



MEMORANDUM

To	Francis Kuranchie, fkuranchie@mmining.com.au
From	Ricky Gellatly, ricky.gellatly@katestone.com.au
Client name	MetRes Pty Ltd
Deliverable No.	D22029-10
Subject	EA Variation
Date	23 April 2024

Dear Francis,

Katestone Environmental Pty Ltd (Katestone) was commissioned by MetRes Pty Ltd to specify the amendments required to its Environmental Authority (EA EPML00819213) to accommodate changes to the dust monitoring network that were recommended in Katestone's report no. D22029-4 (appended to this memorandum in Attachment B, for ease of reference). This memorandum sets out Katestone's recommendations and advice in support of the amendment.

Table A1 in Attachment A details the following:

- Existing EA conditions relating to air quality (Schedule B of EA EPML00819213).
- Where relevant, detail and reasoning behind Katestone's recommendations for changes to the current Schedule B conditions.
- Where relevant, Katestone's recommended revised condition wording.

Katestone's recommended changes will correct some errors in the existing EA and will enable better management of dust emissions by Millennium Mine, and thus enable better protection of the air environment at nearby sensitive or commercial places, and improved environmental values for air. Katestone's recommended monitoring network, requiring monitoring of PM₁₀ concentrations, dust deposition, and meteorological parameters, is consistent with the overarching requirements of the conditions relating to air quality in the current EA, as demonstrated by the limited number of changes required (see Attachment A). While the current EA refers to achievement of concentration limits for TSP and PM_{2.5}, the conditions specifying monitoring (Condition B3) and reporting (Condition B7) requirements do not stipulate monitoring of these size fractions. The recommended monitoring network will clearly identify Millennium Mine's dust generation from its mining activities and its contribution to PM₁₀ concentrations at the nearest sensitive or commercial places (refer to Katestone's report in Attachment B for more detail).

Katestone also recommends the updating of Millennium Mine's Ambient Dust Monitoring Program document to incorporate the recommended monitoring network.

Katestone understands that the Department of Environment and Science (DES) has also advised that any EA amendment will require consideration of the environmental implications of the changes on environmental values relating to water, wetlands, acoustic, groundwater, land, or waste. While Katestone are experts in air quality, we strongly believe that the adoption of our recommended monitoring network through the very limited EA changes outlined in Attachment A will not have any material adverse influence on any of these values. The recommended network of meteorological and ambient air quality monitoring stations will have a minimal physical and environmental footprint, while enabling improved dust management, which in turn is likely to result in the beneficial impact of reduced dust deposition to land, water and wetlands.

If you have any questions, please do not hesitate to contact the undersigned.

Kind regards,

Ricky Gellatly

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ATTACHMENT A RECOMMENDED CHANGES TO CURRENT ENVIRONMENTAL AUTHORITY

Table A1 Conditions of environmental authority EPML00819213 Schedule B: Air and Katestone recommendations for change

Condition number	Condition	Katestone recommendations	
		Details	Recommended revised condition
B1	<p>Dust nuisance</p> <p>The environmental authority holder shall ensure that all reasonable and feasible avoidance and mitigation measures are employed so that the dust and particulate matter emissions generated by the mining activities do not cause exceedances of the following levels when measured at any sensitive or commercial place:</p>	No change.	-
	<p>a) Dust deposition of 120 milligrams per square metre per day, averaged over one month, when monitored in accordance with the most recent version of Australian Standard AS3580.10.1 Methods for sampling and analysis of ambient air—Determination of particulate matter—Deposited matter-Gravimetric method.</p>	No change.	-
	<p>b) A concentration of particulate matter with an aerodynamic diameter of less than 10 micrometres (PM₁₀) suspended in the atmosphere of 50 micrograms per cubic metre over a 24-hour averaging time, for no more than five exceedances recorded each year, when monitored in accordance with the most recent version of either:</p> <ul style="list-style-type: none"> (i). Australian Standard AS3580.9.6 Methods for sampling and analysis of ambient air—Determination of suspended particulate matter—PM₁₀ high volume sampler with size selective inlet – Gravimetric method, or (ii). Australian Standard AS3580.9.9 Methods for sampling and analysis of ambient air—Determination of suspended particulate matter—PM₁₀ low volume sampler—Gravimetric method. 	<p>Katestone recommends that this condition be revised to include the option of a BAM along with HVAS or TEOM. BAMs conform to an Australian Standard for PM₁₀ measurement (AS3580.9.11) and are, therefore, appropriate for meeting the requirements of the EA. Katestone considers there to be no legitimate reason why BAMs should not be used in place of TEOM or HVAS. Further justification for the use of BAMs is provided in Section 5.3.1 of Katestone report no. D22029-4 in Attachment B.</p>	<p>Addition of the following to the end:</p> <p><i>(iii). Australian Standard AS3580.9.11 Methods for sampling and analysis of ambient air—Determination of suspended particulate matter—PM₁₀ beta attenuation monitors</i></p>

Condition number	Condition	Katestone recommendations	
		Details	Recommended revised condition
	c) A concentration of particulate matter with an aerodynamic diameter of less than 2.5 micrometres (PM _{2.5}) suspended in the atmosphere of 25 micrograms per cubic metre over a 24-hour averaging time, when monitored in accordance with the most recent version of AS/NZS3580.9.10 Methods for sampling and analysis of ambient air—Determination of suspended particulate matter—PM _{2.5} low volume sampler—Gravimetric method.	No change.	-
	d) A concentration of particulate matter suspended in the atmosphere of 90 micrograms per cubic metre over a 1-year averaging time, when monitored in accordance with the most recent version of AS/NZS3580.9.3:2003 Methods for sampling and analysis of ambient air—Determination of suspended particulate matter—Total suspended particulate matter (TSP)—High volume sampler gravimetric method.	No change.	-
B2	Ambient Dust Monitoring Program The environmental authority holder must develop an Ambient Dust Monitoring Program to specify how the ambient dust impacts resultant from the activities conducted under this environmental authority will be monitored. The Program must include, but not necessarily be limited to:	No change.	-
	1) identification of an integrated air quality monitoring network, developed in consultation with the owner/operator of the coal mining site;	No change.	-
	2) locations, frequencies and methods for monitoring PM ₁₀ and deposited particulate matter;	No change.	-

Condition number	Condition	Katestone recommendations	
		Details	Recommended revised condition
3)	provision for the use of at least one hi-volume air sampler (HVAS) or Tapered Element Oscillating Microbalance Sampler (TEOMS), five dust depositional gauges and a meteorological station capable of monitoring wind direction and speed;	<p>Katestone recommends that this condition be revised to include the option of a BAM along with HVAS or TEOM. BAMs conform to an Australian Standard for PM₁₀ measurement (AS3580.9.11) and are, therefore, appropriate for meeting the requirements of the EA. Katestone considers there to be no legitimate reason why BAMs should not be used in place of TEOM or HVAS. Further justification for the use of BAMs is provided in Section 5.3.1 of Katestone report no. D22029-4 in Attachment B.</p>	<p>Word change</p> <p>3) provision for the use of at least one beta attenuation monitor (BAM), hi-volume air sampler (HVAS) or Tapered Element Oscillating Microbalance Sampler (TEOMS), five dust depositional gauges and a meteorological station capable of monitoring wind direction and speed;</p>
4)	investigation of the use of HVAS or TEOMS as part of the integrated air quality monitoring network. Should an alternative sampling method be required; the holder may seek approval from the administering authority to exclude this requirement. In seeking such exclusion, the reasons for the exclusion shall be provided and be fully justified;	<p>Katestone recommends that this condition be revised to include the option of a BAM along with HVAS or TEOM, as above. Further justification for the use of BAMs is provided in Section 5.3.1 of Katestone report no. D22029-4 in Attachment B.</p>	<p>Word change</p> <p>4) investigation of the use of BAM, HVAS or TEOMS as part of the integrated air quality monitoring network. Should an alternative sampling method be required; the holder may seek approval from the administering authority to exclude this requirement. In seeking such exclusion, the reasons for the exclusion shall be provided and be fully justified;</p>
5)	provided that the use of TEOMS is proven to be justified (as outlined in 4 above), the holder shall utilise real time monitoring data to inform environmental management decisions associated with the project;	<p>Katestone recommends that this condition be revised to include the option of a BAM along with HVAS or TEOM, as above. Further justification for the use of BAMs is provided in Section 5.3.1 of Katestone report no. D22029-4 in Attachment B.</p>	<p>Word change</p> <p>5) provided that the use of BAMs or TEOMS is proven to be justified (as outlined in 4 above), the holder shall utilise real time monitoring data to inform environmental management decisions associated with the project;</p>

Condition number	Condition	Katestone recommendations																																	
		Details	Recommended revised condition																																
	6) a framework for identifying actual and potential dust impacts, and for applying pro-active and reactive mitigation and management measures to address those impacts;	No change.	-																																
	7) provision for independent review and auditing of the Program; and	No change.	-																																
	8) mechanisms for updating.	No change.	-																																
	The environmental authority holder must submit the Ambient Dust Monitoring Program to the administering authority within ten (10) business days upon request.	No change.	-																																
B3	Ongoing monitoring must be conducted in accordance with the standards and at the locations specified in Table B1: Air Quality Monitoring Details.	No change.	-																																
	<p>Table B1 Air quality monitoring details</p> <table border="1"> <thead> <tr> <th rowspan="2">Air quality determination</th> <th rowspan="2">Monitoring standard</th> <th rowspan="2">Monitoring point description</th> <th colspan="2">Approximate monitoring point location</th> </tr> <tr> <th>Latitude</th> <th>Longitude</th> </tr> </thead> <tbody> <tr> <td>PM₁₀</td> <td>AS/NZS 3580.9.6:2003 or AS 3580.9.8:2008</td> <td>PM₁₀ station</td> <td>22° 0'15" S</td> <td>148° 4'47" E</td> </tr> <tr> <td rowspan="6">Dust deposition</td> <td rowspan="6">AS/NZS 3580.10.1:2003</td> <td>DG1</td> <td>22° 00' 20" S</td> <td>148° 12' 42" E</td> </tr> <tr> <td>DG2</td> <td>21° 59' 43" S</td> <td>148° 15' 16" E</td> </tr> <tr> <td>DG3</td> <td>22° 10' 53" S</td> <td>148° 16' 58" E</td> </tr> <tr> <td>DG4</td> <td>22° 20' 21" S</td> <td>148° 13' 38" E</td> </tr> <tr> <td>DG5</td> <td>22° 20' 10" S</td> <td>148° 12' 40" E</td> </tr> <tr> <td>MS1</td> <td>22° 00' 33" S</td> <td>148° 14' 44" E</td> </tr> </tbody> </table>	Air quality determination	Monitoring standard	Monitoring point description	Approximate monitoring point location		Latitude	Longitude	PM ₁₀	AS/NZS 3580.9.6:2003 or AS 3580.9.8:2008	PM ₁₀ station	22° 0'15" S	148° 4'47" E	Dust deposition	AS/NZS 3580.10.1:2003	DG1	22° 00' 20" S	148° 12' 42" E	DG2	21° 59' 43" S	148° 15' 16" E	DG3	22° 10' 53" S	148° 16' 58" E	DG4	22° 20' 21" S	148° 13' 38" E	DG5	22° 20' 10" S	148° 12' 40" E	MS1	22° 00' 33" S	148° 14' 44" E	<p>The coordinates given for some of the dust deposition gauges in Table B1 of the EA are a considerable distance away from Millennium Mine and consequently dust deposition at these locations is likely representative of impacts from other mine operations and natural sources of dust, rather than Millennium Mine. For example, two of the sets of coordinates relate to a location some 35km to the south of the mine, on the opposite side of Peak Downs Mine. However, two of the locations are in broadly the same locations as two of the existing dust deposition monitoring sites operated by Millennium Mine. Katestone assumes that an error has been made in converting the coordinates of some of the existing monitoring sites and that the coordinates listed should be those of the five existing dust deposition monitors, which are considered appropriate locations for identifying dust deposition rates near to the mine boundary. Table B1 also currently erroneously says "dust description" rather than "dust deposition" and lists the meteorological monitoring site under</p>	<p>Recommend that the contents of Table B1 are replaced with those of Table A2 on Page 9 of this document.</p>
Air quality determination	Monitoring standard				Monitoring point description	Approximate monitoring point location																													
		Latitude	Longitude																																
PM ₁₀	AS/NZS 3580.9.6:2003 or AS 3580.9.8:2008	PM ₁₀ station	22° 0'15" S	148° 4'47" E																															
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Condition number	Condition	Katestone recommendations	
		Details	Recommended revised condition
		<p>this “dust description” category, rather than being for the identification of meteorological parameters.</p> <p>The PM₁₀ monitoring station location listed in Table B1 is located at the eastern boundary of Moranbah town, some 13.5 km west of Millennium Mine, and is not a useful location for identifying the impact of emissions from the mine. Katestone recommends the use of two ambient PM₁₀ monitoring stations at the nearest sensitive receptors in upwind and downwind directions (under prevailing winds) along with measurements of wind speed and wind direction to enable the contribution of operations at Millenium Mine to PM₁₀ concentrations to be determined to a reasonable level of accuracy, using an upwind/downwind approach. See Katestone report no. D22029-4 in Attachment B for more information and justification of the recommended monitoring locations.</p> <p>It should be noted that the proposed locations have been amended compared to those suggested in Katestone report no. D22029-4, for practical reasons, but remain appropriate upwind/downwind locations.</p> <p>Katestone also recommends that this condition be revised to include the option of a BAM along with HVAS or TEOM.</p>	

Condition number	Condition	Katestone recommendations	
		Details	Recommended revised condition
B4	<p>Where monitoring at locations identified in Table B1: Air Quality Monitoring Details indicates that the air quality objectives detailed in Condition B1 have been exceeded, the environmental authority holder must investigate the matter and report to the administering authority within fourteen days:</p> <p>1) the concentration of PM₁₀ particulates or dust deposition rate recorded;</p> <p>2) a description of meteorological conditions occurring at the time; and</p> <p>3) the measures taken to reduce dust generated by the mining activities.</p>	No change.	-
B5	<p>When requested by the administering authority or as a result of a complaint (which is neither frivolous nor vexatious nor based on mistaken belief in the opinion of the authorised officer), additional dust and particulate monitoring (including dust deposition, total suspended particles (TSP), PM₁₀ and PM_{2.5}) must be undertaken, and the results thereof notified to the administering authority within fourteen days following completion of monitoring. This includes providing interim reports if the monitoring lasts for more than one month.</p> <p>Monitoring must be carried out at a place(s) relevant to the potentially affected dust sensitive place. Monitoring must be conducted in accordance with the appropriate standards.</p>	No change.	-
B6	<p>If monitoring conducted as a result of a complaint indicates an exceedance of the guidelines detailed in Condition B1, the environmental authority holder must:</p> <p>1) address the complaint through the use of appropriate dispute resolution if required; and</p> <p>2) in consultation with the administering authority and within an agreed timeframe, implement dust abatement measures.</p>	No change.	-
B7	The results of PM ₁₀ , dust deposition and meteorological monitoring must be reported to the administering authority on request.	No change.	-
B8	If requested by the administering authority, the results of PM ₁₀ , dust deposition and meteorological monitoring must be made available for use in any air quality monitoring network in the Moranbah region operated independently of mining operations.	No change.	-

Condition number	Condition	Katestone recommendations	
		Details	Recommended revised condition
B9	<p>Model validation study</p> <p>Following one full year of data collection in accordance with an approved Ambient Dust Monitoring Program (as required by Condition B2), the environmental authority holder must undertake a model validation study to review PM₁₀ and dust deposition levels to assess compliance with the dust impact predictions made in the documents entitled: "Millennium Expansion Project – Supplementary Report, 2011" and with the ambient air quality objectives specified in Condition B1. The model validation study must be undertaken in accordance with the NSW DECC Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales (DECC, 2005) and specific requirements of the administering authority</p>	No change.	-
B10	<p>Within sixty (60) days of conducting the model validation study required by Condition B9, the environmental authority holder must provide a copy of the report to the administering authority.</p> <p>If the model validation study identifies significant deviance from the predictions made in the documents referred to under Condition B9 or any exceedance with ambient air quality objectives of the Environmental Protection (Air) Policy 2008, the environmental authority holder must detail what additional measures would be implemented to further mitigate dust impacts.</p> <p>The environmental authority holder must clearly indicate who would implement these measures, when these measures would be implemented, and how the effectiveness of these measures would be assessed and reported to the administering authority.</p>	No change.	-
B11	<p>Odour nuisance</p> <p>The release of noxious or offensive odour(s) or any other noxious or offensive airborne contaminant(s) resulting from the mining activity must not cause an environmental nuisance at any nuisance sensitive or commercial place.</p>	No change.	-

Condition number	Condition	Katestone recommendations	
		Details	Recommended revised condition
B12	When requested by the administering authority, odour monitoring must be undertaken within a reasonable and practicable timeframe nominated by the administering authority to investigate any complaint (which is neither frivolous nor vexatious nor based on mistaken belief in the opinion of the authorised officer) of environmental nuisance at any sensitive or commercial place, and the results must be notified within fourteen days to the administering authority following completion of monitoring.	No change.	-
B13	If the administering authority determines the odour released to constitute an environmental nuisance, then the environmental authority holder must: 1) address the complaint including the use of appropriate dispute resolution if required; and 2) immediately implement odour abatement measures so that emissions of odour from the activity do not result in further environmental nuisance.	No change.	-

Table A2 Recommended updated Table B1

Air Quality Determination	Monitoring Standard	Monitoring Point Description	Approximate Monitoring Point Location (GDA94)	
			Latitude	Longitude
PM ₁₀	AS/NZS 3580.9.6:2015 or AS/NZS 3580.9.8:2022 or AS/NZS 3580.9.11:2022	PM1	-22.001825	148.211061
		PM2	-22.023614	148.326378
Dust Deposition	AS/NZS 3580.10.1:2016	DG1	-22.001742	148.210093
		DG2	-21.997781	148.256388
		DG3	-22.031113	148.283054
		DG4	-22.040859	148.226528
		DG5	-22.037938	148.209984
Meteorology - Wind speed and direction, humidity, temperature and precipitation.	AS/NZS 3580.14:2014	MS1	-22.009164	148.245552

ATTACHMENT B KATESTONE REPORT D22029-4

Millennium Mine: Air Quality Monitoring Technical Study

Prepared for:

Millennium Mining Pty Ltd

November 2022

Final

Prepared by:

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Glossary

Term	Definition
$\mu\text{g}/\text{m}^3$	micrograms per cubic metre
μm	microns
km	kilometre
m	metre
Nomenclature	Definition
PM ₁₀	particulate matter with a diameter less than 10 micrometres
PM _{2.5}	particulate matter with a diameter less than 2.5 micrometres
TSP	total suspended particulates
Abbreviations	Definition
BAM	Beta Attenuation Monitor
DES	Department of Environment and Science
EA	Environmental Authority
EET	Emission Estimation Technique
EIS	Environmental Impact Statement
USEPA	United States Environmental Protection Agency
HVAS	High Volume Air Sampler
NPI	National Pollutant Inventory database
TEOM	Tapered Element Oscillating Microbalance

EXECUTIVE SUMMARY

Katestone Environmental Pty Ltd (Katestone) was commissioned by Millennium Mining Pty Ltd (M Mining) to conduct a technical study to identify new suitable monitoring location(s) for PM₁₀, PM_{2.5} and/or TSP that will clearly identify Millennium Mine's dust generation from its mining activities that have the potential to impact sensitive or commercial places.

To identify suitable ambient monitoring locations to meet DES requirements, Katestone has carried out a review of the EA conditions contained within Environmental Authority EPML00819213, the current Millennium Mine ambient dust monitoring program, the proximity and direction of the nearest sensitive receptors, the available dust deposition and ambient PM₁₀ monitoring data, prevailing wind conditions according to local meteorological monitoring data, the surrounding land use and terrain, and the proximity of nearby industrial and anthropogenic sources of dust.

Based on the information collated and analysed, Katestone recommends the following elements are included in the air quality monitoring program for the Millennium Mine:

- Two ambient air quality monitoring stations measuring PM₁₀ as the most critical dust size fraction:
 - One monitor located to the east of the mine, upwind under prevailing wind conditions, beyond the site boundary and away from any immediate sources of dust, near to the nearest sensitive receptor in this direction
 - One monitor located to the west of the mine, downwind under prevailing wind conditions, beyond the site boundary and away from any immediate sources of dust, near to the nearest sensitive receptor in this direction
- Continuation of the onsite meteorological station
- Continuation of the five existing dust deposition gauges.

The use of two ambient air quality monitoring stations measuring PM₁₀ along with continuous measurements of wind speed and wind direction will enable the contribution of operations at Millennium Mine to be determined to a reasonable level of accuracy. When one monitor is downwind of operations at Millennium Mine, the other will be upwind, so by subtracting the upwind measurement from the downwind measurement the contribution of Millennium Mine to concentrations at the downwind monitor (which will be representative of the nearest sensitive receptor) can be estimated. See section 5.2 (specifically Figure 14) for further details on this approach.

When it comes to automatic particulate monitoring, modern EA licence conditions typically only require the monitoring of PM₁₀ to assess compliance of project operations with air quality limits, and this is by far the most relevant size fraction of suspended particulates to focus upon (see Section 2.2 for more details). PM₁₀ monitoring is also all that Millennium Mine's EA specifically requires. Katestone considers it appropriate for the automatic monitoring network to focus on PM₁₀ alone and that monitoring of TSP and PM_{2.5} is unnecessary; mention of these particulate size fractions can be removed from the EA when next reviewed.

Millennium Mine's EA prescribes monitoring by HVAS or TEOM, but Katestone understands that M Mining's preference is to use a BAM. BAMs conform to an Australian Standard for PM₁₀ measurement (AS3580.9.11) and are, therefore, appropriate for meeting the requirements of the EA. Katestone considers there to be no legitimate reason why BAMs should not be used in place of TEOM or HVAS.

1. INTRODUCTION

Katestone Environmental Pty Ltd (Katestone) was commissioned by Millennium Mining Pty Ltd (M Mining) to conduct a technical study to identify new suitable monitoring location(s) for PM₁₀, PM_{2.5} and/or TSP that will clearly identify Millennium Mine's dust generation from its mining activities that have the potential to impact sensitive or commercial places.

1.1 Background

The Millennium Mine is operated under Environmental Authority (EA) EPML00819213. Conditions B1 to B10 of the EA relate to the development of an ambient dust monitoring program, implementation of the ambient dust monitoring network, and reporting of the results of the monitoring, including a model validation study to assess compliance with the relevant air quality objectives and the findings of the Millennium Expansion Project, Supplementary Report, 2011.

Dust deposition monitoring is currently undertaken at five locations in accordance with the EA requirements. To comply with the EA requirements in relation to PM₁₀ monitoring, Millennium Mine intended to utilise the monitoring results from the adjacent Isaac Plains Mine Complex. Millennium Mine and Isaac Plains Mine Complex have a data sharing agreement as the two companies have the same dust monitoring requirements, and in the same locations, outlined in their respective EA's. However, the Department of Environment and Science (DES) advised on 25 August 2022 that Millennium Mine should conduct a technical study that proposes new suitable monitoring location(s) for a sensitive or commercial place for PM₁₀, PM_{2.5}, and/or TSP that will clearly identify Millennium Mine's dust generation from its mining activities that has the potential of impacting sensitive or commercial places.

1.2 Scope of Works

This report provides the technical study that proposes new suitable ambient monitoring location(s) to meet DES requirements and to monitor the impacts of dust generation from Millennium Mine's activities at the nearest sensitive or commercial places. The report has been prepared for submission to DES for approval of the proposed updated ambient dust monitoring network.

The study includes the following scope of works:

- Review of EA conditions contained within Environmental Authority EPML00819213 including the requirement for an ambient dust monitoring program
- Review of the proximity of receptors, both residential and commercial, and potential impacts on air quality at receptors predicted in the 'Millennium Expansion Project – Supplementary Report, 2011'
- Review of the current ambient monitoring program for the site
- Review of the availability of existing ambient air quality monitoring stations including the representativeness of monitoring data collected by DES and the Isaac Plains Mine Complex
- Review of available meteorological monitoring data collected on-site, by the Isaac Complex at Moranbah, and by the Bureau of Meteorology in Moranbah, to determine meteorological patterns in the area, including local wind conditions and seasonal variations
- Review of the land use and terrain variations in the vicinity of the mine as well as the proximity of nearby industrial sources of dust and expected background levels of dust
- Based on the information collated and analysed, make recommendations as to an automatic particulate monitoring network that meets DES' requirements.

2. ENVIRONMENTAL AUTHORITY EA EPML00819213

2.1 Conditions of EA

The Millennium Mine is operated under Environmental Authority (EA) EPML00819213, effective as of 28 February 2017 and amended 11 August 2022. Conditions B1 to B10 are relevant to air quality and are reproduced in Table 1. Conditions reproduced in Table 1 include:

- Dust limits for dust deposition, PM₁₀, PM_{2.5} and TSP consistent with the relevant state legislation
- Requirement for an ambient dust monitoring program
- Requirement for a model validation study

The model validation study is to be completed following one full year of data collection in accordance with the approved ambient dust monitoring program.

Table 1 Conditions relating to air quality from EPML00819213 (Schedule B)

Condition number	Condition
B1	<p>Dust nuisance</p> <p>The environmental authority holder shall ensure that all reasonable and feasible avoidance and mitigation measures are employed so that the dust and particulate matter emissions generated by the mining activities do not cause exceedances of the following levels when measured at any sensitive or commercial place:</p> <ol style="list-style-type: none"> a) Dust deposition of 120 milligrams per square metre per day, averaged over one month, when monitored in accordance with the most recent version of Australian Standard AS3580.10.1 Methods for sampling and analysis of ambient air—Determination of particulate matter—Deposited matter—Gravimetric method. b) A concentration of particulate matter with an aerodynamic diameter of less than 10 micrometres (PM₁₀) suspended in the atmosphere of 50 micrograms per cubic metre over a 24-hour averaging time, for no more than five exceedances recorded each year, when monitored in accordance with the most recent version of either: <ol style="list-style-type: none"> (i). Australian Standard AS3580.9.6 Methods for sampling and analysis of ambient air—Determination of suspended particulate matter—PM₁₀ high volume sampler with size selective inlet – Gravimetric method, or (ii). Australian Standard AS3580.9.9 Methods for sampling and analysis of ambient air—Determination of suspended particulate matter—PM₁₀ low volume sampler—Gravimetric method. c) A concentration of particulate matter with an aerodynamic diameter of less than 2.5 micrometres (PM_{2.5}) suspended in the atmosphere of 25 micrograms per cubic metre over a 24-hour averaging time, when monitored in accordance with the most recent version of AS/NZS3580.9.10 Methods for sampling and analysis of ambient air—Determination of suspended particulate matter—PM (sub)2.5(/sub) low volume sampler—Gravimetric method. d) A concentration of particulate matter suspended in the atmosphere of 90 micrograms per cubic metre over a 1-year averaging time, when monitored in accordance with the most recent version of AS/NZS3580.9.3:2003 Methods for sampling and analysis of ambient air—Determination of suspended particulate matter—Total suspended particulate matter (TSP)—High volume sampler gravimetric method.
B2	<p>Ambient Dust Monitoring Program</p> <p>The environmental authority holder must develop an Ambient Dust Monitoring Program to specify how the ambient dust impacts of the Millennium Mine will be monitored. The Program shall include, but not necessarily be limited to:</p> <ol style="list-style-type: none"> 1) identification of an integrated air quality monitoring network, developed in consultation with the owner/operator of the coal mining site; 2) locations, frequencies and methods for monitoring PM₁₀ and deposited particulate matter;

Condition number	Condition																																
	<p>3) provision for the use of at least one hi-volume air sampler (HVAS) or Tapered Element Oscillating Microbalance Sampler (TEOMS), five dust depositional gauges and a meteorological station capable of monitoring wind direction and speed;</p> <p>4) investigation of the use of HVAS or TEOMS as part of the integrated air quality monitoring network. Should an alternative sampling method be required; the holder may seek approval from the administering authority to exclude this requirement. In seeking such exclusion, the reasons for the exclusion shall be provided and be fully justified;</p> <p>5) provided that the use of TEOMS is proven to be justified (as outlined in 4 above), the holder shall utilise real time monitoring data to inform environmental management decisions associated with the project;</p> <p>6) a framework for identifying actual and potential dust impacts, and for applying pro-active and reactive mitigation and management measures to address those impacts;</p> <p>7) provision for independent review and auditing of the Program; and</p> <p>8) mechanisms for updating.</p> <p>The environmental authority holder must submit the Ambient Dust Monitoring Program to the administering authority within ten business days upon request.</p>																																
B3	<p>Ongoing monitoring must be conducted in accordance with the standards and at the locations specified in Table B1: Air Quality Monitoring Details. (below)</p> <table border="1" data-bbox="363 831 1310 1122"> <thead> <tr> <th data-bbox="363 831 576 898" rowspan="2">Air Quality Determination</th> <th data-bbox="580 831 799 898" rowspan="2">Monitoring Standard</th> <th data-bbox="804 831 975 898" rowspan="2">Monitoring Point Description</th> <th colspan="2" data-bbox="979 831 1310 875">Approximate Monitoring Point Location</th> </tr> <tr> <th data-bbox="979 882 1118 898">Latitude</th> <th data-bbox="1123 882 1310 898">Longitude</th> </tr> </thead> <tbody> <tr> <td data-bbox="363 904 576 949">PM10</td> <td data-bbox="580 904 799 949">AS/NZS 3580.9.6:2003 or AS 3580.9.8:2008</td> <td data-bbox="804 904 975 949">PM10 station</td> <td data-bbox="979 904 1118 949">22° 0' 15" S</td> <td data-bbox="1123 904 1310 949">148° 4' 47" E</td> </tr> <tr> <td data-bbox="363 956 576 978" rowspan="6">Dust Description</td> <td data-bbox="580 956 799 978" rowspan="6">AS/NZS 3580.10.1:2003</td> <td data-bbox="804 956 975 978">DG1</td> <td data-bbox="979 956 1118 978">22° 00' 20" S</td> <td data-bbox="1123 956 1310 978">148° 12' 42" E</td> </tr> <tr> <td data-bbox="804 978 975 1001">DG2</td> <td data-bbox="979 978 1118 1001">21° 59' 43" S</td> <td data-bbox="1123 978 1310 1001">148° 15' 16" E</td> </tr> <tr> <td data-bbox="804 1001 975 1023">DG3</td> <td data-bbox="979 1001 1118 1023">22° 10' 53" S</td> <td data-bbox="1123 1001 1310 1023">148° 16' 58" E</td> </tr> <tr> <td data-bbox="804 1023 975 1046">DG4</td> <td data-bbox="979 1023 1118 1046">22° 20' 21" S</td> <td data-bbox="1123 1023 1310 1046">148° 13' 38" E</td> </tr> <tr> <td data-bbox="804 1046 975 1068">DG5</td> <td data-bbox="979 1046 1118 1068">22° 20' 10" S</td> <td data-bbox="1123 1046 1310 1068">148° 12' 40" E</td> </tr> <tr> <td data-bbox="804 1068 975 1090">MS1</td> <td data-bbox="979 1068 1118 1090">22° 00' 33" S</td> <td data-bbox="1123 1068 1310 1090">148° 14' 44" E</td> </tr> </tbody> </table> <p>NOTE: Wind speed and direction, humidity, temperature and precipitation.</p>	Air Quality Determination	Monitoring Standard	Monitoring Point Description	Approximate Monitoring Point Location		Latitude	Longitude	PM10	AS/NZS 3580.9.6:2003 or AS 3580.9.8:2008	PM10 station	22° 0' 15" S	148° 4' 47" E	Dust Description	AS/NZS 3580.10.1:2003	DG1	22° 00' 20" S	148° 12' 42" E	DG2	21° 59' 43" S	148° 15' 16" E	DG3	22° 10' 53" S	148° 16' 58" E	DG4	22° 20' 21" S	148° 13' 38" E	DG5	22° 20' 10" S	148° 12' 40" E	MS1	22° 00' 33" S	148° 14' 44" E
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		MS1	22° 00' 33" S	148° 14' 44" E																													
B4	<p>Where monitoring at locations identified in Table B1: Air Quality Monitoring Details indicates that the air quality objectives detailed in Condition B1 have been exceeded, the environmental authority holder must investigate the matter and report to the administering authority within fourteen days:</p> <ol style="list-style-type: none"> 1) the concentration of PM10 particulates or dust deposition rate recorded; 2) a description of meteorological conditions occurring at the time; and 3) the measures taken to reduce dust generated by the mining activities. 																																
B5	<p>When requested by the administering authority or as a result of a complaint (which is neither frivolous nor vexatious nor based on mistaken belief in the opinion of the authorised officer), additional dust and particulate monitoring (including dust deposition, total suspended particles (TSP), PM10 and PM2.5) must be undertaken, and the results thereof notified to the administering authority within fourteen days following completion of monitoring. This includes providing interim reports if the monitoring lasts for more than one month.</p> <p>Monitoring must be carried out at a place(s) relevant to the potentially affected dust sensitive place. Monitoring must be conducted in accordance with the appropriate standards.</p>																																
B6	<p>If monitoring conducted as a result of a complaint indicates an exceedance of the guidelines detailed in Condition B1, the environmental authority holder must:</p> <ol style="list-style-type: none"> 1) address the complaint through the use of appropriate dispute resolution if required; and 2) in consultation with the administering authority and within an agreed timeframe, implement dust abatement measures. 																																
B7	<p>The results of PM10, dust deposition and meteorological monitoring must be reported to the administering authority on request.</p>																																
B8	<p>If requested by the administering authority, the results of PM10, dust deposition and meteorological monitoring must be made available for use in any air quality monitoring network in the Moranbah region operated independently of mining operations.</p>																																
B9	<p>Model Validation Study</p> <p>Following one full year of data collection in accordance with an approved Ambient Dust Monitoring Program (as required by Condition B2), the environmental authority holder must undertake a model validation study to</p>																																

Condition number	Condition
	review PM10 and dust deposition levels to assess compliance with the dust impact predictions made in the documents entitled: "Millennium Expansion Project – Supplementary Report, 2011" and with the ambient air quality objectives specified in Condition B1. The model validation study must be undertaken in accordance with the NSW DECC Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales (DECC, 2005) and specific requirements of the administering authority.
B10	<p>Within sixty (60) days of conducting the model validation study required by Condition B9, the environmental authority holder must provide a copy of the report to the administering authority.</p> <p>If the model validation study identifies significant deviance from the predictions made in the documents referred to under Condition B9 or any exceedance with ambient air quality objectives of the Environmental Protection (Air) Policy 2008, the environmental authority holder must detail what additional measures would be implemented to further mitigate dust impacts.</p> <p>The environmental authority holder must clearly indicate who would implement these measures, when these measures would be implemented, and how the effectiveness of these measures would be assessed and reported to the administering authority.</p>

2.2 Commentary on EA conditions

The actual locations of the current five dust deposition monitors vary from the coordinates listed in condition B3 of the EA. The coordinates of some of the monitors specified in the EA (Table 1) are located a considerable distance away from Millennium Mine operations and consequently air quality at these locations is likely to be representative of impacts from other mine operations and natural sources of dust, with the contribution from Millennium Mine difficult to identify. The actual locations of the five dust deposition gauges (see Table 2 below and Figure 2 in Section 3) were selected to best represent the impact of Millennium Mine operations to dust levels just beyond the mine, while also taking into considering site access issues and the Australian Standard for the siting of air quality monitoring equipment. As these dust deposition gauges are located in close proximity to mining operations, they are not representative of conditions experienced by isolated residences.

Table 2 Current M Mining dust deposition gauges

Location name	Coordinates (WGS 84)	
	Easting (m)	Northing (m)
DG1	624912	7566486
DG2	629695	7566886
DG3	632417	7563173
DG4	626574	7562142
DG5	624869	7562479

Condition B1 of the EA specifies limits for dust deposition and ambient concentrations of PM₁₀, PM_{2.5} and TSP; however, conditions B2, B3, B4, B7, B8, and B9 refer only to the monitoring and reporting of PM₁₀, dust deposition, and meteorology. Modern EA licence conditions typically only require the monitoring of PM₁₀ and dust deposition to assess compliance of project operations with air quality limits, and Katestone considers it appropriate for the ambient particulate monitoring network to focus on PM₁₀ alone (alongside dust deposition monitoring).

The EA limit for TSP is an annual one, with monitoring to be carried out by high volume sampler gravimetric method, which typically involves taking a 24-hour sample one day in six. This method can only approximate an annual average concentration, as no sampling is carried out 5/6ths of the year. The 24-hour sample period does not allow for the sources of the TSP collected to be identified based on wind conditions (which typically vary over the course of the day) and does not assist in triggering action on-site to minimise mine dust emissions when elevated concentrations are detected (as samples are typically analysed days or weeks after they are collected). Only automatic monitoring with hourly resolution enables this, and there is no Australian Standard for automatic

monitoring of TSP concentrations. A focus on PM₁₀ or PM_{2.5} is also justified based on evidence of health effects; it is these smaller particles that cause adverse health effects, not particles larger than PM₁₀. While TSP will contribute to dust deposition, it is not necessary to measure it if dust deposition is itself being measured. Katestone therefore considers there to be very little benefit to monitoring of TSP concentrations, with automatic monitoring of a smaller size fraction by an Australian Standard method being far more valuable.

A focus on PM₁₀ over PM_{2.5} can be justified through consideration of the limits for their different size fractions alongside information regarding the fractions emitted by mining operations. The focus for mine limits is 24-hour concentrations; the 24-hour limit for PM_{2.5} is 50% of that for PM₁₀. Therefore, if the fraction of PM₁₀ emitted by mining operations that is PM_{2.5} is less than 50% then PM₁₀ is the more sensitive pollutant.

Common practice when calculating mining emissions in Australia is to use the National Pollutant Inventory (NPI) Emissions Estimation Technique (EET) Manuals alongside the United States Environmental Protection Agency's (USEPA's) AP-42 Compilation of Air Pollutant Emissions Factors (USEPA, 1998) to estimate emissions from mining. The NPI does not address PM_{2.5} emissions other than from combustion, thus emission factor equations, or particle size scaling factors, are typically taken from AP-42. AP-42 is supported by the Background Document for Revisions to Fine Fraction Ratios Used for AP-42 Fugitive Dust Emission Factors (Midwest Research Institute, 2006), which recommends a *"PM_{2.5}/PM₁₀ ratio in the range of 0.1 to 0.15 for typical uncontrolled fugitive dust sources"*, which include emissions from unpaved roads, aggregate handling and storage piles, industrial wind erosion and open area wind erosion, and thus cover the bulk of the particulate emission sources at Millennium Mine. Therefore, the ratio of PM_{2.5}/ PM₁₀ in mining emissions can be expected to be well below 50%, and PM₁₀ is the more sensitive size fraction when compared to PM_{2.5}.

Katestone therefore recommends that monitoring of TSP and PM_{2.5} is unnecessary and mention of these particulate size fractions can be removed from the EA when next reviewed.

3. MILLENNIUM MINE OVERVIEW

3.1 Mining operations

Millennium Mine is an existing open cut coal mine located in central Queensland, approximately 128 km inland from the Queensland coastline and 19 km east of the township of Moranbah (Figure 1). There are a number of existing coal mines operating in the vicinity of the mine, including the Carborough Downs, Poitrel, and Daunia Mines.

Mining operations at Millennium Mine use conventional truck and excavator open cut mining methods. Coal is extracted across Mining Leases (MLs) 70313, 70401, 70457, 70485, 70344, and 70483 and waste rock is placed in existing emplacements and within the mined-out-voids. Run of Mine (RoM) coal is processed at the onsite coal handling and processing plant (CHPP), with product coal transferred approximately 170 km via rail to the Dalrymple Bay Coal Terminal (DBCT) and loaded onto ships for export.

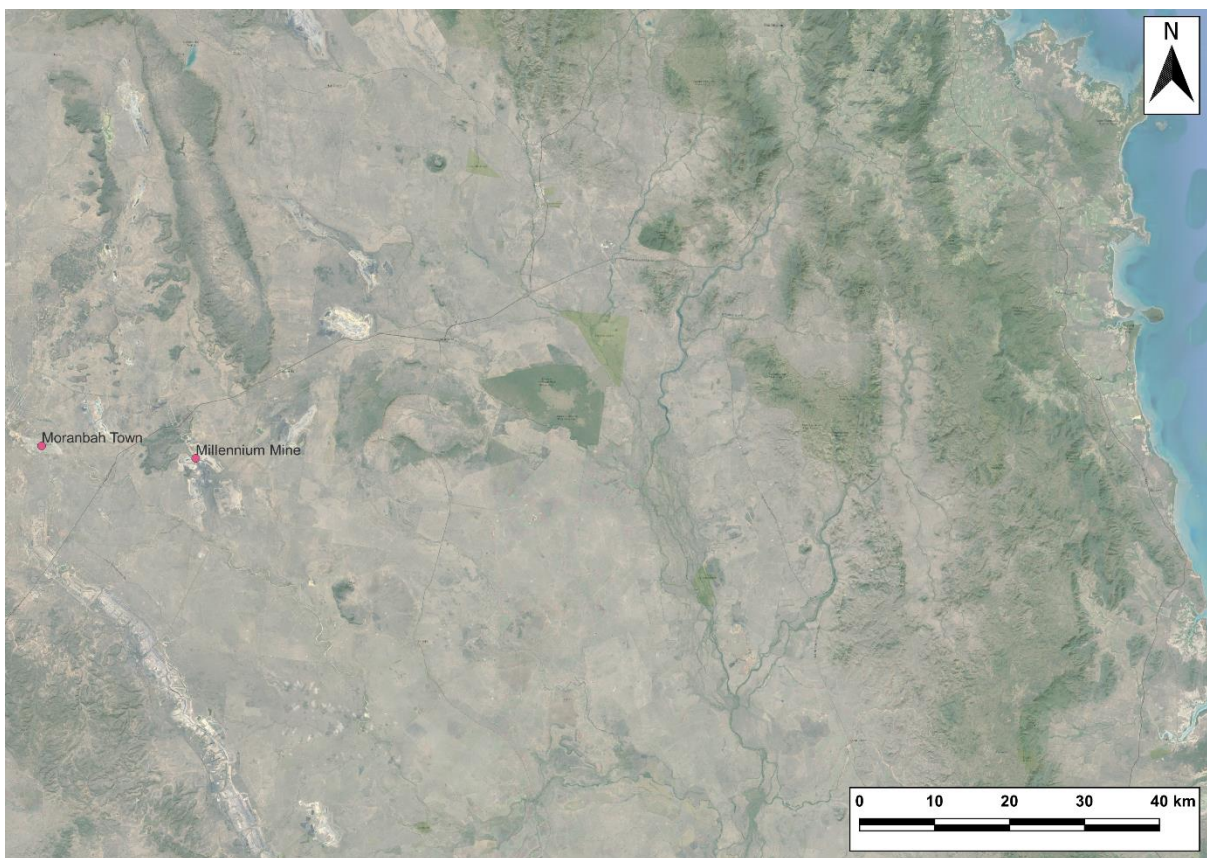


Figure 1 Location of Millennium Mine in Central Queensland

3.2 Dust emissions

During mine operations dust emissions can occur from the extraction, handling, transportation, and processing of material (coal and waste rock) from open-cut pits as well as from wind erosion of exposed areas and material stockpiles. The key dust-generating activities are:

- Drilling and blasting
- Material handling (excavators, dozers, and front-end loaders)
- Haulage of overburden and ROM coal

- Road grading
- Wind erosion of stockpiles, exposed areas, and rehabilitated areas
- Coal Handling and Preparation Plant operation
- Train loading.

3.3 Potential air quality impacts

The potential impacts to air quality from the operation of the Millennium Mine were identified in the air quality impact assessment conducted for the mine as part of the Project's Environmental Impact Statement (EIS) in 2010. The air quality impact assessment identified that:

- The main sources of dust were the in-pit crusher, excavator, unpaved roads, conveying and stockpiling RoM coal, loading trucks, loading trains, and placing and spreading overburden.
- Dust deposition levels were predicted to be close to ambient levels within 5 km of the mine and almost undetectable at greater than 10 km of the mine.
- Predicted maximum concentrations of dust parameters, including ambient background, were below relevant air quality criteria at sensitive receptors nearest to the project boundary.
- The most affected sensitive receptors were located approximately 9 to 13 km northwest of mine operations (aligning with prevailing southeasterly winds).

3.4 Current ambient air quality monitoring program

The current ambient air quality monitoring program for Millennium Mine includes the network of five dust deposition gauges as well as the onsite meteorological monitoring site. Millennium Mine also has a data sharing agreement with Isaac Complex that provides them with access to the PM₁₀, PM_{2.5}, and meteorological monitoring data from the monitoring site to the immediate east of the Moranbah township.

Details of the monitoring program are summarised in Table 3, with the location of the monitors provided in Figure 2.

Table 3 Summary of existing ambient air quality monitoring program

Owner and operator	Air quality determination	Monitoring standard	Monitoring point description	Approximate monitoring location		Frequency	Period of data analysed
				Latitude	Longitude		
Millennium Mining Pty Ltd	Dust deposition	AS/NZS 3580.10.1:2003	DG1	624912	7566486	Monthly	February 2020 to August 2022 (monthly)
			DG2	629695	7566886	Monthly	
			DG3	632417	7563173	Monthly	
			DG4	626574	7562142	Monthly	
			DG5	624869	7562479	Monthly	
	Meteorological data	AS 3580.14	Weather station	628566	7565635	Continuous	15 March 2022 to 12 July 2022 (5-minute data)
Isaac Complex	Particulates as PM ₁₀ and PM _{2.5}	AS/NZS 3580.9.6:2003 or AS 3580.9.8:2008	PM ₁₀ station	611449	7566666	Continuous	1 July 2021 to 30 June 2022 (1-hour data)
	Meteorological data (wind speed and direction, humidity, temperature, and precipitation)	AS 3580.14	Meteorological station	611449	7566666	Continuous	1 July 2021 to 30 June 2022 (1-hour data)

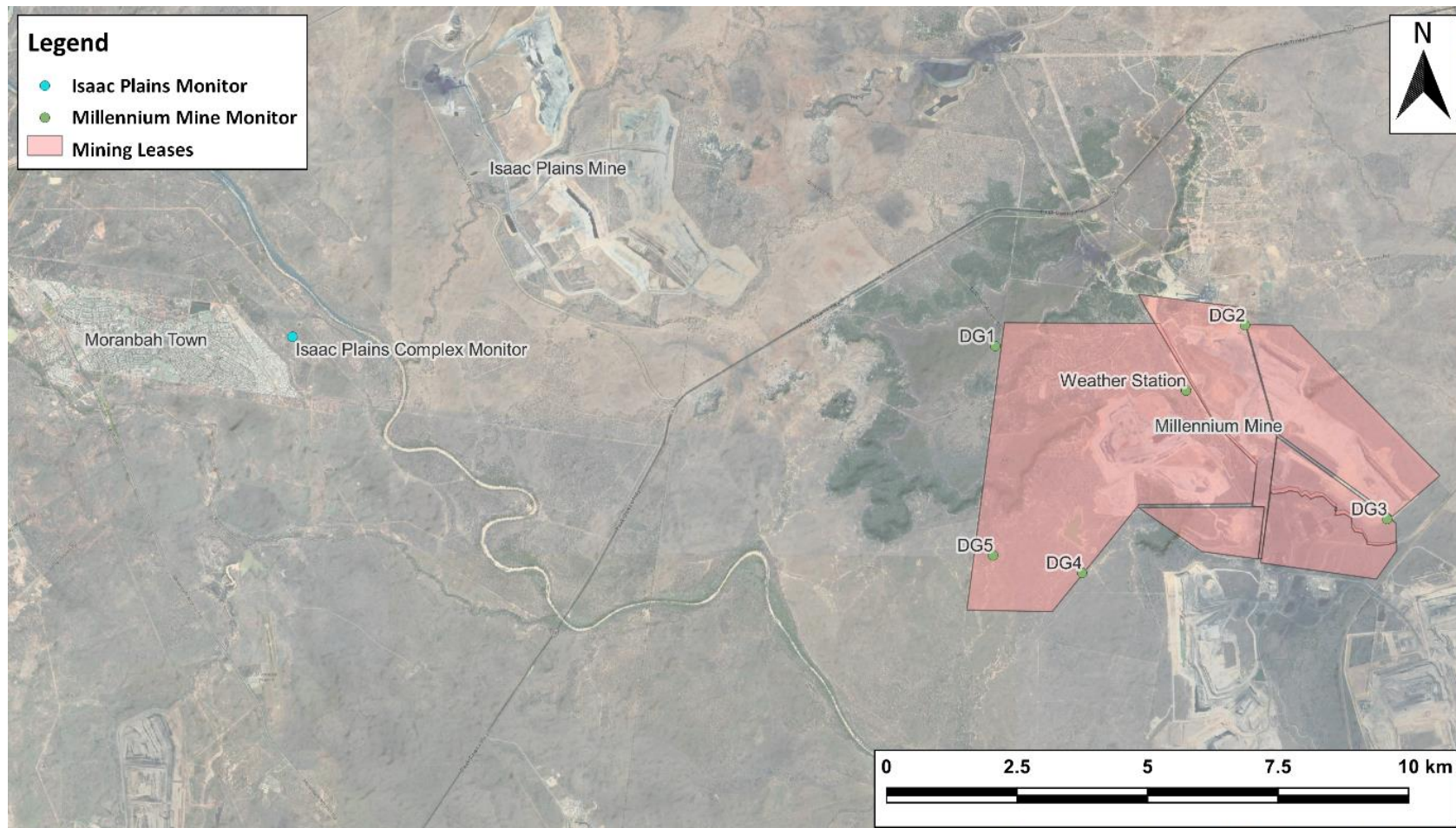


Figure 2 Existing ambient air quality and meteorology monitoring locations

4. EXISTING ENVIRONMENT

4.1 Local terrain and land-use

The Millennium Mine is located approximately 20 kilometres east of Moranbah in the Isaac Regional Shire region of Central Queensland. The region is predominantly rural, with low intensity cattle grazing and coal mining the dominant land uses in the vicinity of the Millennium Mine. The mine is located on the relatively flat plains adjacent (north of) the Isaac River. The terrain of the area is undulating, ranging between an elevation of 200 to 300 metres above sea level. A terrain map is provided in Figure 3.

There are several existing coal mines in close proximity to Millennium Mine, including Isaac Plains, Peak Downs, Caval Ridge, Coppabella, Poitrel, Daunia, Carborough Downs (underground), Moorvale, Goonyella Riverside, and Broadmeadow. The Isaac Plains Mine was not operational during the 2020/2021 financial year and did not report emissions to the NPI for this period; however, the Isaac Downs component was approved for construction and operation in July 2021.

The location of the existing mines and a summary of dust emissions reported from these facilities is provided in Section 4.3.1. The railway spur servicing the Millennium Downs Mine also services Peak Downs Mine, Daunia Mine, and Poitrel Mine, with the spur connecting to the main line and Coppabella approximately 17 kilometres to the northeast of Millennium Mine.

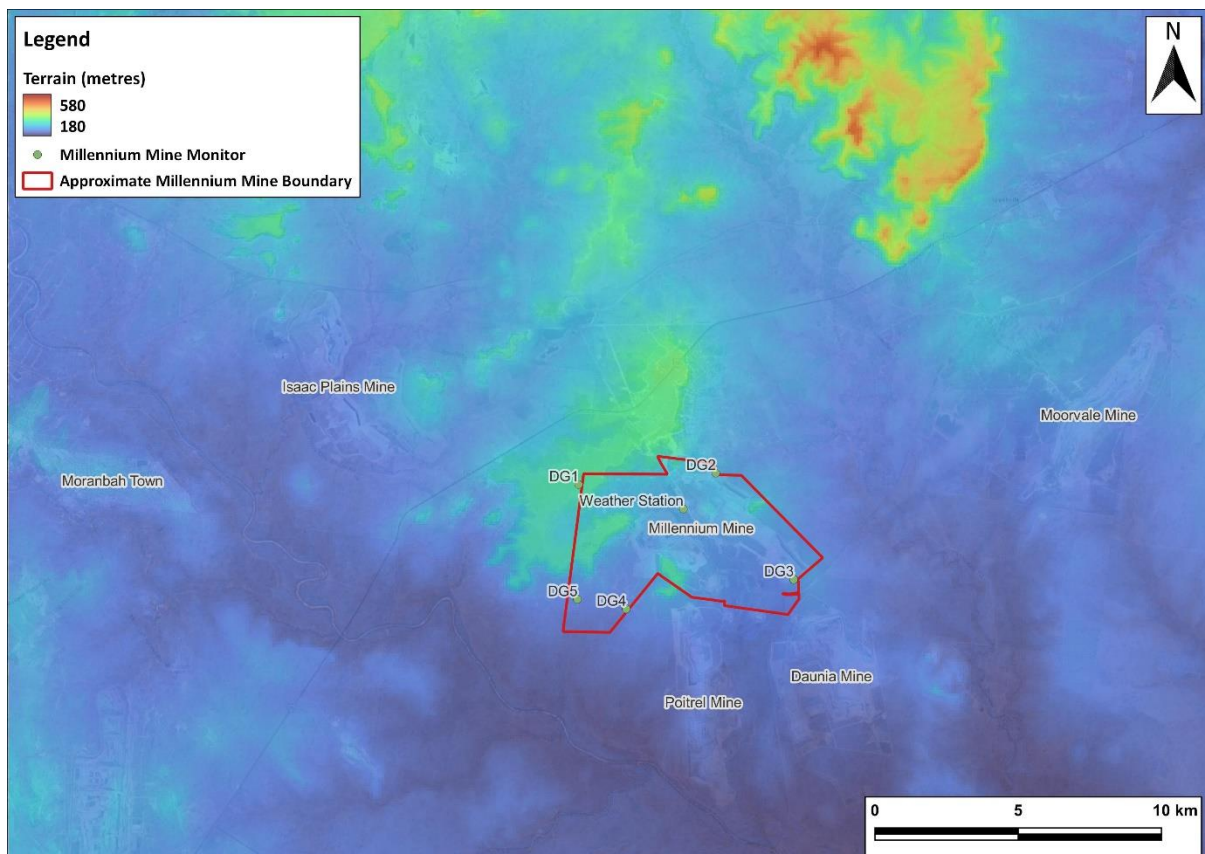


Figure 3 Terrain in the vicinity of Millennium Mine

4.2 Sensitive receptors and predicted air quality impacts

Sensitive receptors in the vicinity of the mine include individual residences or homesteads as well as the towns of Moranbah and Coppabella. These are shown in Table 4 and Figure 4.

The air quality impact assessment conducted for the Project's EIS identified which of these sensitive receptors were most exposed to potential dust impacts from operations at Millennium Mine. These receptors are identified in Table 4, with the distance and direction from the Project determined by Katestone, from the nearest part of the Millennium Mine boundary.

Table 4 Nearest sensitive receptors to the Project

Sensitive Receptor	Description	Distance and direction from the Project
Most affected receptors in Project's EIS		
Annandale	Homestead	6.8 km north-northeast
Moorvale	Homestead	6.3 km north-northeast
Winchester Downs	Homestead	9 km south-southwest
Wotonga	Homestead	4.8 km west
Broadlea	Homestead	7.7 km northwest
Other receptors		
Moranbah	Town	13.8 km west
Coppabella	Town	13.8 km northeast
Wanella	Homestead	15.3 km northeast
Mavis Downs	Homestead	5.7 km east
Daunia	Homestead	8.0 km southeast
Olive Downs	Homestead	9.1 km south-southeast
Coolibah	Homestead	12.0 km southwest
Kurrali Park	Homestead	14.8 km west-southwest
Grosvenor Downs	Homestead	12.8 km west
Moranbah	Homestead	11.1 km west

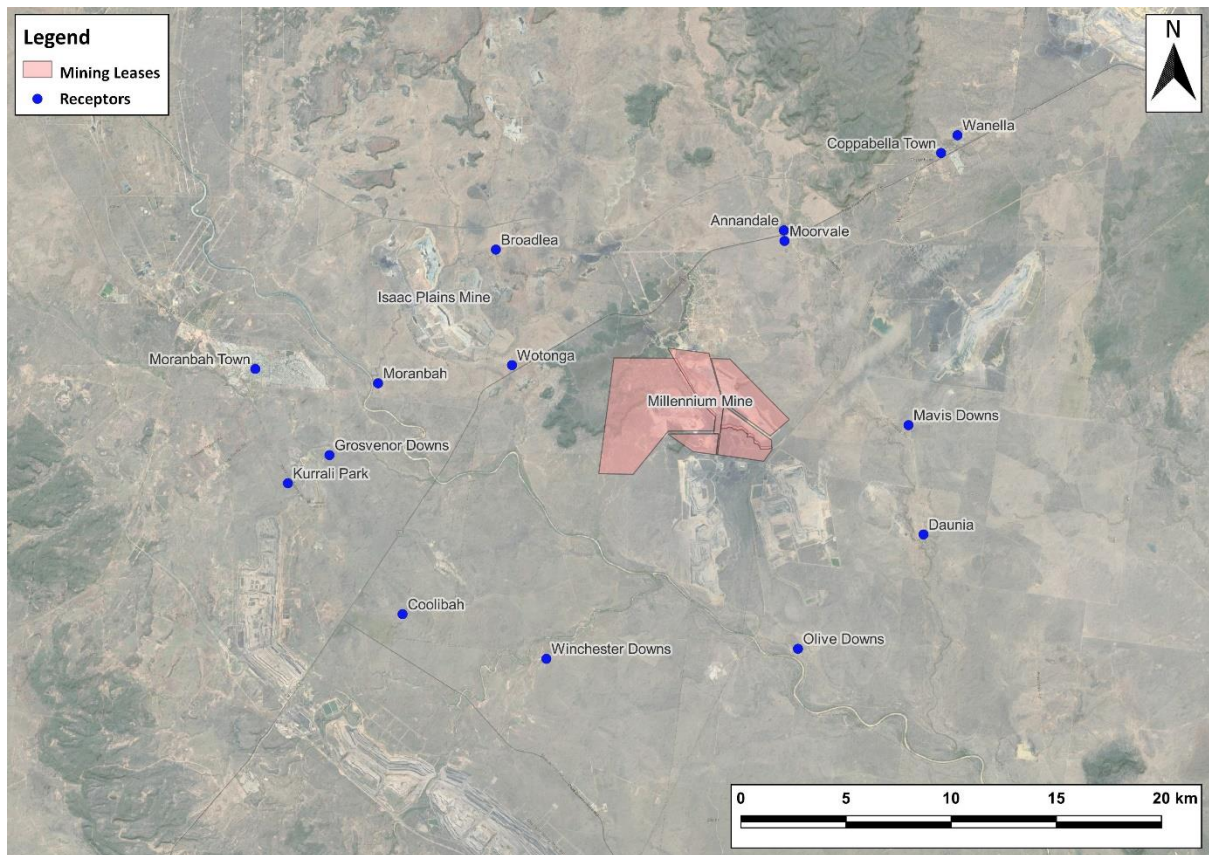


Figure 4 Nearest sensitive receptors to Millennium Coal Mine

4.3 Existing air quality

4.3.1 Existing sources of emissions

In addition to operations at Millennium Coal Mine, ambient dust levels across the rural areas surrounding the mine will be influenced by:

- Operation of other existing coal mines
- Gas production fields
- Natural sources of dust such as wind-blown dust from exposed areas
- Anthropogenic sources of dust within the Moranbah and Coppabella townships such as construction and vehicle activity on unsealed roads

A review of emissions of PM₁₀ and PM_{2.5} reported to the NPI database for the 2020/2021 reporting year identifies 13 facilities reporting particulate emissions within 40 kilometres of the Millennium Mine. These are summarised in Table 5 with the location of each facility shown in Figure 5. The most significant of these is the Peak Downs Coal Mine located to the south.

The Millennium and Isaac Plains Mines did not report emissions of PM₁₀ and PM_{2.5} for the 2020/2021 reporting year.

Table 5 Emissions of PM₁₀ and PM_{2.5} reported to the NPI for the 2020/2021 reporting year

Facility Name	Main activities	Emissions (kg/year)	
		PM ₁₀	PM _{2.5}
Moranbah Operations	Oil and Gas Extraction	9,240	319
Moranbah North	Electricity generation using mineral gas including coal gas	166	166
Carborough Downs Coal Mine	Underground coal mine (development and longwall operations)	1,495,210	4,340
SEI Moranbah Power Station	Burning of coal seam methane to produce electricity	23	23
Daunia Mine	Coal mining	2,150,800	68,970
Poitrel Coal Mine	Coal mining	2,176,640	78,520
Moorvale Coal Mine	Coal mining and coal preparation	3,443,140	47,510
Grosvenor	Electricity generation using mineral gas including coal gas	96	96
Moranbah	Gun cotton manufacturing	10,490	9,670
Caval Ridge Mine	Coal Mining	8,229,060	111,290
Coppabella Coal Mine	Black Coal mining, and processing	8,008,954	74,136
Goonyella Riverside and Broadmeadow Mine	Coal Mining	10,829,850	236,270
Peak Downs Mine	Coal Mining	15,241,800	209,950

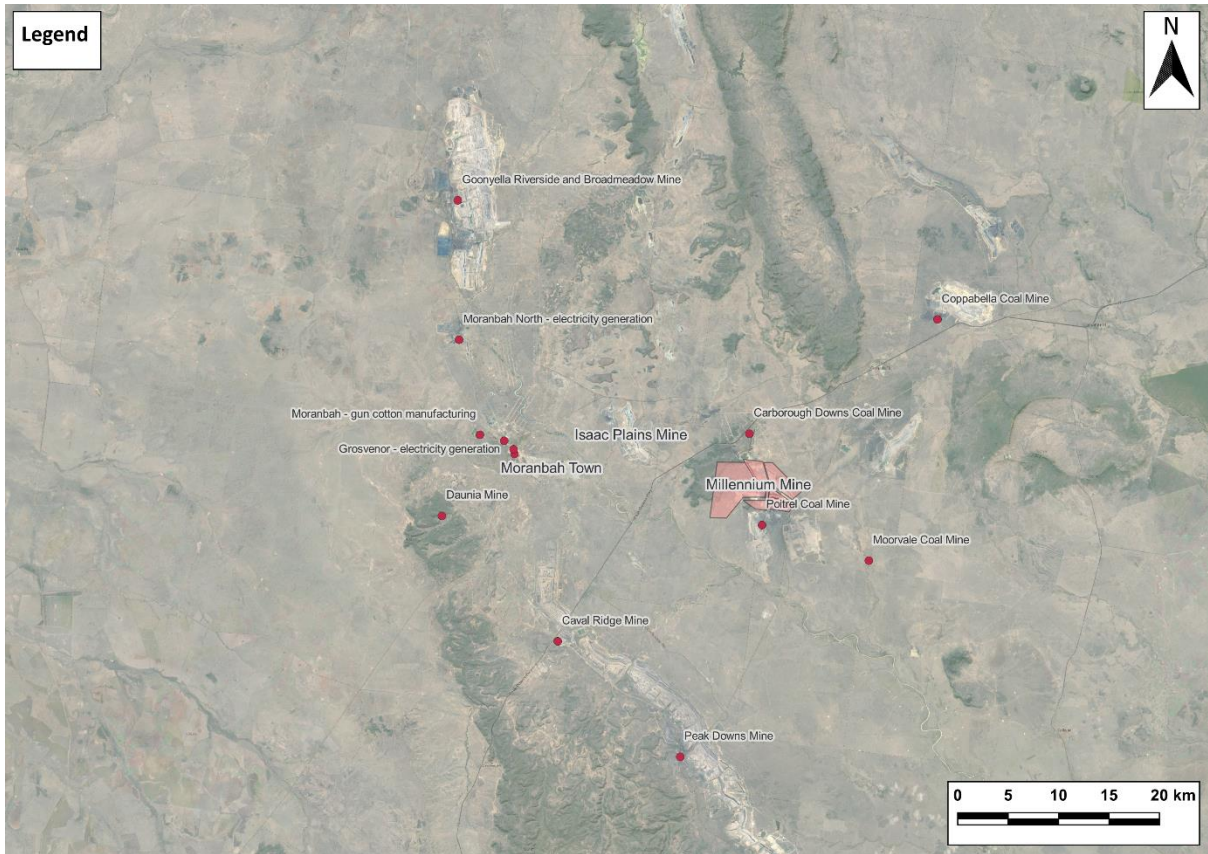


Figure 5 Existing facilities in proximity to Millennium Mine reporting emissions of particulate matter to the NPI for the 2020/2021 reporting year

4.3.2 Existing ambient air quality

4.3.2.1 Dust deposition monitoring

It is beyond the scope of this study to consider dust deposition in detail. However, measured dust deposition rates since February 2020 are summarised in Figure 6. Exceedances of the 120 mg/m²/day criterion have occurred during this period but the monitors are not representative of impacts at a sensitive or commercial place; the nearest sensitive places are further afield where dust deposition rates associated with emissions from Millennium Mine will be lower.

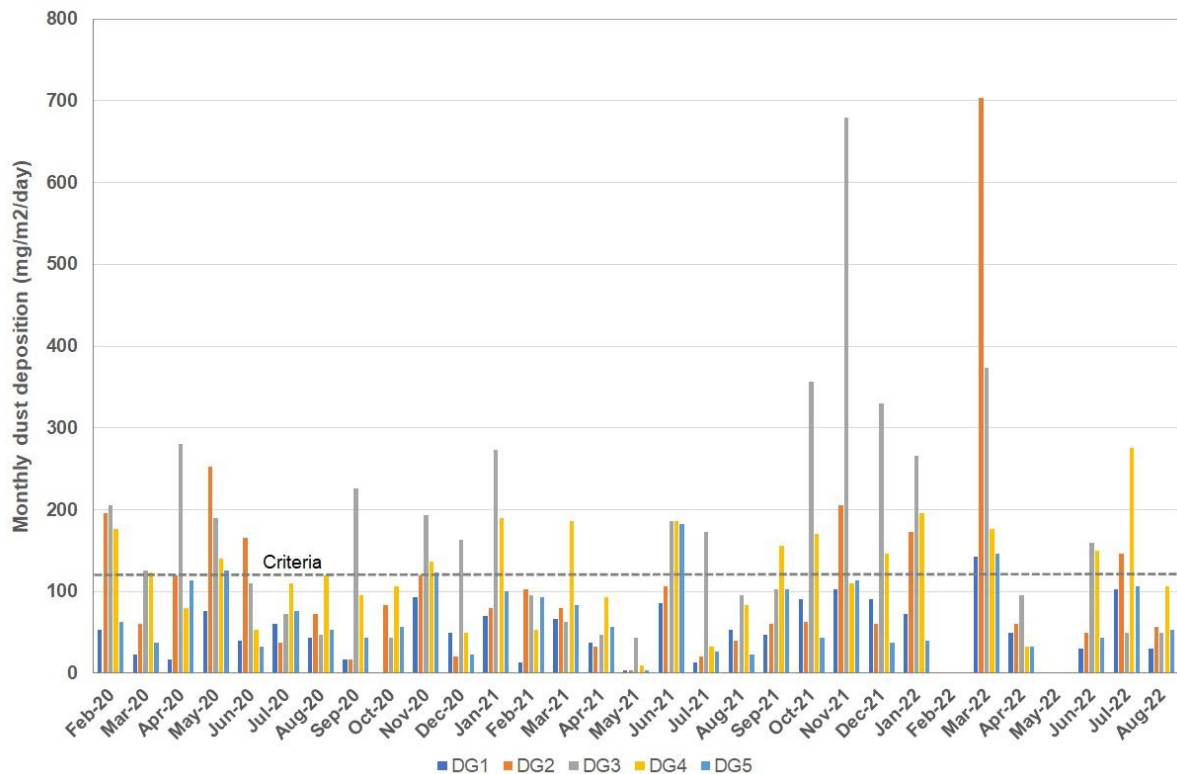


Figure 6 Monthly dust deposition rates (mg/m²/day) across the Millennium Mine dust deposition gauge network

4.3.2.2 Particulate monitoring

Ambient concentrations of particulate matter as PM₁₀ and PM_{2.5} are monitored by the Isaac Complex at a location just beyond the eastern boundary of the Moranbah town (Figure 2). This monitor is to satisfy the requirement for real time monitoring for PM₁₀ and PM_{2.5} at a location between the Isaac Plains Coal Mine and the town of Moranbah as part of the Project's EA. This monitor was located specifically to monitor the impacts from operations at Isaac Plains coal mine on residents at Moranbah and is not representative of impacts from Millennium Mine. Actual impacts from each mine, including Millennium, as well as the contribution from anthropogenic sources of dust, are difficult to establish from the monitoring data at this site. As such, it has not been considered necessary to present data from this site in this report.

DES also currently operates two ambient air quality monitoring stations within Moranbah. The purpose of these two stations, located at Cunningham Way and Utah Drive within the town, is to assess the impact of coal mining operations in the area and monitor air quality for residents at Moranbah. As with the Isaac Complex monitoring site, the actual contribution from Millennium Mine cannot be determined from the data at this site and it has not been included in this report.

4.4 Meteorological monitoring

M Mining conducts meteorological monitoring at a location within the Millennium Mine site boundary (Figure 2), with the site providing continuous measurements of wind speed and wind direction. The data from this site is only available for a short period (15 March 2022 to 12 July 2022) so has not been used to characterise the meteorological conditions for the area for the purposes of the ambient dust monitoring program.

The meteorological conditions for the site have been characterised in the following sections using available short-term monitoring data from the Isaac Complex monitor near Moranbah along with long-term monitoring data from the Bureau of Meteorology site at Moranbah.

Katestone has reviewed the location of the on-site meteorological monitor. Its central location within the mine, in a relatively flat area (see Figure 3), appears sensible and should be representative of general wind conditions across the mine and its surroundings.

4.4.1 Isaac Complex meteorological data

This section provides a summary of the 1-hour wind speed and wind direction data from the Isaac Complex monitor for the twelve-month period from 1 July 2021 to 30 June 2022. This data is presented in the annual, seasonal, and diurnal wind roses provided in Figure 7, Figure 8, and Figure 9, respectively.

The area is characterised by predominant southeasterly winds, with the majority of winds measured at the Isaac Complex site during the twelve-month period observed from the east to southeast direction. The remaining winds are primarily from the northeast to north as well as from the south-southeast and south. Minimal winds were recorded from the southwest and northwest quadrants.

There was minimal seasonal and diurnal variation in the winds measured at the site, with the dominant southeast sector winds occurring across all hours and seasons. The frequency of winds directly from the southeast reduce slightly during the evening (6pm to midnight) as well as during spring, with winds from the east increasing in frequency during these periods.

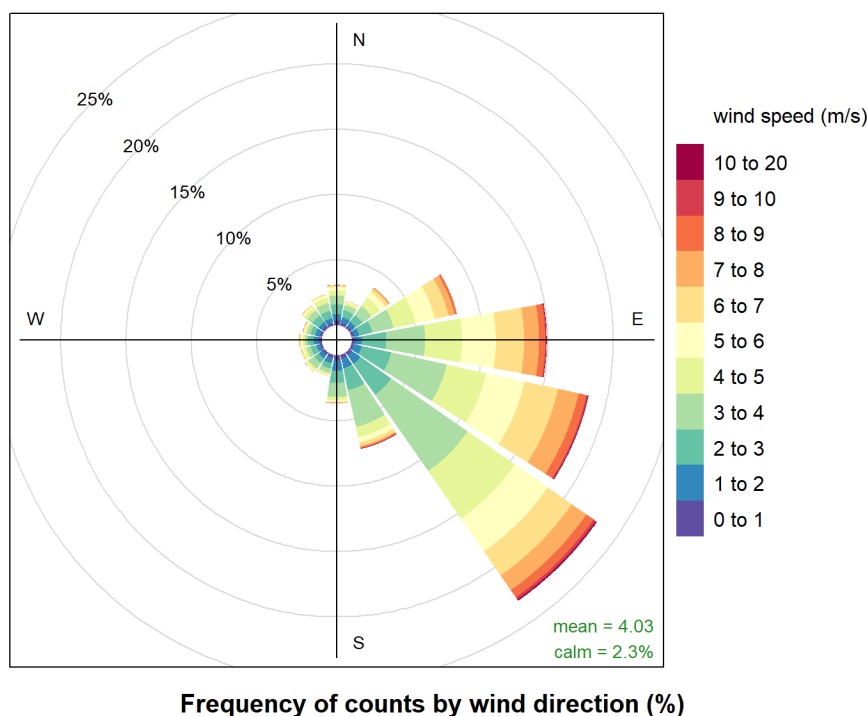
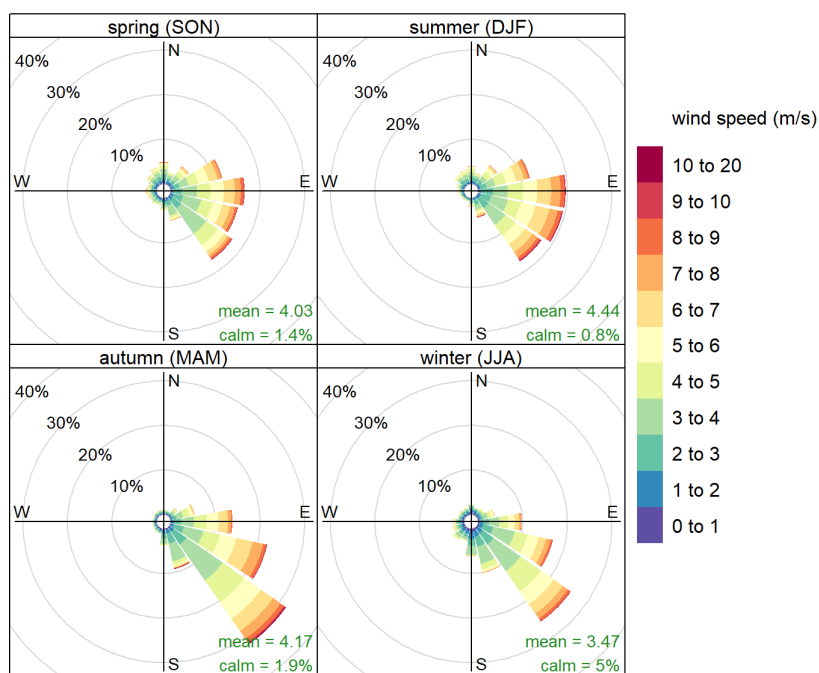
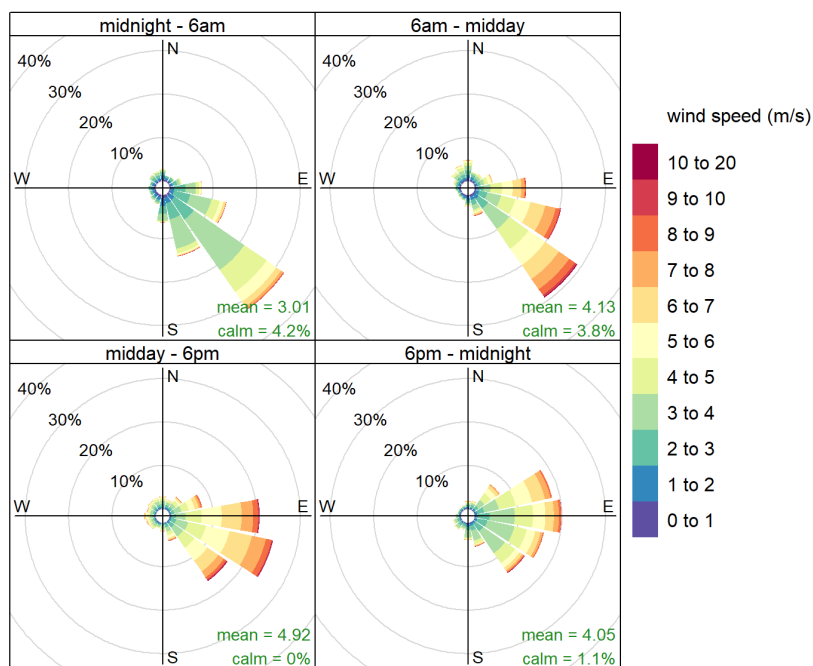


Figure 7 Annual wind rose Isaac Complex Meteorological data (1 July 2021 to 30 June 2022)



Frequency of counts by wind direction (%)

Figure 8 Seasonal wind rose Isaac Complex Meteorological data (1 July 2021 to 30 June 2022)



Frequency of counts by wind direction (%)

Figure 9 Diurnal wind rose Isaac Complex Meteorological data (1 July 2021 to 30 June 2022)

4.4.2 Bureau of Meteorology data at Moranbah

The annual, seasonal, and diurnal distribution of winds measured at the Moranbah Bureau of Meteorology station during the 1 January 2015 to 31 December 2020 period are presented in Figure 10, Figure 11, and Figure 12,

respectively. The longer-term winds at the Bureau of Meteorology site are consistent with those measured at the Isaac Complex site during the July 2021 to June 2022 period (Section 4.4.1). The site is dominated by winds from the southeast sector, with the frequency of winds directly from the southeast slightly higher during autumn and winter, and during the night and early morning (midnight to midday).

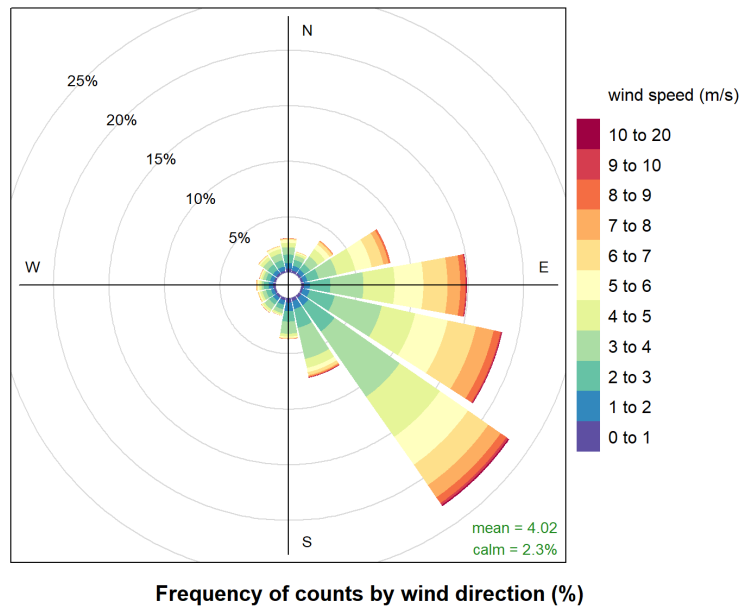


Figure 10 Annual wind rose Bureau of Meteorology at Moranbah (January 2015 to December 2020)

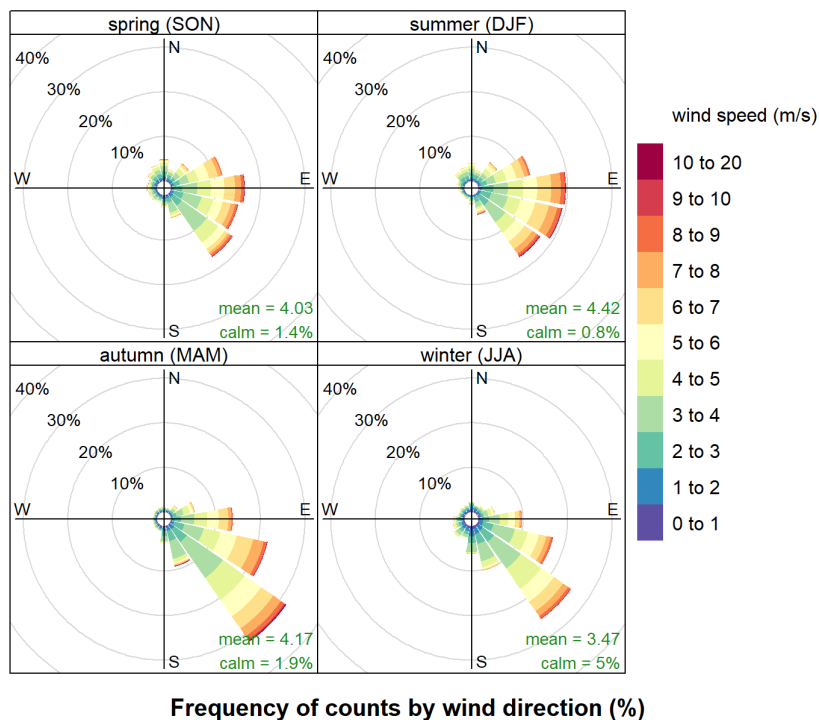
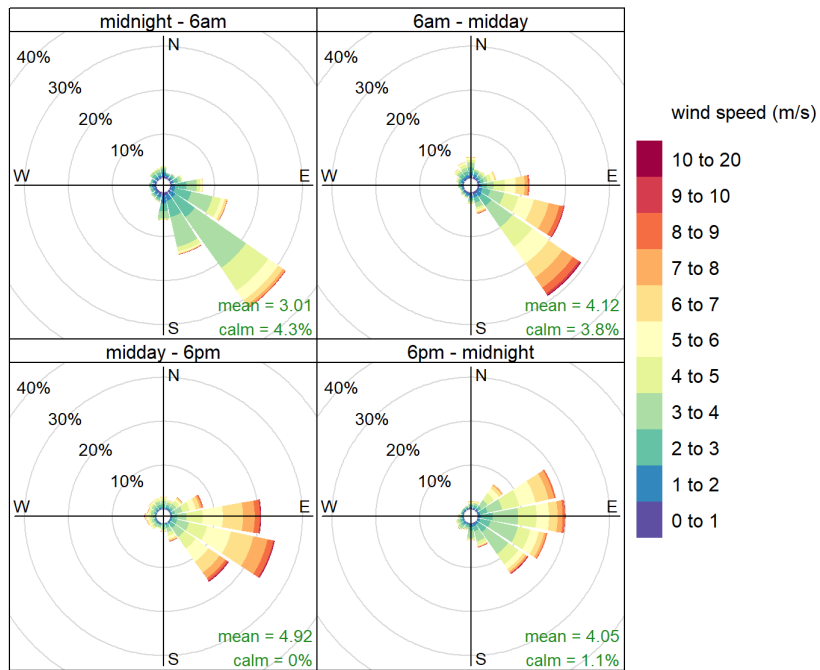


Figure 11 Seasonal wind rose Bureau of Meteorology at Moranbah (January 2015 to December 2020)



Frequency of counts by wind direction (%)

Figure 12 Diurnal wind rose Bureau of Meteorology at Moranbah (January 2015 to December 2020)

5. MONITORING NETWORK DESIGN

5.1 Overview

Considering the existing monitoring program, the proximity and locations of the nearest sensitive receptors, surrounding existing sources of dust and the prevailing southeasterly winds in the region, Katestone recommends the following elements are included in the air quality monitoring program for the Millennium Mine:

- Two ambient air quality monitoring stations measuring PM₁₀ as the most critical dust size fraction:
 - One monitor located to the east-southeast of the mine, upwind under prevailing wind conditions, beyond the site boundary and away from any immediate sources of dust, near to the nearest sensitive receptor in this direction
 - One monitor located to the west-northwest of the mine, downwind under prevailing wind conditions, beyond the site boundary and away from any immediate sources of dust, near to the nearest sensitive receptor in this direction
- Continuation of the onsite meteorological station
- Continuation of the five existing dust deposition gauges

The use of two ambient air quality monitoring stations measuring PM₁₀ along with continuous measurements of wind speed and wind direction will enable the contribution of operations at Millennium Mine to be determined to a reasonable level of accuracy. When one monitor is downwind of operations at Millennium Mine, the other will be upwind, so by subtracting the upwind measurement from the downwind measurement the contribution of Millennium Mine to concentrations at the downwind monitor (which will be representative of the nearest sensitive receptor) can be estimated. See section 5.2 (specifically Figure 14) for further details on this approach.

As described in Section 2.2, when it comes to automatic particulate monitoring, modern EA licence conditions typically only require the monitoring of PM₁₀ to assess compliance of project operations with air quality limits, and this is by far the most relevant size fraction of suspended particulates to focus upon. PM₁₀ monitoring is also all that Millennium Mine's EA specifically requires. Katestone considers it appropriate for the automatic monitoring network to focus on PM₁₀ alone and that monitoring of TSP and PM_{2.5} is unnecessary; mention of these particulate size fractions can be removed from the EA when next reviewed.

The ability to infer the contribution of Millennium Mine operations to ambient dust levels using the data from the ambient PM₁₀ monitoring stations is dependent on the validity of the wind speed and wind direction data measured at the onsite meteorological monitoring station. It is therefore critical that this site is located, operated, and maintained according to standard.

5.2 Monitoring locations

The recommended locations for the ambient PM₁₀ monitoring stations are shown in Figure 13. The locations shown in Figure 13 are recommendations and the final locations will necessarily be dependent on site access, security, land ownership, and potentially the availability of electricity. The upwind (under prevailing southeasterly winds) site is recommended to be located within a short distance to the west of the Mavis Downs receptor (approximately 638908 easting and 7563767 northing), while the downwind (under prevailing southeasterly winds) site is recommended to be located southeast of the Wotonga receptor on the opposite side of Peak Downs Highway (approximately 620880 easting and 7566605 northing).

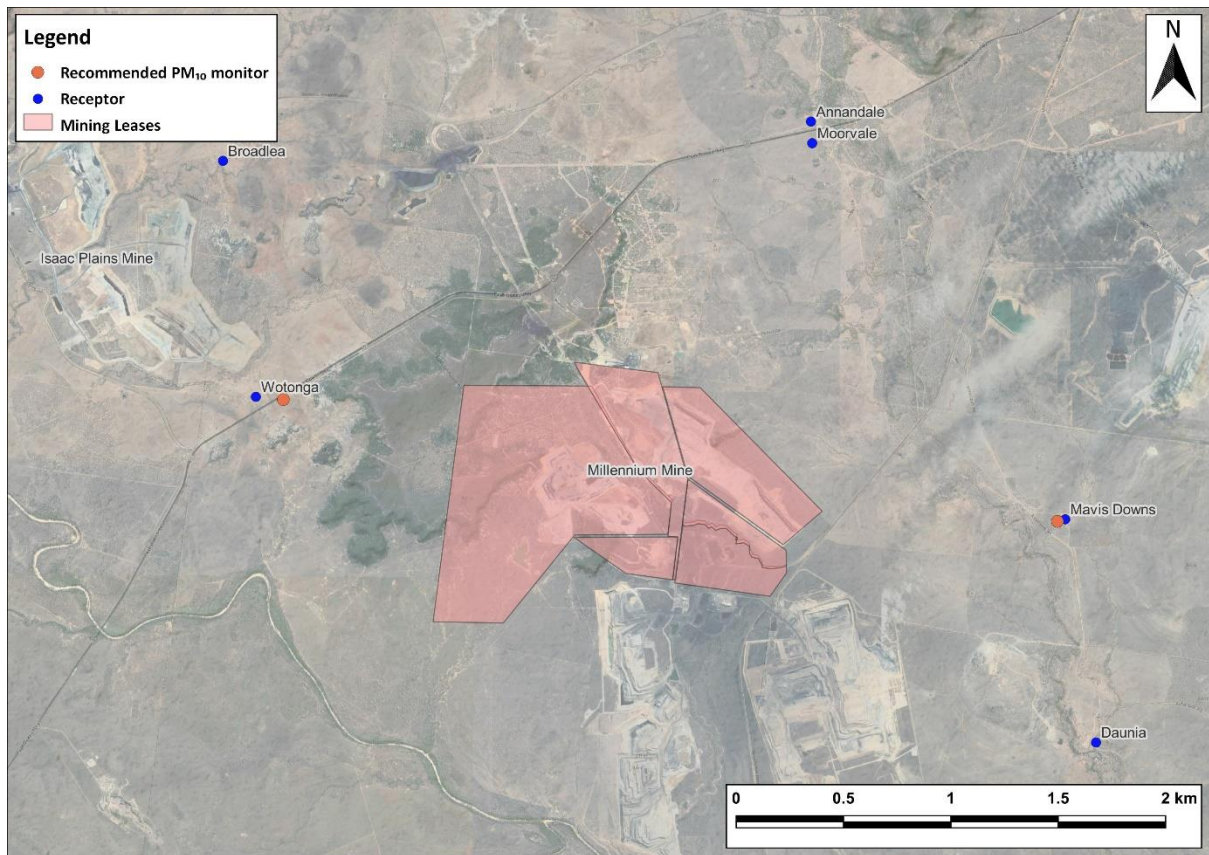


Figure 13 Recommended PM₁₀ monitoring locations

Figure 14 shows the arcs of influence at each of the proposed monitoring locations that could be used to estimate the contribution of Millennium Mine to measured PM₁₀ concentrations:

- At the proposed monitor to the west of the mine, under winds from between 88° and 115°, the monitor will be downwind of the bulk of Millennium Mine while not being downwind of a significant portion of any other nearby mining activities. The proposed monitor to the east of the mine will also not be downwind of any nearby mining activities that the western monitor is not also downwind of, thus it will represent a suitable background under these wind directions. Subtracting the concentration at the eastern monitor from that at the western monitor under these wind directions should give a good approximation of the contribution of operations at Millennium Mine to concentrations at the nearest sensitive receptor in this direction (Wotonga).
- At the proposed monitor to the east of the mine, under winds from between 255° and 290° (which it must be noted are very uncommon), the monitor will be downwind of the bulk of Millennium Mine while not being downwind of a significant portion of any other nearby mining activities that the proposed monitor to the west of the mine is not also downwind of. The western monitor will thus represent a suitable background under these wind directions. Subtracting the concentration at the western monitor from that at the eastern monitor under these wind directions should give a good approximation of the contribution of operations at Millennium Mine to concentrations at the nearest sensitive receptor in this direction (Mavis Downs).

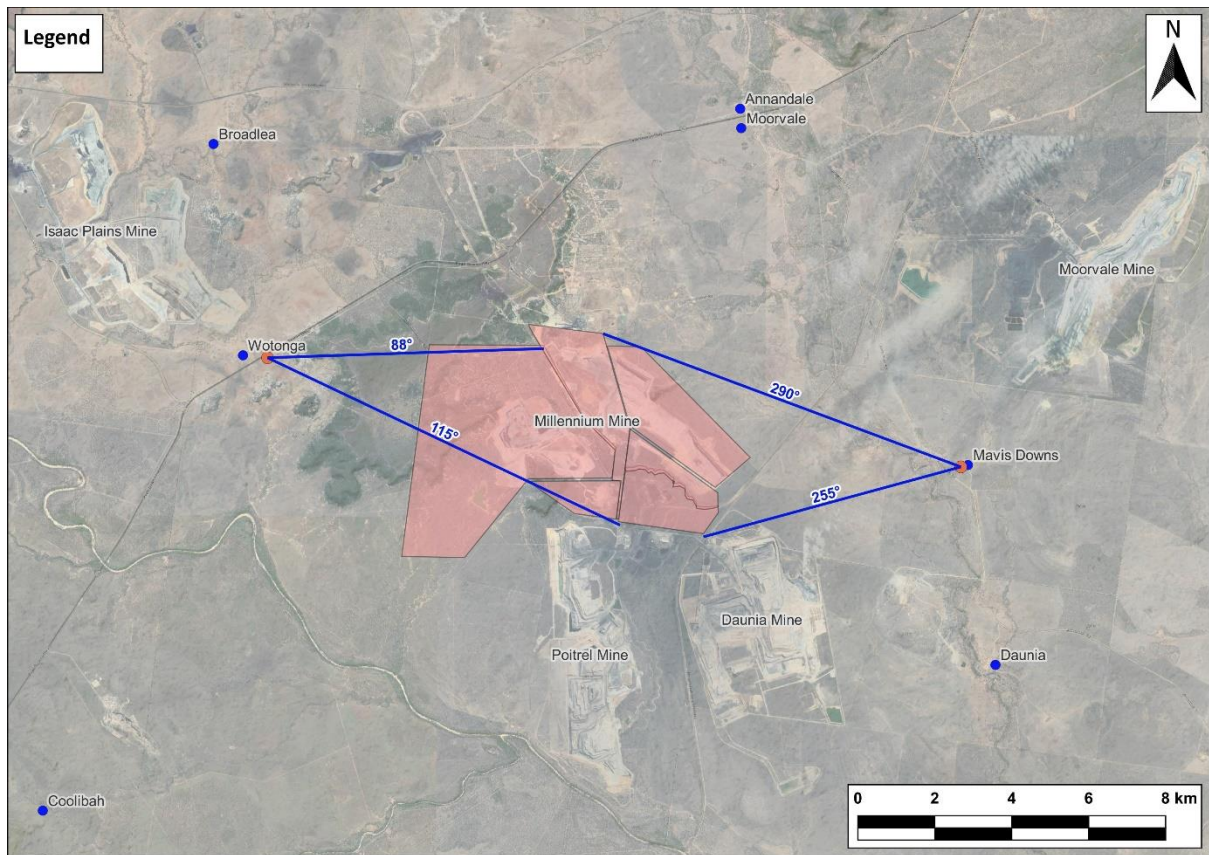


Figure 14 Arcs of influence at recommended PM₁₀ monitoring locations

5.3 Equipment

5.3.1 PM₁₀

There are a wide range of monitors available that can measure PM₁₀ concentrations in ambient air. Millennium Mine's EA prescribes monitoring by HVAS or TEOM, but Katestone understands that M Mining's preference is to use a BAM. BAMs conform to an Australian Standard for PM₁₀ measurement (AS3580.9.11) and are, therefore, appropriate for meeting the requirements of the EA. They can be powered either via mains power or solar power, unlike TEOMs which require mains power. BAMs are generally very reliable and have much less intensive maintenance requirements compared to TEOMS. These instruments measure hourly concentrations and, therefore, can inform management practices. The high data resolution means that it is easier to identify sources of elevated dust concentrations when combined with meteorological data and that these monitors can be used to inform management strategies regarding dust mitigation and the data can be incorporated into Trigger Action Response Plans.

Katestone considers there to be no legitimate reason why BAMs should not be used in place of TEOM or HVAS.

5.3.2 Dust deposition

M Mining currently monitors dust deposition at five locations beyond the mine boundary in accordance with the Australian Standard AS 3580.10.1 *Methods for sampling and analysis of ambient air – Determination of particulates – Deposited matter – Gravimetric method*. This approach is appropriate and should be maintained.

5.3.3 Meteorological monitoring

M Mining currently monitors meteorological parameters in accordance with Australian Standard AS 3580.14; Katestone recommends this approach be maintained.

6. RELEVANT MONITORING STANDARDS

The Australian Standards that are relevant to the siting and conduct of the monitoring for particulate matter and meteorology are specified in Table 6.

Table 6 Australian Standards that are relevant to ambient air quality monitoring and meteorology

Pollutant	Australian Standard
Siting	AS/NZS 3580.1.1:2016 - Methods for sampling and analysis of ambient air - Guide to siting air monitoring equipment
Dust deposition rate	AS/NZS 3580.10.1:2003 - Methods for sampling and analysis of ambient air - Determination of particulate matter - Deposited matter - Gravimetric method
PM ₁₀	AS/NZS 3580.9.6:2015 - Methods for sampling and analysis of ambient air - Determination of suspended particulate matter - PM ₁₀ high volume sampler with size-selective inlet - Gravimetric method; or equivalent AS/NZS 3580.9.9:2017 - Methods for sampling and analysis of ambient air - Determination of suspended particulate matter - PM ₁₀ low volume sampler - Gravimetric method AS/NZS 3580.9.11:2016 - Methods for sampling and analysis of ambient air - Determination of suspended particulate matter - PM ₁₀ beta attenuation monitors AS/NZS 3580 9.16:2016 - Methods for sampling and analysis of ambient air - Determination of suspended particulate matter - PM ₁₀ continuous direct mass method using a tapered element oscillating microbalance (TEOM) monitor incorporation a filter dynamic measurement system (FDMS) unit
Weather monitoring equipment	Australian Standard AS 3580.14 - Methods for sampling and analysis of ambient air – Meteorological monitoring for ambient air quality monitoring applications

7. REFERENCES

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