Appendix 3

Air Quality Impact Assessment – Addendum

prepared by
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(Total No. of pages including blank pages = 73)

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Taronga Tin Project

Air Quality Impact Assessment - Addendum

Addressee(s):	R.W. Corkery & Co. Pty Limited
Site Address:	Emmaville, NSW
Report Reference:	22.1124.FR7V1
Date:	2 April 2026
Status:	Final

air quality | environment | sustainability

Quality Control

Report	Reference	Status	Prepared by	Checked by	Authorised by
Taronga Tin Project - Air Quality Impact Assessment - Addendum	22.1124.FR7V1	Final	Northstar	GCG	MD

Report Status

Northstar References		Report Status	Report Reference	Version
Year	Job Number	(Draft: Final)	(R*x*)	(V*x*)
22	1124	Final	7	1
Based upon the above, the specific reference for this version of the report is:				22.1124.FR7V1

Final Authority

This report must be regarded as draft until the above study components have been each marked as final, and the document has been signed and dated below. A draft report is a working document, is issued without prejudice and is subject to change.

M Doyle **2 April 2026**

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1. INTRODUCTION

Taronga Mines Pty Ltd (the Applicant) submitted an Environmental Impact Statement (EIS) to support a State Significant Development Application (SSDA) (SSD-74389710) in September 2025. To support the SSDA, an Air Quality Impact Assessment (AQIA) was performed by Northstar Air Quality Pty Ltd (Northstar) and provided as Appendix 7 of the EIS.

The NSW Department of Planning, Housing and Infrastructure (DPHI) placed the EIS on public exhibition between 7 October and 4 November 2025 and called for public submissions on the Project. During this period, the DPHI also circulated the EIS to relevant Government agencies, including the NSW Environment Protection Authority (NSW EPA) who raised several matters for the Applicant's consideration.

This document has been prepared by Northstar to provide responses to the matters raised by the NSW EPA in relation to air quality with the intention that it is included as an addendum the AQIA.

2. EPA ADVICE

NSW EPA provided advice on the EIS for the Taronga Tin Mine on 4 November 2025 (ref DOC25/848046-5). A summary of each comment is presented in Table 1, with the section of this addendum where more detailed information can be found.

Table 1 NSW EPA Advice on AQIA

EPA recommendation	Addressed in Addendum
Issue 1: The AQIA has not complied with the Approved Methods The AQIA must comply with the Approved Methods. The Proponent must: 1. include a scenario that demonstrates no additional exceedances for any air pollutants assessed 2. specifically model and describe the implementation of the TARP if the scenario in a. includes a TARP b. describes which TARP measures are material in reducing emissions and impacts on days of elevated background and sensitivity around these measures c. adequately describes how the TARP will address arsenic and other principal air toxics.	Section 3.1
Issue 2: Assessment of toxic metals 1. The AQIA must be revised to provide a thorough and rigorous benchmarking of the proposal with best practice process design and emission control, including comparison with applicable best practice for metalliferous mining. Where the Project is not consistent with best practice, the project should be modified to adopt additional emission control. 2. The AQIA devise a robust toxic metals monitoring campaign that includes provisions for baseline and for the life of the mine campaigns.	Section 3.2
Issue 3: Adopted background concentrations for particulate matter not representative of local airshed 1. The AQIA is revised to adopt site representative background data for the cumulative assessment and must demonstrate compliance with the IAC.	Section 3.3
Issue 4: Control factors outlined in the AQIA may be difficult to achieve in practice The EPA requests that the AQIA be revised to include: 1. supporting information (including any supporting calculations) to demonstrate a 97.5% control efficiency would be readily achieved. 2. a sensitivity analysis where a range of control efficiencies are adopted for water application on haul roads. The predicted ground level concentrations for this sensitivity analysis are requested.	Section 3.4
Issue 5: Emissions inventory lacks detail regarding wind erosion of exposed areas 1. The AQIA be revised to enable emission estimates to be assessed and replicated for exposed areas susceptible to wind erosion. Further specific detail should be provided regarding the calculation of all exposed and actively disturbed areas to ensure the emissions inventory is accurate, transparent, and able to be replicated and include maps. Additional justification on the control measures for the RSF must be provided.	Section 3.5

EPA recommendation	Addressed in Addendum
Issue 6: Source parameters and locations not included in assessment 1. Identify and confirm source locations for all emissions scenarios. 2. Identifies the release type and source parameters used in the modelling. 3. Clarify if there are point source emissions and update the AQIA accordingly.	Section 3.6
Issue 7: Meteorology modelling not adequately evaluated and justified as representative The AQIA should be revised to: 1. Quantitatively evaluate meteorological model performance, including a statistical evaluation and images of the wind fields that captures potentially complex flow systems. 2. Provide additional information on the TAPM and CALMET model configuration settings, grid resolution, terrain inputs, land use inputs and TERRAD.	Section 3.7
Issue 8: CALPUFF model configuration lacks transparency 1. The Proponent provide information of the CALPUFF configuration settings and particle size and distribution settings used in the modelling.	Section 3.8
Issue 9: Source apportionment and arsenic requires clarification and investigation 1. Provide additional information on how the arsenic averages were determined for the site. 2. Investigate whether a more refined approach in using source apportionment for the arsenic predictions demonstrates compliance with the IAC. 3. Identify the meteorological conditions that are conducive to arsenic exceedances for future incorporation in the TARP.	Section 3.9

3. RESPONSE

The following sections provide a response to the NSW EPA comments and recommendations.

3.1. Issue 1: The AQIA has not complied with the Approved Methods

NSW EPA has identified that the original AQIA predicted two exceedances of the 24-hour $PM_{2.5}$ criterion in each of the three scenarios subject to modelling. These exceedances were predicted at receptors R167 and R168, located on the eastern side of the Mine Site, and were both predicted on the same day, being 4 August 2020, when the adopted background $PM_{2.5}$ concentration was assumed to be 24.8 $\mu g \cdot m^{-3}$ (i.e. 99.2 % of the criterion). The adopted (background) particulate concentrations used to approximate conditions in the area without the impact of the Project were taken from the NSW Department of Climate Change, Energy, the Environment and Water (NSW DCCEEW) air quality monitoring station (AQMS) at Armidale.

It is also noted that the annual average $PM_{2.5}$ concentration adopted in the AQIA was already in exceedance of the relevant criterion, even without the impact of the Project being considered.

This issue raised by the NSW EPA is also related to issue 3 that is addressed in detail in Section 3.3.

As described in Section 3.3, Northstar has reviewed NSW DCCEEW AQMS data from four locations, namely:

- Armidale (adopted in the original AQIA);
- Narrabri;
- Gunnedah; and
- Tamworth.

Of these sites, the environment surrounding the Narrabri AQMS is considered the most representative of the Mine Site as, in comparison to the other sites, its locality has the smallest urban population and has the largest distance from an urban population and corresponding pollution sources.

As a sensitivity test, when the more representative Narrabri AQMS data is adopted, the annual average $PM_{2.5}$ criterion, both with and without the impacts of the Project is not exceeded. In addition, use of the Narrabri AQMS data results in no additional exceedances of the 24-hour $PM_{2.5}$ (or PM_{10}) criteria.

Therefore, adoption of the Narrabri AQMS data that is more representative of local conditions at the Mine Site complies with the Approved Methods criteria (annual and daily) for $PM_{2.5}$ and PM_{10}, and no further dispersion modelling has been performed.

In relation to the Trigger Action Response Plan (TARP), section 7.2 of the original AQIA describes how this would be implemented to ensure no exceedances of the 24-hour PM_{10} and $PM_{2.5}$ criteria are experienced at surrounding receptor locations on a practical day-to-day management level. As described above, dispersion model predictions do not indicate that any exceedances would occur, when adopting a more representative background particulate matter dataset.

In relation to arsenic, Figure 1 presents the calculated daily emissions totals, split by source when adopting the arsenic composition data as described in detail in Section 3.9. For clarity, this arsenic composition data was applied within the original AQIA. The most significant sources of arsenic emissions are calculated as a fraction of total particulate emissions (expressed as % w/w), and are identified to be:

- Handling of ore in the Northern Open Cut (NOC) (19.4 % of site total emissions);
- Unloading of ore from the NOC at the processing plant (9.7 % of site total emissions);
- Processing of ore (HPGR) (9.1 % of site total emissions);
- Front-end loader loading primary crusher (when not directly loaded) (7.9 % of total emissions); and
- Handling of ore in the Southern Open Cut (SOC) (5 % of site total emissions);

In terms of broad source groups, materials handling and materials processing contribute 55 % and 39.3 % of total site emissions, respectively, which provides focus for the TARP.

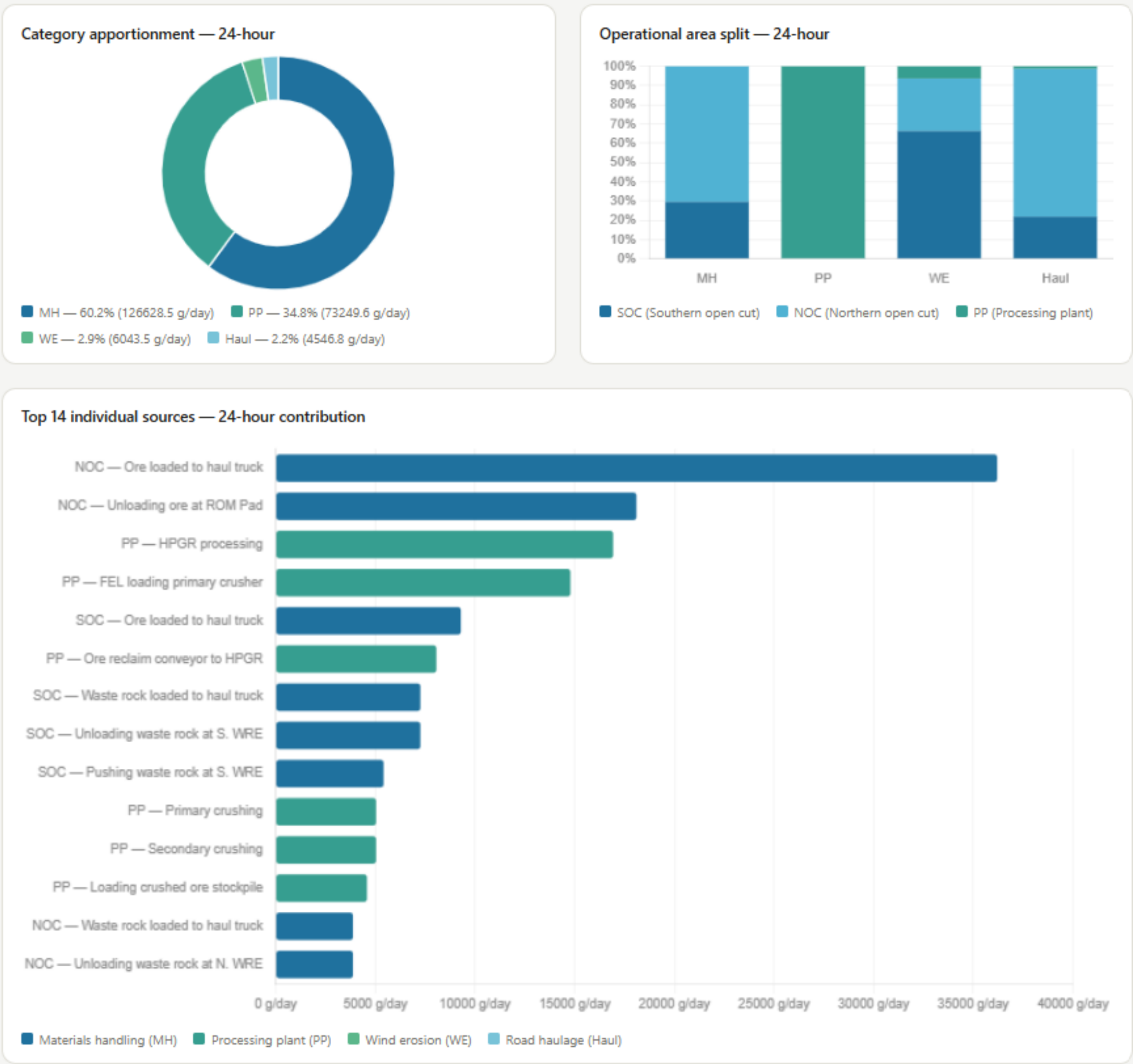
It is acknowledged that the current TARP does not explicitly address arsenic as a discrete parameter, and this shortfall will be addressed. A revised and expanded TARP will be prepared prior to commencement of operations, that formally integrates arsenic management. The Air Quality Management Plan (AQMP) and TARP will continue to provide a management framework for holistic emission controls across all activities, and will provide additional emphasis on the emissions controls applied during materials handling and processing, especially when material from the NOC is being handled to offer heightened arsenic management measures.

The AQMP and TARP will utilise the data and triggers provided through the existing monitoring network and will be reactive / responsive to the data collected through that network.

For example, where assessment of the arsenic deposition data during operations indicates that the existing real-time PM monitoring network does not provide sufficient spatial resolution to support timely operational response, for example if deposition trigger exceedances occur under wind directions not adequately captured by the current monitor locations, additional real-time PM monitoring will be installed at locations determined in consultation with NSW EPA.

The revised TARP would be submitted to NSW EPA for review prior to commencement of operations.

Figure 1 Source emissions analysis, arsenic Year 3



Level 1 - Alert

Threshold: Arsenic deposition rate at any operational gauge exceeds the mean pre-operational baseline plus two standard deviations, established from the pre-disturbance monitoring program.

Response: Review of operational activities and meteorological conditions coinciding with the sampling period; inspection and reinstatement of dust suppression (if required) following the priority source sequence outlined above.

Level 2 - Action

Threshold: Arsenic deposition rate at any gauge exceeds the project-specific deposition trigger derived from the annual arsenic assessment criterion (4 $\mu g \cdot m^{-2} \cdot day^{-1}$, TA LUFT, 1990, 1999), adjusted for the background deposition component established during the pre-operational monitoring program.

Response: All Level 1 actions, plus formal review of TARP and AQMP adequacy, notification to NSW EPA within 7 business days.

Level 3 - Exceedance

Threshold: Annualised arsenic deposition rate corresponds to exceedance of the annual arsenic assessment criterion (4 $\mu g \cdot m^{-2} \cdot day^{-1}$, TA LUFT, 1990, 1999) at any gauge, or Level 2 threshold reached simultaneously at two or more gauges.

Response: Reduction of activity rates of principal arsenic-generating operations pending independent review, immediate notification to NSW EPA; operations not to recommence at maximum rates without written NSW EPA approval.

Specific numeric trigger values for Levels 1 and 2 will be documented in the revised TARP once the pre-operational baseline monitoring program has generated a statistically sufficient dataset.

The integrated framework described above provides a higher degree of regulatory assurance than the current PM-only TARP for the following reasons.

- The framework is risk proportionate. The trigger response sequence is directly derived from the Mine Site emission apportionment analysis, which quantifies the relative arsenic contribution of each source group. When a trigger is exceeded, operational response is directed to the sources accounting for the majority of modelled arsenic emissions, being ore handling in the NOC and at the processing plant, and HPGR processing, rather than being applied generically.
- The framework provides continuous and verified monitoring coverage. The real-time PM monitors ensure that dust generation events are identified on the same day they occur, enabling immediate operational response before arsenic impacts can accumulate at receptor locations. The monthly deposition program then provides the analytically verified, arsenic-specific compliance record.

- The framework is auditable and transparent. All trigger exceedances, inspection outcomes, and corrective actions will be recorded in a standardised compliance log. Deposition monitoring results will be reported to NSW EPA on an annual basis and made publicly available, providing a transparent and independently verifiable record of performance against the defined thresholds.
- The framework is adaptive to site-specific background conditions. The Level 1 alert threshold is set relative to the pre-operational baseline rather than as a fixed absolute value, calibrating it to the actual background arsenic deposition surrounding the Mine Site. Given the setting of the Project, natural background arsenic deposition may be elevated relative to typical regional levels, and the baseline-referenced threshold ensures the TARP responds to operational change rather than to background variability that predates the project.

The Applicant is committed to preparing the revised TARP in direct consultation with the EPA, and welcomes the opportunity to discuss the specific trigger values, response actions, and reporting arrangements prior to finalisation.

3.2. Issue 2: Assessment of toxic metals

NSW EPA has requested that the Project be benchmarked against best practice process design and emission control. This benchmarking is to include a comparison with applicable best practice for metalliferous mining.

The Applicant has engaged Mincore to perform a review of particulate management across the mining process with particular emphasis on the potential emissions from the materials processing operations. This review is attached as Appendix A to this addendum. The review is based on laboratory tests of dust extinction moisture content (DEMC), and has evaluated the potential adoption of wet suppression, dry dust extraction, and mechanical ventilation options for particulate matter control.

A summary of the outcomes of that review is presented in Table 2. Note that all other control measures not included in Table 2 are consistent with the original AQIA.

In summary:

- Wet suppression: Best for open, high-impact dust sources; lower CAPEX; adds moisture.
- Dry extraction: Best for enclosed or clay-sensitive areas; higher CAPEX/OPEX. Needs extensive structural modification.
- Dry and wet system cannot be used at the same location as filter bags will clog up handling moist air and fail prematurely.
- Recommended approach: Wet suppression at crushers, conveyor transfers, screen feed, and HPGR discharge; stockpile feed by a telescopic chute; ventilation only in the reclaim tunnel.

It is noted that the Vertical Shaft Impact (VSI) crusher as part of the processing circuit is now proposed to be replaced with a High-Pressure Grinding Roller (HPGR). The adoption of a HPGR also removes the need for a tertiary crusher in the front-end crushing circuit, thus producing larger material for placement in the crushed ore stockpile.

VSI crushers operate by accelerating material at high velocity against anvils or a rock shelf, producing significant impact energy and substantial particle breakage through fracture and attrition. This high-energy, high-velocity process tends to generate considerable quantities of fine particulate matter, because the repeated impact and inter-particle collisions create a broad size distribution of dust. The open, dynamic nature of the crushing chamber also tends to promote dust liberation, meaning emissions controls such as enclosures, water suppression, or dust extraction systems are typically essential to manage fugitive dust from the VSI crushing process.

The HPGR process, by contrast, grinds material through interparticle compression between two counter-rotating rolls under very high pressure. While this process does generate fines, the material is typically discharged as a compacted cake (or 'flake') rather than loose, airborne particles, which fundamentally changes the rate of dust propagation. Studies and operational experience generally indicate that HPGR circuits produce lower fugitive dust emissions at the point of crushing compared to VSI crushers, because the compressed discharge suppresses immediate dust release.

After review, no process-specific particulate emission factors could be identified for HPGR crushing, and review of other studies (e.g. Mt Todd Gold Project[1]) indicates that the adoption of an emission factor associated with grinding (0.16 $kg \cdot t^{-1}$ PM_{10} uncontrolled) was adopted to characterise emissions from the HPGR at that project (dry grinding, Table 3 of the NPI Emission Estimation Technique Manual for Mining, 2012), which were then controlled by 99 % to characterise the reduction afforded by enclosure (i.e. 0.0016 $kg \cdot t^{-1}$ PM_{10} controlled).

The AQIA supporting the Project previously adopted an emission factor for VSI crushing of 0.0075 $kg \cdot t^{-1}$ PM_{10} which was associated with the emission factor published in Chapter 11.19 of AP42, representing uncontrolled fines crushing. A 91.2 % control was applied to that emission factor to represent the control afforded by enclosure (i.e. 0.00066 $kg \cdot t^{-1}$ PM_{10}).

Given that HPGR crushing is anticipated to result in lower emissions than a VSI crushing process, it is counterintuitive to adopt a more conservative emission factor to approximate emissions from that process, and therefore the original emission factor representing the VSI crushing process has been retained. Furthermore, tertiary crushing is not now required given the inclusion of the HPGR process, and the emission associated with tertiary crushing has been removed. In addition, removal of the tertiary crusher will increase

[1] https://ntepa.nt.gov.au/_resources/documents/eia/mt-todd-gold-mine-project/draft-eis/appendices/appendixT_air_quality.pdf

material size at the crushed ore stockpile and potentially reduce emissions from this source. Although an emission factor reduction cannot be applied to take this change into account in the dispersion modelling assessment, the full suite of design refinements adopted act in concert to reduce particulate matter emissions.

Table 2 Summary of dust management review and adoption in AQIA

Emission control	Applied to sources	Previously applied control	Updated control
High-pressure wet suppression at ROM dump hopper	Loading of processing plant feed bin	Minimise drop height (30 %), water sprays on ROM pad/load point (50 %)	No change
Wet suppression at jaw crusher discharge	Primary crushing	Enclosed (assumed controlled) (77.7 %)	Enclosed (assumed controlled) with water sprays (92.3 %)(A)
Wet suppression at secondary crusher discharge	Secondary crushing	Enclosed (assumed controlled) (77.7 %)	Assumed controlled with water sprays (92.3 %)(A)
Water-mist suppression at conveyor feed/discharge points (all conveyors)	All conveyor points in processing plant	Wet material from water sprays (50 %)	No change
Conveyor covers (hoods) on overland/elevated conveyors	All conveyor points in processing plant	Wet material from water sprays (50 %)	Wet material from prior water sprays (50 %) plus roof and sidewalls on conveyors (70 %)
Dedicated ventilation fan in reclaim tunnel (≈7.5 kW)	Reclaim tunnel	Dust collector on reclaim tunnel (95.3 %), wet material from prior water sprays (50 %)	Wet material from prior water sprays (50 %)
Telescopic chute at crushed stockpile feed	Loading crushed ore stockpile	Chute (75 %), water sprays (50 %)	No change in calculated emissions, but increase in material size at crushed ore stockpile would act to reduce emission potential
Water-mist suppression at screen feed	HPGR screening	Enclosed (assumed controlled) (91.2 %)	Enclosed (assumed controlled) with water sprays (98.8 %)(B)

Notes: (A) Control factor for "controlled fines crushing" from AP-42 Chapter 11.19.2 (Crushed Stone Processing and Pulverised Mineral Processing)

(B) Control factor for "controlled fines screening" from AP-42 Chapter 11.19.2 (Crushed Stone Processing and Pulverised Mineral Processing)

The application of the controls identified in Table 2 result in quantifiable reductions in particulate emissions from the materials processing and materials handling operations. A comparison of the calculated emissions totals (Scenario 1, Year 3, PM_{10}, kg·day^{-1}) is presented in Table 3. The same reduction in emissions is seen in all modelled scenarios, with year 3 presented as it was calculated to result in greatest emissions of all three scenarios modelled.

Table 3 Calculated reduction in emissions through additional control

Emissions source	Uncontrolled PM_{10}	Original Controlled PM_{10}	Updated Controlled PM_{10}	Reduction (original / updated)
Haulage	2,107.4	52.7	52.7	-
Materials handling	162.6	84.4	74.9	11 %
Materials processing	194.6	28.0	7.8	72 %
Wind erosion	27.5	8.8	8.8	-
Total	2,492.2	173.8	144.2	17 %

While the additional particulate emissions reductions across the Mine Site are calculated to be 17 % when compared with the original AQIA, significant additional emissions reduction is demonstrated from materials processing operations (72%). The proposed emissions controls at the processing plant result in total emission reductions (uncontrolled vs controlled) of over 95 %, which represents a high standard of particulate control.

The original AQIA predicted exceedances of the 1-hour arsenic concentration criteria at locations at and beyond the Mine Site boundary, these additional reductions in emissions have been shown to result in a more constrained area of impact as discussed further in Section 3.9.

As discussed in Section 3.1 and Section 3.3, no exceedances of any particulate matter criteria are predicted as a result of the Project operation through the adoption of more appropriate assumptions relating to the existing air quality environment. The additional controls as presented above will result in a further reduction in particulate emissions and predicted impacts at all surrounding receptor locations, providing further confidence that incremental impacts from the Mine Site will not result in any exceedances of the relevant criteria. As discussed in the AQIA, a Trigger Action Response Plan, including real time particulate matter monitoring will be implemented to ensure ongoing compliance with air quality criteria.

NSW EPA has also recommended that a robust toxic metals monitoring campaign is designed which includes provisions for baseline and for the life of mine.

In late January 2026, four dust deposition gauges were installed at the locations presented in Figure 2. Whilst the AQIA predicted exceedances of the 1-hour arsenic concentration criterion, dust deposition monitoring represents a feasible and practical option that is supported by the NSW EPA. The gauge locations shown on Figure 2 are where the Project's AQIA predicted exceedances of the 1-hour arsenic criterion.

Data collected from these gauges will be used to characterise background metals concentration in deposited dust and constrain any variability. In accordance with AS/NZS 3580.10.1, the Applicant will continue this monitoring program at a monthly sampling frequency.

Samples are sent to a laboratory for analysis of deposited dust, and a suite of the following toxic metals are assayed in accordance with US EPA method 6020:

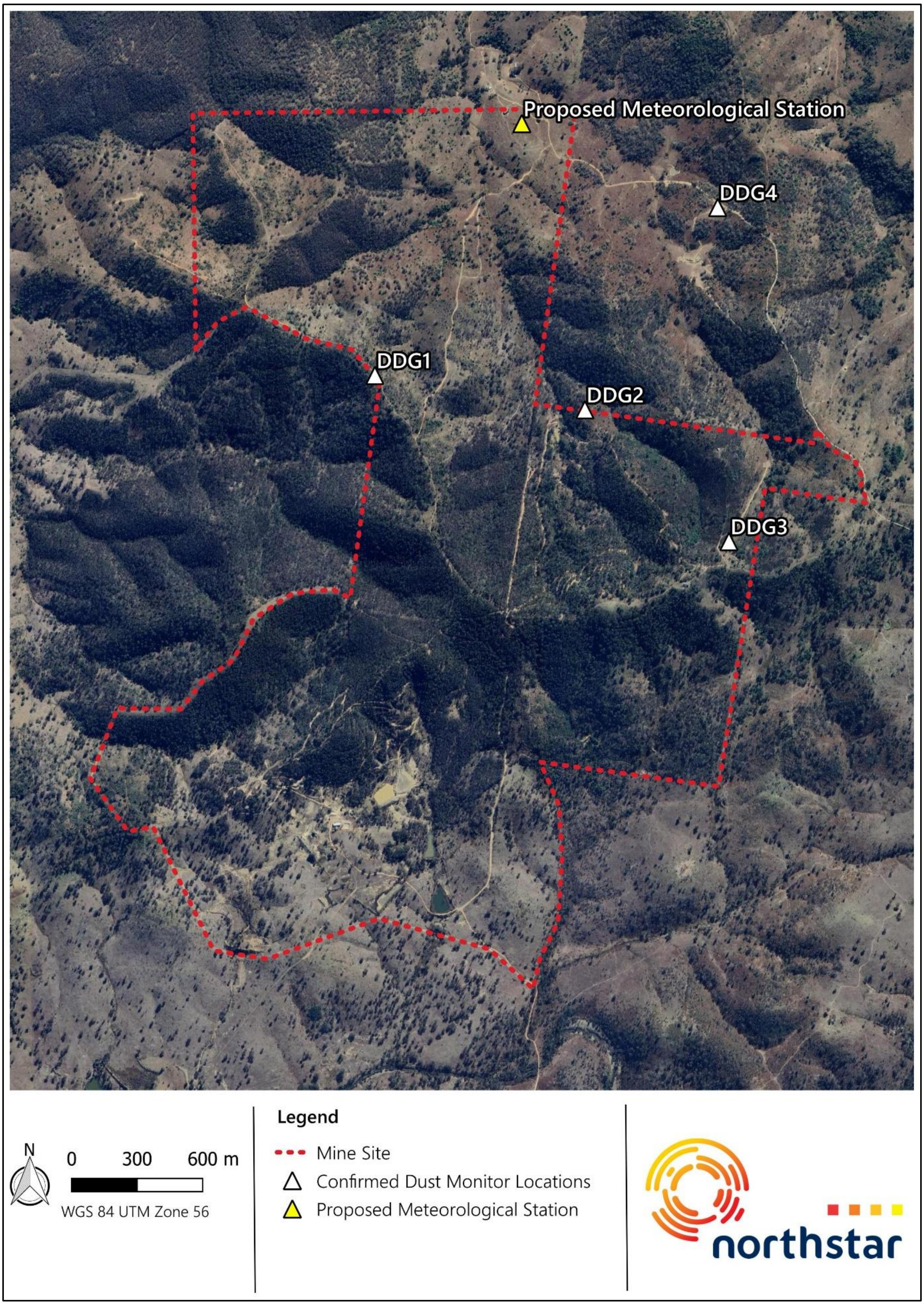
- Arsenic (As);
- Beryllium (Be);
- Cadmium (Cd);
- Copper (Cu); and
- Nickel (Ni).

Should the Project be approved, the Applicant would continue the program and fully document the approach and implementation of air quality monitoring in an AQMP that would be submitted to DPHI and NSW EPA for approval. Under this AQMP, sampling frequency and locations would be reviewed annually to ensure its efficacy. After two years of operations, the monitoring program would be reviewed to determine whether the cessation of that monitoring may be justified. However, any such decision would only occur in consultation with DPHI and the NSW EPA.

In addition, a meteorological monitoring station is to be installed in April 2026 at the location shown in Figure 2. The meteorological monitoring station will measure all parameters in real-time as outlined in Attachment B of the NSW EPA advice (item M4.1):

- Air temperature at 2 m and 10 m AGL;
- Solar radiation at 2 m;
- Wind speed and direction at 10 m;
- Temperature at 10 m;
- Rainfall; and
- Barometric pressure.

Figure 2 Locations of air quality and meteorological monitoring



3.3. Issue 3: Adopted background concentrations for particulate matter not representative of local airshed

Issue 3 raised by NSW EPA suggests that the background particulate data adopted from the Armidale AQMS may be conservative in nature. The NSW EPA considered Armidale AQMS data as representative of an urbanised regional centre, experiencing cool winters, and subsequent prolific woodfire heater use that results in elevated ambient particulate matter concentrations. The Mine Site is located in a very sparsely populated rural area approximately 7.5 km from Emmaville in northern NSW. The NSW EPA advised that data from another AQMS, without known ongoing air quality issues would likely be more representative of ambient air quality at the Mine Site.

The following AQMS have been selected for review due to their proximity:

- Armidale (adopted in the original AQIA);
- Narrabri;
- Gunnedah; and
- Tamworth.

The background information for each AQMS is presented in Table 4.

Table 4 AQMS background information

Location	Armidale	Narrabri	Gunnedah	Tamworth
Distance from Mine Site (km)	112	196	205	183
Site description	"Rural Monitoring Site"	"Rural Monitoring Site"	"Rural Monitoring Site"	"Rural Monitoring Site"
Population surrounding AQMS (persons)	23 967	6 876	8 338	43 874
Land-use character	Urban area, subject to elevated background concentrations due to winter woodfire heater use	Located at an air strip, close to agricultural sources	Urban area, subject to elevated background concentrations due to winter woodfire heater use	Urban area, subject to elevated background concentrations due to winter woodfire heater use

A summary of the data measured at each AQMS is presented in Table 5. Intensive bushfires occurred across northern NSW in 2019, which is reflected in the summary data with maximum pollutant concentrations within the 5-year data occurring in 2019.

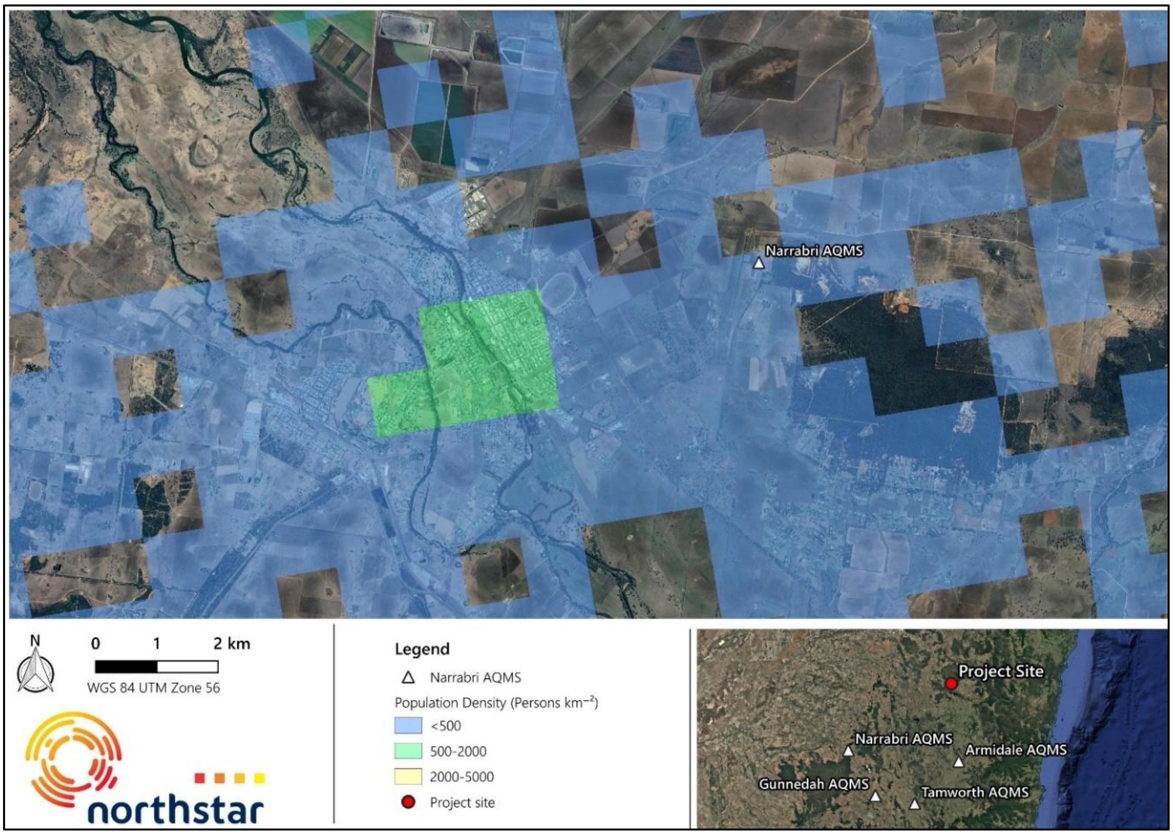
Table 5 Summary of selected AQMS background air quality statistics

Location	Armidale		Narrabri		Gunnedah		Tamworth	
Pollutant (µm/m³)	$PM_{2.5}$	PM_{10}	$PM_{2.5}$	PM_{10}	$PM_{2.5}$	PM_{10}	$PM_{2.5}$	PM_{10}
2020 mean	9.2	13.7	5.5	12.4	7.7	13.9	6.8	16.8
5-year mean	9.3	13.8	4.8	10.8	7.6	14.2	7.2	17.0
2020 max	53.7	112.5	42.4	119.6	34.7	101.2	52.6	178.0
5-year max	267.3	309.7	87.7	232.6	94.1	205.2	164.2	240.2
2020 75th percentile	11.7	17.8	6.7	13	9.5	17.4	8.5	18.6
5-year 75th percentile	12.1	17.1	5.5	12.1	9.2	16.9	8.3	19.2

Note: '5-year' – 2019 to 2024

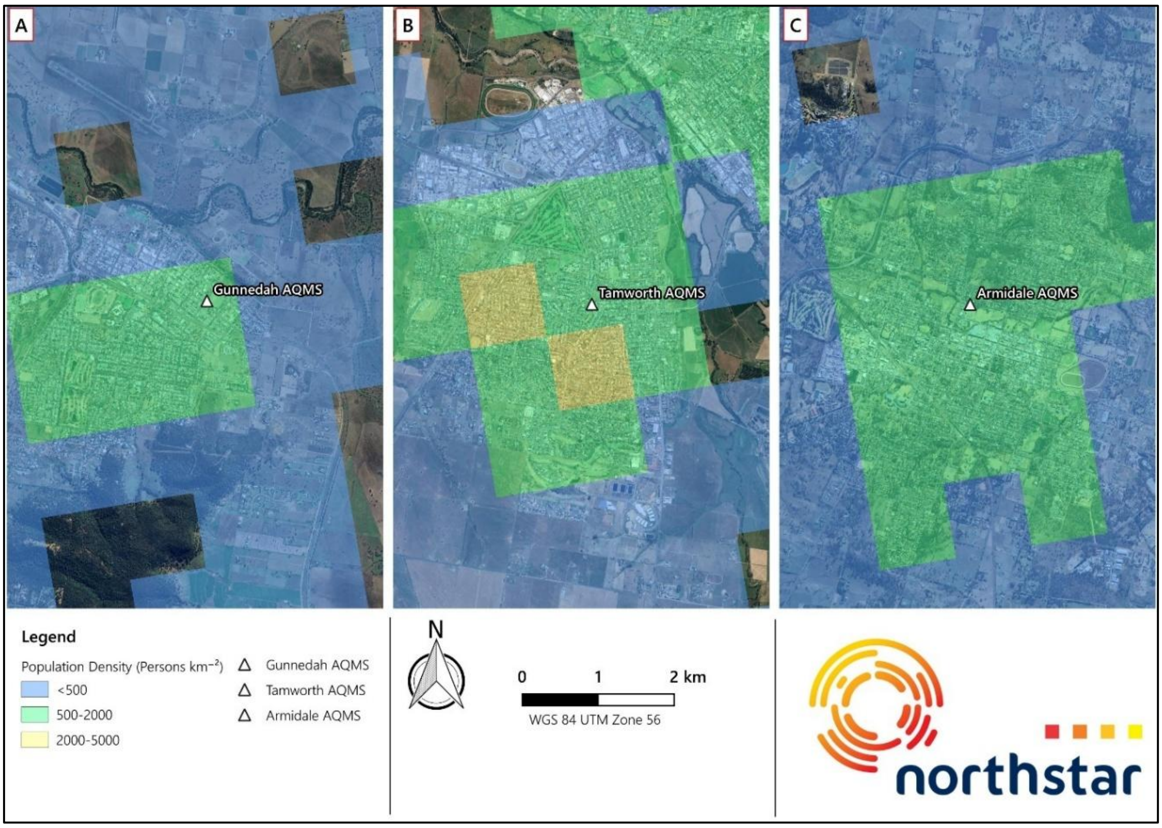
Of the four AQMS reviewed, the environment surrounding the Narrabri AQMS is most representative of the Mine Site. This is because Narrabri AQMS is located in an area with the smallest urban population nearby, the largest distance from an urban population and corresponding pollution sources, in comparison to the other sites assessed (refer Figure 3 and Figure 4).

Figure 3 Narrabri AQMS location



Source: Northstar

Figure 4 Gunnedah, Tamworth and Armidale AQMS locations



Source: Northstar

Based on this review, data from the Narrabri AQMS has been adopted to represent the air quality environment of the Mine Site, without the impact of the Project and for a re-evaluation of its potential impacts.

The adoption of more representative background air quality data results in compliance with the impact assessment criteria.

3.4. Issue 4: Control factors outlined in the AQIA may be difficult to achieve in practice

3.4.1. Adopted Emission Factors and Control Assumptions

The AQIA estimated haul-road emission rates using the USEPA AP-42 Section 13.2.2 unpaved road methodology. A silt content of 8.3 % was adopted, consistent with the '*haul road to/from pit*' category for '*stone quarrying and processing*' in AP-42 Table 13.2.2-1, and an average vehicle mass of 94.9 t (mean of loaded and unloaded weight) was applied. The resulting uncontrolled emission factors for TSP, PM_{10}, and $PM_{2.5}$ were calculated as 5.28 kg·VKT^{-1}, 1.50 kg·VKT^{-1}, and 0.15 kg·VKT^{-1} respectively.

A combined emission control efficiency of 97.5 % was applied, comprising a 90 % reduction for water and/or chemical dust suppressant application, and a 75 % reduction for vehicle speed restriction to 50 $km \cdot hr^{-1}$.

The Applicant has advised that a 40 $km \cdot hr^{-1}$ speed limit is to be applied at the Mine Site, and whilst a 50 $km \cdot hr^{-1}$ speed limit was discussed in the AQIA, a reduction in vehicle speeds will result in a reduction in particulate matter resuspension. However, the control factors available are not sufficiently refined to allow additional control efficiency to be applied, and a 75 % control has been retained.

3.4.2. NSW EPA Comments

The NSW EPA has raised the following concerns:

> *"the EPA raise concerns that this significant control efficiency would need to be maintained at all times throughout the project lifetime to reduce the risk of project related dust impacts."*
>
> *"...the EPA considers that the adoption of a 97.5% control efficiency for watering may not reflect a reasonable worst-case scenario, and such a control efficiency may not be achievable at all times."*
>
> *"The EPA acknowledges the level of conservatism inherent in adopting default emission factors and in also providing consistency in methodology enables a clearer understanding of the change in air quality from the Project. The use of site-specific data is generally preferred, when robust and scientifically valid data is available."*

3.4.3. Response

The EPA's concern can be addressed on two independent grounds: (i) the conservatism of the uncontrolled emission rate, and (ii) the defensibility of each component of the adopted control efficiency.

3.4.3.1. Conservatism of the Uncontrolled Emission Rate

The adopted AP-42-derived emission factors are conservative relative to Australian conditions for several reasons.

Firstly, the adopted AP-42 dataset for unpaved industrial roads was derived from field tests conducted between 1979 and 1996 in the United States. Australian field conditions differ materially, including differences in road construction practices, vehicle design, and climate. In NSW, the combination of higher temperatures and seasonally elevated humidity reduces the propensity for dust generation compared with the arid conditions representative of many historical US test sites. Australian site conditions, vehicle fleets and haul-road management practices are not identical to those represented in the historical AP-42 database, such that direct transfer of the AP-42 uncontrolled factors is itself conservative.

Secondly, an ACARP Project (C22027, (Pacific Environment Operations, 2015)) compiled Australian field measurement data and found that AP-42-derived haul-road emission factors are, on average, approximately five times higher than measured site-specific values for comparable vehicle mass and silt conditions. The report recommends an Australia-specific uncontrolled PM_{10} emission factor of 0.26 kg·VKT$^{-1,}$ materially lower (i.e. 83 %) than the adopted value of 1.50 kg·VKT$^{-1.}$

Thirdly, the AP-42 default silt content of 8.3 % used in this assessment is above the average haul-road silt content reported across the ACARP C22027 dataset (mean 4.6 %, range 0.6 % to 10.2 % for uncontrolled surfaces). Given that silt content is the dominant driver of the AP-42 predictive equation, this further biases the modelled emission rate upward relative to typical Australian haul-road conditions.

3.4.3.2. Defensibility of the Adopted Control Efficiencies

Watering/Suppressant Control

The adopted 90 % control efficiency for water and/or chemical suppressant application is consistent with published Australian field monitoring evidence. ACARP Report C20023 (Pacific Environment Limited, 2014), which investigated dust generation and control on unsealed haul roads at Australian coal mines, found that watering alone can achieve approximately 85 % to 95 % control under operational conditions. The report documents site monitoring results where calculated efficiencies commonly fall within this range and, in some cases, exceed 90 %, reflecting real-world performance across different sites and seasonal conditions.

This is also consistent with the regulatory expectation established under the NSW EPA Dust Stop Pollution Reduction Program, which required all NSW open-cut coal mines to achieve a minimum of 80 % control of wheel-generated haul-road dust through watering and suppressant application. The Applicant's adopted 90 % control efficiency for watering therefore exceeds the minimum standard that has been demonstrated to be practically achievable across the NSW coal mining sector and is independently supported by quantitative field evidence.

Speed Reduction Control

The adopted 75 % control efficiency for vehicle speed restriction reflects the practical reduction in haul-road dust emissions associated with limiting haul truck speeds to 50 km·hr^{-1}, relative to less controlled operating conditions. Vehicle speed is a well-recognised operational factor influencing wheel-generated dust emissions, as lower travel speeds reduce tyre-induced turbulence, mechanical entrainment and the intensity of road-surface disturbance.

The AP-42 Section 13.2.2 predictive equation does not include vehicle speed as an explicit parameter. However, this does not indicate that speed is irrelevant in practice. Rather, the AP-42 formulation is a generalised empirical relationship in which the independent contribution of speed was not retained in the final predictive expression, in part due to correlation with other variables such as silt content. Accordingly, application of a separate speed-related control factor is a reasonable means of representing the benefit of an enforceable site speed limit where this forms part of the dust management regime.

In this case, the adopted 75 % reduction is intended to represent the contribution of active speed management to overall haul-road dust control, in combination with watering or dust suppressant application. The speed control assumption is therefore not presented as a substitute for the underlying AP-42 methodology, but as an additional operational mitigation applied to a conservatively derived uncontrolled emission factor. This remains a reasonable and precautionary basis for assessment, particularly given the use of an above-average silt content and an uncontrolled AP-42 emission rate that is materially higher than Australian field-derived values reported in the literature.

3.4.3.3. Summary

The adopted haul-road emission assessment is conservative, owing to the use of AP-42 default parameters that are demonstrably higher than Australian field-derived equivalents. The watering/suppressant control efficiency of 90 % is independently defensible and consistent with both published ACARP field data and the minimum standard enforced under the NSW EPA Dust Stop Program. The vehicle speed control efficiency of 75 % is also considered reasonable as a component of a layered haul-road dust management strategy, reflecting the practical dust reduction associated with maintaining a 50 $km \cdot hr^{-1}$ site speed limit (40 $km \cdot hr^{-1}$ to be applied in practice).

When applied together, the watering/suppressant and speed controls represent a combined haul-road control efficiency of 97.5 %. This combined efficiency should be considered in the context of the conservatively high uncontrolled AP-42 emission rate adopted in the assessment. On that basis, the Applicant considers the modelled haul-road dust emissions to represent a reasonable and appropriately precautionary estimate for impact assessment purposes.

Notwithstanding the above, the Applicant commits to undertaking site-specific verification testing at Project commencement to refine and validate key emission inputs, including haul-road surface silt content, moisture conditions, and a review of the in-situ effectiveness of dust controls under representative operating conditions. This testing will enable project-specific calibration of emission estimates and control efficiencies, ensuring that ongoing dust management remains aligned with measured performance and best-practice expectations.

We do not consider a separate sensitivity analysis for a range of haul-road dust control efficiencies to be warranted in this case. The AQIA already adopts a conservative assessment framework at the emissions estimation stage, through use of AP-42-derived uncontrolled emission factors and parameters that are demonstrably biased upward relative to Australian field conditions. As outlined above, the adopted uncontrolled haul-road emission rate is materially higher than Australian field-derived values reported in the literature, and is based on a silt content assumption above the average reported for comparable haul-road surfaces. In that context, the modelled emissions already represent a precautionary estimate of potential off-site impacts.

Further, the control measures adopted in the AQIA are not arbitrary assumptions, but are supported by published Australian field evidence and regulatory practice. The watering/suppressant efficiency is consistent with measured outcomes reported in ACARP field studies, while the speed control measure reflects an enforceable operational mitigation forming part of the Project's dust management regime.

A further sensitivity analysis would therefore primarily test hypothetical lower control efficiencies without corresponding adjustment to the already conservative uncontrolled emission inputs, resulting in compounded conservatism rather than a more realistic assessment. The more appropriate means of addressing uncertainty is the Applicant's commitment to site-specific verification testing at Project commencement, to confirm and, if necessary, refine the adopted assumptions based on measured on-site performance.

3.5. Issue 5: Emissions inventory lacks detail regarding wind erosion of exposed areas

NSW EPA recommended that:

> *"The AQIA be revised to enable emission estimates to be assessed and replicated for exposed areas susceptible to wind erosion. Further specific detail should be provided regarding the calculation of all exposed and actively disturbed areas to ensure the emissions inventory is accurate, transparent, and able to be replicated and include maps. Additional justification on the control measures for the RSF must be provided."*

Specific details relating to wind erosion calculations are presented in Section 3.6.

The 100 % control assumption adopted for the RSF reflects the expected operating condition of the facility, namely deposition of tailings as wet slurry to the RSF, with operation of the facility intended to maintain exposed tailings surfaces in a wet, non-erodible condition. The assumption is therefore not intended to represent an uncontrolled dry tailings surface with an assumed abatement factor, but rather the physical condition of the material as managed on the RSF.

To ensure that this condition is maintained in practice, the AQMP will include RSF-specific inspection and contingency measures, including routine inspections for drying or dust lift-off, weather-based surveillance during hot and windy conditions, and implementation of corrective actions which could potentially include wetting, surface stabilisation and operational adjustments if drying, desiccation, surface cracking, or conditions conducive to dust lift-off are observed.

It must also be noted that the RSF would only store approximately 300 000 t of materials and therefore does not represent a spatially significant emissions source area for dust when compared to similar facilities at other metalliferous mines.

3.6. Issue 6: Source parameters and locations not included in assessment

NSW EPA recommended that:

> *The Proponent:*
>
> *1. Identify and confirm source locations for all emissions scenarios.*
>
> *2. Identifies the release type and source parameters used in the modelling.*
>
> *3. Clarify if there are point source emissions and update the AQIA accordingly.*

The locations of modelled emission sources are presented in the following figures:

- Figure 5 Volume source emissions – Northern Open Cut;
- Figure 6 Volume source emissions – Southern Open Cut, plus point sources;
- Figure 7 Volume source emissions (haulage) – Scenario 1;
- Figure 8 Volume source emissions (haulage) – Scenario 2;
- Figure 9 Volume source emissions (haulage) – Scenario 3; and
- Figure 10 Area source emissions.

Emission source parameters are presented in Table 6.

Point source emissions were used for the gas-fired generators. Details of those source parameters are presented in Table 7.

The areas in Figure 10 and column 4 of Table 8 represent the maximum extents of each disturbance area. Information provided by the Applicant confirms the areas of active disturbance (i.e. the subject of mining operations, vehicle traffic etc) to be as presented in columns 5 and 6 of Table 8.

Table 6 Emission sources parameters adopted in CALPUFF

Source type	Location	Source name	Height (m)	Sigma y (m)	Sigma z (m)
VOL	Southern Open Cut	Vegetation removal and soil stripping	0.3	0.47	0.14
VOL		Loading soil to haul trucks	2	0.47	0.47
VOL		Unloading of soil at soil stockpile	0.5	0.47	0.12
VOL		Drill	5	0.47	1.16
VOL		Blast	10	11.16	2.33
VOL		Waste rock loaded to haul truck	2	0.47	0.47
VOL		Unloading of waste rock at Southern WRE	0.5	0.47	0.12
VOL		Pushing waste rock at Southern WRE	0.5	0.70	0.12
VOL		Ore loaded to haul truck	2	0.47	0.47
VOL		Unloading of ore at ROM Pad (38% direct tip, 62% to ROM pad)	0.5	0.47	0.12
VOL	Northern Open Cut	Vegetation removal and soil stripping	0.3	0.47	0.14
VOL		Loading soil to haul trucks	2	0.47	0.47
VOL		Unloading of soil at soil stockpile	0.5	0.47	0.12
VOL		Drill	5	0.47	1.16
VOL		Blast	10	11.16	2.33
VOL		Waste rock loaded to haul truck	2	0.47	0.47
VOL		Unloading of waste rock at Northern WRE	0.5	0.47	0.12
VOL		Pushing waste rock at Northern WRE	0.5	0.70	0.12
VOL		Ore loaded to haul truck	2	0.47	0.47
VOL		Unloading of ore at ROM Pad (38% direct tip, 62% to ROM pad)	0.5	0.47	0.12
VOL	Processing plant	FEL on stockpiles loading primary crusher (62% from ROM pad)	2	0.47	0.47
VOL		Primary crushing	5	1.16	1.16
VOL		Secondary crushing	5	1.16	1.16
VOL		Conveyor to screening building	2	2.33	0.47

Source type	Location	Source name	Height (m)	Sigma y (m)	Sigma z (m)
VOL		Screening	5	1.16	1.16
VOL		Conveyor to fine ore stockpile (all ore less coarse rejects)	2	2.33	0.47
VOL		Loading fine ore stockpile	2	0.47	0.47
VOL		Ore reclaim conveyor to VSI screening	2	0.47	0.47
VOL		HPGR screening	5	1.16	1.16
VOL		Conveyor to HPGR crushing	2	2.33	0.47
VOL		HPGR crushing	5	1.16	1.16
VOL		Conveyor to HPGR rejects screening building (all ore less coarse rejects and coarse tailings)	2	2.33	0.47
VOL		Conveyor to CDA (coarse rejects, coarse tailings, fine tailings)	2	2.33	0.47
VOL		Unloading rejects at CDA	0.5	0.47	0.12
VOL		Wet processing (all ore less coarse rejects, fine rejects, coarse tailings)	2	0.47	0.47
VOL		Concentrate bagging	2	0.47	0.47
VOL		Loading of bagged concentrate to trucks	2	0.47	0.47
VOL		Coarse rejects, dewatered coarse tailings, dewatered, thickened and fine tailings via conveyor to CDA	0.5	2.33	0.12
VOL		Pushing rejects at CDA	0.5	0.47	0.12
VOL		Wet tailings pumped as slurry to RSF	2	2.33	0.47
AREA	Soil stockpiles (SOC)	Wind Erosion 1	5	NA	1.25
AREA	Actively disturbed SOC	Wind Erosion 2	0.1	NA	0.025
AREA	Actively disturbed Southern WRE	Wind Erosion 3	5	NA	1.25
AREA	Soil stockpiles (northern soil stockpile)	Wind Erosion 4	5	NA	1.25

Source type	Location	Source name	Height (m)	Sigma y (m)	Sigma z (m)
AREA	Actively disturbed NOC	Wind Erosion 5	0.1	NA	0.025
AREA	Actively disturbed Northern WRE	Wind Erosion 6	5	NA	1.25
AREA	ROM and Processing Area	Wind Erosion 7	5	NA	1.25
AREA	Co-Disposal Area	Wind Erosion 8	5	NA	1.25
VOL	Southern Open Cut	Road 1 (10 sources) Haulage of soil to soil stockpile	2.125	58.14	4.25
VOL		Road 2 (6 sources) Haulage of waste rock to Southern WRE	2.125	58.14	4.25
VOL		Road 3 (9 sources) Haulage of ore to ROM Pad from SOC	2.125	58.14	4.25
VOL	Northern Open Cut	Road 4 (13 sources) Haulage of soil to soil stockpile	2.125	58.14	4.25
VOL		Road 5 (7 sources) Haulage of waste rock to Northern WRE	2.125	58.14	4.25
VOL		Road 6 (11 sources) Haulage of ore to ROM Pad from NOC	2.125	58.14	4.25
VOL	Processing plant	Road 7 (15 sources) Haulage of concentrate offsite	2.125	58.14	4.25

Table 7 Point source emission parameters adopted in CALPUFF

Source	Turbine	Stack height (m)	Stack diameter (m)	Exhaust temperature (K)	Exhaust velocity ($m \cdot s^{-1}$)	NO_X emission rate ($g \cdot s^{-1}$)
Cummins HSK78G series natural gas engine	Engine 1	2.8	0.5	663.15	30.8	0.72
	Engine 2	2.8	0.5	663.15	30.8	0.72

Note: C2000N5CD model assumed. Emissions not anticipated regularly, and only during non-daylight or cloudy periods. Two engines assumed to be operational at full load for all hours of the year to represent potential impacts concurrent with highest rates of blasting. Project may install up to five gas engines, but incremental impacts minimal (<2 % of criterion at any receptor).

Figure 5 Volume source emissions – Northern Open Cut

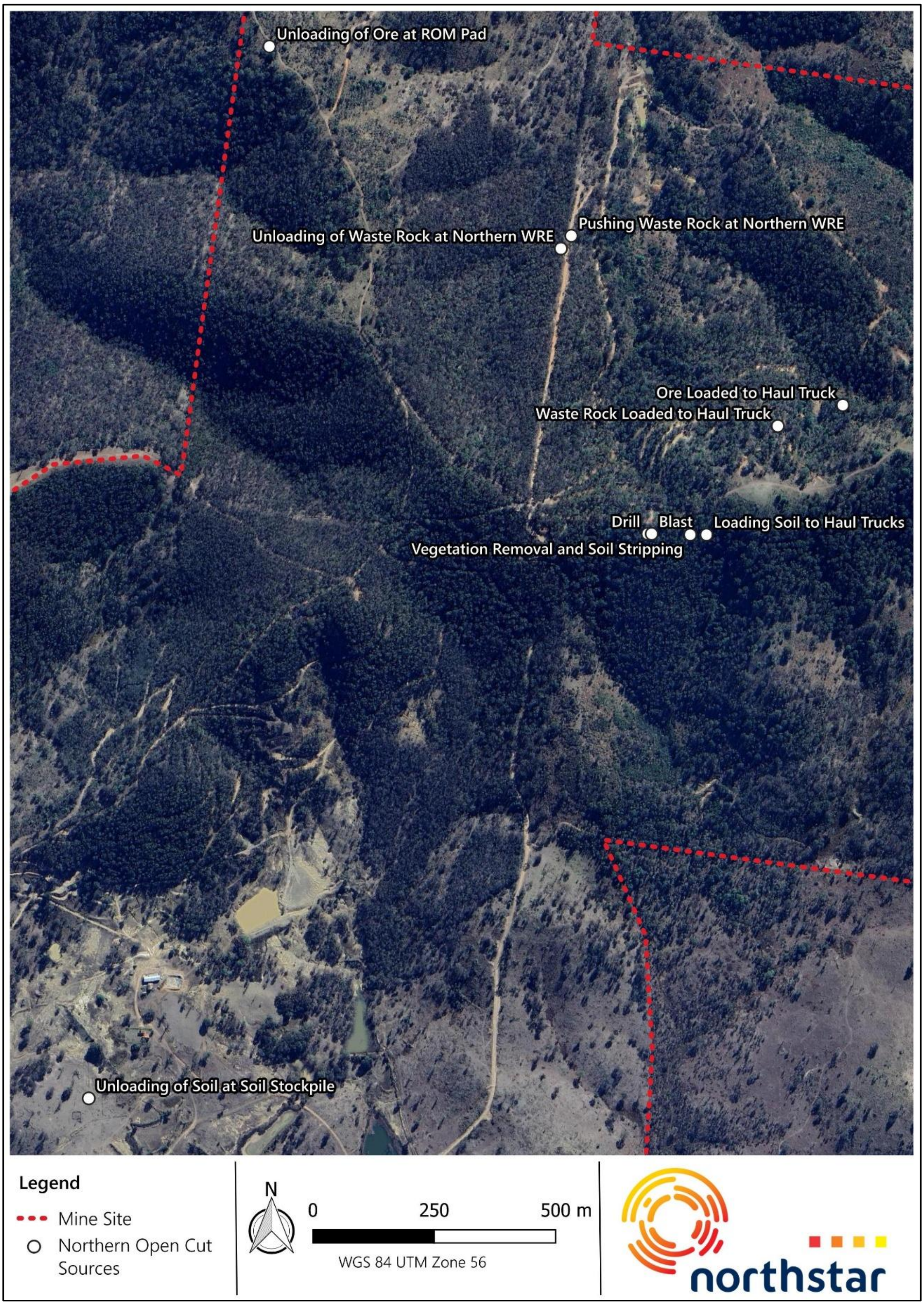


Figure 6 Volume source emissions – Southern Open Cut, plus point sources

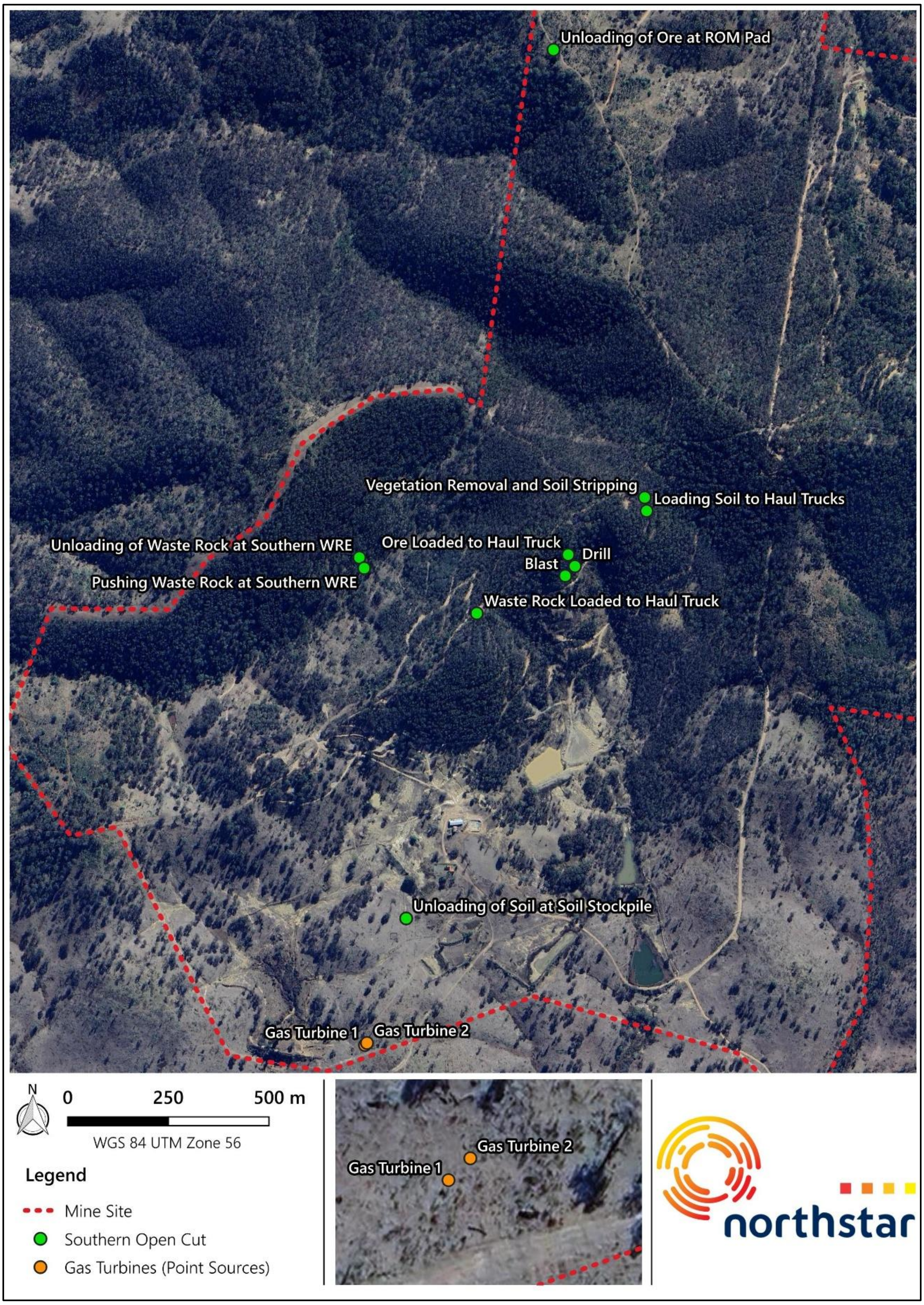


Figure 7 Volume source emissions (haulage) – Scenario 1

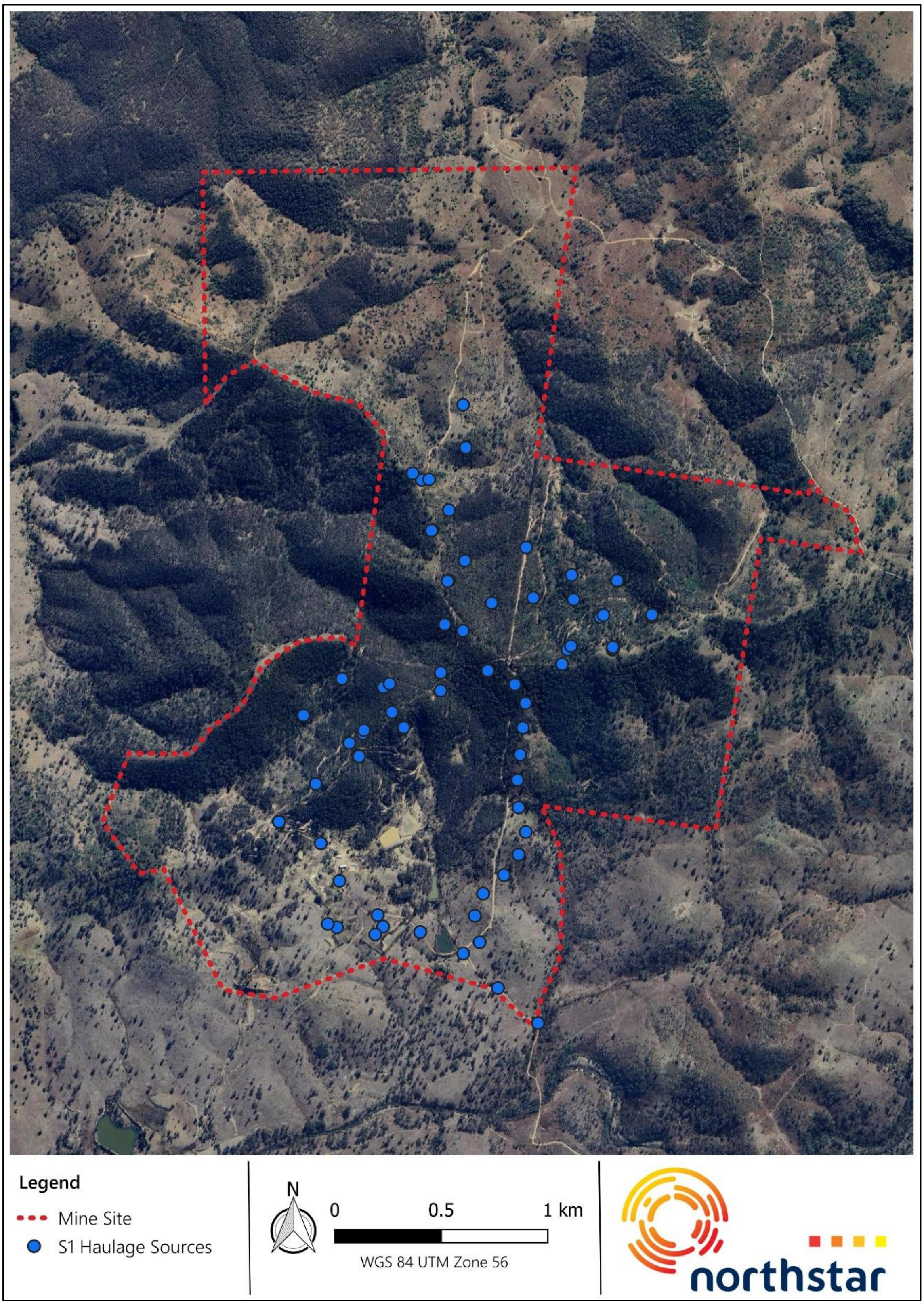


Figure 8 Volume source emissions (haulage) – Scenario 2

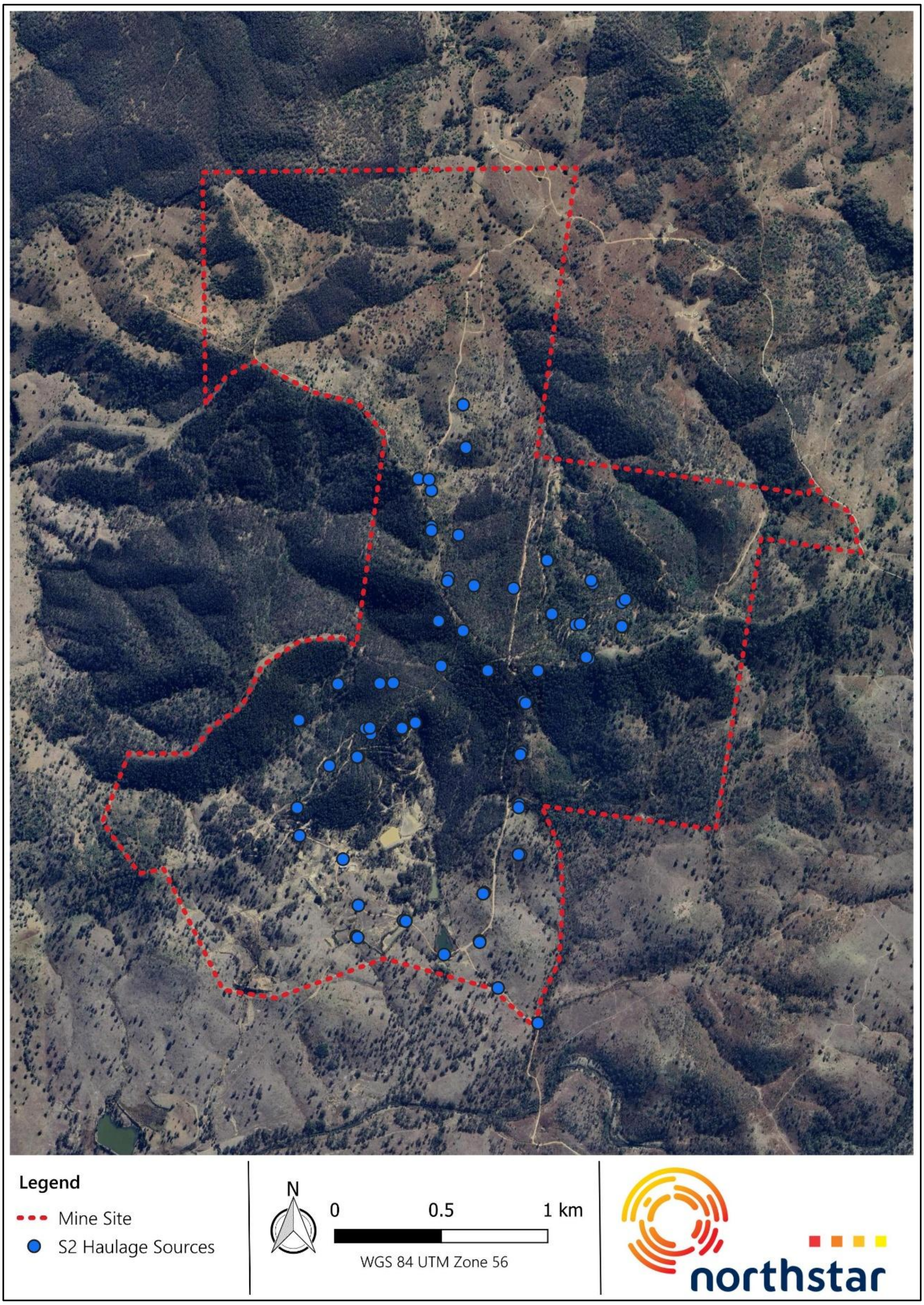


Figure 9 Volume source emissions (haulage) – Scenario 3

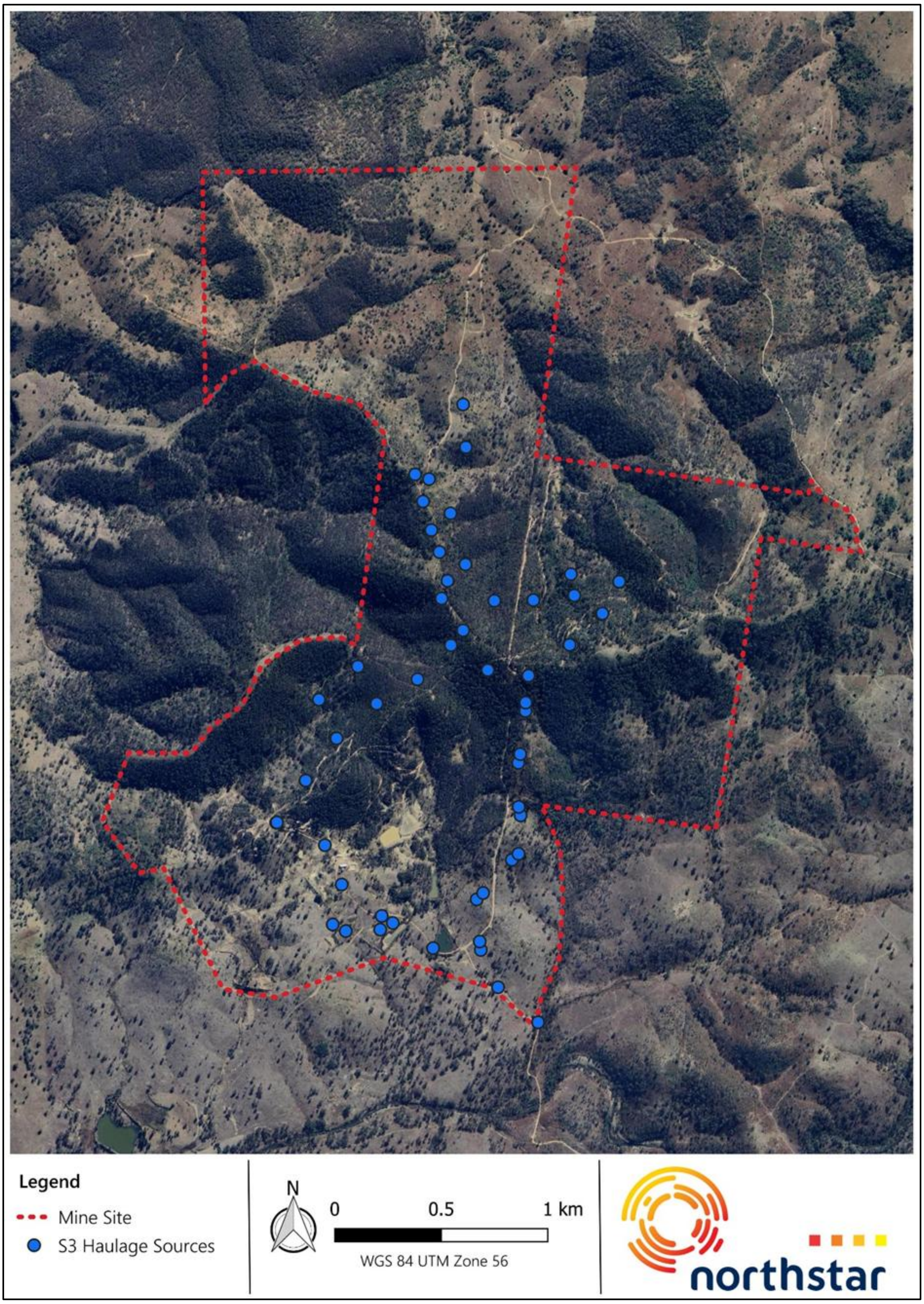
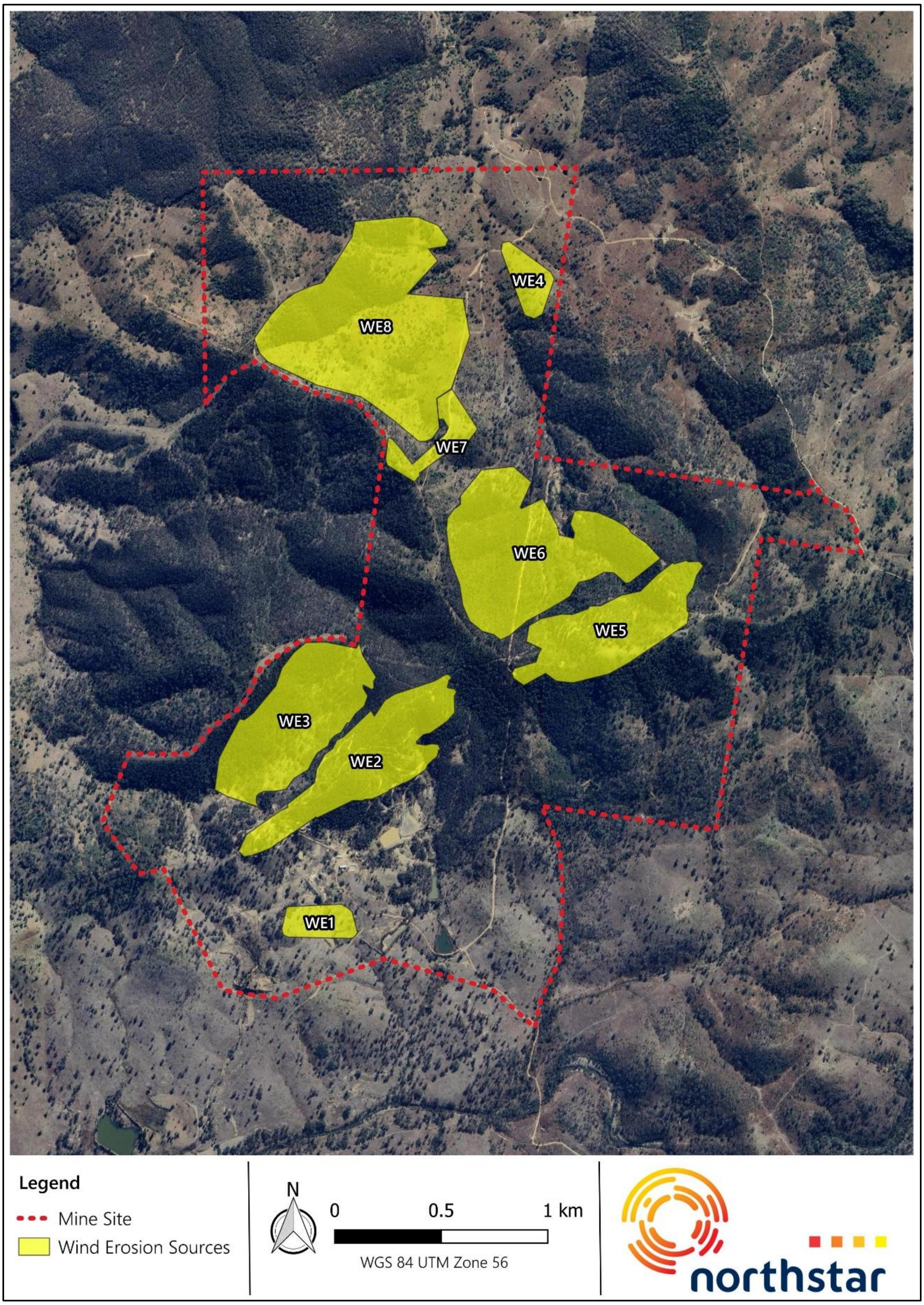


Figure 10 Area source emissions



Note: Total areas shown

Table 8 Areas subject to wind erosion included in the AQIA

ID	Area	Name	Total area (ha)	Assumption	Area in model (ha)
WE1	Southern Open Cut (SOC)	Wind erosion of soil stockpiles	5.03	10 % of area actively disturbed	0.50
WE2		Wind erosion of actively disturbed SOC	27.35	1 % of total area actively disturbed	0.27
WE3		Wind erosion of actively disturbed Southern WRE	31.08	25 % of area actively disturbed	7.77
WE4	Northern Open Cut (NOC)	Wind erosion of soil stockpiles (northern soil stockpile - southern accounted for above [WE1])	5.05	10 % of area actively disturbed	0.51
WE5		Wind erosion of actively disturbed NOC	24.78	1 % of area actively disturbed	0.25
WE6		Wind erosion of actively disturbed Northern WRE	45.28	25 % of area actively disturbed	11.32
WE7	Processing	Wind erosion of ROM and Processing Area	5.92	2.5 ha total actively disturbed	2.50
WE8		Wind erosion of Co-Disposal Area	60.59	0.5 ha actively disturbed	0.50
WE9		Wind erosion of Residue Storage Facility	3.91	Tailings deposited as wet slurry; surface assumed non-erodible under normal operation	0

Dispersion modelling of wind erosion sources incorporates a number of conservative assumptions that, in combination, are likely to substantially overestimate actual dust emissions and downwind concentrations. One of the most significant relates to the meteorological threshold for wind erosion. Standard practice typically applies emission factors across all modelled wind speeds, yet experimental research identifies a threshold friction velocity for fine particulate material of approximately 5.4 $m \cdot s^{-1}$, equivalent to a mean wind speed well above typical ambient conditions at many sites. Below this threshold, aerodynamic forces are insufficient to entrain and suspend fine particles, meaning that a large proportion of modelled hourly periods during which emissions are assumed to occur would in reality generate little or no dust lift-off. Applying emissions uniformly across all wind speeds therefore systematically inflates both the frequency and magnitude of modelled source contributions.

A further conservatism arises from the treatment of disturbed surface area. Modelling typically assumes that the full nominated disturbance footprint is active and emitting continuously throughout the assessment period. In practice, wind erosion is a self-limiting process on undisturbed surfaces. Once the readily available fine fraction of surface material has been entrained and transported away, the surface develops a coarser lag layer that resists further erosion until the surface is mechanically disrupted again. This means that only areas subject to ongoing active disturbance, such as active earthworks, vehicle trafficking, or recently stripped surfaces, can sustain meaningful emission rates. Modelling the entire disturbed area as a continuously active source, rather than reflecting the episodic and spatially limited nature of actual disturbance activity, is an overestimation of real-world conditions.

Additional conservatism is introduced through the use of generic emission parameters. In this assessment, the AP-42 default wind erosion emission factor for exposed areas of 850 $kg \cdot ha^{-1} \cdot year^{-1}$ from Table 11.9-4 has been adopted. This factor is intended for broad application and does not account for site-specific conditions that may substantially reduce erodibility, including surface crusting, consolidation, elevated moisture content, recent rainfall, or active dust suppression measures. Similarly, wind erosion modelling does not generally provide credit for temporary or persistent surface moisture, notwithstanding the well-established suppressive effect of moisture on particle cohesion.

Accordingly, the adopted approach should be regarded as a conservative upper-bound estimate of potential wind erosion emissions from exposed areas, rather than a prediction of likely average emissions under actual site conditions.

3.7. Issue 7: Meteorology modelling not adequately evaluated and justified as representative

NSW EPA recommended that:

The AQIA should be revised to:

1. Quantitatively evaluate meteorological model performance, including a statistical evaluation and images of the wind fields that captures potentially complex flow systems.

2. Provide additional information on the TAPM and CALMET model configuration settings, grid resolution, terrain inputs, land use inputs and TERRAD.

Meteorological model performance was evaluated by comparing TAPM-modelled hourly outputs against concurrent observations recorded at the BoM Glen Innes Airport AWS for the full 2020 modelling year. The evaluation focused on the three parameters most relevant to atmospheric dispersion modelling: wind speed, wind direction, and near-surface temperature. Calm wind conditions (observed wind speed ≤ 0.5 m/s) were excluded from the wind direction analysis to avoid spurious directional errors under near-zero flow.

A performance evaluation of the CALMET diagnostic wind field model was not practicable for this assessment. The Glen Innes Airport AWS, being the nearest station with a continuous hourly record suitable for model comparison, lies approximately 34 km from the Mine Site and falls outside the CALMET modelling domain. No surface meteorological monitoring station exists within the domain that could provide the concurrent observational record required for a paired statistical comparison. The performance evaluation was therefore limited to TAPM, with model skill assessed using five quantitative metrics applied to each variable:

- mean bias (MB);
- mean absolute error (MAE);
- root mean square error (RMSE);
- Willmott's Index of Agreement (IOA, d); and
- the Pearson correlation coefficient (r).

MB quantifies systematic over- or under-prediction, while IOA provides a normalised measure of model skill ranging from 0 to 1 that captures both bias and variance. Results were assessed against the performance benchmarks established by Emery et al. (2001), which are widely adopted in regulatory air quality practice and consistent with United States EPA guidance:

- MB ≤ ±0.5 $m \cdot s^{-1}$ and IOA ≥ 0.60 for wind speed;
- MB ≤ ±10° and IOA ≥ 0.60 for wind direction; and
- MB ≤ ±0.5 °C and IOA ≥ 0.80 for temperature.

Visual comparisons were also prepared, including annual wind roses, hourly time series overlays, scatter plots with best-fit lines, and monthly bias distributions, to provide a qualitative assessment of model behaviour across the full annual cycle.

The statistical results and visual comparisons are presented in Figure 11 to Figure 14 and Table 9 and Table 10. Overall, TAPM demonstrated good to very good performance across the three evaluated parameters, with temperature and wind direction meeting all Emery et al. (2001) benchmarks and the modelled wind speed showing acceptable skill with a modest systematic bias.

Temperature performance was strong, with a mean bias of -0.26 °C, well within the ±0.5 °C benchmark, and an IOA of 0.94 and Pearson r of 0.91, both indicating a high degree of agreement with observations (Table 9). The time series comparison (Figure 12) and scatter plots (Figure 13) confirm that TAPM reproduces the diurnal temperature cycle and seasonal progression closely throughout the year.

Wind direction performance was similarly strong. The mean bias of -7.9° falls within the ±10° benchmark, and the IOA of 0.91 substantially exceeds the 0.60 threshold (Table 9 and Table 10). Comparison of the observed and modelled wind roses (Figure 11) shows good agreement in the dominant wind direction regimes, with both roses reflecting a pronounced easterly to south-easterly flow regime. A secondary westerly mode is also evident in both wind roses, though it is considerably less frequent than the dominant easterly fetch. The monthly bias distributions (Figure 14) indicate that the directional agreement is consistent across seasons without a pronounced seasonal trend.

Wind speed performance met the IOA benchmark (0.82 against a threshold of 0.60), and the Pearson r of 0.73 indicates reasonable correlation with observed variability (Table 9 and Table 10). However, the mean bias of -0.73 $m{\cdot}s^{-1}$ marginally exceeds the ±0.5 $m{\cdot}s^{-1}$ benchmark, indicating a tendency for TAPM to slightly under-predict wind speeds on average. The time series (Figure 12), scatter plots (Figure 13), and monthly bias distributions (Figure 14) suggest this under-prediction is broadly consistent across the year rather than being confined to a particular season, pointing to a systematic offset rather than a structural modelling deficiency. Such a modest negative bias in wind speed is not uncommon for TAPM in complex terrain environments and does not preclude use of the modelled meteorology for dispersion assessment purposes. Notably, a negative wind speed bias is conservative with respect to atmospheric dispersion modelling with lower modelled wind speeds reducing the dilution of emitted pollutants, producing higher predicted ground-level concentrations. The modelled meteorology is therefore considered appropriate for use in CALPUFF dispersion modelling for this assessment.

A meteorological monitoring station is to be installed at the Mine Site as part of the broader environmental monitoring program. Once a sufficient on-site observational record has been collected, it is proposed that a site-specific evaluation of the CALMET-modelled wind climatology be undertaken to supplement the TAPM assessment presented here. As the modelled meteorological year (2020) will pre-date the monitoring record, a strict paired hourly statistical comparison will not be practicable; instead, the evaluation would compare the frequency distributions of wind speed, wind direction, and temperature derived from the CALMET output against the corresponding distributions from the on-site observations. Broadly consistent distributions would provide confidence that the 2020 modelled meteorology is representative of typical conditions at the Mine Site.

Table 9 TAPM model performance evaluation

Parameter	Mean bias	MAE	RMSE	IOA (d)	Pearson r
Wind speed (m·s^{-1})	-0.734	1.350	1.711	0.818	0.726
Wind direction (°)	-7.888	34.994	55.057	0.909	-
Temperature (°C)	-0.261	2.558	3.223	0.938	0.912

Table 10 TAPM model performance – pass/fail assessment

Parameter	Mean bias		IOA (d)	
	Value	Assessment	Value	Assessment
Wind speed (m·s^{-1})	-0.734	Fail	0.818	Pass
Wind direction (°)	-7.888	Pass	0.909	Pass
Temperature (°C)	-0.261	Pass	0.938	Pass

Figure 11 Modelled and observed meteorological data – Glen Innes Airport AWS, 2020

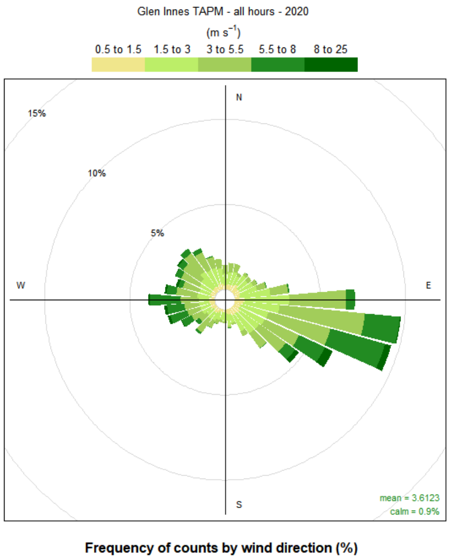
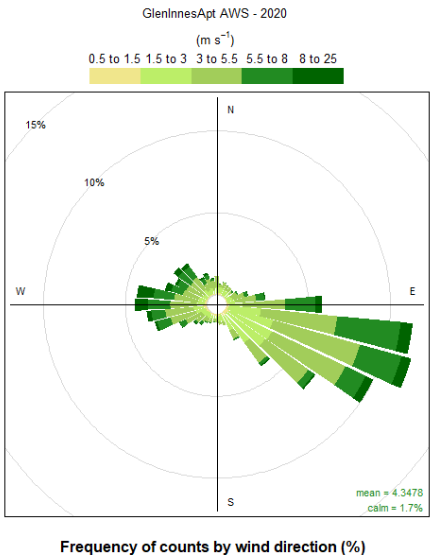
TAPM generated windrose	Observations at Glen Innes Airport AWS
	

Figure 12 TAPM modelling vs BoM Glen Innes AWS observations, 2020 (1)

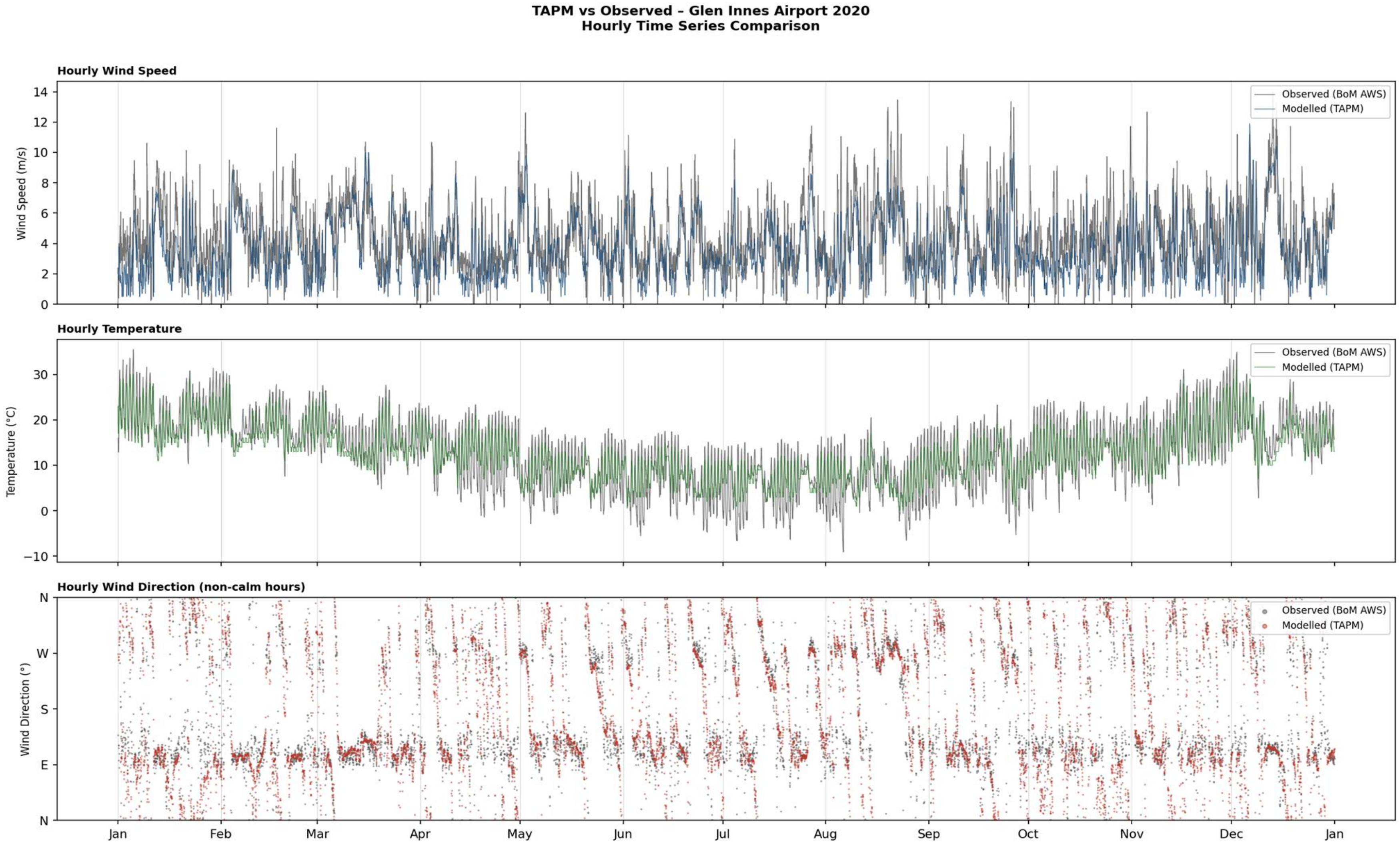


Figure 13 TAPM modelling vs BoM Glen Innes AWS observations, 2020 (2)

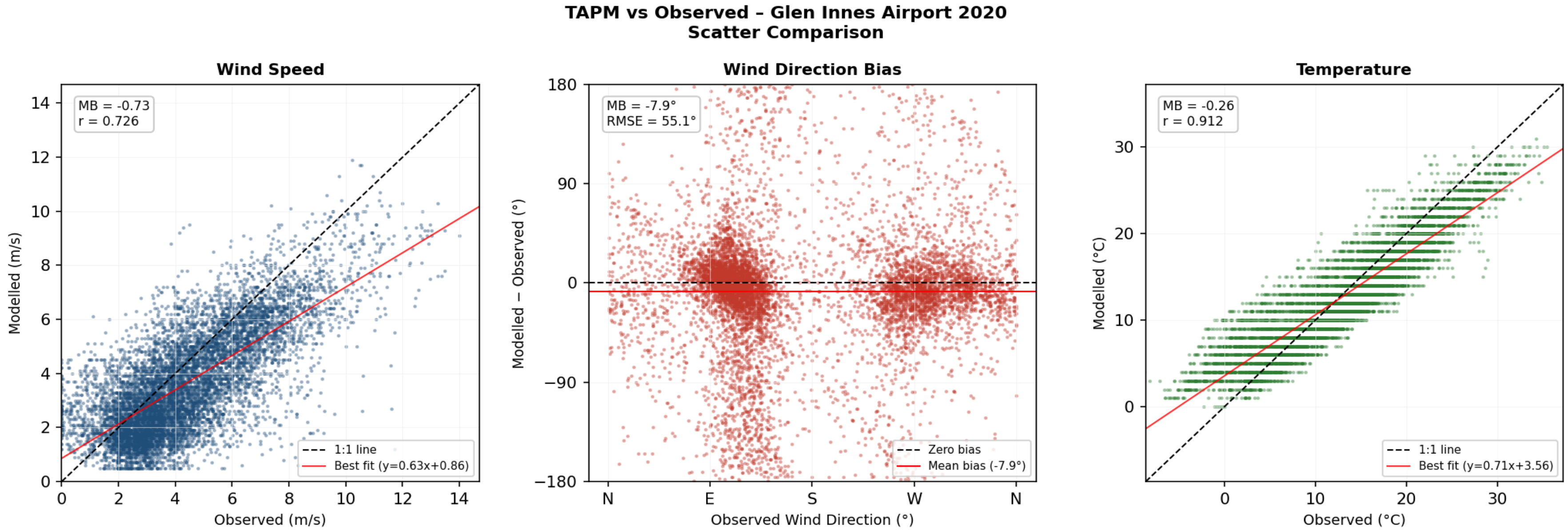
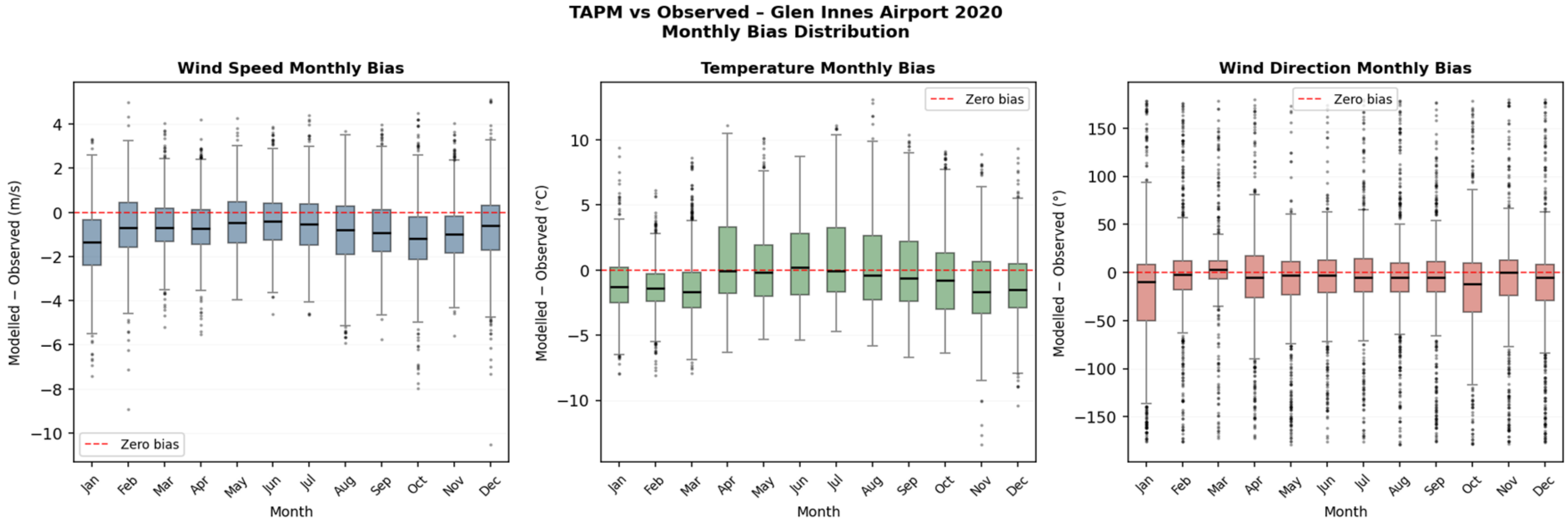


Figure 14 TAPM modelling vs BoM Glen Innes AWS observations, 2020 (3)



An example image of the modelled meteorological conditions applied in the dispersion modelling assessment is presented as Figure 15. This represents a 1-hour period, of the total 8 760 hours modelled. The figure clearly shows the influence of terrain on the modelled wind fields, providing confidence that the resolution and parameters adopted are suitable.

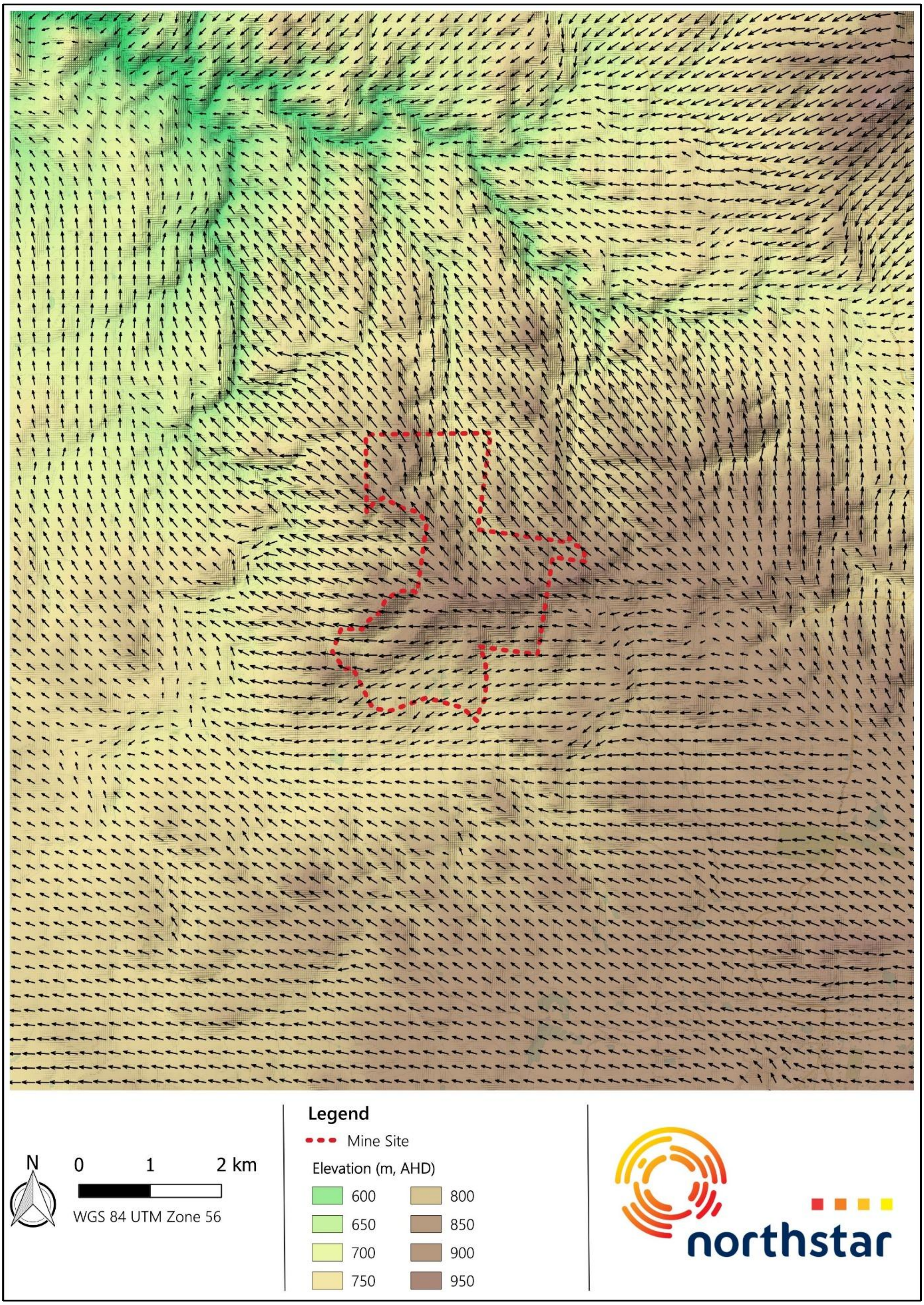
Table 11 shows the parameters adopted in the meteorological modelling exercise, as requested by NSW EPA.

Table 11 Meteorological parameters adopted

TAPM v 4.0.5	
Modelling period	1 January 2020 to 31 December 2020
Centre of analysis	367 547 mS, 6 733 991 mN (UTM Coordinates)
Number of grid points	50 × 50 × 25
Number of grids (spacing)	4 (30 km, 10 km, 3 km, 1 km)
Terrain	AUSLIG 9 second DEM
Data assimilation	No data assimilation
CALMET	
Modelling period	1 January 2020 to 31 December 2020
South-West corner of analysis	350 500 mS, 6 738 500 mN (UTM Coordinates)
Meteorological grid domain (resolution)	95 km × 95 km (200 m)
Vertical resolution (cell heights)	10 (0 m, 20 m, 40 m, 80 m, 160 m, 320 m, 640 m, 1200 m, 2000 m, 3000 m, 4000 m)
Data assimilation	No-obs approach using TAPM – 3D.DAT file
TERRAD	6
IEXTRP	1
BIAS (NZ)	N/A[a]
R1 and R2	N/A[a]
RMAX1 and RMAX 2	N/A[a]
Terrain inputs	SRTM 1 (Global 30 m v3) Tile S30 E151
Land Use inputs	GLCC (Global ~1 km)

Note: a No-obs approach using TAPM 3D.dat file

Figure 15 Example of wind field characterisation applied in dispersion modelling



3.8. Issue 8: CALPUFF model configuration lacks transparency

NSW EPA recommended:

1. *The Proponent provide information of the CALPUFF configuration settings and particle size and distribution settings used in the modelling.*

The requested parameters are presented in Table 12 and Table 13.

Table 12 Key CALPUFF dispersion modelling switches

Option	Parameter	Recommended value (Barclay, Scire, 2011)	Adopted value
Vertical distribution used in the near field	MGAUSS	1	1
Terrain adjustment method	MCTADJ	3	3
Sub grid-scale complex terrain	MCTSG	0	0
Near-field puffs modelled as slugs	MSLUG	0	0
Transitional plume rise	MTRANS	1	1
Stack tip downwash	MTIP	1	1
Method to compute plume rise	MRISE	1	1
Method to simulate building downwash	MBDW	2	1[a]
Vertical wind shear modelled above stack top	MSHEAR	0	0
Puff splitting allowed	MSPLIT	0	0
Chemical transformation	MCHEM	1	0[b]
Aqueous phase chemistry	MAQCHEM	0	0
Wet removal modelled	MWET	1	1
Dry deposition modelled	MDRY	1	1
Plume tilt	MTILT	0	0
Dispersion coefficients	MDISP	2	2
σv / σθ and σw measurements	MTURBVW	3	3
Dispersion when turbulence data are missing	MDISP2	3	3
Lagrangian time scale for σy	MTAULY	0	0
Turbulence σv and σw profiles	MCTURB	1	1
PG σy , σz adjusted for roughness	MROUGH	0	0
Partial plume penetration (elevated inversions)	MPARTL	1	1
Partial plume penetration (buoyant area sources)	MPARTLBA	1	0[c]
Strength of temperature inversion	MTINV	0	0
Probability density function (PDF)	MPDF	1	1
Sub-Grid TIBL model used for shoreline	MSGTIBL	0,1	0
Boundary conditions modelled	MBCON	0	0
Fog module	MFOG	0	0
	SVMIN	0.2	0.5[d]

Option	Parameter	Recommended value (Barclay, Scire, 2011)	Adopted value
Minimum turbulence velocities, sigma v and sigma w for stability class over land and water	SWMIN	default	default

Notes:

a: No buildings modelled

b: Regarding chemical transformation (MCHEM), the MESOPUFF II scheme was not enabled because it is intended for long-range (10 – 20 km+) transformation of SO_2 and NO_X species, which is not required.

c: The partial plume-penetration option (MPARTLBA) was not used, as it is designed for very hot, buoyant area sources (such as forest fires) and is not applicable with regard to the source emission characteristics considered in this AQIA.

d: The SVMIN parameter was set to 0.5 rather than the recommended 0.2 as calm or stagnation conditions are not a defining feature of the Mine Site, and the default lateral plume spread is suitable for the meteorological conditions being modelled.

Table 13 Particulate parameters adopted in dispersion modelling

Species	Geometric mass mean diameter (μm)	Geometric standard deviation (μm)
Coarse	20	1.24
Intermediate	5	1.24
Fine	1.25	1.24

Note: following modelling of individual particulate species, impacts summed (Coarse + Inter + Fine = TSP, Inter + Fine = PM_{10}, Fine = $PM_{2.5}$)

3.9. Issue 9: Source apportionment and arsenic requires clarification and investigation

NSW EPA recommended:

The Proponent:

1. Provide additional information on how the arsenic averages were determined for the site.

2. Investigate whether a more refined approach in using source apportionment for the arsenic predictions demonstrates compliance with the IAC.

3. Identify the meteorological conditions that are conducive to arsenic exceedances for future incorporation in the TARP.

As outlined in section 5.3.2 of the AQIA, a detailed review of arsenic levels in ore and waste material in different locations throughout the proposed Southern and Northern open cuts has been performed by the Applicant. In addition, the potential arsenic content of ore and tailings streams has been reviewed by the Applicant. A detailed summary of these assessments is provided in Appendix E of the AQIA.

A summary of the arsenic content of materials at the Mine Site assumed in the emissions estimation is presented in Table 14. This applies specific arsenic contents to all sources assumed in dispersion modelling which is a refined approach.

The meteorological conditions conducive to predicted arsenic boundary exceedances are currently being reviewed for incorporation into the Project TARP. The current modelling outputs provide total cumulative arsenic impacts at and beyond the assessment boundary. Identification of the specific meteorological conditions associated with exceedance events requires further interrogation of the modelled time series to extract the wind speed, wind direction, and atmospheric stability conditions coinciding with predicted exceedance hours. This analysis is ongoing and the outcomes will be incorporated into the TARP prior to construction commencement.

Updated dispersion modelling of predicted arsenic impacts during Scenario 1 (Year 3 operations) is presented in Figure 16. The updated modelling indicates:

- A significant reduction in the predicted area of exceedance to the east of the Mine Site, with the exceedance moving further away from receptors 167 and 168.
- A reduction in the affected area to the west of the Mine Site.
- A reduction in total off-site impacts from 134 ha (original AQIA) to 40 ha (updated modelling), a reduction of 70 %.

The discussion presented in section 6.5.2.1 of the original AQIA is noted, with regards to the likelihood of transitory exposure, the terrain, and planning controls in these areas. The discussion relating to the bioavailability and bio-accessibility of arsenic as provided in section 6.5.2.2 of the AQIA is also requested to be reviewed. Where this is considered, the bioavailable concentration of arsenic relevant to acute (and chronic) inhalation exposures would be lower than modelled in this AQIA. As the calculated acute Hazard Index is low and acceptable, as outlined in the HHRA, this aspect adds an additional margin of safety to the conclusions.

Figure 16 Updated 99.9th percentile 1-hour arsenic concentration predictions

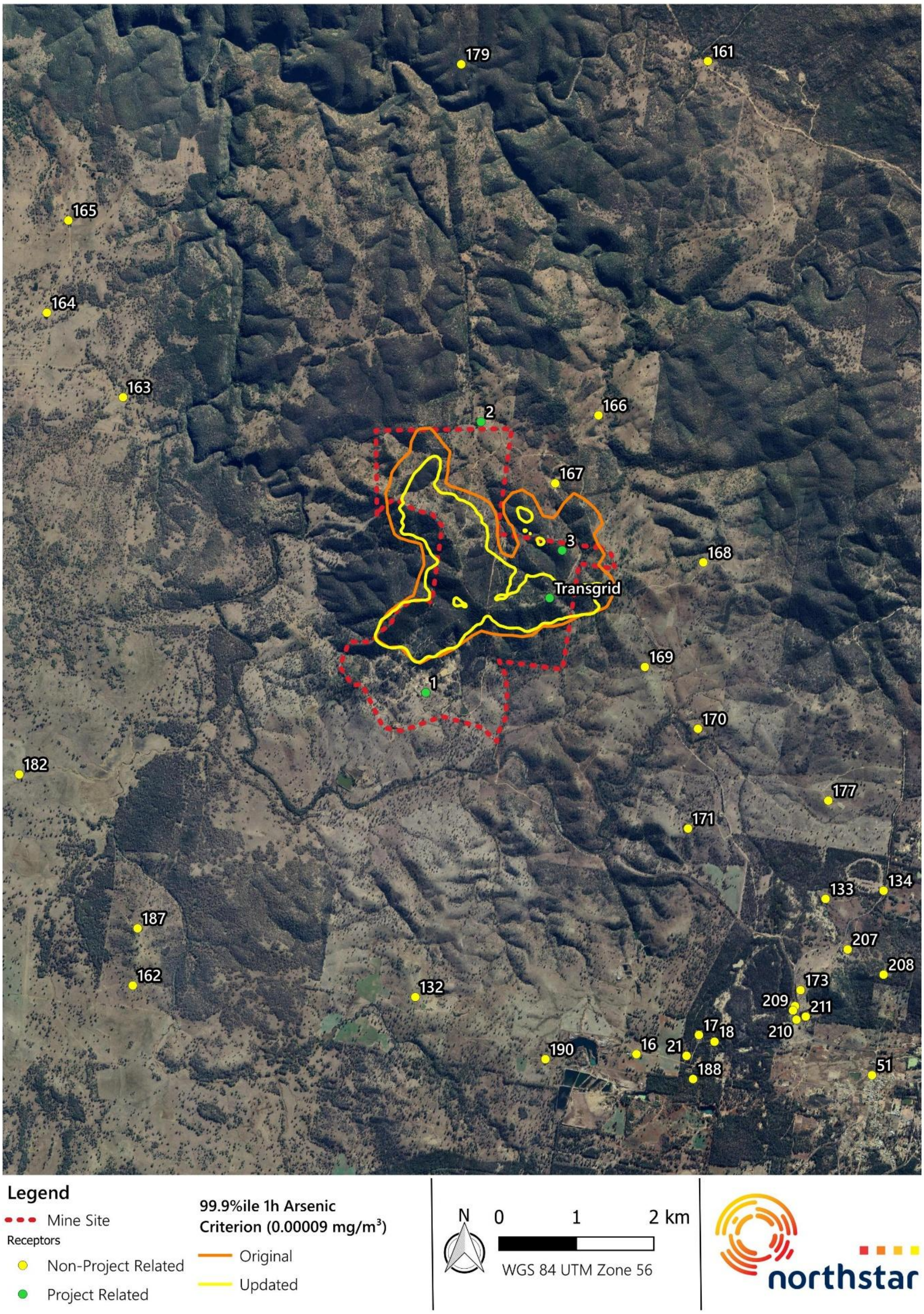


Table 14 Adopted arsenic concentrations

Location	Source name	Data source	Arsenic (mg·kg^{-1})
Southern Open Cut	Vegetation removal and soil stripping	TMPL soils data	2 026
	Loading soil to haul trucks	TMPL soils data	2 026
	Unloading of soil at soil stockpile	TMPL soils data	2 026
	Drill	Average South (ore), South (waste)	2 978
	Blast	Average South (ore), South (waste)	2 978
	Waste rock loaded to haul truck	South (waste)	1 663
	Unloading of waste rock at Southern WRE	South (waste)	1 663
	Pushing waste rock at Southern WRE	South (waste)	1 663
	Ore loaded to haul truck	South (ore)	4 293
	Unloading of ore at ROM Pad (38% direct tip, 62% to ROM pad)	South (ore)	4 293
Northern Open Cut	Vegetation removal and soil stripping	TMPL soils data	86
	Loading soil to haul trucks	TMPL soils data	86
	Unloading of soil at soil stockpile	TMPL soils data	86
	Drill	Average North (ore), North (waste)	2 100
	Blast	Average North (ore), North (waste)	2 100
	Waste rock loaded to haul truck	North (waste)	489
	Unloading of waste rock at Northern WRE	North (waste)	489
	Pushing waste rock at Northern WRE	North (waste)	489
	Ore loaded to haul truck	North (ore)	3,710
	Unloading of ore at ROM Pad (38% direct tip, 62% to ROM pad)	North (ore)	3,710
Processing plant	FEL on stockpiles loading primary crusher (62% from ROM pad)	Average North (ore), South (ore)	4 002
	Primary crushing	Average North (ore), South (ore)	4 002
	Secondary crushing	Average North (ore), South (ore)	4 002
	Conveyor to screening building	Average North (ore), South (ore)	4 002

Location	Source name	Data source	Arsenic (mg·kg^{-1})
	Screening	Average North (ore), South (ore)	4 002
	Conveyor to fine ore stockpile (all ore less coarse rejects)	Average North (ore), South (ore)	4 002
	Loading fine ore stockpile	Average North (ore), South (ore)	4 002
	Ore reclaim conveyor to HPGR screening	Average North (ore), South (ore)	4 002
	HPGR screening	Average North (ore), South (ore)	4 002
	Conveyor to HPGR crushing	Average North (ore), South (ore)	4 002
	HPGR crushing	Average North (ore), South (ore)	4 002
	Conveyor to HPGR rejects screening building (all ore less coarse rejects and coarse tailings)	TMPL - met testwork	2 200
	Conveyor to CDA (coarse rejects, coarse tailings, fine tailings)	TMPL - met testwork	2 200
	Unloading rejects at CDA	TMPL - met testwork	2 200
	Wet processing (all ore less coarse rejects, fine rejects, coarse tailings)	Assumed to be zero (wet processing)	0
	Concentrate bagging	Assumed to be zero (arsenic removed)	0
	Loading of bagged concentrate to trucks	Assumed to be zero (arsenic removed)	0
	Pushing rejects at CDA	TMPL - met testwork	2 200
	Wet tailings pumped as slurry to RSF	Assume zero, pumped in closed pipe as slurry	0
Soil stockpiles (SOC)	Wind Erosion 1	TMPL soils data	2 026
Actively disturbed SOC	Wind Erosion 2	South (waste)	1 663
Actively disturbed Southern WRE	Wind Erosion 3	South (waste)	1 663
Soil stockpiles (northern soil stockpile)	Wind Erosion 4	TMPL soils data	86
Actively disturbed NOC	Wind Erosion 5	North (waste)	489
Actively disturbed Northern WRE	Wind Erosion 6	North (waste)	489

Location	Source name	Data source	Arsenic ($mg \cdot kg^{-1}$)
ROM and Processing Area	Wind Erosion 7	TMPL construction material data (assumes erosion of hardstand area only)	86
Co-Disposal Area	Wind Erosion 8	TMPL - met testwork	2 200
Southern Open Cut	Road 1 (10 sources) Haulage of soil to soil stockpile	TMPL construction material data	86
	Road 2 (6 sources) Haulage of waste rock to Southern WRE	TMPL construction material data	86
	Road 3 (9 sources) Haulage of ore to ROM Pad from SOC	TMPL construction material data	86
Northern Open Cut	Road 4 (13 sources) Haulage of soil to soil stockpile	TMPL construction material data	86
	Road 5 (7 sources) Haulage of waste rock to Northern WRE	TMPL construction material data	86
	Road 6 (11 sources) Haulage of ore to ROM Pad from NOC	TMPL construction material data	86
Processing plant	Road 7 (15 sources) Haulage of concentrate offsite	TMPL construction material data	86

APPENDIX A

Particulate matter control review

MEMORANDUM

TO:	Tony Truelove, Rob Kidd, Peter Miers	**COMPANY:**	First Tin PLC
FROM:	Manas Sinhababu	**DATE:**	23/03/26
CC	Cameron Bain, Steven Arnott, Kevin Pickworth	**PROJECT NO:**	953

SUBJECT: Dust Management – Basis of Design

This document identifies feasible dust-mitigation options and recommends a preferred design basis for the crushing, screening, conveying, stockpiling and HPGR areas.

This memo incorporates the findings of the dust extinction moisture content (DEMC) testwork (BME2603, Rev 1).

Wet suppression, dry dust extraction and mechanical ventilation options have been evaluated. Based on the DEMC results and operational constraints, the recommended strategy is:

Water/Misting Controlled system is recommended:

- **Wet suppression** at crushers, conveyors, screens, stockpile feed and HPGR discharge
- **Dry extraction** not used
- **No water sprays and no dry extraction in the reclaim tunnel, a dedicated ventilation fan** in the reclaim tunnel for dilution and visibility control

Total Utilities Required for the Water/Misting Controlled System is approximately:

- **Water:** ≈222 m^3/d. This water will be lost.
- **Power:** ≈100 kW (pump) + ≈ 7.5 kW (tunnel fan)
- **Total installed power:** ≈110 kW

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1 PURPOSE

This document identifies feasible dust-mitigation options and recommends a preferred design basis for the crushing, screening, conveying, stockpiling and HPGR areas.

2 KEY DUST SOURCES IN THE CRUSHING, SCREENING AND HPGR CIRCUIT

- Primary jaw crusher feed hopper
- Crusher drop points
- Transfer points on conveyors
- Screens
- Stockpile loading
- Reclaim tunnel
- HPGR
- Dust lift off from conveyors and stockpile
- Vehicle movement on unsealed roads
- Wind erosion from exposed surface

3 DUST SUPPRESSION PHILOSOPHY

The following controls are envisaged and discussed.

3.1 Engineering Controls (Primary Controls)

The following engineering basis of design is recommended:

3.1.1 Plant Design & Enclosures

- Enclose crusher feed hoppers, conveyor head/tail ends, and screening units to contain dust.
- Install covers over conveyors to reduce wind entrainment and dust lift off.
- Minimise free-fall heights at transfer points and ensure material lands at similar velocity to receiving belt.
- Drop material at the centre of the belt at the same velocity as the receiving belt.

3.1.2 Wet Suppression Systems

Dust control for the crushing and grinding processes is achieved primarily through high-pressure wet suppression.

Pressure can be low to high. When the dust source is close to the nozzle, then low pressure water spray will work, when dust is a long distance away then high pressure water is needed to get penetration and have sufficient energy.

Air-water nozzles are ok for enclosed transfer chutes but need a lot of air and maintenance to clean nozzles and compressor systems incl. pipelines. Hence, this is not used.

DEMC testwork (BME2603) determined:

- DEMC (sub-6.3 mm fraction): 3.42% wb
- Equivalent bulk DEMC (sub-32 mm): ≈2.2% wb

All wet-suppression systems shall be designed and operated such that cumulative moisture addition to the ore does not exceed 2.2% wb bulk at any point in the circuit. Exceeding this limit increases the risk of chute blockage, screen blinding and HPGR feed instability.

Generally, water only dust suppression systems don’t add too much water to the ore but Bulk Ore Conditioning (BOC) does. As the conveyors are covered and short length (unlike over land conveyor) BOC is not used.

Needs a method to monitor moisture content such as online moisture analyser.

Wet suppression is, therefore, applied only where moisture can be tolerated and controlled:

dump hopper, crusher discharge, conveyor transfers, screen feed, HPGR discharge.

Note: water suppression on a stockpile has been known to cause issues with too much water being added to the volume of ore under the head pulley or suppression system causing flow problems. Water spray system tends to run constantly so the volume of water that penetrates the stockpile can become excessive.

Wet suppression is not used in the reclaim tunnel.

3.1.2.1 Dump Hopper

Crushing station is the biggest emitter of dust in the whole plant. Due to the large area, some containment is possible, but a complete sealing of the crushing station is not possible. The operators do not like sealing of the drop points as it does not allow inspection and maintenance.

Spraying water on the ore to coat the outer surface helps to prevent dust liberation. Applying water to the ore before it enters the crushing unit is most effective.

Needs to ensure the water is mixed, wetting the surface doesn't stop the dust and coarse water droplets installed on the hoppers to wet the surface of ore are not effective. A mist curtain to be created over the opening to capture airborne dust from the entrained and displaced air released.

A significant amount of water is needed at very high pressure (typically 30 to 100 bar) at the dump hopper. Generally between 100 to 150 bar is most effective over a large bin to produce a fine mist with plenty of energy.

Low pressure dry fog system calcifies and clogs the nozzles, hence self-cleaning high-pressure fine misting system is recommended.

A multistage pump is needed to achieve the required pressure as it cannot be achieved with air/water mixture which is way above the limit of standard air compressors.

The other significant issue with air/water nozzles is that the velocity and energy of the mist is low and gets blown away too easily in open environments from high velocity air flow.

The description of the system is as follows:

- Generally, a series of stainless-steel spray bars or blocks are used for dump hoppers on three sides. This allows some flexibility to turn nozzle banks on and off and easier maintenance. Refer to Figure 1 for a typical set up.
- Fitted with multiple nozzles spaced evenly (e.g., every 300 mm).
- Nozzles point inward and downward to intercept the falling ore stream.
- Used of 0.6 - 0.8 mm nozzles with water pressure of 150 barg consume about 1.5-2.5 Lit/m per nozzle.
- The goal is to create a curtain of fine droplets that capture dust as the truck tips.

The downsides of the system are as follows:

- Operator cannot see the hopper and determine if it is full or empty.
- Very high-pressure pump.
- Generally, needs plunger type high pressure pumps and the quality of the water is important. Water shall be clean and filtered to protect the pump. High calcium in the water can be problematic for blockages of valves, however, not too much of an issue with high pressure nozzles as they self-clean.
- High water consumption, at times difficult to source.
- Wet sprays may be unsuitable for high-clay ores due to risk of chute/plant blockage.

Engineering control is required to automatically activate the spray by using:

- Truck detection sensors / Weight sensors / Vibration switches.
- Spray turns on only during dumping to save water.
- Minimise too much water soaking into the material.
- Water mist tends to coats equipment and structures nearby so sludge can build-up on walk ways and equipment requiring periodic wash downs.

Figure 1 - Fine Mist Spray on a Dump Hopper

3.1.2.2 Jaw and Cone Crusher Discharge

When ore drops from the jaw crusher discharge chute onto the crusher product conveyor, a dust plume forms at the point of impact.

A water spray system at the jaw crusher discharge point on the conveyor belt is critical for suppressing airborne dust and minimizing carry back. The system uses atomized water or spray bars to dampen material without oversaturation.

A high-pressure low-volume (HPLV) water spray system is designed to intercept that plume right at the source.

A horizontal spray bar (usually 25–50 mm stainless steel pipe) is mounted just below the jaw crusher discharge point and spans the whole width of the conveyor belt.

Location of spray block/bar is important for protection of rocks. Using high pressure sprays allows to place nozzle away from the danger zones and point it towards the dust.

The bar is fitted with multiple nozzles angled to create a mist curtain across the falling ore stream. A straight pipe with 3–6 small nozzles pointing inward/downward, bolted to the chute frame.

Water spray reduces dust emissions by up to 90% by clumping particles.

Too much water causes material to stick in feeders and increases blinding, so systems must be tuned properly.

Based on BMEA testwork (Report BME2603), the dust extinction moisture content (DEMC) for the sub-6.3 mm fraction of the crushed tin ore is 3.42% wb, corresponding to approximately 2.2% wb on a bulk sub-32 mm basis. All wet-suppression systems shall therefore be tuned so that cumulative moisture addition remains below 2.2% wb bulk.

Note: Pointing sprays to dead material in chutes as this material will get too wet.

Moisture addition at the crusher discharge sprays shall be controlled to remain below this limit. Exceeding DEMC risks chute blockage, screen blinding and HPGR feed instability, while operating significantly below DEMC increases airborne dust.

Using retractable spray bars can simplify maintenance in high-particulate environments.

For optimal performance, these systems often combined with conveyor cleaners to wash away residue, requiring careful tuning of water pressure and nozzle angle.

Sprays typically activate:

- When the crusher is running, or
- When the belt is running, or
- When a level switch detects material in the chute.

This prevents unnecessary water use.

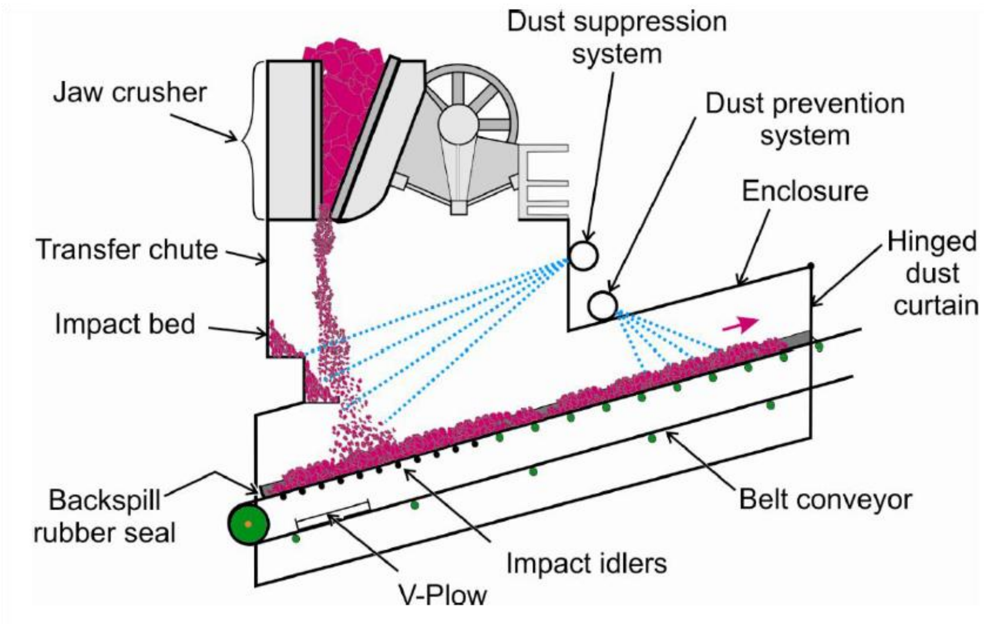

Figure 2 - Water Mist at Jaw Crusher Discharge

3.1.2.3 Water Mist Dust Suppression at Conveyor Feed & Discharge Points.

Dust is generated at feed points by:

- Mainly if air entrainment from free fall that forces this air out of the bulk solid at impact inside chute and belts
- Impact of material falling onto the belt
- Turbulence inside the chute
- Rebound and splash from ore transfer

Water mist (high-pressure atomised mist) systems are one of the most effective and low-moisture dust-suppression methods for conveyor transfer points. They work by producing ultra-fine droplets that bind with airborne dust, causing particles to agglomerate and fall out of suspension.

- High-pressure pumps (>30 bar) atomise water into fine droplets that behave like fog.
- These droplets collide with airborne dust, increasing particle mass and causing rapid settling.
- As the mist is airborne rather than sprayed directly onto ore, material moisture is minimally affected.
- This reduces risks of conveyor slippage, chute blockages, and wet carry back.

Water-mist placement strategy:

- Install misting nozzles inside the chute or at the chute mouth.
- Use directional fogging to fill the airspace where dust becomes airborne.
- Maintain a “fog curtain” across the chute opening to prevent escape.
- Integrate with belt skirting and enclosure for maximum containment.

Benefits:

- Captures respirable dust (<10 µm) at the point of generation
- Reduces dust lift-off without wetting the ore

Dust is generated at discharge points by:

- Material free-fall
- Belt speed differences
- Air entrainment as material leaves the head pulley

Water-mist placement strategy:

- Position misting bars or fog nozzles around the discharge hood.
- Create a fog envelope that intersects the dust plume trajectory, and this mist is then entrained into the material flow.
- Implement automated controls integrated with conveyor operations to optimise water usage and prevent waste.

Benefits:

- Suppresses airborne dust before it spreads

- Improves visibility and air quality around transfer stations

Large stilling chambers and the need to seal the chute as much as possible from the head chute to the loading zone. Large stilling chambers allows dust and mist to mix and drop out of suspension and back onto the belt using rubber curtains inside the stilling chamber. Good belt support and skirt sealing is important.

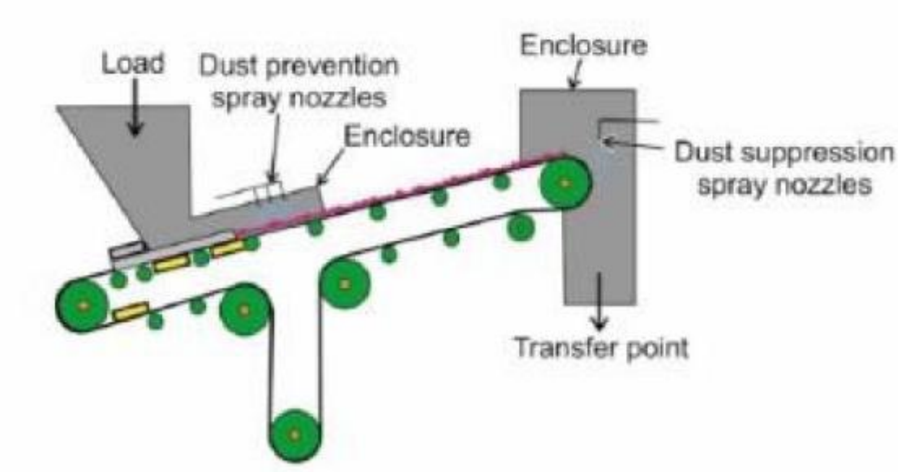

Figure 3 - Dust Suppression Spray Nozzles on Conveyor Feed and Discharge Point

Given the measured DEMC, spray flow rates and duty cycles at conveyor feed and discharge points shall be tuned to prevent cumulative moisture addition from exceeding 2.2% wb bulk, particularly on conveyors feeding the stockpile and HPGR.

3.1.2.4 Telescopic Chute or Water Mist Suppression at Stockpile

Stockpile feed points are significant dust generators due to the long free-fall distance from the elevated conveyor, high material velocity, and wind entrainment around the discharge zone.

As ore leaves the head pulley, a dust plume forms from particle impact, air displacement, and dispersion across the stockpile surface.

A telescopic / super chute can be used to reduce drop height and shield the discharge from crosswinds.

This chute is subjected to erosion from the falling rock and induce load on the cantilever type support structure.

If the chute is designed well with a nice deflector to contain the material and keep the material away from the super chute, then it’s a viable and recommended option when designed correctly.

This is a recommended option.

Figure 4 - Telescopic Chute

Alternative water mist curtain can be used as per following:

High-pressure atomised misting nozzles should be installed around the conveyor discharge hood to create a fog curtain that intersects the falling ore stream and captures airborne dust without over-wetting the material.

Due to the large distances and high cross winds, generally the system needs to operate at pressures around 150 bar. When the wind gets up above 3m/s, even high-pressure systems are not very effective as the mist is blown away easily.

These systems work well if wind velocity is very low but it can be seen in Figure 5, there is a lot of water added to the stockpile just below the head chute that can cause flow issues with the stockpile and vibro feeders, i.e. build-up on the rear of the feeder.

Figure 5 - Water Mist Dust Suppression at Stockpile

This water spray is not a recommended option.

3.1.2.5 Total Estimated Water Consumption

a) Basis of Estimation

For any spray system (or group of nozzles):

Equation 1 - Estimated water consumption

$$Q_{\text{daily}} = \frac{Q_{\text{inst}} \times H \times D}{1000}$$

Where:

- Q_{daily} = daily water use in m3/d
- Q_{inst} = instantaneous flow in L/min (sum of all nozzles on that system)
- H = operating hours per day (12 or 24 h/d)
- D = duty factor (fraction of time the system is running, e.g. 1.0 = continuous, 0.3 = 30% of the time)
- 1000 = converts liters to cubic meters

b) 12-hour circuit (crushing, screening, stockpile feed)

Table 1 – Water Required for 12 hrs Circuit

Spray Location	**Basis**	**Calculation**	**Result**
ROM dump hopper (3111-BN-001)	Assuming 0.6 to 0.8mm nozzles with water pressure of 150 bar consume about 1.5-2.5 L/min/per nozzle at 30% duty	Hopper length 7m Hopper width 9m Nozzle spacing: 300mm Qty of nozzles (3 sides): 75 Water required: 2.0 L/min X 75 nos X 30% of duty X 60 min X 12 Hrs / 1000 m3	108 m^3/d
Vibrating grizzly discharge (3111-GR-002→ 3111-CV-001):	assuming 20 L/min at 50% duty at 30 bar pressure	20 L/min X 50% of duty X 60 min X 12 Hrs / 1000 m3	7.2 m^3/d
Jaw crusher discharge (3111-CR-001 → 3111-CV-001):	Assuming 6 nozzles @ 2.0 L/min/nozzle continuous at 30 bar pressure	2.0 L/min X 6 no's X 100% of duty X 60 min X 12 Hrs / 1000 m3	8.6 m^3/d
Screen feed (3113-SC-001 → 3113-SC-002):	Assuming 8 nozzles (300mm across 2.4m) @ 2.0 L/min/nozzle continuous at 30 bar pressure	2.0 L/min X 8 nose X 2 screens X 100% of duty X 60 min X 12 Hrs / 1000 m3	23 m^3/d

Spray Location	Basis	Calculation	Result
Sizing screen to product conveyor (3113-SC-001/002 →3112-CV-001/ 3113-CV-001)	4 Discharge points each assuming 10 L/min continuous at 30 bar pressure	10 L/min X 4 nos X 100% of duty X 60 min X 12 Hrs / 1000 m3	28.8 m³/d
Secondary crusher discharge to product conveyor (3112-CR-001/002 → 3112-CV-002)	2 Discharge points each assuming 10 L/min continuous at 30 bar pressure	10 L/min X 2 nos X 100% of duty X 60 min X 12 Hrs / 1000 m3	14.4 m³/d
Subtotal 12 h circuit:			**190 m3/d**

c) 24-hour circuit (Reclaim conveyor, HPGR discharge)

Table 2 - Water Requirement 24 Hour circuit

Spray Location	Basis	Calculation	Result
Reclaim conveyor to HPGR feed conveyor (3114-CV-001 → 3115-CV-001)	1 Discharge point assuming 10 L/min continuous at 30 bar pressure	10 L/min X 1 nos X 100% of duty X 60 min X 24 Hrs / 1000 m3	14.4 m³/d
HPGR discharge to conveyor (3115-CR-001 → 3115-CV-002)	Assuming same as jaw crusher 6 nozzles @ 2.0 L/min/nozzle continuous at 30 bar pressure	2.0 L/min X 6 nos X 100% of duty X 60 min X 24 Hrs / 1000 m3	17.2 m³/d
Subtotal 24 h circuit:			**32 m3/d**

d) Total dust-suppression water demand: ≈**190 + 31 =222 m³/d**.

For water balance suggest to use (20% more): 260 m³/d

A moisture test shall be completed during operation to confirm that this water addition does not increase ore moisture above the bulk DEMC of 2.2% wb.

Water quality shall meet the minimum requirements for high-pressure misting systems (filtered to <50 µm).

3.1.2.6 Total Estimated Power Consumption

Depending on the pressure requirement and geographic location few pumps will be required to maintain spray pressure and avoid running high pressure lines.

The following pumps are considered:

Table 3 - Total Power Estimation

			Dump Hopper	Crusher Area (Others)	HPGR Area	Screen Area
Flowrate		m3/d	108	59	32	32
Hours of operation		hr	12	12	24	12
Average flow rate		m3/h	9.0	4.9	1.3	2.7
Pump Differential Head		bar	150	30	30	30
		m	1500	300	300	300
S.G			1	1	1	1
Power - Hydraulic	QXSGXgXH / 3600	kw	36.79	4.02	1.09	2.18
Q/H			0.01	0.02	0.00	0.01
Pump Efficiency	Consider eff 70% for Q/H < 1.5; 85% for Q/H > 1.5		0.7	0.7	0.7	0.7
Power - Rated		kw	52.55	5.74	1.56	3.11
Power Factor (API 610 Equivalent)			1.15	1.15	1.15	1.15
	<22kw, 125% of rated power					
	22 - 55kw, 115% of rated power					
	>55kw, 110% of rated power					
Power - Motor Calculated		kw	60.44	6.60	1.79	3.58
Power - Motor Selected		kw	75	15	5.5	7.5
Total installed Power		Kw	~ 100 KW			

3.1.3 Dust Extraction / Ventilation (Dry Extraction Systems)

Dry systems is not used for the screen area as the screens are with the large 35mm apertures and they are not expected to blind using water spray.

Dry extraction is not required in the reclaim tunnel and has been eliminated from that location.

a) Reclaim Tunnel

The reclaim tunnel will not use water sprays or dry extraction. Instead, dust will be controlled using a dedicated ventilation fan providing approximately 3,000 m^3/h of airflow along the tunnel. This provides adequate dilution and visibility control without adding moisture or requiring baghouse infrastructure.

A typical installed motor power of ≈7.5 kW is sufficient.

3.1.4 Spillage & Fines Management

a) Design chutes and skirting to minimise spillage.
b) Provide safe access for cleaning accumulated fines.

3.2 Operational Controls

3.2.1 Watering & Road Management

- Regular watering of haul roads and plant areas.
- Use dust palliatives or road stabilisers where water is insufficient.

3.2.2 Stockpile Management

- Maintain moisture content in stockpiles.
- Minimise drop heights during stacking.

Stockpile moisture shall be managed to remain at or slightly above the DEMC threshold for effective dust control, while ensuring that the average bulk moisture does not exceed 2.2% wb to maintain reclaim and downstream handling performance.

3.2.3 Housekeeping

- Routine removal of accumulated dust and spillage.
- Maintain plant to prevent leaks, worn skirting, or damaged covers.

3.3 Administrative Controls

- Implement dust monitoring programs (personal and static).
- Conduct routine airborne dust monitoring (AS 2985 for respirable dust, AS 3640 for inhalable dust).
- Train workers on dust hazards and control measures.
- Ensure systems are normally ON by default and require intervention to turn OFF.

4 RECOMMENDATION AND MOVING FORWARD

Comparison of both systems are as follows:

4.1 High-Pressure Wet Suppression

- Best suited for open, high-energy dust sources (ROM dump hopper, crusher discharge, screens with the large apertures, conveyor transfers).
- Creates a fine-mist curtain that captures airborne dust at the moment of generation.
- Requires ~222 m^3/d of water across all spray points/.
- Supported by four pumps of total 100 kW installed power.
- Simple, robust, and highly effective (up to 90% dust reduction).
- Adds moisture to ore; must remain below DEM to avoid blockages.
- Less suitable for high-clay ores or areas where visibility is critical (e.g., dump hopper).
- Lower capital cost and moderate operating cost.

DEMC testwork (3.42% wb fines, 2.2% wb bulk) confirms that wet suppression can achieve effective dust control provided that moisture addition is controlled within this limit. Wet systems shall therefore be designed and operated with DEMC as a hard upper bound on ore moisture.

4.2 Dry Dust-Extraction (Baghouse / LEV Systems)

- Ideal for enclosed or moisture-sensitive areas.
- Maintains negative pressure to prevent dust escape; highly effective for air borne dust control.
- Not used in the plant.
- Reclaim tunnel use a ventilation fan.

4.3 Overall Comparison

- Wet suppression: Best for open, high-impact dust sources; lower CAPEX; adds moisture.
- Dry extraction: Best for enclosed or clay-sensitive areas; higher CAPEX/OPEX. Needs extensive structural modification.
- Dry and wet system cannot be used at the same location as filter bags will clog up handling moist air and fail premature.
- Recommended approach: Wet suppression at crushers, conveyor transfers, screen feed, and HPGR discharge; stockpile feed by a telescopic chute; ventilation only in the reclaim tunnel.

The DEMC values provide a quantitative basis for the Water/Misting Controlled strategy: wet suppression is applied where moisture can be tolerated and controlled below 2.2% wb bulk, while dry extraction is applied in enclosed or moisture-sensitive areas where additional water would risk exceeding DEMC or causing blockages.

4.3.1 Utilities required for the proposed Water/Misting Controlled system

4.3.1.1 For Wet Suppression

- Water: ≈222 m^3/d
- Pump power: ≈100 kW installed

4.3.1.2 For dry Extraction

- Not used

Reclaim Tunnel Ventilation

- Ventilation fan: ≈7.5 kW

4.3.1.3 Total Utilities

- Water: 222 m3/d
- Power: pumps 100 kW + tunnel vent fan 7.5 kW = say 110 kW

5 REASONABLE AND FEASIBLE DUST MITIGATION MEASURES MATRIX

Table 4 - Reasonable and Feasible Dust Mitigation Measures Matrix

Mitigation Option	**Feasible Mitigation Test**	**Justification for Adopting or Disregarding this Option**
High-pressure wet suppression at ROM dump hopper	Technically feasible; proven to reduce dust at the largest emission source; high-pressure misting effective for coarse ore under open-environment conditions.	**Adopted** – ROM hopper is the dominant dust source. High-pressure misting is essential despite water demand. DEMC-compliant operation is achievable with duty-cycle control.
Wet suppression at jaw crusher discharge	Readily installable; HPLV sprays effectively suppress impact-generated dust and are compatible with DEMC limits when correctly tuned.	**Adopted** – Critical for suppressing impact-generated dust. Moisture addition controlled to remain below 2.2% wb bulk
Wet suppression at secondary crusher discharge	Technically feasible; effective control at high-energy drop points with low operational complexity.	**Adopted** – Provides strong dust reduction with low cost and no impact on crusher performance.
Water-mist suppression at conveyor feed/discharge points (all conveyors)	Proven technology; fine mist captures airborne dust without over-wetting ore and is compatible with DEMC constraints.	**Adopted** – Essential for controlling dust at multiple transfer points. Duty-cycle and nozzle selection ensure cumulative moisture stays <2.2% wb.
Bulk ore conditioning (BOC) stations on long conveyors	Feasible where long, uncovered conveyors operate in hot or windy conditions; improves dust control without excessive moisture addition.	**Not Adopted** – Short, covered conveyors
Conveyor covers (hoods) on overland/elevated conveyors	Simple installation; reduces wind entrainment and overall dust lift-off without requiring utilities.	**Adopted** – Reduces reliance on water and improves compliance margin.
Dry extraction in reclaim tunnel	Technically feasible but requires extensive ducting and high fan power; introduces unnecessary system complexity for this application.	**Disregarded** – Not reasonably practicable. Ventilation alone provides adequate dilution and visibility control.

Mitigation Option	Feasible Mitigation Test	Justification for Adopting or Disregarding this Option
Water sprays in reclaim tunnel	Feasible but incompatible with DEMC constraints and presents a risk of material build-up and blockage.	**Disregarded** – Moisture addition here would exceed DEMC and cause operational instability.
Dedicated ventilation fan in reclaim tunnel (≈7.5 kW)	Simple, reliable, and effective for dilution and visibility control without adding moisture.	**Adopted** – Provides adequate dilution and visibility without adding moisture or requiring baghouse infrastructure.
Water-mist suppression at stockpile feed	Technically feasible; effective for short drop heights and low wind conditions with automated operation.	**Disregarded** – High water consumption and water loss due to cross-wind dispersion
Telescopic chute at stockpile feed	Technically feasible subject to appropriate mechanical and structural design.	**Adopted** – reasonably practicable for this drop height.
Water-mist suppression at Screen feed	Technically feasible; effective at maintaining visibility and controlling airborne dust for large-aperture screens.	**Adopted** – Viable control for large-aperture screens; maintains visibility and dust control without risk of blinding.
Road watering for haul roads	Simple and effective method for reducing dust generated by vehicle movement on unsealed roads.	**Adopted** (recommended as outside of this memo) – Required for visibility and compliance with nuisance dust criteria.

air quality | environment | sustainability

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