

In the matter of the Fingerboards Mineral Sand Project EES

Inquiry and Advisory Committee

Proponent: Kalbar Operations Pty Ltd

Expert Witness Statement of Karen Teague

Expert of Kalbar Operations Pty Ltd

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Table of contents

1.	Name and address	1
2.	Qualifications and experience	1
2.1.	Qualifications.....	1
2.2.	Affiliations.....	1
3.	Scope	1
3.1.	Role in preparation of the EES.....	1
3.2.	Other persons who assisted.....	2
3.3.	Instructions	2
4.	Methodology.....	3
4.1.	Assessment methodology	3
4.2.	Statement methodology	5
5.	Findings	5
5.1.	Summary of opinions	5
5.1.1.	Evidence for the Inquiry and Advisory Committee	5
5.1.2.	Key assumptions in the preparation of the Assessment	5
5.1.3.	Identification of changed circumstances or assumptions.....	6
5.1.4.	Assessment report completeness and accuracy	6
5.1.5.	Outline of key findings	6
5.2.	Additional work to be undertaken after the preparation of this statement	9
5.3.	Response to submissions	9
5.4.	General responses to common issues.....	9
5.4.1.	Tiered approach	9
5.4.2.	Changes in the applicable air quality screening criteria for particulate matter..	10
5.4.3.	Mental health baseline assessment.....	11
5.4.4.	Regional receptor radius and selection of sensitive populations.....	11
5.4.5.	Dust fallout on drinking water sources	11
5.4.6.	Dust on crops	12
6.	Declaration	13

Appendices

Appendix A - Curriculum vitae

Appendix B - Instructions

Appendix C - Reports and information reviewed

Appendix D - Detailed response to submissions

1. Name and address

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2. Qualifications and experience

I have over 20 years' experience in environmental consulting and specialise in the assessment and management of human health and environmental risks. I have conducted and peer reviewed human health risk assessments to evaluate current or future exposures to human and ecological receptors to a wide range of chemicals and hazards associated with contaminated soil, groundwater, soil vapour, particulates and dust, food, water, air and other media. I have undertaken health baseline and/or impact assessments, assessing potential impacts to human health from mining operations, construction, transport and tunnelling activities and waste facilities.

I provide expert technical support in the area of human health exposure and health risk assessment to Environmental Auditors (site contamination). I have delivered specialised training in quantitative and qualitative health risk assessments for the past 13 years via the Australian Contaminated Land Consultants Association.

My curriculum vitae is provided as Annexure A which offers further details of my qualifications and expertise.

2.1. Qualifications

My formal qualifications are:

- Bachelor of Science (Monash University), 1984.
- Post Graduate Diploma in Entrepreneurship & Innovation (Swinburne University), 1993.
- Post Graduate Diploma Internet Software Development (Swinburne University), 2001.

2.2. Affiliations

- Member of the Australasian College of Toxicology and Risk Assessment
- Australian Contaminated Land Consultants Association.
 - Member of the Risk Assessment focus group
 - Member of the Regulatory Affairs and Audit focus group.
- Member of the Australian Land & Groundwater Association

3. Scope

3.1. Role in preparation of the EES

I am the primary author of the *Human Health Risk Assessment* report (Coffey, 2020), herein referred to as the Assessment. The Assessment forms Appendix A019 of the Fingerboards mineral sands project (Project) environment effects statement (EES).

A work scope was prepared in 2018 following a request by Kalbar to prepare a Human Health Risk Assessment (HHRA) based on available information obtained in relevant specialist technical reports.

The purpose of the Assessment was twofold; to evaluate the baseline health conditions associated with environmental media, and to assess the potential health risks to off-site populations related to the potential release of pollutants associated with Project activities to environmental media.

The scope of the baseline HHRA was to undertake a desktop review of relevant reports and investigations conducted to date to inform the EES. The scope included a compilation of the data and information collected to for other EES technical studies to develop a conceptual site model (CSM) and undertake a Tier 1 baseline evaluation of health risks to off-site populations associated with selected chemical and radionucleotide substances.

The scope of the impact assessment was to review, compile and summarise the impact evaluations and modelling undertaken in other EES specialist technical reports, associated with potential releases of chemical and radioactive substances relating to the project activities. The exception to this scope was the estimation of contaminant concentrations in harvested rainwater which I undertook using the available information and data in specialist technical reports related to dust contaminant concentrations and leach testing.

The Assessment compiled the relevant data collected from the available specialist technical reports and present the exposure pathway and health risk evaluation in the one document. All the data and supporting information contained in the Assessment is referenced to the relevant technical report. Where calculations have been undertaken, the inputs, assumptions and processes are presented and referenced where applicable. Whilst the Assessment is dependent on the information collected, modelled and presented in the cited specialist technical reports, the Assessment is considered to be a standalone report.

3.2. Other persons who assisted

The people who assisted me in the preparation of the Assessment and/or this statement include; Erin Pears (Principal) who reviewed the draft Assessment for consistency with the work scope, Emma Waterhouse (Senior Principal) who reviewed the Assessment for consistency with other EES technical reports and provided editorial suggestions, and Benjamin Casillas-Smith (Project Manager) and Carolyn Balint (Senior Principal) who provided instructions, documents or data required to update the Assessment throughout the process.

The Assessment includes the collation of work conducted by several technical specialists as presented in their reports. When preparing this expert witness statement, and addressing issues raised in public submissions to the Planning Panel, issues that are directly related to my authorship, or my interpretation of a specialist technical report, have been addressed. In certain instances, I have provided a response where an issue is considered likely to have a significant effect on the Assessment outcomes.

3.3. Instructions

I have been instructed by White and Case Pty Ltd (White and Case), acting as legal advisors to Kalbar Operations Pty Ltd (Kalbar), to prepare this expert witness statement to assist the inquiry being held by Planning Panel Victoria. A copy of White and Case's engagement letter is provided in Annexure B.

I have read Planning Panels Victoria's Guide for Expert Witnesses and I am aware that I have an overriding duty to the Inquiry and Advisory Committee on matters relevant to my expertise.

4. Methodology

4.1. Assessment methodology

The Assessment framework was based on the *National Environment Protection (Assessment of Site Contamination) Amendment Measure 2013* (ASC NEPM). The ASC NEPM risk assessment framework is based on the revised *Environmental Health Risk Assessment - Guidelines for assessing human health risks from environmental hazards* (EHRA), published by enHealth in 2012, which provides a general environmental health risk assessment methodology. The ASC NEPM provides detailed guidance specific to the derivation and application of health screening levels for chemical contaminants, and the tiered approach to undertaking health risk assessments.

The methodology I adopted to prepare the Assessment was consistent with the ASC NEPM and EHRA and can be generally summarised as follows:

Baseline Assessment

- A desktop review of the project description and selected specialist technical reports was undertaken to understand the proposed Project activities and to develop a conceptual site model in relation to the environmental, land use and social settings.
- Identified the potential sources of chemical and radioactive substances relating to Project activities and, if released, how they may migrate and where future points of exposure may be present based on the conceptual site model. Identified the off-site receptor populations that may be exposed, and the likely exposure routes involved (such as inhalation, ingestion, or dermal contact).
- Chemical and radioactive substances were identified as potentially migrating off-site via water (groundwater and surface water), air (in the form of dust particulates and gases) and dust fallout. Sensitive receptor populations were identified based on proximity to Project activities and releases off-site, on the assumption these receptors were likely to have higher exposures than those at greater distances from Project related releases.
- Reviewed the nature and extent of the environmental baseline studies undertaken in each specialist report.

My initial review of available draft reports was conducted in late 2018 - early 2019, selected based on their relevance for the baseline evaluation in the Assessment as follows:

- Fingerboards Project Radiation Assessment Report. Prepared by SGS Radiation Services for Kalbar Resources.
- Fingerboards Mineral Sands - Groundwater and Surface Water Impact Assessment. Report prepared by Coffey Services for Kalbar Resources.
- Stage Two Air Quality and Greenhouse Gas Assessment for the Fingerboards Mineral Sand Project. Report prepared by Katestone for Kalbar Resources.
- Landform, Geology, and Soil Investigation, Fingerboards Mineral Sands Project. Report prepared by Landloch for Kalbar Resources.
- Fingerboards Mineral Sands Project Horticultural Impact Assessment. Report prepared by RMCG for Kalbar Resources.
- Fingerboards Mineral Sands Landscape Stability and Sediment Transport Regime Assessment. Report prepared by Water Technology for Kalbar Resources.
- Fingerboards Mineral Sands Project Socioeconomic Impact Assessment. Coffey Services Australia. Report prepared for Kalbar Operations Pty Ltd.
- Geochem Testing of Fingerboard Tailings and Overburden - Preliminary Report. Environmental Geochemistry International. Report prepared for Kalbar Operations Pty Ltd.
- Fingerboards Mineral Sands Project. Land use and planning impact assessment. Matrix Planning Australia Pty Ltd. Report prepared for Kalbar Operations Pty Ltd.

- Prepared a summary of the relevant data sets based on the information in each specialist report, to calculate and present the average and concentration range in each media.
- The baseline evaluation was a Tier 1 screening assessment where the average and maximum concentrations were compared to adopted health screening criteria. Based on the ASC NEPM framework, a Tier 1 assessment uses conservatively derived screening criteria to evaluate chronic exposures to contaminants in a particular setting. The adopted screening criteria derived for metal contaminants in soil and water include toxicity safety factors where appropriate, and Australian derived soil and drinking water values include adjustments for background exposures associated with other sources.
- In order to be consistent with the specialist reports, the selected health screening criteria was also adopted for the Assessment. Health screening criteria were generally selected from Australian guidance sources where available, or international agencies as appropriate. A number of air quality screening criteria were replaced by the Texas Commission on Environmental Quality Effects Screening Levels (TCEQ ESL), as recommended by the independent peer reviewer of Katestone's Air Quality report.
- Evaluation of uncertainties. The key uncertainties in the baseline data set were identified in the initial draft Assessment and refined where additional data was collected prior to the final Assessment report.
- Prepared a sampling protocol and survey to assist in the collection of harvested rainwater from tanks in the regional area.
- The draft baseline assessment sections were updated when new or revised information was identified in any of the selected specialist reports, response to comments from the Technical Reference Group, peer reviewers and comments from Kalbar where justified. Baseline data from the 2019 rainwater tank investigation was also added to the Assessment in late 2019.

Impact assessment

The impact assessment evaluated potential health risks associated with predicted off-site conditions to identified populations as a result of project activities. The methodology I adopted to assess predicted impacts is generally summarised as follows:

- A Tier 1 screening assessment of predicted concentrations associated with the release of chemical and radioactive substances to environmental media with adopted health screening criteria as the basis of the impact assessment. Where predicted concentrations were not available, a qualitative assessment was done. The impact assessment approach for media evaluated was as follows:
 - The impact evaluation utilised modelling undertaken in the specialist technical reports to predict concentrations in air, surface water and groundwater.
 - The assessment of chemical and radioactive substances in rainwater tanks was based on calculations which adopted the maximum concentrations in dust modelling and the maximum leachability results (in tests conducted for the Geochem Testing report). Other calculation inputs were based on a combination of reasonable and reasonably maximum assumptions.
 - A qualitative assessment of impacts associated with dust deposition on dams was based on multiple lines of evidence approach.
 - The qualitative evaluation of predicted impacts to soils associated radionuclides within the rehabilitation mine area was undertaken by SGS Radiation and adopted in the Assessment.
- A Tier 2 assessment was undertaken in the Radiation report prepared by SGS to assess potential radiation exposures to:
 - Farmers and consumers of crops as a result of dust deposition and plant uptake.
 - The general public using road and rail transport routes used to haul heavy concentrate material.
- The impact evaluations assumed management measures were implemented as recommended in each of the relevant specialist reports.

- Evaluation of uncertainties. The ASC NEPM framework requires the assessment of uncertainties is conducted for each of the main steps of the HHRA process. The Assessment included a section identifying the key uncertainties associated with the impact assessment.

The list of all specialist reports reviewed for the Assessment are presented in Appendix C, along with other documents used or referred to in preparation of this statement and the preparation of responses to public submissions in this statement. A full list of the references used to prepare the Assessment are listed in Section 12 of the Assessment report.

4.2. Statement methodology

The methodology adopted in preparation of this statement is consistent with the Planning Panels Victoria Guide for Expert Witnesses. In addition, I have responded generally to common issues raised in the submissions to the EES and have provided a more detailed response to relevant submissions in Appendix D where warranted.

5. Findings

5.1. Summary of opinions

5.1.1. Evidence for the Inquiry and Advisory Committee

I adopt the Assessment as the basis of my evidence the Inquiry and Advisory Committee, subject to the additional work, updates and corrections as detailed in Section 5.1.3 and Section 5.2.

5.1.2. Key assumptions in the preparation of the Assessment

The key assumptions adopted in the preparation of the Assessment include:

- The baseline data sets for each media are representative of current regional background levels for each substance of concern. Whilst some uncertainties for data sets relating to soil and crops were noted to be small, localised, composited or collected over a short period or limited area, these uncertainties were identified for Kalbar's benefit should they choose or be required to address them prior to commencement of the Project. Additional baseline data collected over wider or targeted areas would provide more confidence in understanding existing levels of contaminants in the various media.
- The health screening criteria selected by each specialist report was adopted in the Assessment. The screening criteria adopted for each media are generally assumed to be protective of public health, including more sensitive subpopulations such as young children. While screening criteria are derived based on the best information available at the time they are developed and include conservative assumptions to increase the safety margin, they may not necessarily protect all of the people all of time, from all possible health effects.
- The quality assurance or quality control aspects of the data were assumed to be adequate where laboratory reports were not provided.
- The management measures and design measures noted in the Assessment and/or in specialist technical reports I relied upon are assumed to be undertaken during the construction, operation and closure phases of the Project.
- Many of the adopted parameters and input assumptions used in modelling future concentrations of chemical or radioactive substances in air, dust deposition, runoff, surface water, leachate and groundwater in the specialist technical reports will inherently include various degrees of uncertainty. Regular ongoing monitoring of specific media, and corrective action taken as required, during critical phases has been assumed to confirm the modelling outcomes. Redundancy measures or triggers in the vicinity of likely source emissions would be required to ensure compliance.

5.1.3. Identification of changed circumstances or assumptions

The following report updates and relevant information have been provided after the finalisation of the Assessment:

- Updated Air Quality Assessment outcomes prepared by Katestone as presented in Simon Welchman's witness statement.
- Proposed calculation of uptake of radioactive substances by cattle, as discussed in the witness statement of Darren Billingsley. Darren Billingsley has made a recommendation to undertake this assessment for incorporation into the Radiation Environment Plan which will require approval from the Victorian DHHS prior to issue of a Management License.
- Identification of a likely change in the PM_{2.5} and PM₁₀ screening criteria applicable for the Project in the Environmental Reference Standard (ERS) to be adopted in December 2021 or earlier.

5.1.4. Assessment report completeness and accuracy

Based on the available data and information relied upon in the specialist reports, I confirm the Assessment report is considered to be complete, with the following exceptions:

1. The following exposure pathways have been identified as potentially incomplete:
 - a. Consumption of animal products from livestock raised in the regional area, that may have ingested impacted food, water or inhaled particulates associated with Project activities.
 - b. The uptake of metals in dust fallout by edible plants and sequent ingestion by regional populations.
2. The Assessment describes the tailings handling, storage and placement process and conditions that will potentially be superseded by a proposed change to this process by Kalbar (18 January 2021). The process changes have ramifications for predicted dust and water source releases and concentrations that were reported in the Assessment.

5.1.5. Outline of key findings

Baseline health assessment

The key findings of the baseline assessment, as described in the Assessment, based on the available data, concluded the substances of concern are within acceptable levels the exception of the following exceedances:

- The maximum reported concentrations of arsenic, total chromium, lead and manganese exceeded the Tier 1 health screening criteria for drinking water at three surface water locations within the Project area, noting the total chromium concentration marginally exceeded the screening criteria protective of the more toxic chromium VI species at one location and hence may be acceptable.
- The average concentrations of nickel and manganese in filtered groundwater samples from regional bores and Project area bores exceeded Tier 1 screening criteria for drinking water.
- The maximum reported concentrations of arsenic in filtered groundwater samples exceeded the Tier 1 screening criteria for drinking water at one regional monitoring well and Project area well.
- The maximum reported concentrations of cadmium in filtered groundwater samples exceeded the Tier 1 screening criteria for drinking water at one regional monitoring well.
- Tier 1 screening criteria for drinking water was exceeded for manganese and nickel in filtered groundwater samples at all project and regional monitoring locations.
- The maximum reported concentrations of nickel in filtered groundwater samples exceeded the Tier 1 screening criteria recreational use at one monitoring well located off-site to the northeast near the Mitchell River.

Based on the available data, assumptions and uncertainties noted in the Assessment, the outcomes of the Tier 1 baseline evaluation of average and maximum concentrations reported in each media, with criteria selected for relevant receptor populations, are presented in Table 1.

Table 1: Key findings of the baseline health assessment

Media	Substance	Relevant receptors in off-site areas	Average concentration	Maximum concentration
Air				
Particulate matter	PM ₁₀	Regional residents	Below criteria	Below criteria
	PM _{2.5}		Below criteria	Below criteria
	Respirable crystalline silica ⁽¹⁾		Below criteria	Below criteria
	Metals		Below criteria	Below criteria
	Radionuclides		No exceedances	
Dust	Deposition		Below criteria	NA
Exhaust gases	NO ₂ , SO ₂	Transport route residents	Below criteria	
		Regional residents	Below criteria	
Ambient air	Radiation	Transport route residents	Within background levels	
		Regional residents		
Soil				
Topsoil – regional area	Metals	Regional residents	Below criteria	
	Radionuclides		Within average global range	
Crops	Radionuclides ⁽²⁾	Horticultural farmers	Within global average intake range	
Sediment	Metals	Recreational users	Below criteria	
Water				
Surface water	Metals	Regional residents	Below criteria	4 exceedances ⁽³⁾
		Recreational users	Below criteria	
	Radionuclides	Regional residents	Below criteria	
		Recreational users	Below criteria	
Harvested rainwater	Metals	Regional residents	Below criteria	
	Radionuclides		Below criteria	
Groundwater	Metals	Regional residents	2 exceedances ⁽⁴⁾	4 exceedances ⁽⁵⁾
		Recreational users	Below criteria	1 exceedance ⁽⁶⁾
	Radionuclides	Regional residents	Below criteria	
		Recreational users	Below criteria	

¹ Measured as PM_{2.5}.

² Based on a quantitative assessment undertaken by SGS (2020).

³ Arsenic, chromium, lead and manganese

⁴ Manganese and nickel.

⁵ Arsenic, cadmium, manganese and nickel.

⁶ Nickel

Predicted impact health assessment

As described in the Assessment, the potential impacts during the construction, operational and rehabilitation stages of the project were predicted on the basis that releases of contaminants would be minimised as a result of the management measures recommended by the technical specialists. Different methodologies were adopted to qualitatively assess exposures or quantitatively estimate concentrations of contaminants at the point of exposure. Almost all the qualitative and quantitative assessments undertaken to inform this Assessment made allowances in their evaluations for the application of proposed key management measures.

Based on the available data, assumptions and uncertainties noted in the Assessment, the Tier 1 screening assessment of predicted concentrations in media with adopted health screening criteria determined the risk profiles of substances of concern in air, groundwater and surface, soil or sediments to be low and acceptable.

The Tier 1 health screening assessment of potential exposures to the identified human receptor populations in off-site areas to contaminants associated with mining activities are presented in Table Table 2.

Table 2 Tier 1 screening assessment – modelled/predicted project impacts

Media	Contaminant	Relevant receptors in off-site areas	Construction	Operations / rehabilitation
Air				
Particulate matter	PM ₁₀	Regional residents	Additional management measures may be required on days where meteorological conditions indicate a greater potential for dust migration offsite.	
	PM _{2.5}		Below criteria	Below criteria
	Respirable crystalline silica ⁽¹⁾		Below criteria	Below criteria
	Metals		Below criteria	Below criteria
	Radionuclides		Low and acceptable	
Dust	Deposition	Low and acceptable		
Exhaust gases	NO ₂ , SO ₂	Transport route residents	Negligible	
		Regional residents	Negligible	
Ambient air	Radiation	Transport route residents	Negligible	
		Regional residents	Negligible	
Soil				
Topsoil	Metals	Regional residents	NA	NA
	Radionuclides		NA	Low and acceptable post rehabilitation
Crops	Radionuclides ⁽²⁾	Horticultural farmers	Low and acceptable	
Water				
Surface water	Metals	Regional residents	Low and acceptable	
		Recreational users	Low and acceptable	
	Radionuclides	Regional residents	Low and acceptable	

Media	Contaminant	Relevant receptors in off-site areas	Construction	Operations / rehabilitation
		Recreational users	Low and acceptable	
Rainwater tanks and dams	Metals	Regional residents	Negligible	
		Recreational users	Negligible	
Groundwater	Metals	Regional residents	Low and acceptable	
		Recreational users	Low and acceptable	
	Radionuclides	Regional residents	Low and acceptable	
		Recreational users	Low and acceptable	

¹ Measured as PM_{2.5}.

² Based on a quantitative assessment undertaken by SGS (2020).

5.2. Additional work to be undertaken after the preparation of this statement

Additional work is proposed in response to concerns in a number of the public submissions in relation to the potential indirect ingestion of substances of concern associated with animal products and edible plants, as a result of dust deposition related to Project activities.

The information needed to address these pathways was not available at the time this statement was being prepared. The outcomes will be presented to the IAC during the planning panel session.

5.3. Response to submissions

I have made reasonable efforts to review all submissions made in relation to the Project that raise health issues regarding the release of chemical and radioactive substances to the air (in the form of particulates or gases), dust fallout on soil, crops and water sources, and to surface waters and groundwater. Given the large number of public submissions to the Inquiry and Advisory Committee (>900), I relied on Kalbar's review and classification of key issues raised in each submission. Only those submissions identified by Kalbar as relating to human health issue have been reviewed, a total of 276, of which 60 submissions were considered to be detailed in nature.

Where an issue raised by a submission relates directly to information presented in a specific specialists report (e.g., Air Quality and Greenhouse Gas Assessment) which has been adopted or referred to in my Assessment report, I have not provided a response in my statement as this issue has been assumed to be addressed by the relevant specialist. The specialist technical reports were responsible for the baseline scoping and sampling, and/or the modelling of predicted impacts. I have provided a response where my interpretation or application of their work is warranted, or where an issue is considered to have a direct effect on the Assessment outcomes (e.g. potential change to the adopted Tier 1 screening criteria).

5.4. General responses to common issues

Common issues raised in the public submissions are addressed generally here and are also included in my responses tabulated in Appendix D. In addition, the key comments in the public submissions relating to my interpretation, or an issue that may alter the Assessment outcomes, are summarised in the following sections.

5.4.1. Tiered approach

Under the ASC NEPM framework, the recommended process for assessing site contamination involves a tiered approach (refer to Schedule A of the ASC NEPM). The first stage is a Tier 1 screening assessment using generic screening criteria that have been conservatively derived for a

particular land use setting or for general public health. Exceedances of Tier 1 screening criteria are triggers for further investigations, a refined site-specific Tier 2 or Tier 3 risk assessment, remediation, management, or a combination of these strategies.

The baseline evaluation in the HHRA relied on the conservatively adopted Tier 1 screening criteria for each media to be protective of health. Whilst a limited number of exceedances of screening criteria in baseline data were noted in soil (radiation), surface water (arsenic, chromium, lead and manganese) and groundwater (metals), a Tier 2 evaluation was not considered warranted based on the following:

- The objective was to understand baseline conditions rather than determining overall exposures.
- Most exceedances were related to the Project area rather than off-site areas.
- Identified impact in surface water and groundwater was not used for drinking water purposes.
- Limited data sets for most media, particularly offsite, is indicative of a Preliminary Tier 1 evaluation under the ASC NEPM framework. Further data would be required to refine the conceptual site model and the inputs and assumptions for a Detailed Tier 1 or a Tier 2 evaluation.

The impact evaluation did not proceed to a Tier 2 health evaluation on the basis no Tier 1 screening criteria were exceeded. The inclusion of mitigation or management measures in the air and water modelling, and the identification of additional measures required to minimise dust generation depending on meteorological conditions, suggests exceedances may occur in some instances if such measures were not undertaken. This approach is consistent with a Detailed Tier 1 determination in Schedule A of the NEPM which would require the development of an environmental management plan rather than a Tier 2 evaluation.

Tier 1 screening criteria

Screening criteria are generally scientifically based and derived to be protective of chronic exposures to contaminants for use in generic evaluations. They are intentionally conservative and are based on a reasonable worst-case scenarios for a particular setting (for example, for a residential setting ASC NEPM criteria assumes occupants will be exposed for 20 hours per day, 365 days per year for 70 years). They are intended to be used in the first stage of an assessment of potential risks to human health. Australian and some international agencies also take into account potential background exposures to the contaminant that may occur from other sources when screening deriving criteria. Screening criteria derived in the ASC NEPM for soils and the NHMRC & NRMMC Australian Drinking Water Guidelines (2011) both incorporate an adjustment for background exposures.

5.4.2. Changes in the applicable air quality screening criteria for particulate matter.

The adopted health screening criteria are intervention levels, published in the 2007 Protocol for Environmental Management (PEM) for mining and extractive industries under the State Environment Protection Policy for Ambient Air Quality (SEPP AAQ). The Environment Protection Act (1970) will be repealed (no later than December 2021) and replaced with the 2017 Environment Protection Act, as amended by the 2018 Environment Protection Amendment Act. The date at which the amended 2018 Act commences, the screening criteria applicable for the Project will be in the Environmental Reference Standard (ERS).

The draft 2019 ERS environmental objectives for particulate matter (PM) are based on the protection of environmental values, including human health. It is likely screening criteria for PM₁₀ and PM_{2.5} will be reduced by 20%. Based on the air quality modelling undertaken (Katestone, 2020), the predicted PM₁₀ levels may exceed the PM₁₀ criteria at identified sensitive receptor locations during construction and operation phases.

Based on the updated modelling undertaken and presented in Simon Welchman's statement, the health risks outcomes of the HHRA for air quality associated with PM₁₀ would not change if the management measures under his Scenario 3 were implemented.

5.4.3. Mental health baseline assessment

Australian and international guidance for undertaking a health impact assessment often includes the evaluation of mental health as part of the objective. Assessments of mental health impacts to communities associated with a project are generally undertaken qualitatively as part of a socio-economic impact assessment. It is acknowledged impacts to a community's mental health may affect their physical health however, guidance on the measurement of potential risks associated with mental health has yet to be established. Unlike exposures to toxic substances which can be studied via the use of epidemiological and animal studies, mental health impacts cannot be measured as readily.

A large number of submissions indicated their concerns relating to the potential negative impacts on the community's mental health associated with the Project. I acknowledge these concerns, however it is beyond my expertise to evaluate the potential mental health impacts related with Project activities. The scope of the Assessment focussed on substances that may cause health effects if they were to be released to the environment as a result of Project activities.

5.4.4. Regional receptor radius and selection of sensitive populations.

Receptor populations were identified based on their location in relation to the potential transport pathways of contaminants released by the project activities. A 5 km radius beyond the project area boundary was adopted based on the air quality report (Katestone, 2020) which identified 49 sensitive receptor locations, all generally within a 3 km radius of the project area boundary (or in the project area near the project boundary). These sensitive receptor populations were assumed to include young children, older people and people with chronic health conditions.

Whilst a 5 km radius was selected for the purpose of the Assessment to indicate the locations of populations who were likely to have the greatest exposures to airborne contaminants migrating from the Project area, it was not intended to signify a boundary beyond which no exposures were expected.

Concerns have been raised as to the number of sensitive receptors identified off-site, and the potential for farmers undertaking activities within the Project area. Where the air modelling predicts no exceedances to residential occupants located near the boundary to the north and northeast, immediately downwind of the prevailing wind direction, additional receptors off-site would also be considered protected. Although I was not aware of the potential for farming activities on-site during mine operations, it is suggested Kalbar provides these farmers with appropriate health and safety training, updates and PPE if required.

A number of submissions commented on the likelihood that particulate matter would migrate further than 5km, particularly on days of high wind speed or where the management of dust generation was insufficient.

I agree the distance of dust migration from the Project boundary would likely exceed 5km down wind, especially on days of high winds. Whilst schools, kindergartens, hospitals and other sensitive receptors are located beyond 5km, these sensitive receptor populations were already assumed by the Assessment to be present. Given the concentration of dust particulates decreases over increasing distance from the source due to dispersion, fallout and other factors, these populations will have lower exposures, particularly when compared to a young child residing within a 3 km radius. In addition, the number of days or hours where exposures may occur is likely to be higher for receptors closer to the source than those located at greater distances, as a direct proportion of days where higher wind speeds are required.

5.4.5. Dust fallout on drinking water sources

A number of submissions noted their concerns on the potential impacts from dust fallout to drinking water sources, including private rainwater harvesting, private dams and the water storage dam at Woodglen located 3.5km from the Project boundary.

Rainwater tanks and dams

My calculations in section 9.3.2 of the Assessment were based on a selection of maximum inputs (e.g., dust deposition, contaminant concentrations, pH and leachate concentrations) and reasonable assumptions (e.g., average rainfall). The maximum inputs were reliant on the air modelling predictions, geochemistry testing of metals in fine and coarse tailings and leachate testing of tailings, heavy mineral concentrate and overburden. The combination of mostly maximum and some average inputs are often used to calculate the reasonable maximum levels of a contaminant at the point where a receptor may be exposed. The use of mostly maximum inputs are therefore likely to overestimate the predicted concentrations.

Whilst the predicted concentrations can be confirmed with an ongoing monitoring program, the Project has no control over the management of tanks or the collection, storage and distribution of water. Of the 11 properties surveyed, none had first flush devices installed. These devices divert the initial water washing into tank inlet pipes, water that is likely to most sediment laden. Almost all properties had not removed sediments from their storage tanks in the previous three years or changed the filter if a filtration point was present between the tank and the house.

Regional users of harvested water may also be concerned with the contribution of contaminants in bushfire particulates to their harvested rainwater. The Environmental Health Committee (enHealth) of the Australian Health Protection Committee have produced *Guidance on the use of Rainwater Tanks*. It provides guidance on managing rainwater collected in domestic tanks to maximise the quality of water (for both microbes and contaminants) and includes recommended maintenance and schedules.

Dust fallout on private dams or surface water storage impoundments is expected to be deposited to underlying sediments. Where minimal disturbance of sediments occurs, dissolved phase concentrations of metals are considered negligible based on the calculations undertaken for rainwater tanks. It is recommended ongoing monitoring of dam water and sediments is undertaken to confirm this assumption.

Woodglen water storage dam

The water storage dam at Woodglen utilises a dissolved air floatation and filtration (DAFF) water treatment process before water is released to customers. The process uses a coagulant to attract dirt and particles which then stick to air bubbles injected into the water. The bubbles float to the surface where they are skimmed off as sludge. The water is then passed through a dual filter of sand and coal filter to further remove impurities.

Based on the calculations used to estimate concentrations of contaminants in harvested rainwater located closer to the Project area, in addition to the water treatment undertaken at the Woodglen dam prior to its release to customers, the drinking water supply from the Woodglen storage dam is not considered to pose an unacceptable health risk to users who consume the water.

5.4.6. Dust on crops

A large number of submissions raised concerns associated with the impact of dust fallout on the crops grown in the Lindenow region located northeast of the Project. Whilst most were primarily concerned with the perception of contaminated produce impacting farmers and the flow on effects on the local community, the health impacts associated with radionuclides in deposited dust on soil and on edible crops were quantified and found to be low and acceptable (refer to section 9.1.4 of the Assessment).

Kalbar has committed to undertaking a baseline investigation of metals and radiation in soil and crops from the Lindenow horticultural region. While I endorse this approach, I also suggest ongoing monitoring of crops and co-located soils during project construction and operations to confirm the health outcomes noted in the Assessment and ensure trigger levels are set where further mitigation would be instigated.

6. 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 Inquiry and Advisory Committee.

Signed *Karen Teague*

Dated2 February 2021.....

Appendix A - Curriculum vitae

Our people

Karen Teague BSc, Grad. Dips. Entrep. & Innov., Internet Software Dev.

Principal Risk Assessor



Professional profile

I have over 20 years' experience in environmental consulting and specialise in human health and environmental risk assessments. I have completed numerous human health risk assessments on the potential exposure of humans to a wide range of chemicals associated with contaminated soil, groundwater, soil vapour, particulates and dust, food, water, air and other media. I have undertaken ecological risk assessments; focussing on the potential impacts of contaminated groundwater and sediments on marine and freshwater aquatic ecosystems, and soils and dust for terrestrial flora and fauna.

My experience includes assessing and managing environmental and health risks associated with contaminated sites and industrial facilities, proposed mining projects, chemical toxicity assessment, chemical fate and transport modelling (soil, water and air), environmental and occupational risk assessment and management and regulatory compliance. I have provided peer reviews and expert technical support in the area of human health exposures and risk evaluations. I also conduct training to people in the environmental industry relating to quantitative and qualitative risk assessments.

I have experience in undertaking health impact assessments, assessing potential impacts to human health from mining operations, construction, transport and tunnelling activities and waste facilities. I have also conducted and reviewed microbial health risk assessments, specialist reports for contaminated site audits and environmental impact statements, construction and site management plans, risk communication and the development of risk management strategies.

Qualifications

- Bachelor of Science - Monash University, 1984 (Biochemistry and Immunology)
- Grad. Dip. Entrepreneurship & Innovation, Swinburne University, 1993
- Grad. Dip. Internet Software Development, Swinburne University, 2001

Professional Affiliations

- Australasian College of Toxicology and Risk Assessment (ACTRA)
- Australian Contaminated Land Consultants Association. Member of the Risk Assessment and Regulatory Affairs sub-committees.
- Australian Land & Groundwater Association.

Other training

- Reproductive & Developmental Toxicology – Toxicity & Health Impacts, ACTRA, 2019
- Particulate matter – Toxicity & Health Impacts, ACTRA, 2018
- TPH Biodegradation & Metabolite Plumes – Risk Management Implications CRC Care 2016
- Toxicology: Dose-Response Bootcamp, TERA, Sydney 2012
- Carcinogen Workshop, ACTRA, 2010
- Vapour Intrusion Workshop, ACLCA, 2010
- Human & Ecological Risk Assessment Practice & Theory, AIOH, VIC, 2007

Areas of expertise

Human Toxicology

Environmental Toxicology

- Evaluation of toxicity data for a number of compounds where appropriate toxicity criteria were not readily available. Toxicity studies were evaluated based on route of exposure, dose- response relationships, species tested, length of study etc. Identified where a conservative approach required in instances where toxicity information is absent or where chemical mixtures are present.
- Evaluated contaminants such as PFAS, PAHs, BTEX, chlorinated hydrocarbons, pesticides, metals, phenolics, TPHs and radionuclides, amongst others, and their potential effects on human or ecological health. Experienced in evaluating less common contaminants such as those associated with explosives, dyes, dioxins and asbestos.
- Review and compilation of toxicological profiles for numerous chemicals including metals, chlorinated and petroleum hydrocarbons and many other compounds associated with soil, air and groundwater contamination.

Human Health and Ecological Risk Assessment

- Conducted numerous human health risk assessments on the potential exposure of humans to various chemicals associated with contaminated soil, groundwater and air.
- Quantitative Risk Assessment methodologies include Australian guidance provided by NEPM and enHealth as well as state specific guidance where available.
- Qualitative Risk Assessment methodologies published by Standards Australia or other methodologies such as process (HAZOP, HACCP and FMEA) or barrier based (BOWTIE) techniques as appropriate. Conducted and reviewed risk assessments for contaminated site overseas using USEPA and other international guidance documents.
- Performed numerous quantitative health risk assessments which involved multiple exposure pathways including inhalation of vapours, aerosols and/or particulates, dermal contact, ingestion, plant uptake and animal intake and subsequent ingestion and dermal contact with various media.

- Peer reviewed and conducted health risk assessments for a variety of property developmental sites as part of the statutory environmental audits in all relevant Australian states.
- Developed of risk-based site-specific clean up goals for chemical contaminants in soil, groundwater, surface water, volatile emissions and dust. Developed Site-Specific Risk-Based Criteria for various land uses including day care centres, residential developments and industrial facilities. Derived risk-based criteria for impacted media such as groundwater, air, soil vapour and soil at various depths, with vapour barriers and water seepage in basements. Derived risk based criteria where multiple exposure routes and pathways were identified.
- Developed and refined numerous site conceptual models. Many sites included multiple historical soil and groundwater investigations with various objectives and characterisation of complex geological and/or hydrogeological settings. Recommended further investigations required to fill data gaps or refine inputs required to evaluate the potential risks.
- Designed soil, soil vapour, air quality and groundwater investigations and appropriate methodologies as required providing more site-specific information suitable for use in quantitative risk assessments to address data gaps.
- Determined vapour intrusion mitigation system specifications, reviewed design, installation and effectiveness of both passive and active systems.
- Ecological risk assessments include the potential impacts of contaminated groundwater on freshwater and marine aquatic ecosystems. Example projects include Port Facility at Groote Eyandt, Shell Refinery in Geelong, Department of Defence site in Point Cook.
- Coordinated an ecological assessment which included a rapid bio-assessment of an aquatic environment in order to identify and characterise the stressors on each of the selected zones. Also conducted a sediment study to identify the chemicals of potential concern and delineate impact zones.

- Conducted and reviewed Environmental Management Plans to address residual contamination in surface soils as well as soils at depth and in groundwater in order to protect human health and other broader environmental values.
 - Conducted Health and Ecological Risk Assessments reports for inclusion in Environmental Impact Statements and Environmental Effects Statements for national and international mining projects. These assessments evaluated the baseline and predicted health and environmental impacts.
- Contaminant Fate and Transport**
- Conducted and peer reviewed numerous fate and transport assessments of contaminants in air, water and soil. Modelling undertaken include (but are not limited by):
 - Vapour Intrusion Modelling: Used to estimate receptor point concentrations in groundwater, indoor and outdoor air.
 - Fate and Transport Modelling of contaminants in Groundwater
 - Air Emission Modelling: Prediction of ground-level concentrations from one or more sources.
 - Leachate modelling.
 - Conducted numerous health risk assessments where contaminants were detected in air, soil, groundwater and soil vapour. Many different hydrogeological and geological settings have been assessed in the fate and transport of contaminants and evaluating various management options. These settings range from porous fractured rock formations to sands, clays, silts, gravels and complex combinations that vary from site to site.
 - Conducted groundwater assessments including the quantification of monitored natural attenuation (MNA) processes and the fate and transport of compounds in impacted aquifers using mathematical modelling to predict the extent and hence potential environmental receptors.



Selected Project Experience

Department of Defence, NT. Human Health Risk Assessment related to PFAS in AFFF.

- Conducted a health risk assessment to evaluate potential risks associated with exposures to PFAS compounds in environmental media to residents located down-gradient of RAAF Base Tindal.
- Evaluated direct contact and ingestion of water (drinking, whilst swimming or undertaking domestic activities), direct contact, incidental ingestion and inhalation of dusts associated with garden soils and ingestion of home-grown foods and animal products.
- Media collected to inform the HHRA included PFAS in private bore water, water and sediments from local waterways, public pools, irrigated soils poultry eggs, livestock serum, home grown fruits and vegetables, aquatic foods caught by recreational fishers and traditional foods.
- The HHRA conducted a Tier 1 screening evaluation and a Tier 2 assessment to refine the assumptions and quantify the potential risks. Receptor populations included urban and rural residents, Base personnel and residents, recreational users of local waterways and public spaces, and workers, including sub-surface and maintenance workers.

- Presented health risk assessment scope, interim findings and final conclusions to Northern Territory government and Katherine City Council. Provided technical expertise at community consultation and information sessions.

Newcrest, Proposed Gold Mine, Fiji

Human Health and Environmental Risk Assessment

- Conducted a detailed human health and environmental risk assessment of baseline conditions and impacts relating to the proposed Project in villages and waterways located near the mine and downstream of the proposed Project activities.
- The HHRA evaluated the baseline health exposures using a tiered approach. The Tier 1 screening assessment followed by a detailed Tier 2 quantitative assessment of exposure pathways that were considered to pose the greatest background exposures.
- The potential health impacts associated with Project activities were assessed based on modelled concentrations predicted in water and terrestrial and aquatic food sources, in conjunction with site specific exposure modelling.
- The uncertainty assessment and gap analysis formulated the requirements for

future investigations and exposure management associated with the Project.

WGJV: Historical Lead and Zinc Mine, Myanmar.

Health baseline and impact study for the resumption of mining.

- A health baseline study was undertaken for a former lead mine to understand the exposure pathways and current lead intakes to village communities surrounding the mine area and former mine processing areas.
- Extensive lead sampling of media included soil, sediment, surface water, groundwater, drinking water, air, dust fallout and food.
- Trained survey team on collection of environmental sampling and preparation of food samples for storage, transportation and laboratory analysis (as per FAO/WHO CODEX requirements).
- Environmental and public health surveys collected information from each village area to determine their current health status (including maternal and child health, addictions, housing and sanitation conditions, food and drinking water sources and potential background sources. Anthropometric data was also collected.
- Conducted a Tier 1 human health and environmental risk assessment of baseline conditions in villages located at the Bawdwin mine area and Namtu concession areas.
- Evaluated blood lead testing of long term mine workers and recently hired non-local contract workers.
- An impact assessment is currently underway to evaluate the potential health impacts to communities who may be affected by the release of contaminants as a result of resumption of mining activities.

Wafi-Gulpu Joint Venture, Proposed Gold Mine, PNG

Human Health Risk Assessment

- Undertook a detailed Health Risk Assessment of baseline conditions at villages located near proposed mine related areas, and the potential impacts of the proposed Project activities.
- The HHRA evaluated the baseline health exposures initially adopting a Tier 1 screening approach followed by a Tier 2 quantitative assessment of the exposure pathways considered to pose the greatest background exposures.
- The potential health impacts associated with Project activities were assessed using

predicted concentrations in fresh and marine waters and terrestrial and aquatic food sources, in conjunction with site specific exposure modelling.

- The uncertainty assessment and gap analysis formulated the requirements for future investigations to refine the risk outcomes.

Boeing Aerostructures Australia

- Provided technical audit support for the voluntary 53V audit.
- Reviewed conceptual site model, advice re sampling/data collection and data gaps.
- Reviewed the derivation of risk based criteria derived to be protective of inhalation risks to on and off-site receptors. Reviewed the final quantitative health and environmental risk assessment and contributed to the audit report.
- The audit report was accepted by EPA Victoria with no issues identified.

Contaminated Waste Disposal Facility, Dandenong, Victoria.

- Evaluated the potential health risks to future workers and visitors of a proposed facility designed to store and treat highly contaminated materials such as soil and sludge.
- Contaminants included VOCs, chlorinated and petroleum hydrocarbons, PCBs, PAHs, arsenic and metals such as mercury, lead and chromium. The facility is designed to treat 70,000 tonnes of contaminated material per year. The transport, unloading, distribution and storage of material generate significant amounts of contaminated dusts and the release of volatile and semi-volatile compounds.
- Developed health criteria for identified contaminants to ensure the health of workers was not compromised and provided risk management advice on appropriate monitoring and personal protection.

Confidential Chemical Manufacturer, Victoria. Health Risk Assessment for 53V Audit and Clean-up Plan.

- Chemicals of potential concern included chlorinated hydrocarbons and petroleum hydrocarbons in soil and groundwater.
- Chlorinated plume extends over a kilometre down-gradient, towards the bay. Plume is present beneath commercial and residential areas, and includes schools and kindergartens.

- Complex geology and hydrogeology setting including fractured basalt, shallow groundwater areas and sewer sink.
- Development of site conceptual model based on site history, extensive historical environmental investigations. Multiple and ongoing active and passive soil vapour investigations to determine nature and extent of impact and assist in refining the area of potential vapour intrusion risk.
- Conducted a human health risk assessment to assess potential risks to on and off-site receptors.
- Comprehensive exposure assessment undertaken including quantitative assessments of extracted groundwater and reuse of treated water from water treatment facility and facility workers.
- Vapour intrusion modelling to evaluate indoor air scenarios including basement structures and buildings with crawl space.
- Reviewed toxicological assessments associated with the relevance of the USEPA TCE inhalation toxicity evaluations and other chlorinated hydrocarbons where limited information was available.
- Prepared margin of safety evaluation and figures to determine the COPCs that were driving the vapour intrusion risks for each scenario, and in which areas.

**Former Industrial Processor & Manufacturer
North Melbourne, Victoria. 53X Audit**

- Redevelopment of site for medium density residential purposes. The chemicals of potential concern included chlorinated hydrocarbons and petroleum hydrocarbons in soil and groundwater.
- Development of site conceptual model based on site history, historical environmental investigations and post remediation activities.
- Conducted a quantitative human health risk assessment to assess potential risks to on and off-site residents.
- Assessed reduction of potential inhalation health risks associated with the addition of a geosynthetic liner beneath future dwellings to mitigate vapour intrusion from the subsurface.
- Provided advice on the passive venting system design in addition to the vapour barrier selection and construction.
- Derived risk-based levels for two carcinogens detected in groundwater for use

in the management and assessment of potential future migration at the site.

Former Railway, Adelaide, SA

Health Risk Assessment

- Coffey Environments was involved in the assessment of a large former railway yard in Adelaide. A large portion of the site was redeveloped for public health purposes and a smaller area remains an operational communications centre. Excavations associated with the redevelopment of the site encountered significant odorous impact at depth. Tar material was identified in a large waste pit.
- Site workers were concerned about the potential health effects of inhaling the compounds emanating from the exposed and excavated soils. Whilst further assessment was undertaken to determine the nature and extent of the contamination, the associated risks were communicated to workers in a timely and appropriate manner to enable work to continue.
- Potential inhalation health risks to workers in the existing buildings at the site also required indoor air quality analysis and evaluation of the potential sources. The assessment findings of acceptable health risks were communicated to the environmental site auditor, workers and union representatives.

Former Railway Workshop. Midland, Western Australia.

Human Health Risk Assessment for Multipurpose Redevelopment.

- Redevelopment of the site for low, medium and high density residential land use, sensitive and non-sensitive commercial purposes and tertiary educational facilities.
- Chemicals of concern included chlorinated hydrocarbons, petroleum hydrocarbons and metals in soil and groundwater.
- Fate and transport modelling and monitored natural attenuation evaluation conducted on the chlorinated hydrocarbon plume to determine whether the off-site plume posed future health and environmental risk.
- Provided advice and direction on filling data gaps in the site conceptual model.
- Selected methodologies, locations and for additional works to ensure site specific inputs were obtained and uncertainties were reduced.

**Bridgestone Edwardstown Facility,
Edwardstown, South Australia
Human Health Risk Assessment for an
Environmental Audit**

- Chemicals of concern included chlorinated compounds and petroleum hydrocarbons historically stored in underground storage tanks. Two chlorinated impacted groundwater plumes were identified extending hydraulically down and cross gradient, beneath industrial and residential areas.
- Comprehensive environmental investigations were conducted on-site. The nature and extent of off-site contamination in groundwater was confounded by multiple additional off-site sources.
- Iterative development of conceptual site model was undertaken to refine the risk assessment inputs and to further understand the nature and extent of impact in groundwater and associated soil vapour.
- Evaluated toxicity data to determine appropriate toxicity criteria for a number of chemicals of concern based on threshold and non-threshold health effects.
- Vapour intrusion modelling was undertaken to assess potential inhalation risks to off-site commercial, maintenance and residential receptors. Direct contact exposures to workers in a deeper excavation were also evaluated.
- Liaised with the Environmental Auditor and client to determine cost effective methods to expand the conceptual site model and provide multiple lines of evidence.

**Former Pigment Manufacturer, Laverton,
Victoria, 53V Audit,
Human Health Risk Assessment**

- DNAPL associated with waste injected to groundwater within a multiple aquifer system. Disposal of sludge and other solid waste associated with dyes and pigment manufacture.
- On and off-site assessment of residential and commercial receptor populations.
- Extensive list of potential chemicals of concern, many not commonly encountered at contaminated sites. A number of compounds detected in soil and groundwater had no screening criteria established, either nationally or internationally.
- Evaluated toxicity data to determine appropriate toxicity criteria for a number of chemicals of concern.

- Vapour intrusion model used to estimate volatilisation factor and hence determine appropriate risk based screening level for exposure via the inhalation pathway to future workers and off-site residents.
- Derivation of site specific risk based screening levels for contaminants based on numerous potential exposure pathways including inhalation of vapours, inhalation of particulate matter, ingestion and dermal contact.
- Prepared toxicological profiles for a number of chemicals of concern.

**Port Facility, Groote Eylandt
Environmental Risk Assessment
Health Risk Assessment.**

- Evaluated the potential environmental risks to marine water ecosystem associated with petroleum hydrocarbon impact identified in discharging groundwater.
- Assessed potential health risks to existing populations identified at the port area, associated with petroleum hydrocarbon impact identified in beneath the Milner Bay area.
- Derived risk based levels for soil vapour, which would be protective of future site users based on the potential redevelopment of the site for residential purposes at lease end.

**Former Manufacturing Facility, Preston,
Victoria. 53V Audit.**

- Former motor vehicle electrical component manufacturing site with contamination of soil and groundwater due to historical leakage of chlorinated solvents.
- Assessment of health impacts of chlorinated hydrocarbon contaminated groundwater to workers on and off-site.
- Complete exposure pathways determined to include inhalation by indoor workers and workers involved in subsurface activities.
- Utilisation of vapour intrusion model to determine volatilisation factor for each chemical of potential concern.
- The estimation of intake doses for populations of concern calculated based on adopted exposure parameters.
- Selection of appropriate toxicity criteria based on threshold and non-threshold health effects. The derivation of site-specific risk based levels for a number of volatile chlorinated compounds in order to protect human health.

Former Gasworks Facility, Port Pirie, SA Environmental Audit, Health Risk Support

- Conducted technical review of the health risk assessment reports as undertaken by the assessing consultant.
- Reviewed the adequacy of the conceptual site model, identified data gaps and evaluated the assumptions, parameters and calculations associated with the quantitative health risk assessment.
- Evaluated the adopted methodology and requirements as set out in NEPM and enHealth guidance documents. This included data review, confirmation of exposure assumptions and exposure pathways, selection of appropriate toxicity criteria and risk characterisation and interpretation.

Ongoing Service Station Operation, VIC Health and Environmental Risk Assessment, Environmental Audit under a Clean-Up Plan

- Extensive LNAPL and petroleum hydrocarbon plume extending off-site beneath residential dwellings, buildings with basements and extending to an urban creek.
- Conducted soil vapour, sub-slab and pit sampling to determine the nature and extent of vapour migration.
- Developed a comprehensive and detailed conceptual site model on an iterative basis.
- Provided a multiple lines of evidence approach to show the environmental risks to ecological receptors were low and acceptable.
- Derived site specific clean up concentrations for volatile contaminants in soil vapour that were protective of off-site residents.
- Based on a weight of evidence approach that relied on the conclusions of a full health risk assessment, it was agreed the remedial activities were sufficient to obtain a CUTEF and cessation of the remediation system.

Regional Gasworks, VIC Environmental Audit, Health Risk Support

- Provided risk assessment expert support for the Environmental audit of 4 regional gasworks site's proposed for redevelopment.
- Project involved review of remedial action plans, review of significant volumes of stockpile and validation data, review of groundwater assessments, consideration of risks to human and ecological receptors from soil and groundwater contaminants and

impact on groundwater quality from leaching of soil contaminants.

- Assessment of data quality required an excellent understanding of laboratory methods and contaminant transport mechanisms.

Shell Refinery, Geelong. Clean Up Notice Shell Creek Ecological Risk Assessment.

- Rapid Bioassessment of adjacent creek was undertaken to identify and characterise the stressors on Shell Creek and evaluate the potential impacts on the creek ecosystem. The information was intended to be used to develop an environmental management plan for sustaining the environmental value of Shell Creek.
- A sediment study conducted to identify the chemicals of potential concern and delineate impact zones.
- Four potential hazard input zones identified.
- Summer and autumn data collection.
- Habitat assessment.
- Water quality and sediment assessment
- Biological assessment
- AUSRIVAS Modelling
- Macroinvertebrate bioassessment – SIGNAL Biotic Index

Former Service Station, Rocherlea, Tasmania, Human Health and Environmental Risk Assessment

- Potential health impacts associated with petroleum hydrocarbons in groundwater were evaluated for populations of concern on-site (commercial workers) and hydraulically down-gradient off-site (residential occupants).
- Fate and transport modelling of chemicals of concern in groundwater was done to estimate the likely extent of migration from the site. Vapour intrusion modelling predicted the concentration of volatile compounds in indoor air or within a subsurface trench.
- Exposure assessment and toxicity assessment were used to characterise the potential inhalation health risks associated with threshold and non-threshold contaminants to populations on and off-site.
- The potential for leachate transport to the underlying aquifer was conduct using a contaminant transport model to predict contaminant migration in the unsaturated and saturate zones.

Department of Defence, Point Cook, Victoria, Ecological Risk Assessment - Former Fire Training Area

- An ecological risk assessment was conducted to evaluate on the potential impacts of contaminated groundwater discharging to the adjacent bay on marine aquatic ecosystems.

Lead Contamination in Drinking Water, Primary School, VIC, Department of Education & Training

- Technical Lead for the identification of potential lead sources at a primary school with rainwater collection system.
- Evaluated the potential health risks to children using lead contaminated drinking water and participated in the school community meeting.
- The identification of lead sources included a tiered approach involving the testing of waters in gutters and along the entire distribution and storage points and water outlets. Pipework components were also analysed under varying conditions to determine whether an ongoing health risk was present and provided management recommendations.

Mangrove Swamp, Former Power Station, Northern Spencer Gulf, South Australia

- Undertook an ecological risk assessment to evaluate the potential environmental impacts of the power station activities on the adjacent mangrove swamp.
- Potential contamination sources included the discharge of drainage waters directly to the mangrove, surface water run-off from adjacent roads, groundwater discharges and other physical aspects of the facility.
- Metals such as boron, cobalt, copper, chromium, lead, manganese, mercury, nickel and zinc were detected in mangrove sediments. Total petroleum hydrocarbons was also identified in drain water and sediments.
- The ecological risk assessment included a flora and fauna assessment of the mangrove and a nearby unaffected mangrove.
- A Tier 1 evaluation identified potential risks to the mangrove ecosystem which was generally confirmed in the flora and fauna assessment. Other factors potentially affecting the health of the mangrove were identified and management options were provided to improve the condition of the mangrove.

Former Mine Rescue Training site, Environmental Audit, New South Wales

- Provided a technical review of Site Specific Risk Based Levels derived for soil and groundwater, specifically for the protection of human health in a residential setting.
- The most sensitive exposure scenario was associated with the potential for extraction groundwater or creek water to be extracted for potable, domestic or recreational purposes. Risk based levels were developed for PFOS and PFOA.

Ongoing Gold Mining Operation, Environmental Audit Expert Support, Western Australia

- Provided risk assessment expert support for the Environmental audit of a gold mining operation where arsenic contaminated tailings dust was dispersed over an extensive area on and off-site.
- The technical support role in the project involved the review of significant volumes of data, data collection methodology and the consideration of potential risks to human and ecological receptors from contaminated dust, soil and groundwater.
- The project identified potential exposure pathways to mine workers, on and off-site prospectors and highway users, and the identification of ecological receptors including grazing cattle, wildlife, birds and other flora and fauna. The assessment of data quality required an excellent understanding of laboratory methods and contaminant transport mechanisms.
- Provided advice on the evaluation of bioavailability, the quantitative and qualitative evaluation of exposures and the identification of data gaps and potential methods of monitoring or managing the risks.

Former Albion Explosives Factory, Deer Park, Victoria. Environment Audit.

- Provided expert technical support to the appointed Environment Auditor.

Environmental Site Management Plans

- Prepared and reviewed numerous Environmental Management Plans to address residual contamination in surface soils as well as soils at depth and in groundwater in order to protect human health and other broader environmental values.

Appendix B - Instructions

10 November 2020

Karen Teague
Coffey Services Australia Pty Ltd
Level 1, 436 Johnston Street
Abbotsford, Victoria 3067

By email: karen.teague@coffey.com

Confidential and subject to legal professional privilege

Dear Ms Teague

Fingerboards mineral sands project

We act as legal advisors to Kalbar Operations Pty Ltd (**Kalbar**), the proponent of the Fingerboards mineral sands project (**Project**).

This letter confirms and sets out the scope of your retainer to prepare an expert witness statement and potentially also present evidence at the inquiry hearing to be held in relation to the environment effects statement (**EES**) prepared for the Project pursuant to the *Environment Effects Act 1978* (Vic).

1. The Project

Kalbar proposes to develop the Project on an area of approximately 1,675 hectares within the eastern part of the Glenaladale mineral sands deposit in East Gippsland, Victoria. The Project site is located near the Mitchell River, approximately 2 km south of Glenaladale, 4 km south-west of Mitchell River National Park and 20 km north-west of Bairnsdale.

The Project includes the development of an open cut mineral sands mine and associated infrastructure. It is expected to have a mine life of 15–20 years and involve extraction of approximately 170 Mt of ore to produce approximately 6 Mt of mineral concentrate for export overseas.

2. Panel and EES inquiry

The EES and the studies and assessments that underpin it (together with a draft planning scheme amendment and application for an EPA works approval) are presently on public exhibition until the end of October 2020.

The inquiry is scheduled to convene its directions hearing on 13 November 2020, and the inquiry hearing is scheduled to commence on 7 December 2020. We will keep you informed of any relevant directions, including the timetable for filing evidence and, if required, any expert conferences.

3. Scope

This letter is confirmation of your engagement as an independent expert to:

- (a) prepare an expert witness statement in which you:
 - (i) set out your background and relevant expertise;

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10 November 2020

- (ii) briefly describe and summarise the Human Health Risk Assessment (**Assessment**) prepared in support of the EES and your role in preparing it. In particular, we ask that you detail whether there is anything in the Assessment that you disagree with or wish to elaborate on and set out any additional information that you consider necessary to include, including any additional assumptions; and
 - (iii) consider the submissions that are relevant to your area of expertise and respond to any issues raised; and
- (b) if required, prepare and present expert evidence at the inquiry hearing.

We will provide further instructions on the scope of your engagement and any new instructions as necessary.

4. Form of your expert witness statement

The form and content of your expert witness statement should be prepared in accordance with Planning Panel Victoria's *Guide to Expert Evidence (Guide)*. We enclose a copy of the Guide for your reference. Please review the Guide and ensure your witness statement addresses the matters set out in it, in particular those matters listed under the heading 'The expert witness statement'. Please contact us if there is anything in the Guide that you do not understand, or if you have questions in relation to it.

Until your expert witness statement is in final form it should not be signed. You should, however, be aware that unsigned documents may need to be disclosed to other parties.

5. Your duties and responsibilities as an expert witness

Even though you are engaged by Kalbar, you are retained as an expert to assist the inquiry, and you have an overriding duty to it. The inquiry will expect you to be objective, professional and form an independent view as to the matters in respect to which your opinion is sought.

6. Timing

The timing for completion of your expert witness statement is to be advised. We will let you know as soon as we can.

7. Conflict of interest

It is important that you are free from any possible conflict of interest in providing your advice. You should ensure that you have no connection with any potential party to this matter that could preclude you from providing your opinion in an objective and independent manner.

10 November 2020

8. Costs and invoicing

Coffey will continue to be contractually engaged by Kalbar and Kalbar will continue to be responsible for the payment of your fees. Your accounts should be sent directly to the appropriate person nominated by Kalbar.

9. Confidentiality

Your engagement and any documents you prepare under it should be marked “Confidential and subject to legal professional privilege”.

If anyone other than ourselves, Kalbar or its technical advisers contact you about this engagement or the work you are undertaking under this engagement, please contact us immediately.

If you have any questions about this letter or require any additional information, please contact us.

Yours sincerely,

Tim Power

Tim Power
Partner

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Kirsty Campbell

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Senior Associate

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Enc: Planning Panel Victoria's *Guide to Expert Evidence* - April 2019

Appendix C - Reports and information reviewed

Reports and Information Reviewed or Referenced.

1 The Technical Specialist Studies listed in the table below and selected references contained within these studies.

Related studies and data sources	Prepared by
Radiation Assessment Report	SGS Radiation Services, April 2020
Groundwater and Surface Water Impact Assessment	Coffey Services, May 2020
Stage Two Air Quality and Greenhouse Gas Assessment	Katestone Environmental, April 2020
Landform, Geology, and Soil Investigation	Landloch, April 2020
Horticultural Impact Assessment	RMCG, April 2020
Landscape Stability and Sediment Transport Regime Assessment	Water Technology, April 2020
Land Use and Planning Impact Assessment	Matrix Planning, April 2020
Socioeconomic Impact Assessment	Coffey Services, May 2020
Geochem Testing of Fingerboard Tailings and Overburden - Preliminary Report	Environmental Geochemistry International, April 2020
Rainwater Tank Report	Ventia, October 2019

2 All references included in Section 12 of the Assessment and selected references contained within these documents.

3 All references noted or referred to in this Statement and appendices.

Appendix D - Detailed response to submissions

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Submission No	Who	Section	Related comments in Submission No.	Theme	Selected Comments	Response
813	MFG	ES, Ch 5	899	Risk ratings	"What is noticeably absent from the HHRA is any indication of why the consequence levels were set as they are and how ratings were applied."	There appears to be some confusion relating to the referencing of the HHRA and the Health Impact chapter in the EES. The HHRA does not use the rating of consequences to assess risk.
813	MFG	Ch5	79, 679, 738	Cumulative & indirect effects	"They require consideration of the interaction of identified hazards and other agents in the environment rather than this assessment in isolation. This is a clear direction to consider cumulative impacts of all hazards associated with the mine."	<p>Cumulative and indirect effects according to the definition in the 2006 Ministerial guidelines for the assessment of environmental effects relate to potential regional sources/activities, project stages and those that may be separated by space and time. With the exception of gas emissions, the baseline levels measured in media are generally considered to be indicative of other regional source contributions to the potential background exposures to off-site populations. Occasional sources of pollution to air will vary, particularly in relation to bushfires.</p> <p>Cumulative chronic (usually <3 months) exposures may occur when intakes relate to multiple pathways and/or substances in different media. Whilst the assessment relied on the adoption of screening criteria, that in the most part includes adjustments for background exposures, safety factors and chronic exposure periods, this is generally consistent with the NEPM ASC framework. In addition, the toxicity of substances is often dependant on the route of exposure, the dose at the target organ and the resulting adverse health effect. This is a complex discussion that is explained in greater detail in guidance documents such as ASC NEPM (2013), EnHealth (2012) and USEPA RAGS A (1999).</p>
813	MFG	Ch5	60	Chemical toxicity: Health endpoints considered for carcinogenic and non-carcinogenic substances	<p>"Where no existing Australian standards exist, world's best practice is to be adopted; that is, the USEPA. This has been ignored for a number of toxic compounds. No toxicity of the ore body has been presented which has major implications for many of the study areas. Without this information the risk assessment must be considered high until proven otherwise."</p> <p>"One of the most significant issues for the community is that Australian HIL levels may be silent on a number of toxic and carcinogenic elements that are recognised by other world authorities. In the interests of world's best practice and to protect community and environmental health maximum levels set for all such elements should reflect the standards of the USEPA or similar internationally recognised bodies."</p> <p>"In addition to radioactive substances, cancer-causing substances are also expected to be in the dust."</p>	<p>A number of submissions seek clarification relating to whether a substance is considered to be carcinogenic, and how this is determined and interpreted in the ASC NEPM.</p> <p>Toxicity assessment background: The selection of toxicity reference values (TRV) used in the development of health screening criteria for chemical substances involves an evaluation of the type of health effect a particular chemical has been reliably shown to exhibit in robust epidemiology and laboratory studies. The two classes of health effects are based on dose response characteristics relating to threshold (non-carcinogenic) effects or non-threshold (carcinogenic) effects.</p> <p>The threshold value refers to a dose below which deleterious effects are not expected to occur. The threshold dose is based upon biological mechanisms that have the ability to metabolise or excrete a toxin or repair damage up to a certain dose (enHealth, 2012).</p> <p>A compound is classified as non-threshold (carcinogenic) based on its mode of action. Compounds that have been demonstrated to cause damage to genetic information (DNA) within a cell, either via mutation, amplification or other means, are considered to be genotoxic. Genotoxic compounds are assumed to be non-threshold compounds on the basis that any exposure to the compound may potentially result in genetic damage. Non-threshold substances are often assessed via a calculated slope factor. The exposure risks are estimated as the incremental probability of an individual developing cancer over a lifetime as a result of exposure to the carcinogen. The estimated intake for each exposure pathway and non-threshold TRV are multiplied to produce pathway-specific estimates of increased lifetime cancer risks.</p> <p>Some chemicals exhibit both non-threshold (i.e., carcinogenic) and threshold (i.e., non-carcinogenic) health effects and whilst the lower TRV is selected in most instances, this is not always the case. It is noted the NEPM ASC evaluated the toxicity of a number of chemicals of concern in this HHRA and although some metals are considered to have threshold and non-threshold endpoints, the threshold TRV was selected for arsenic, cadmium, chromium (VI) and nickel. The air criteria adopted for crystalline silica is based on threshold health effects associated with silicosis as there was no approved cancer potency factor for non-threshold health effects.</p> <p>National and international agencies that publish health screening criteria follow different procedures and policies</p>

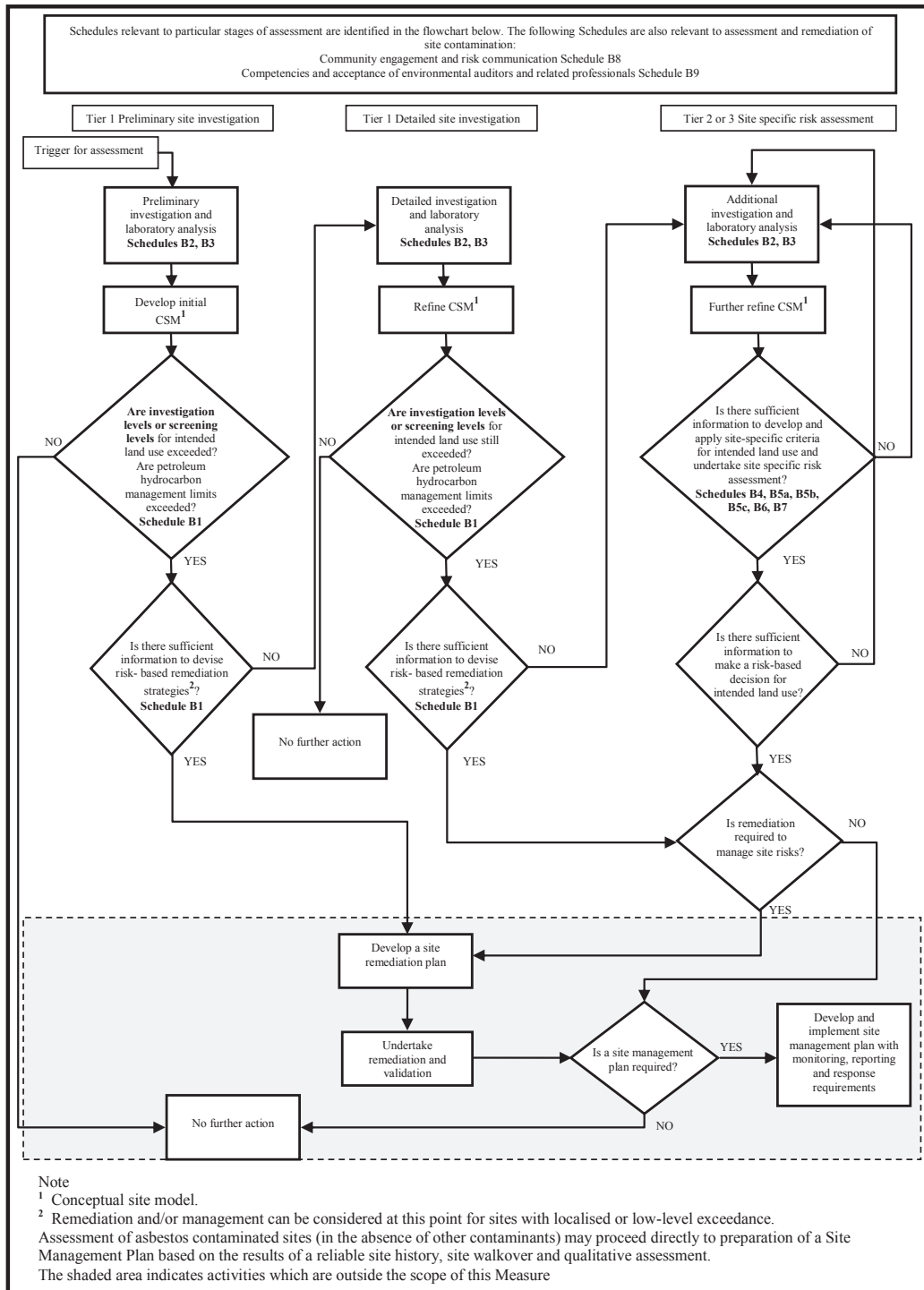
Submission No	Who	Section	Related comments in Submission No.	Theme	Selected Comments	Response
813	MFG	Ch5	74, 548, 575, 712, 737	Composition of chemical or radioactive substances in media	"Reliance on inadequate and insufficient geochemistry and mineralogy information due to limited sampling"	The chemical or radionuclide composition in various environmental media is dependent on the source composition and any transformations that may occur over time. The baseline data set was reliant on the number of samples collected, locations and depth, the selected analytical suite, and well as other factors that may impact the quality of the results. Although most of the data had already been collected prior to my involvement in the Project, the substances of concern are generally selected basis on mineralogy of the site soil and ore materials and their relative abundance and toxicity. In addition, the form they may migrate from the site to the point of exposure is also considered (such as dust). The selection of substances of concern therefore relied on the mineralogy testing results, as did the inputs for fate and transport modelling to predict air quality off-site. I note that although the composition of deposited dust was not analysed for the baseline assessment, the metal and metalloid and composition radionuclide activity of PM2.5 and PM10 was measured. While this is appropriate for particulates that may be inhaled and retained in the lungs, it may not be representative of contaminant concentrations in deposited dust that may be incidentally ingested directly or indirectly. Larger dust particles do not travel as far in air suggesting the composition of dust deposited may differ somewhat with distance from the source area.
813	MFG	Ch5	32, 79, 94, 135, 157, 169, 219, 241, 319, 344, 369, 473, 476, 481, 484, 522, 541, 558, 673, 679, 703, 712, 713, 734, 738, 759, 767, 814, 830, 833, 837, 843, 847, 875, 878	Mental health and well being. Non physical health effects	"...the very limited focus on only a couple of areas in the Human Health Risk Assessment is asserted to be inadequate. Noise and mental health are just two other areas that will have significant, persistent and ongoing effects on the community."	The scope of HHRA was on physical health impacts associated with potential exposures to toxic substances that may be released to environmental medias as result of Project activities. A large number of submissions indicated their concerns relating to the potential negative impacts on the community's mental health associated with the Project. Australian and international guidance for undertaking a health impact assessment often includes the evaluation of mental health as part of the objective. It is acknowledged impacts to a community's mental health may affect their physical health however, guidance on the measurement of potential risks associated with mental health has yet to be established. Unlike exposures to toxic substances which can be studied via the use of epidemiological and animal studies, mental health impacts cannot be measured as readily. Impacts to health relating to noise, vibration, light, social and other issues that may affect mental health, were
813	MFG	ES,Ch 5		Farmers on the Project area	"Given that Kalbar has long insisted that current landholders and farmers should be able to co-manage the land in the footprint or co-exist with the mine, the failure to include the footprint itself in the health risk assessment is a glaring omission."	Whilst potential farming activities undertaken on-site during mine operations has not been specifically assessed, it is likely these exposure periods are less than that assumed for off-site receptors (20 hours/day, 365 days/year). However, it is suggested Kalbar provides these farmers with appropriate health and safety training, updates and PPE for the periods they are undertaking farming activities within the Project area.
813	MFG	ES,Ch 5	40, 219, 241, 375, 442, 481, 484, 488, 531, 546, 564, 765, 812, 887, 893	Impact beyond 5 km radius	"Kalbar have identified receptor populations as residential populations within 5km radius of the boundary of the project area; transport route residents adjacent to heavy mineral concentrate transport routes (into Bairnsdale); horticulture farmers in the Lindenow Valley, within 5 km radius; recreational users of waterways within 5km radius. A 5km radius is inadequate, as the prevailing winds in the area are consistently high for much of the year, and dusts will travel 25kms in high winds."	Receptor populations were identified based on their location in relation to the potential transport pathways of contaminants released by the project activities. A 5 km radius was selected for the purpose of the HHRA to indicate the locations of sensitive populations who were likely to have the greatest exposures to airborne contaminants migrating from the Project area, it was not intended to signify a boundary beyond which no exposures were expected. These sensitive receptor populations were assumed to include young children, older people and people with chronic health conditions. It should be noted receptors associated with transport routes and recreational water users were also identified beyond the 5km radius where appropriate.
813	MFG	Ch 5		NEPM guidelines	"The assessment does not attempt to achieve guidelines set under the NEPM for assessing environmental risks to human health. The NEPM guidelines clearly state that worst case rather than averages should be used in making these judgements (enHEALTH, 2017)"	The HHRA used average and maximum concentrations reported in soil, sediments, groundwater, surface waters, rainwater tanks, as well as metals and radionuclides in fine particulates in air. The maximum PM2.5 and PM10, and dust deposition were also adopted.

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813	MFG	Ch 5		Tiered assessment	"The NEP guidelines state that the investigations and risk assessment should proceed until the level of information is appropriate for the decision making required. It is common for most risk assessments, regardless of which tier, to have a screening step and a detailed assessment step."	<p>Tier 1 screening assessments are the most common form of risk assessments undertaken under the ASC NEPM or enHealth frameworks. In the instance a chemical does exceed the adopted health screening criteria, a further qualitative assessment may be undertaken, or a Tier 2 assessment undertaken, to evaluate only the compound/s that exceeded screening. The NEPM process is outlined in Schedule A of the ASC NEPM (attached at the end of this table).</p> <p>Under the ASC NEPM framework, the first stage is a Tier 1 screening assessment using generic screening criteria that have been conservatively derived for a particular land use setting or for general public health. Exceedances of Tier 1 screening criteria are triggers for further investigations, a refined site-specific Tier 2 or Tier 3 risk assessment, remediation, management, or a combination of these strategies.</p> <p>The baseline evaluation in the HHRA relied on the conservatively adopted Tier 1 screening criteria for each media to be protective of health. Whilst a limited number of exceedances of screening criteria in baseline data were noted in soil (radiation), surface water (arsenic, chromium, lead and manganese) and groundwater (metals), a Tier 2 evaluation was not considered warranted based on the following:</p> <ul style="list-style-type: none"> * The objective was to understand baseline conditions rather than overall exposures. * Almost all exceedances were related to the Project area rather than off-site areas. * Impacted surface water and groundwater was not known to be used for drinking water purposes. * Further data would be required to refine the inputs and assumptions for a Tier 2 evaluation.
813	MFG	Ch 5		Precautionary principle	"The precautionary principle has not been applied"	<p>The assessment of uncertainty in the HHRA notes: Taken as a whole, the assumptions used in the risk assessment are considered to be conservative and tend to adopt the Precautionary Principle (enHealth, 2012b) in estimating risk. The risk assessment approach presented does not consider a fully probabilistic estimate of risk (i.e., evaluation of all the permutations of each input value), but presents conditional estimates based on a number of assumptions regarding exposure and toxicity that have been incorporated in the screening criteria adopted. Thus, it is necessary to specify the assumptions and uncertainties inherent in the risk assessment to place the risk estimates into perspective.</p> <p>Risk assessment methodologies reflect an iterative process of development and as such it should be recognised that this exposure assessment and risk assessment are based on existing methodologies and their limitations which may be subject to change.</p>
813	MFG	Ch 5	241, 375, 558, 679, 747, 759, 847	Sensitive populations and screening criteria	"Levels in excess of the HILs do not imply unacceptability or that a significant health risk is likely to be present. Similarly, levels under the HILs do not necessarily imply acceptability or that a health risk is not likely to be present if sensitive subpopulations are receptors or the assumptions for land-use scenarios are not appropriate. (NEPC, 2020)"	<p>The adopted screening criteria were considered to be appropriate for chronic exposures to residential populations in a rural or urban setting, or for general public health. It is noted sensitive subpopulations (such as young children) were generally considered in the derivation of the adopted screening criteria. However, while sensitive subpopulations are considered in the standard derivation process, they may not necessarily protect all of the people all of time, from all possible health effects. Screening criteria are derived based on the best information available at the time they are developed. The process also includes policy decisions such as the acceptable lifetime cancer risk which differs internationally, and selection of appropriate toxicity or epidemiological studies.</p>

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813	MFG	Ch 5	889, 893	Baseline data	<p>"Baseline data has been selected in such a way that it allows the proponent to avoid accountability for any increases that might occur as a result of the mine."</p> <p>"...the majority of studies reported by the proponent relied on unvalidated foundational data and information that was not checked for adequacy or accuracy by the consultants."</p> <p>"Using such inappropriate baseline data will negate the ability to quantify increases in emissions in the Glenaladale area due to the operation of the mine. Air quality data can only be useful in baseline assessments if collected at the actual location of the proposed operation."</p>	<p>Baseline data is collected prior to the commencement of a project to understand existing conditions and the levels of substances of concern that may be present in various media. The baseline data collected for the Project included soil, sediment, groundwater, surface water and air. The adequacy of the various baseline data sets was described in section 8.2 of the Assessment with some noted as being limited in number, extent and locations selected. I would recommend that Kalbar collect robust baseline data sets to measure the potential effects of the project on environmental media once it is operational.</p> <p>It is also worth noting the background concentrations of contaminants are also used in dust, gas emission modelling. The air modelling evaluates the additional impacts above background levels that may be allowable. Higher background levels indicate lower levels may be emitted from Project activities. The adoption of background data from more polluted areas such as Traralgon is therefore considered conservative in this instance.</p> <p>I relied on the authors and peer reviewers of specialist technical reports used to inform the Assessment to ensure adequate QA/QC had been undertaken during their sample collection and evaluation of the results.</p>
813	MFG	Ch 5	32, 40, 79, 94, 96, 119, 120, 137, 219, 241, 268, 344, 413, 442, 481, 484, 488, 506, 546, 522, 531, 541, 548, 564, 575, 604, 673, 679, 733, 737, 744, 745, 747, 750, 752, 759, 781, 812, 814, 830, 837, 838, 843, 847, 849, 854, 878, 887, 893	Drinking water related exposures associated with dust deposition on water storage dam at Glenandale, rainwater tanks and dams.	<p>"Potential for wind-blown dust (including radioactive material) from the project to contaminate surface and groundwater, crops, horticulture, rainwater tanks and affect human health and amenity of residents."</p> <p>"ordinary dust can cause visibility issues, deposition on roofs, contamination of water tanks and stock dams"</p>	Please refer to response provided in section 5.4.5 of this statement.
813	MFG	Ch 5	32, 74, 96, 157, 172, 219, 241, 268, 344, 371, 375, 389, 390, 413, 442, 481, 484, 522, 524, 531, 546, 554, 558, 600, 673, 679, 712, 713, 734, 737, 738, 743, 744, 745, 752, 759, 763, 765, 781, 812, 814, 830, 833, 837, 838, 843, 847, 848, 854, 878, 887, 896	Agricultural related exposures associated with dust deposition on soil, crops, livestock, orchards	<p>"Potential for wind-blown dust (including radioactive material) from the project to contaminate surface and groundwater, crops, horticulture, rainwater tanks and affect human health and amenity of residents."</p> <p>"ordinary dust can cause... deposition on stock dams and impact on pastures."</p> <p>"pollution of primary production rendering milk, meat, vegetable and grain crops a consumer health risk along with disqualifying area organic producers."</p>	The potential for health impacts to livestock and other ecological receptors is beyond the scope of the HHRA. It is proposed that quantitative estimates will be undertaken to address the potential health risks associated with the ingestion of edible produce and/or animal products grown or raised in the off-site area by regional receptors. This undertaking is dependent on the revised air quality modelling that was not available at the time this statement was prepared.

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241	Dr Pearce	Section 3 and 4	32, 79, 219, 241, 344, 484, 575, 600, 679, 812, 814, 875	Regional baseline public health / recent effects associated with bushfire smoke	<p>"The change from dairying to horticulture occurred in the 1970s and 1980s therefore the current health of the population can be considered to be stable, which can be confirmed with relevant Department of Health statistics, therefore any significant changes will be due to the mine processes"</p> <p>"Investigation of biomarkers in blood, urine, hair, or tissue samples, that could indicate exposures to mine waste toxicants via various and/or multiple exposure routes, including inhalation, ingestion and/or dermal absorption, should be undertaken as part of environmental health risk assessments"</p> <p>"Human health impacts of various environmental exposure scenarios may be modified by the local community's prevalence of pre-existing comorbid conditions,... thus confounding hazard identification and the health risk assessment of multiple and cumulative exposures"</p> <p>"Damage to public health from exposure to cancer-causing air born fine particulate matter risks an exploding long term health care crisis."</p>	<p>Baseline information on the general health of regional populations, or the potential for cumulative effects of historical exposures to substances such as particulate matter associated with bushfires or other sources was not undertaken in the HHRA. A public health survey can be a desktop review of available local health information or may collect information relating specifically to health determinants likely to be affected by substances associated with a project. Such surveys may include the collection of anthropometric data, a medical examination and questionnaires that collect information on medical history and relevant lifestyle factors. Whilst an investigation of biomarkers may indicate exposures, they would also require a baseline investigation for comparison. Although EnHealth guidance (2012, 2017) discusses various levels of detail and requirements for a health profile, it was beyond the scope of the HHRA to undertake a baseline public health study.</p> <p>Bushfire smoke and health: Summary of the current evidence: In response to the 2019/20 bushfires that affected many parts of the country, the Australian Health Protection Principal Committee requested that enHealth review the evidence on the known health effects of prolonged bushfire smoke exposure. A statement of the summary of the current known health effects of bushfire smoke exposure was published whilst further research is undertaken on this issue. The summary noted that "Although all air pollutants from bushfire smoke have the potential to affect health, there is good evidence that PM2.5 is the air pollutant of greatest concern. This is because it is present in high concentrations in smoke and because there is very strong evidence of its health effects." The enHealth review noted only a small number of studies have specifically investigated the effects of PM2.5 from bushfires. The studies found that based on the transient and infrequent exposure to smoke from bushfires, the health effects were generally acute. The evidence indicates that the risk of illness declines when PM-2.5 levels fall and the long term health effects for most individuals is extremely low. The summary concluded there is limited information about the long-term implications relating to prolonged exposures to bushfire smoke and the potential longer term health effects across groups at higher risk, such as those with chronic conditions, very young children, pregnant women and their babies. The summary document link: https://www1.health.gov.au/internet/main/publishing.nsf/Content/health-pubhlth-publicat-environ.htm</p>
241	813	Ch5	241, 679, 733	Health effects of co-exposure of substances	<p>"It is important that the cumulative effects of risks to health be considered rather than isolate the individual hazards, such that the risks are not fully evaluated."</p>	<p>Health screening criteria are generally derived for individual compounds, primarily because of the enormous number of concentration combinations that may occur over time in a mixture of substances in air or other media. In many instances the safety margin incorporated in most screening criteria will be protective in situations where co-exposures to contaminants may occur. This is likely to be appropriate where contaminants have a threshold health effect however not may not be so for substances that have low or unidentified thresholds. Health impacts associated with co-exposures to a number of contaminants are complex to evaluate given each contaminant may cause health effects at different target organs or have different modes of action at the same target organ.</p>

Schedule A—Recommended general process for assessment of site contamination



33 Schedule B