategy associated with using fine tailings in rehabilitation is described as:

Fines tailings will be placed at depth in the backfilled mine void so that any restrictions to drainage are far enough below the soil to avoid impacts on vegetation growth and grazing animals (RH03).

154. As discussed in Point 111 and 114, fine tailings are being considered for use in rehabilitation and manufactured subsoils. There are also figures in the EES (see Point 96) that demonstrate that the fine tailings will be close to the surface, including in the top 3 m of the rehabilitated landform. Therefore, it is unclear to me what is meant by the mitigation strategy in Point 153 (i.e. what is meant by ‘placed at depth’ relative to what has been described as the reuse of fine tailings elsewhere in the EES?).

155. It is my opinion that if tailings and overburden are to be used in a manufactured subsoil, the research from Appendices A021 and A022, including gaps and limitations, should be wholly considered in the rehabilitation plan, risk report and mitigation register. The current information presented in Appendices A021 and A022, although limited (Sections F.4 and

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F.5), suggests amendments and fertility are key for rehabilitation, as are further trials, appropriate analysis of materials, etc. Furthermore, the risk register and mitigation strategies do not appear to match what is discussed in other sections of the EES related to soils, manufactured soils, tailings, and overburden in a rehabilitation and closure context. It is my opinion that the risks and mitigation strategies should be wholly reflective of the outcomes of any research and technical sections of the EES in order to have certainty that these issues have been and will be considered as part of successful rehabilitation of the site, and that design criteria "*Most appropriate material mix (of topsoils, overburden, tailings) is used in the upper layers (~ 1 m) of post-mining landforms*" as per Table 11.2 of Chapter 11 (Closure targets and criteria) can be achieved.

156. I agree with the author of Appendix A022 that further research is required to determine an appropriate manufactured subsoil for use on the project area as part of rehabilitation activities, and that time needs to be a factor in further experiments (Section 7.1.2 of Appendix A022):

The first profile reconstruction study (Landloch 2020b) noted that there appeared to be increases in subsoil permeability with time, as plant roots extended through the subsoil layer. That was particularly important for the 50:50 and 75:25 fine:coarse tailings mixtures, which initially showed some waterlogging due to low profile permeability.

The full range of soil changes that can result from vegetation establishment are discussed in Loch (2016), but in this case, key considerations for subsoil development and sustainability of plant growth are:

- *Bulk density, hardness, and root penetration;*
- *Ability to store and retain nutrients; and*
- *Water entry and storage.*

At one extreme, profiles with a coarse sand "subsoil" will not hard set, but will store little water, and most applied nutrients will rapidly leach through the profile and be lost. At the other extreme, subsoils high in unstable clay will become hard set, impermeable, and not able to be penetrated by plant roots.

Consequently, not only is it important to select appropriate mixtures to be placed as subsoils, but the management of those mixtures through the initial years of vegetation establishment will also be a key component of rehabilitation planning.

It is highly likely that the relatively short testing period used in the two studies carried out to date has not allowed time for potential long-term changes in subsoil and topsoil properties to fully develop. Although such changes are fairly predictable, it would, nonetheless, be desirable to have more definitive assessment of longer-term soil and ecosystem trends.

Consequently, establishment of longer-term trialling of subsoil management options is strongly recommended.

157. The information presented in Section 7.1.2 of Appendix A022 should also be included in the risk register with associated mitigation strategies. Failure to consider further research, time, and to select appropriate mixtures for rehabilitation could impact on the success of rehabilitation and the ability to achieve design criteria "*Most appropriate material mix (of topsoils, overburden, tailings) is used in the upper layers (~ 1 m) of post-mining landforms*" as per Table 11.2 of Chapter 11 (Closure targets and criteria).

158. Attachment K also noted that the risk assessment/register and mitigation measure they reviewed did not completely reflect the technical reports (i.e., other EES sections):

The risk assessment/register and mitigation measures need to be updated so that they include missing but relevant risks identified in other technical reports such as geotechnical and geochemical (water quality) risks.

159. Overall, given the information presented in the EES sections, I am not confident that the risk report and mitigation strategies have adequately considered the information presented in the technical reports/sections of the EES in relation to soil, manufactured soil, tailings and overburden aspects of rehabilitation and closure.

F.7 Characterisation of tailings

160. It is my opinion that the tailings have been incorrectly assessed against the '*National Environmental Protection (Assessment of Site Contamination) Measure'* (NEP(ASC)M)[13] in Appendices A001, A020, and A021 of the Fingerboards EES, which I reviewed as part of this expert witness statement. Tailings are a waste under the *Environment Protection Act (1970)* (EP Act), and thus should be characterised, assessed and managed as a waste. Thus, the method used to understand the effects of tailing reuse in rehabilitation is not appropriate.

[13] National Environment Protection Council (NEPC) (2014). National Environmental Protection (Assessment of Site Contamination) Measure.

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161. Soils are formed by five factors: parent material, climate, relief or topography, organisms and time[6]. Tailings are formed through an industrial process for the extraction of minerals and are not formed through soil forming factors. Tailings can therefore not be considered soil.

162. I have experience in the interpretation of the regulatory hierarchy for the EP Act in relation to soil and waste. I am relying on this experience, as a regulatory and soil scientist, to make the following statements.

163. It is my understanding that while the project has a licence to undertake mining, as per the *Mineral Resources (Sustainable Development) Act 1990*, that the EP Act does not apply to the project area that is listed on the licence. As soon as that licence is relinquished, however, the EP Act applies to the project area. Furthermore, any potential or actual offsite impacts both during mining and after mining has ceased are governed by the EP Act. Therefore, it is my understanding that the rehabilitation of the project area and any potential risks for offsite impacts should be considered within the scope of the EP Act.

164. The EP Act defines industrial waste as:

a) Any waste arising from commercial, industrial or trade activities or from laboratories; or
b) Any waste containing substances or materials which are potentially harmful to human beings or equipment.

165. The EP Act defines industrial plant as:

a) Any plant or equipment used for the manufacturing, processing, handling, transport, storage or disposal of materials (including raw materials, materials in the process of manufacture, manufactured materials, by-products and waste materials) in or in connection with any trade, industry or process; or
any plant or equipment of a prescribed class or description—but does not include fuel burning equipment or a motor vehicle;

166. Earth Resources Regulation also refer to tailings as waste[14] and include the term waste in their definition of tailings[15]. Tailings are referred to as waste in relation to the EP Act by Earth Resources Regulation[15].

167. As tailings are a waste arising from an industrial activity or plant (Points 164 and 165), and that tailings are considered as a waste by Earth Resources Regulation whom regulate mining in Victoria (Point 166), tailings should be considered and characterised as an industrial waste.

168. The goal of the NEP(ASC)M, as defined in Section 5 of the National Environment Protection (Assessment of Site Contamination) Measure 1999 is:

To establish a nationally consistent approach to the assessment of site contamination to ensure sound environmental management practices by the community which includes regulators, site assessors, environmental auditors, landowners, developers and industry.

169. Contamination, as defined in Section 3 of the NEP(ASC)M, is:

… the condition of land or water where any chemical substance or waste has been added as a direct or indirect result of human activity at above background level and represents, or potentially represents, an adverse health or environmental impact.

170. As per Point 161 and 167, tailings are a waste. Tailings are not land, water or soil. Based on the definitions of the NEP(ASC)M in Points 168 and 169, the use of the NEP(ASC)M is not appropriate for the characterisation and management of tailings. Thus, the method used to understand the effects of tailing reuse as part of the Fingerboards EES is not appropriate.

171. We note that waste categorisation criteria (*EPA Victoria Publication IWRG 631 – Solid Industrial waste hazard categorisation and management* (IWRG 631)) has been referred to for Tailings in Appendix C of Attachment B, and a table of results has been included. Details of methods, including sampling methods, as required by IWRG 631, do not appear to be

[14] Earth Resources Regulation. 2020. Environmental guidelines for the management of small tailings storage facilities. https://earthresources.vic.gov.au/legislation-and-regulations/guidelines-and-codes-of-practice/environmental-guidelines-for-the-management-of-small-tailings-storage-facilities. Accessed 20 January 2021. Last Updated 30 December 2020.

[15] Earth Resources Regulation. 2017. Technical Guidelines. Design and Management of Tailings Storage Facilities. State Government of Victoria, Department of Economic Development, Jobs, Transport and Resources. April 2017.

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included in the text. Therefore, I cannot determine if the tailings have been adequately and reliably assessed as being Category C industrial waste.

172. Section 9.3.5 of Appendix C of Attachment B of the EES determines tailings are a Category C industrial waste using IWRG 631. Using IWRG 631 for categorisation of tailings as waste is correct under the EP Act, as described in the Point 161 and 167. Following this, Section 9.3.5 of Appendix C of Attachment B then uses a separate guideline (*EPA Victoria Publication IWRG 621 – Soil Hazard Categorisation and Management*)(IWRG 621) designed for categorisation of waste soils. As discussed in the Point 161 and 167, the use of guidelines specifically designed for soils is not correct as tailings are not soils.

173. To the best of my knowledge, I have not been able to find any consideration of IWRG 631 or IWRG 621 in relation to tailings in Appendices A001, A020, A021 and A022.

174. It is in my opinion that the appropriate industrial waste regulations and guidelines under the relevant EP Act, noting a new act will come into effect in 2021, should be used for tailings categorisation, characterisation and management throughout the EES.

G. Limitations

175. Geotechnical engineering, hydrology and hydrogeology are critical in understanding the project area prior to project implementation and for planning rehabilitation. I do not have any formal training in these areas, and thus my expert witness statement does not consider these aspects. They are, however, crucial in understanding the stability of soils both during and after the project is completed, as well as for understanding success of rehabilitation, soil-water interactions, erosion potential of the site (particularly at the mine-offsite interface and for tunnel erosion) and water available for plant growth.

176. I did not review or consider other aspects of rehabilitation or closure planning other than soils, manufacturing of soils, tailings, overburden and soil-plant interactions in this statement. Rehabilitation is inherently interdisciplinary. Thus, I acknowledge that there are a range of aspects that are relevant to the adequacy of the rehabilitation and closure

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planning of the project area that have not been fully covered as part of this statement (e.g., ecology).

177. In my opinion, the statistical design of project of this scale requires input and/or peer review by either a statistician, biometrician or another scientist with relevant experience. This should consider aspects such as the research question, experimental design and statistical analysis. I have experience in experimental design and analysis of soil glasshouse and field trials, and the statements I have provided above are limited to my experience. Review by a statistician or biometrician is highly recommended.

178. The statements made as part of this expert witness statement were limited to the sections of the EES reviewed, as per Point 20, due to time and resources. Further investigation of other sections of the EES may provide additional detail or information that satisfies the queries and concerns raised in this expert witness statement.

179. I have not reviewed any information related to decommissioning of earth structures, tailings storage facilities, infrastructure areas or decommissioning of infrastructure areas, geotechnical engineering, fire, ecology (including vegetation and revegetation), visual values, social values, economics, performance requirements, hydrology, hydrogeology, statistics or radiation. Therefore, these aspects have not been covered in this expert witness statement, but may be related to or influenced by the information presented herein.

180. I note that the EES has not included all referenced documents as appendices (e.g., Point 39). Therefore, the review undertaken for this expert witness statement was limited by what has been provided as part of the EES. Further investigation of the EES references may provide additional detail or information that satisfies the queries and concerns raised in this expert witness statement.

181. I did not undertake a review of the Quality Assurance and Quality Control methods used for the chemical and physical analysis of soils, overburden or tailings.

182. Due to the 20MB size limit for this file, all figures, tables and diagrams have been compressed. Please see the sections of the EES referred to for original quality diagrams, tables and figures.

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H. Attachment A: Curriculum Vitae

Dr Jess Drake

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Work experience

Environmental consulting

4.5 years

Environmental Regulation and Soil Scientist

Murrang Earth Sciences, July 2018 – Present

I am currently the Environmental Regulation and Soil Scientist at Murrang Earth Sciences. My work includes provision of regulatory science in soils, waste, waste to land and chemicals in the environment, and specialist technical knowledge in land, agriculture, soils, waste to land, mining rehabilitation, organic waste, composting, erosion, soil fertility, sodicity and salinity, report writing, scientific research, development of monitoring programs, evidence-based decision making, emerging risk research, collaboration and consultation with stakeholders, project management.

Freelance Environmental Scientist

Melbourne, January 2015 – November 2015

I worked independently for a year as a Freelance scientist. I worked alongside communities to help them investigate and solve their real-world problems. Some of my work included technical lead, research, editing and writing land management documents, education and soil reports.

Environmental Scientist
Earth Tech Pty Ltd Environment Group - Canberra, March 2007 – March 2008
Role included undertaking site assessment, planning and supervision of erosion control works in riparian areas. Modelling erosion and rainfall/runoff. Soil amelioration and land reclamation. Project management and administration. Policy procedures. Budget management. Communications and liaison with stakeholders and clients.

Government

4 years

Specialist Applied Scientist – Land and Groundwater

EPA Victoria - Melbourne, November 2015 – April 2018

As a Specialist Applied Scientist my two main functions were to provide technical advice to EPA and government, and to undertake research to inform policy. My functions generally included provision of specialist technical knowledge to business (land, groundwater, waste to land, mining rehabilitation, emerging chemicals, organic waste and composting), report writing, scientific research for policy review, development of monitoring programs, evidence-based decision making, emerging risk research, external-facing scientific representation, collaboration and consultation with stakeholders.

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Soil and Environment Project Officer

Environment ACT – Canberra, March 2005 – August 2006

My short-term contract role included environmental management of operations, staff training in environmental management, soil mapping, erosion control programs, on-ground and aerial land restoration and rehabilitation, joint programs and stakeholder engagement, project management, administration, budget management and policy development.

Research

8 years

Senior Research Scientist

Monash University – Melbourne, December 2012-August 2015

As a Senior Research Scientist (Post-Doctoral) on a short-term research contract, I undertook two research projects in science-extension funded by the Australian Government. These projects worked directly with farmers on ground to help them solve their real-world problems. During this time, I also wrote and won grants for other industry and business research projects. Main tasks during this research included: project management, outreach and communication, liaison, capacity building, research, design, analysis, collaboration, information dissemination through reports and events, student and staff supervision, one-on-one research training, practical recommendations and planning, grant writing.

PhD Scholar – Soil Science

The Australian National University – Canberra, March 2008-October 2012

As a PhD Scholar, I undertook research on mine rehabilitation. The original theme of the PhD was to use organic amendments to kick-start nutrient cycling. However, halfway through my PhD I discovered a high-degree of small-scale soil variability which affected nutrient analyses. This meant that half my PhD was on nutrient cycling and the other half on methods of nutrient analysis. My main tasks during this research included: project management, outreach and communication, liaison, research, design, analysis, information dissemination through reports and events, staff supervision.

Teaching

6 years

Teacher – Conservation and Land Management

Vocational School of Science and Health, RMIT – Melbourne, January 2015 – November 2015

As a casual teacher, I designed of all practical assessment and coursework, undertook teaching practical skills, lecturing, tutorials and field/lab work, course coordination and administration, and supervising students.

Higher Education Teacher in Environmental Studies (University and Vocational)

Building and Environment Centre, Canberra Institute of Technology – Canberra July 2011 – December 2012

The Fenner School, ANU – Canberra, September 2007 – December 2011

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AS a casual teacher, I designed all assessment and coursework, teaching practical skills, lecturing, tutorials and field/lab work, course coordination and administration, supervising students.

During this time, I also worked as a back-fill lab manager, my role was not just about running a laboratory, but also about training and teaching students. Roles included maintaining and running specialised soil and water laboratory equipment, standardising new and adapting methods, undertaking analytical and statistical work, supervising and teaching students, OHS, budget and other project management duties.

Environmental Science Advisor

Live and Learn – Solomon Islands, August 2006 – January 2007

My role at Live and Learn, a short term volunteer placement, was primarily about teaching and capacity building. It included program development and implementation, teaching stakeholders, mentoring, capacity building, scientific support, project management, liaison and communication with stakeholders and collaborators.

Education

The Fenner School, Australian National University (2013) - PhD (Soil Science)
Centre for the Public Awareness of Science, Australian National University (2008) - Graduate Certificate in Science Communication
Australian National University (2005) - Bachelor of Science (Resource and Environmental Management) with First-Class Honours
Inspire Education (2015) - Certificate IV Training and Assessment

Memberships and volunteer work

Member of Castlemaine Landcare Group (2018-), including as committee member 2019-2020. Founding Member of Equity and Diversity Group of Soil Science Australia (SSA)(2013-2015) and Committee Member of Victorian Branch (2014-2015) and ACT/NSW branch (2009-2011). Member of SSA since 2005. Member of EGU in Soil Science Systems Division since 2013. Public Communication Activities, including invited speaker at Soil Change Matters 2014 and 2018 ANZ Soil Science Conference.

Grants and awards

Successful:2019 Two Fruit Fly Community Program Grants, 2018 Observership Rural Women Scholarship, 2014 State (Tech Voucher) and Federal (Researcher in Business) funding for practical scientific research; 2014 Early Career Congress Scholarship from European Geophysical Union; 2008 and 2012 Student Prize from Soil Science Australia. Nominated: The Fenner School Teacher Award (2009) and Teaching Awards at RMIT (2015).

Publications and communications

Over forty government and industry reports, over 250 technical reviews, five papers published, three papers in refereed conference proceedings, ten conference papers, and one soil map. Online communication at Murrang Earth Sciences Blog.

Journal Publications

- Drake, J. A. Patti, A.F, Whan, K, Jackson, W.R, Cavagnaro, T.R. (2018) Can we maintain productivity on broad acre dairy farms during early transition from mineral to compost fertilisation? Agriculture, Ecosystems and Environment, 257, 12-19
- Mikkonen, H. G, Dasika, R, Drake, J.A, Wallis, C. J, Clarke, B. O, Reichman, S. M. (2018) Evaluation of environmental and anthropogenic influences on ambient background metal and metalloid concentrations in soil. STOTEN, 624, 599-610
- Drake, J. A, Carrucan, A, Jackson, W.R, Cavagnaro, T. R, Patti, A. F. (2015) Biochar application during reforestation alters species present and soil chemistry. STOTEN, 514, 359-365
- Jessica A Drake, Timothy R Cavagnaro, Shaun C Cunningham, W. Roy Jackson, Antonio F. Patti (2015) Does biochar improve establishment of tree seedlings in saline sodic soils? Land Degradation and Development, 27:1, 52-59
- Jessica Drake, Bennett Macdonald & Lorna Fitzsimons (2014) Precision of the Anion Exchange Membrane Phosphorus Technique When Using a Range of Low-Ionic Solutions in Analysis of Heterogeneous Mine Soils, Communications in Soil Science and Plant Analysis, 45:6, 829-843

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I. Attachment B: Letter of Instruction

The following letter has been copied and pasted from the original version.

17 December 2020

Dr Jessica Drake
Environmental Regulation & Soil Scientist
Murrang Earth Sciences

By email only: jessica.drake@murrang.com.au

Dear Dr Drake

Fingerboards Mineral Sands Mine Project, Glenaladale, Victoria – soils and rehabilitation

We act on behalf of [redacted] a not-for-profit community group formed in response to the proposed Fingerboards mineral sands mine project (the **project**).

We write to you as an expert on environmental regulation and soil science, including rehabilitation.

The purpose of this letter is to seek your expert opinion on the environmental effects of the project.

We request your expert opinion be provided as an expert witness statement to be submitted to the Fingerboards Mineral Sands Project Inquiry and Advisory Committee. We request that your expert report be provided by **27 January 2021**.

References to Tab numbers in bold in this letter are to the documents in an electronic brief which we provide to you via DropBox

[redacted]

A. Background

1. Kalbar Operations Pty Ltd (**Kalbar**) propose to develop an open pit mineral sands mine covering an approximate area of 1,675 hectares within the eastern part of the Glenaladale mineral sands deposit in East Gippsland, Victoria. The site is located near the Mitchell River and approximately 2km south of Glenaladale, 4km south-west of Mitchell River National Park and 20km north-west of Bairnsdale.

2. The proposal includes the development of an open pit mineral sands mine, two mining unit plants, wet concentrator plant, water supply infrastructure, tailings storage dam and additional site facilities (i.e. site office, warehouse, workshop, loading facilities and fuel storage). The proposed mining methods involve open pit mining to extract approximately 170 million tonnes (Mt) of ore over a projected mine life of 20 years to produce 8 Mt of mineral concentrate. Heavy mineral concentrate, separated into magnetic and

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non-magnetic concentrates, are proposed to be transported via road, rail or a combination of both for export overseas.

3. The project would require up to 9000 kilovolt-ampere (kVA) hours of power likely to be supplied from the electricity grid and water requirements of approximately 3 gigalitres per annum (**Tab 2.1.2 / Project Description**).

4. On 18 December 2016, the Minister for Planning issued a decision determining that an Environment Effects Statement (**EES**) was required for the project due to the potential for a range of significant environmental effects. The purpose of the EES is to provide a sufficiently detailed description of the proposed project, assess its potential effects on the environment and assess alternative project layouts, designs and approaches to avoid and mitigate effects (**Tab 1.1 / Scoping Requirements**).

5. An Inquiry and Advisory Committee (**IAC**) has been appointed to review the EES and public submissions (**Tab 1.2 / Terms of Reference**). The IAC will hold public hearings for 4 to 6 weeks, after which it will produce a report for the Minister for Planning. Following receipt of the IAC's report, the Minister for Planning will then make an assessment as to whether the likely environmental effects of the project are acceptable (**Minister's Assessment**).

6. All EES documents are available online at: https://ees.fingerboardsproject.com.au/download.

B. Instructions

7. We request that you undertake a review of the soils and rehabilitation components of the EES and prepare an expert witness statement providing your opinion on:

   a. The compliance of the soils and rehabilitation components of the EES (listed below) with the relevant evaluation objective in the Scoping Requirements (**Tab 1.1**):

      Technical Studies

      i. Landform, Geology and Soil Investigation (Technical Study, Appendix 1) (**Tab 2.3.1**)

      ii. Rehabilitation Report (Technical Study, Appendix 20) (**Tab 2.3.2**)

      iii. Soil Profile Reconstruction Studies 1 and 2 (Technical Studies, Appendices 21 and 22) (**Tab 2.3.3**)

      Chapters and Attachments

i. Environmental and socioeconomic context (Chapter 8, Sections 8.1) (**Tab 2.1.3**)

ii. Closure (Chapter 11) (**Tab 2.1.4**)

iii. Environmental Management Framework (Chapter 12) (**Tab 2.1.5**)

iv. Draft Mine Rehabilitation Plan, from page 337 of the Draft Work Plan (Attachment B) (**Tab 2.2.1**)

v. Risk Report (Attachment F) (**Tab 2.2.2**)

vi. Mitigation Register (Attachment H) (**Tab 2.2.3**)

vii. Rehabilitation Independent Peer Review Report and Proponent Response (Attachment K) (**Tab 2.2.4**)

b. The adequacy of the baseline data collected by the project proponent to confidently describe pre-development conditions (as relevant to soil and rehabilitation).

c. The appropriateness of the methods used to identify and evaluate the effects of the project (as relevant to soil and rehabilitation).

d. Whether the actual or likely effects in relation to soil and rehabilitation are identified and or appropriately assessed.

e. The adequacy of the proposed design and mitigation measures, including the design criteria and draft mine rehabilitation and closure plans.

f. Any other matters you identify which you consider relevant within the limits of your expertise.

g. Any appropriate qualifications or conditions that should be attached to findings or conclusions, such as uncertainties or gravity of threats or impacts.

8. As an expert you are able to consider any such material you consider relevant to your enquiry. Please identify in your report any further materials you consult outside of the briefed materials.

C. Expert Witness Code of Conduct

9. We have enclosed a copy of the *Guide to Expert Evidence provided by Planning Panels Victoria*, which is the relevant guidance for hearings before the IAC (**Tab 3.1**).

10. In preparing your final expert witness statement, please ensure that you include:

a. your name, address, qualifications, experience and area of expertise

b. details of any other significant contributors to the report (if there are any) and their expertise

c. all instructions that define the scope of the statement (original and supplementary and whether in writing or verbal)

d. details and qualifications of any person who carried out any tests or experiments upon which the expert has relied in preparing the statement

e. the following declaration:

'I have made all the inquiries that I believe are desirable and appropriate and no matters of significance which I regard as relevant have to my knowledge been withheld from the Panel.'

D. Important dates

11. *We request your expert witness report be provided by* ***27 January 2021.***
12. *The IAC will conduct public hearings over a period of 4-6 weeks, commencing on* ***15 February 2021****.*

E. Confidentiality

13. *This request for an expert opinion and the subsequent expert witness statement, as well as any correspondence relating to this request, is for the purposes of the Fingerboards mineral sands mine project EES process, including the public hearings before the IAC. It is therefore confidential and is protected by legal professional privilege.*

F. Fees

[redacted]

Please contact Virginia Trescowthick if you have any questions or require further information.

Yours faithfully

Virginia Trescowthick
Lawyer